



STUDENT HAND BOOK

Polytechnic

Semester- 5th

Study Scheme- 2010 onwards

DEPARTMENT OF MECHANICAL ENGINEERING

ASRA COLLEGE OF ENGINEERING & TECHNOLOGY

BHAWANIGARH (SANGRUR)

Department of Mechanical Engineering

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Syllabus

5.1 PRODUCTION MANAGEMENT

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DETAILED CONTENTS.

1. Production Planning and Control (PPC) (06 hrs)

1.1 Introduction.

1.2. Objectives and factors affecting PPC

1.3. Functions (Elements) of PPC - Planning, Routing, Loading, scheduling, dispatching, progressing and inspection

1.4. Types of production system - Flow or continuous production, Intermittent Production

1.5. Production Control - Objectives and fields of production control, Production control system

1.6 Break even analysis and Gantt chart.

2. Plant Location, Layout and Material Handling (12 hrs)

2.1 Definition and Factors affecting the plant location, Rural versus Urban Plant sites.

2.2 Definition and importance of Plant layout, Factors affecting plant layout.

2.3 Types of Plant layout- Process, product, combination and fixed position layout.

2.4 Methods of plant layout - Process flow charts, layout analogues Travel chart, distance, volume matrix.

2.5. Plant layout procedure and work station design.

2.6. Material Handling- Definition, Significance and objectives of material handling, Principles of economic material handling,. Types of material handling equipment - Characteristics and classification of material handling equipment, Hoisting and conveying equipment (different types), Safety requirements while using material handling equipment

3. Work Study (12 hrs)

3.1 Production System and Productivity (Introduction and definitions), Difference between Production and productivity, Measures to improve productivity

3.2 Definition, advantages and procedure of work study

3.3 Method study – Definition, Objectives and Procedures, Process chart symbols, outline process chart, Flow process charts, Two handed processes charts, Multiple activity chart (Mn-Machine charts), Flow diagram, string diagram.

3.4 Principles of motion economy, Therblig symbols, SIMO chart.

3.5. Work Measurement :- Definition and objective, Work measurement technique, Time Study- Definition, objectives and procedure, Calculation of basic time, performance rating and its techniques, normal time, allowance and its types, standard time (simple numerical problems)

4. Inventory Control (10 hrs)

4.1 Definition and objectives of inventory control.

4.2 Inventory types

4.3 Procurement and carrying cost, EOQ, lead time, reorder point (simple numerical problems)

4.4 Inventory Classification - ABC Analysis, VED Analysis, FMS Analysis

4.5 Standardization and Codification - Objective and advantages of standardization, Levels and types of standards, .Objective and advantages of codes. Coding systems-. National and International Codes, ISO-9000 Concept and Evolution

4.6. Concept of Just-In-Time (JIT)

5. Repair and Maintenance (06 hrs)

5.1. Objectives and importance of Maintenance

5.2. Different types of maintenance- Corrective or Breakdown maintenance, Scheduled Maintenance, Preventive Maintenance, Predictive Maintenance

5.3. Nature of maintenance problems

5.4. Range of maintenance problems

6. Value Engineering (04 hrs)

6.1. Introduction, Concept

6.2. Objectives of value engineering

6.3. Value Analysis Procedures

6.4. Benefits of value analysis

6.5. Technique of value engineering

7. Cost Estimation and Control: (14 hrs)

7.1 Definition and functions of cost estimation

7.2 Estimation procedure

7.3 Elements of cost, ladder of costs (simple numericals)

7.4 Overhead expenses and its distribution

7.5 Depreciation -: Concept and Definition, Methods of calculating depreciation, .Straight line method, Diminishing Balance Method, Sinking fund method (Numerical problems).

7.6 Cost control- definition and objectives, Capital cost control (planning and scheduling), operating cost control.

7.7. Cost estimation for machining processes like turning, drilling, and milling. Cost estimation of forming processes like forging, pattern making, and casting.

5.2. REFRIGERATION AND AIR CONDITIONING

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DETAILED CONTENTS

REFRIGERATION

1. Fundamentals of Refrigeration (02 hrs)

Introduction to refrigeration, and air conditioning, meaning of refrigerating effect, units of refrigeration, COP, difference between COP and efficiency, methods of refrigeration, Natural system and artificial system.

2. Vapour Compression System (12 hrs)

Introduction, principle, function, parts and necessity of vapour compression system, T- ϕ and p-H charts, dry, wet and superheated compression. Effect of sub cooling, super heating, mass flow

rate, entropy, enthalpy, work done, Refrigerating effect and COP. actual vapour compression system

3. Refrigerants (04 hrs)

Functions, classification of refrigerants, properties of R - 717, R – 22, R–134 (a), CO₂, R – 11, R – 12, R – 502, Properties of ideal refrigerant, selection of refrigerant

4. Air Refrigeration System (08 hrs)

Introduction, advantages and disadvantages of air-refrigeration system over vapour compression system, bell – Collemann cycle, calculation of mass flow rate, work done and COP

5. Vapour Absorption System (06 hrs)

Introduction, principle and working of simple absorption system and domestic electrolux refrigeration systems. Solar power refrigeration system, advantages and disadvantages of solar power refrigeration system over vapour compression system.,

6. Refrigeration Equipment (12 hrs)

6.1 Compressors- Function, various types of compressors

6.2 Condensers - Function, various types of condensers

6.3 Evaporators- Function, types of evaporators

6.4 Expansion Valves - Function, various types such as capillary tube, thermostatic expansion valve, low side and high side float valves, application of various expansion valves

6.5. Safety Devices-Thermostat, overload protector LP, HP cut out switch.

AIR CONDITIONING

7. Psychrometry (08 hrs)

Definition, importance, specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, sensible heat, latent heat, Total enthalpy of air.

8. Applied Psychrometry and Heat Load Estimation. (12 hrs)

Psychrometric chart, various lines, psychrometric process, by pass factor, room sensible heat factor, effective room sensible heat factor, grand sensible heat factor, ADP, room DPT.

Heating and humidification, cooling and dehumidification, window airconditioning, split type air-conditioning, car air-conditioning, central airconditioning.

LIST OF PRACTICALS

1. Identify various tools of refrigeration kit and practice in cutting, bending, flaring, swaging and brazing of tubes.

2. Study of thermostatic switch, LP/HP cut out overload protector filters, strainers and filter driers.

3. Identify various parts of a refrigerator and window air conditioner.

4. To find COP of Refrigeration system

5. To detect trouble/faults in a refrigerator/window type air conditioner

6. Charging of a refrigerator/ window type air conditioner.

7. Disassembly and assembly of single cylinder open type compressor

8. Visit to an ice plant or cold storage plant or central air conditioning plant

5.3 THERMODYNAMICS-II

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DETAILED CONTENTS

1. IC Engines (09 hrs)

1.1 Introduction

1.2 Working principle of two stroke and four stroke cycle, SI engines and CI engines, Otto cycle, diesel cycle and dual cycle

1.3 Location and functions of various parts of IC engines and materials used for them

2. Fuel Supply and Ignition System in Petrol Engine (08 hrs)

2.1 Concept of carburetion

2.2 Air fuel ratio

2.3 Simple carburetor and its application

2.4 Description of battery coil and magneto ignition system, fault finding and remedial action in ignition system

3. Fuel System of Diesel Engine (06 hrs)

3.1 Components of fuel system

3.2 Description and working of fuel feed pump

3.3 Fuel injection pump

3.4 Injectors

4. Cooling and Lubrication (10 hrs)

4.1 Function of cooling system in IC engine

4.2 Air cooling and water cooling system, use of thermostat, radiator and forced circulation in water cooling (description with line diagram)

4.3 Function of lubrication

4.4 Types and properties of lubricant

4.5 Lubrication system of engine

4.6 Fault finding in cooling and lubrication and remedial action

5. Testing of IC Engines (09 hrs)

5.1 Engine power - indicated and brake power

5.2 Efficiency - mechanical, thermal, relative and volumetric

5.3 Methods of finding indicated and brake power

5.4 Morse test for petrol engine

5.5 Heat balance sheet

5.6 Concept of pollutants in SI and CI engines, pollution control, norms for two or four wheelers - EURO - 1, EURO - 2, methods of reducing pollution in IC engines, alternative fuels like CNG, LPG, Hydrogen

6. Steam Turbines and Steam Condensers (10 hrs)

- 6.1 Function and use of steam turbine
- 6.2 Steam nozzles - types and applications
- 6.3 Steam turbines - impulse, reaction, simple and compound, construction and working principle
- 6.4 Governing of steam turbines
- 6.5 Function of a steam condenser, elements of condensing plant
- 6.6 Classification - jet condenser, surface condenser
- 6.7 Cooling pond and cooling towers

7. Gas Turbines and Jet Propulsion (12 hrs)

- 7.1 Classification, open cycle gas turbine and closed cycle gas turbine, comparison of gas turbines with reciprocating IC engines, applications and limitations of gas turbine
- 7.2 Open cycle constant pressure gas turbines - general layout, PV and TS diagram and working of gas turbine
- 7.3 Closed cycle gas turbines, PV and TS diagram and working
- 7.4 Principle of operation of ram-jet engine and turbo jet engine – application of jet engines
- 7.5 Rocket engine - its principle of working and applications
- 7.6 Fuels used in jet propulsion

LIST OF PRACTICALS

1. Dismantle a two stroke engine, note the function and material of each part, reassemble the engine.
2. Dismantle a single cylinder diesel engine. Note the function of each part, reassemble the engine.
3. Dismantle Solex, Amal carburetor, locate and note down the functions of various parts, and re-assemble.
4. Study of battery ignition system of a multi-cylinder petrol engine stressing ignition timings, setting, fixing order and contact breaker; gap adjustment.
5. Study of cooling of IC engine.
6. Study of lubricating system of IC engine.
7. Determination of BHP by dynamometer.
8. Morse test on multi-cylinder petrol engine.
9. Local visit to roadways or private automobile workshops.
10. Study of steam turbines through models and visit.
11. Study of steam condensers through model and visits.

5.4 WORKSHOP TECHNOLOGY - III

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DETAILED CONTENTS

1. Milling (18 hrs)

- 1.1 Specification and working principle of milling machine
- 1.2 Classification, brief description and applications of milling machines
- 1.3 Details of column and knee type milling machine

- 1.4 Milling machine accessories and attachment – Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment
- 1.5 Milling methods - up milling and down milling
- 1.6 Identification of different milling cutters and work mandrels
- 1.7 Work holding devices
- 1.8 Milling operations – face milling, angular milling, form milling, straddle milling and gang milling.
- 1.9 Cutting speed and feed, simple numerical problems.
- 1.10 Indexing on dividing heads, plain and universal dividing heads.
- 1.11 Indexing methods: direct, Plain or simple, compound, differential and angular indexing, numerical problems on indexing.
- 1.12 Thread milling

2 Grinding (14 hrs)

- 2.1 Purpose of grinding
- 2.2 Various elements of grinding wheel – Abrasive, Grade, structure, Bond
- 2.3 Common wheel shapes and types of wheel – built up wheels, mounted wheels and diamond wheels. Specification of grinding wheels as per BIS.
- 2.4 Truing, dressing, balancing and mounting of wheel.
- 2.5 Grinding methods – Surface grinding, cylindrical grinding and centreless grinding.
- 2.6 Grinding machine – Cylindrical grinder, surface grinder, internal grinder, centreless grinder, tool and cutter grinder.
- 2.7 Selection of grinding wheel
- 2.8 Thread grinding.

3. Gear Manufacturing and Finishing Processes (08 hrs)

- 3.1 Gear hobbing
- 3.2 Gear shaping
- 3.3 Gear finishing processes

4. Modern Machining Processes (08 hrs)

- 4.1 Mechanical Process - Ultrasonic machining (USM): Introduction, principle, process, advantages and limitations, applications
- 4.2 Electro Chemical Processes - Electro chemical machining (ECM) –Fundamental principle, process, applications, Electro chemical Grinding (ECG) – Fundamental principle, process, application
- 4.3 Electrical Discharge Machining (EDM) - Introduction, basic EDM circuit, Principle, metal removing rate, dielectric fluid, applications
- 4.4 Laser beam machining (LBM) – Introduction, machining process and applications
- 4.5 Electro beam machining (EBM)- Introduction, principle, process and applications
- 4.6 Plasma arc machining (PAM) and welding – Introduction, principle process and applications

5. Metallic Coating Processes (08 hrs)

- 5.1 Metal spraying – Wire process, powder process, applications
- 5.2 Electro plating, anodizing and galvanizing
- 5.3 Organic Coatings- oil base paint, rubber base coating

6. Metal Finishing Processes (08 hrs)

- 6.1 Purpose of finishing surfaces.
- 6.2 Surface roughness-Definition and units
- 6.3 Honing Process, its applications
- 6.4 Description of hones.
- 6.5 Brief idea of honing machines.
- 6.6 Lapping process, its applications.
- 6.7 Description of lapping compounds and tools.
- 6.8 Brief idea of lapping machines.
- 6.9 Super finishing process, its applications.
- 6.10 Use of super finishing attachment on center lathe.
- 6.11 Polishing
- 6.12 Buffing.

PRACTICAL EXERCISES

Advance Turning Shop

1. Exercise of boring with the help of boring bar
2. Exercises on internal turning on lathe machine
3. Exercises on internal threading on lathe machine
4. Exercises on external turning on lathe machine
5. Resharpener of single point cutting tool with given geometry

Machine Shop

1. Produce a rectangular block by facing on a slotting machine
2. Produce a rectangular slot on one face with a slotting cutter
3. Produce a rectangular block using a milling machine with a side and face cutter
4. Prepare a slot on one face using milling machine
5. Job on grinding machine using a surface grinder
6. Prepare a job on cylindrical grinding machine.
7. Exercise on milling machine with the help of a form cutter
8. Exercise on milling machine to produce a spur gear
9. Grinding a drill-bit on tool and cutter grinder
10. Exercise on dressing a grinding wheel

5.5 THEORY OF MACHINES

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DETAILED CONTENTS

THEORY

1. Simple Mechanisms (06 hrs)

- 1.1 Introduction to link, kinematic pair, lower and higher pair, Kinematic chain, mechanism, Inversions.
- 1.2 Different types of mechanisms (with examples)

2. Friction (10 hrs)

- 2.1 Definition and its necessity
- 2.2 Horizontal force required to move a body on an inclined plane both upward and downward
- 2.3 Frictional torque in screws, both for square and V threads
- 2.4 Screw jack (Derivation and Numericals)
- 2.5 Different types of bearings and their application

3. Power Transmission (14 hrs)

- 3.1 Introduction to Belt and Rope drives
- 3.2 Types of belt drives and types of pulleys
- 3.3 Concept of velocity ratio, slip and creep; crowning of pulleys (simple numericals)
- 3.4 Flat and V belt drive: Ratio of driving tensions, power transmitted, centrifugal tension, and condition for maximum horse power (simple numericals)
- 3.5 Different types of chains and their terminology
- 3.6 Gear terminology, types of gears and their applications; simple and compound gear trains; power transmitted by simple spur gear

4. Flywheel (08 hrs)

- 4.1 Principle and applications of flywheel
- 4.2 Turning - moment diagram of flywheel for different engines
- 4.3 Fluctuation of speed and fluctuation of energy - Concept only
- 4.4 Coefficient of fluctuation of speed and coefficient of fluctuation of energy

5. Governor (10 hrs)

- 5.1 Principal of governor
- 5.2 Simple description and working of Watt, Porter and Hartnel governor (simple numerical based on watt and porter governor)
- 5.3 Hunting, isochronism, stability, sensitiveness of a governor

6. Balancing (06 hrs)

- 6.1 Concept of balancing
- 6.2 Introduction to balancing of rotating masses (simple numericals)

7. Vibrations (10 hrs)

- 7.1 Types-longitudinal, transverse and torsional vibrations (simple numericals)
- 7.2 Dampening of vibrations
- 7.3 Causes of vibrations in machines, their harmful effects and remedies

5.6 COMPUTER AIDED DRAFTING

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1. Introduction to AutoCAD commands (6 drawing sheets)

- 1.1 Concept of AutoCAD, Tool bars in Auto CAD, coordinate system, snap, grid, and ortho mode (Absolute, Relative and Polar)
- 1.2 Drawing commands – point, line, arc, circle, ellipse,
- 1.3 Editing commands – scale, erase, copy, stretch, lengthen and explode.

- 1.4 Dimensioning and placing text in drawing area
- 1.5 Sectioning and hatching
- 1.6 Inquiry for different parameters of drawing entity

2. Detail and assembly drawing of the following using AUTOCAD (4 sheets)

- 2.1 Plummer Block
- 2.2 Wall Bracket
- 2.3 Stepped pulley, V-belt pulley
- 2.4 Flanged coupling
- 2.5 Machine tool Holder (Three views)
- 2.6 Screw jack or knuckle joint

3. Isometric Drawing by CAD using Auto CAD (one sheet)

Drawings of following on computer:

- Cone
- Cylinder
- Isometric view of objects

4. Modelling (01 sheet)

3D modelling, Transformations, scaling, rotation, translation

5. Introduction to other CAD softwares;

(Pro Engineer/CATIA / Inventor/Unigraphics/Solid Work: Salient features, simple drawing of components (2 D and 3D)(At least one software)

PERSONALITY DEVELOPMENT CAMP

This is to be organized at a stretch for two to three days during fifth or sixth semester. Extension Lectures by experts or teachers from the polytechnic will be delivered on the following broad topics. There will be no examination for this subject.

1. Communication Skills
2. Correspondence and job finding/applying/thanks and follow-up
3. Resume Writing
4. Interview Techniques: In-Person Interviews; Telephonic Interview' Panel interviews; Group interviews and Video Conferencing etc.
5. Presentation Techniques
6. Group Discussions Techniques
7. Aspects of Personality Development
8. Motivation
9. Leadership
10. Stress Management
11. Time Management
12. Interpersonal Relationship
13. Health and Hygiene

List of Assignments

Refrigeration and Air-Conditioning

Assignment No. 1

1. What do you understand by Refrigerating Effect?
2. What is one ton of refrigeration?
3. What is evaporative refrigeration?
4. Difference between refrigerator and a heat pump.
5. Explain working of heat pump.

Assignment No. 2

1. What are the functions of Vapour Compression System?
2. What is the necessity of Vapour Compression refrigeration system?
3. Discuss effects of subcooling.
4. What is refrigerating effect & Mass of refrigerant?
5. Define the term enthalpy.

Assignment No. 3

1. Explain the Classification of refrigerants.
2. What are the properties of ideal refrigerant?
3. What are the methods to detect leakage of refrigerants?
4. What are secondary refrigerants?
5. What are the lubrication methods used in refrigeration system?

Assignment No. 4

1. What are advantages and disadvantages of air refrigeration system over vapour compression system?
2. Explain Simple Cooling System.
3. Explain Domestic Electrolux Refrigerator.
4. Explain Solar Power refrigeration System refrigeration system?
5. Comparison between vapour absorption and vapour compression system.

Assignment No. 5

1. Explain the function of compressor.
2. What are the essential requirements of a condenser?
3. Explain cooling towers.
4. Explain safety devices used in modern refrigeration system.
5. What are various terms used in psychrometry?

Production Management

Assignment No-1

1. What is PPC? Explain its objective.
2. What are elements of PPC?
3. Explain different type of production system.
4. Explain break even analysis.

Assignment No-2

1. What is plant layout explain its objective?
2. Explain different type of plant layout.
3. Explain material handling and its principles.

Assignment No-3

1. Explain difference between production and productivity
2. What is work study explain its objectives.
3. Explain Method study its Objectives and Procedures
4. Explain Process chart symbols.

Assignment No-4

1. What is standard time, normal type, and allowance?
2. Explain Therblig symbols.
3. What is inventory? Explain its types.
4. What is inventory control? Discuss ABC analysis

Assignment No-5

1. What is JIT? Concept discuss in detail.
2. Explain different types of maintenance.
3. What is Value Engineering? Explain objectives of value engineering.
4. Explain cost estimation in detail.

Theory of Machines

Assignment No-1

1. Define link, kinematic pair, lower pair and higher pair.
2. What is meant by inversion?
3. What is mechanical advantage of a linkage?
4. Draw a neat diagram of Oldham's coupling and explain its working?
5. Sketch and explain the various inversions of a slider crank chain

Assignment No-2

1. What is friction and its necessity?
2. What is angle of friction and angle of repose?
3. What are different types of anti friction bearings?
4. Explain the difference between static and dynamic friction?
5. A body of weight 50 N is at rest on a horizontal plane. A horizontal force of 325 N just causes it to slide. What is limited force of friction and co-efficient of friction?

Assignment No-3

1. What is centrifugal tension in a ball? How does it affect the power transmitted?
2. Write a short note on slip in belts?
3. Explain the advantages and disadvantages of V-belt drive over flat belt drive.
4. Explain different types of chains?
5. Give relation between the circular pitch, diametrical pitch and module?

Assignment No-4

1. Discuss the principle of flywheel?
2. Draw an expression for energy stored in a flywheel?
3. What is the function of a governor? How does it differ from that of a flywheel?
4. Explain with help of a neat sketch the working of Hartnell governor.
5. What is the principle of governor? Explain the sensitiveness of governor in detail?

Assignment No-5

1. Write a short note on balancing of rotating masses?
2. What is balancing and how it is achieved in rotating masses?

3. Explain the method of balancing of several masses rotating in the same plane?
4. What are the causes and effect of vibration in machines? Discuss
5. What do you mean by :-
 - i. free and forced vibrations
 - ii. undamped and damped vibration

Workshop Technology-III

Assignment No. 1

- 1 Explain the working principle of Milling machine.
- 2 Write a short note on Collets and Tail stock
- 3 Define up milling.
- 4 Write a short note on Tread milling.
- 5 What is angular milling?

Assignment No.-2

- 1 What is the purpose of grinding?
- 2 What are the different types of grinding wheels?
- 3 Define the term balancing?
- 4 Classify the different types of grinding machines?
- 5 Write a note on surface grinder.

Assignment No.-3

- 1 What are different types of the gears?
- 2 Write a note on gear hobbing.
- 3 What are the advantages of gear shaping?
- 4 Write a note on gear burnishing.
- 5 Explain the various materials used in gear manufacturing.

Assignment No.-4

- 1 Write a short note on plasma arc machining.
- 2 Give classification of various non-conventional modern machining processes.
- 3 Write the advantages of electro-chemical machining.
- 4 Write the applications of laser beam machining.
- 5 Draw the basic Electrical discharge machining.

Assignment No.-5

- 1 Explain briefly the term galvanizing.
- 2 Write a note on electroplating.
- 3 Explain briefly oil base point.
- 4 Explain briefly the term polishing in metal finishing processes.
- 5 What are the applications of honing?
- 6 What is the purpose of finishing surfaces?

Thermodynamics-II

Assignment # 1

1. Explain the terms compression ratio, cylinder bore, and mean effective pressure?
2. Describe with the help of neat sketch the working principle of four stroke petrol engine?
3. Difference between petrol and diesel engine?
4. Explain with neat sketch theoretical valve timing diagram?
5. Explain the term clearance volume applicable to ic engine?

Assignment # 2

1. Define carburetor and carburation?.
2. Name various components involved in fuel supply sys . petrol engine?
3. Write notes on (a)air fuel ratio and rich mixture?.
4. What are the requirements of fuel injection system in diesel engine?.
5. Define fuel injector?

Assignment # 3

1. What are desirable properties of good lubricant?
2. Write the advantages and disadvantages of air cooling system ?.
3. Define lubrication and types of lubricants?.
4. What is cranke case ventilation ? explain open and close type ventilation?

Assignment # 4

1. Difference between surface and jet condensers?.
2. Explain the function and uses of a steam turbine?.
3. Give advantages of gas turbine over steam turbine?
4. State and explain daltons law of partial pressure as applied to condenser?.
5. What is the function of nozzle ? explain diiferent types of nozzle?

Assignment # 5

1. Write short notes on rocket engine?.
2. Give a comparison of gas turbine with ic engines?.
3. Explain the difference between the turbo jet and turbo propeller unit?

Lab Manuals

WORKSHOP TECHNOLOGY-III Practical

ADVANCE TURNING SHOP

JOB NO-1

Object: Exercise of boring with the help of a boring bar.

Requirements:

1. **Material:** A mild steel rod.
2. **Tools:** Scale, vernier calliper, spanner set, callipers, centre drill, boring bar and boring tools.
3. **Machine:** A centre lathe and power hacksaw.

Theory: Boring is an operation employed for machining internal surfaces termed as internal turning. The object of boring involves enlarging of holes through machining. For short holes the boring tools are used but for long holes boring bars are commonly used. These bars are usually cylindrical in shape and carry a slot to accommodate the tool bit. The commonly used types of boring bars are shown in Fig. 1.1 (a) & (b) respectively. The one shown at (a) has the tool bit projecting in front of its end. It is used for boring blind holes. Boring bar as shown at (b) is for boring through holes and carries a slot for fixing the bit at some distance from the end of the bar.

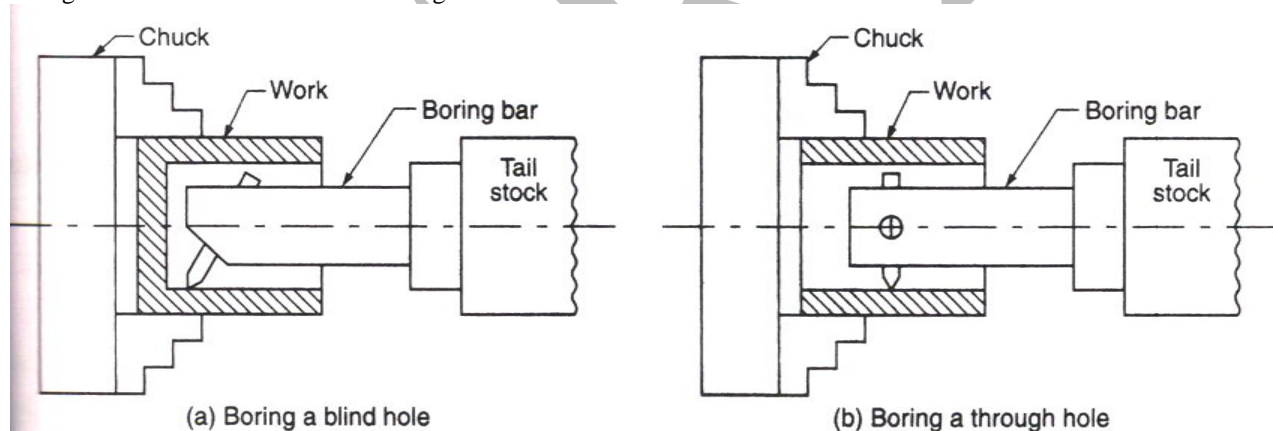
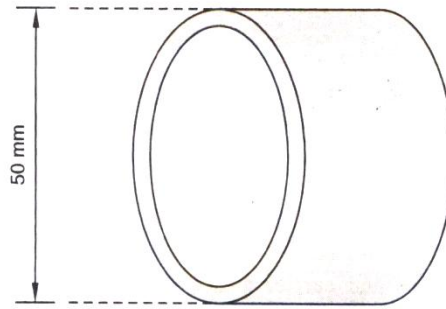


Fig. J-1.1. Use of boring bars.

Procedure:

1. Use power hacksaw to cut the M.S. rod as per the given dimensions.
2. After cutting, the workpiece is held tightly and firmly in the lathe chuck having three or four jaws. The job is revolved in a chuck and the tool is fitted to the tool post for short holes and in the tail stock for long holes. The selection of the boring bar depends upon the size of the bore.
3. The boring bar or boring tool is set so that it is parallel with the axis of rotation of the work and the cutting edge is on centre.
4. Set the spindle speed and carriage feed lever in the same position as for turning.
5. Start the spindle and move the carriage and cross feed slide to the correct position for the boring tool and spot the cutting edge in the hole.
6. Engage the carriage feed and take a cut to straighten out a hole. After the tool is fed through the hole, disengage the carriage feed and stop the spindle without disturbing the cross feed setting and take back the tool out of the hole.
7. In this way take more cuts to bore the hole to size and test the size of the hole with calliper or plug gauge corresponding to the finished size of the hole as shown in Fig.



Precautions:

1. Hold the workpiece tightly and firmly in the chuck.
2. Select proper tools and boring bars and hold them properly in the tool post or tail stock.
3. Adjust proper speed and feed.
4. Avoid measuring the work on a running machine.
5. Never remove chips by hand. Always use brush.
6. Always focus your attention on the job. Avoid talking to others while working.
7. Wear tight fitting clothes when working on machine.
8. Be aware about the position of the first aid box and fire extinguishers.

JOB NO-2

Object: Exercise on internal turning on lathe machine.

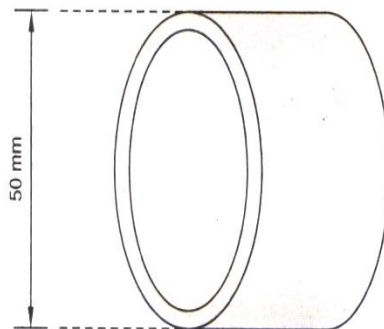
Requirements:

1. **Material:** A mild steel rod.
2. **Tools:** Scale, vernier calliper, spanner set, callipers, centre drill, boring bar, boring tools and single point cutting tools.
3. **Machine:** A centre lathe and power hacksaw.

Theory: The lathe operation of producing perfectly internal surface of the work is known as internal turning. The work is held in a chuck and turning is accomplished causing the work to revolve while the tool is fed longitudinally to peel off a chip from the internal surface of the work.

Procedure:

1. Use power hacksaw to cut the M.S. rod as per the given dimensions.
2. Hold the workpiece in a chuck fitted on the head stock of the lathe tightly and face on both the ends of M.S. rod.
3. Centre the job for drilling.
4. Hold the drill in the drill chuck and hold the drill chuck in the tail stock.
5. Produce a hole in the M.S. rod according to drawing and dimensions with the help of a drilling tool.
6. After drilling enlarge the hole with the help of boring bar and boring tools as shown in Fig., which is similar to the boring operation.



Precautions:

1. Hold the workpiece tightly and firmly in the chuck.
2. Never play with the control panel and control lever.
3. Never remove chips by hand. Always use brush.
4. Always focus your attention on the job. Avoid talking to others while working.
5. Wear tight fitting clothes when working on machine.
6. Adjust proper speed and feed.
7. Avoid measuring the work on a running machine.

JOB NO-3

Object: Exercise on internal threading on lathe.

Requirements:

1. **Material:** A mild steel rod.
2. **Tools:** Scale, vernier calliper, spanner set, callipers both internal and external, centre drill, boring bar, boring tools and single point cutting tools.
3. **Machine:** A centre lathe and power hacksaw.

Theory: For cutting internal threads on lathe, the main requirement is to have a proper system of gearing between the lathe spindle and the lead screw so as to establish the required ratio of speeds between the two. Setting up of the lathe for internal thread cutting includes proper holding of the job in the chuck and the thread cutting tool is mounted on the tool post. The feed bar of lathe is made idle by disengaging the clutch, while lead screw of the lathe is engaged by engaging half nut. A centre gauge is used for setting the threading tool correctly as shown in Fig.

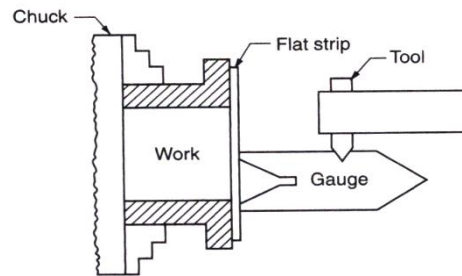


Fig. J-3.1. Setting threading tool for internal threading.

Procedure:

1. Use power hacksaw to cut the M.S. rod as per the given dimensions.
2. Hold the workpiece in a chuck fitted on the head stock of the lathe tightly.
3. Face on both the ends of M.S. rod.
4. Before drilling mark the centre of the rod by using drill held in the tail stock.
5. Hold the drill in the drill chuck and fix the drill chuck in the tail stock.
6. Produce a hole in the M.S. rod according to the drawing and dimensions with the help of drilling and enlarge it by using boring bars and boring tools.
7. Before cutting internal threads ensure, the hole is bored to the correct diameter of the thread.
8. Use a single point internal threading tool which is similar to the boring tool with cutting edges ground to the shape conforming to the type of thread to be cut. For metric threads, the compound slide is swiveled 30° towards the head stock. The tool is fitted on the tool post or on the boring bar and set at right angles to the lathe axis by using a thread gauge. The depth of the cut is given by the compound slide and the thread is finished in the usual manner as shown in fig.

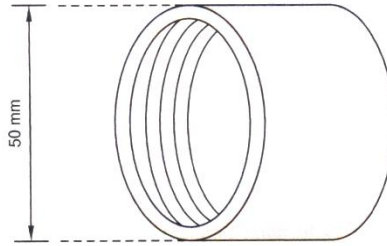


Fig. J-3.2

Precautions:

1. When working, wear tight fitting clothes.
2. Do not touch or fiddle control panel or control lever or any movable part of machine.
3. For the chip removal, always use brush.
4. Before starting the machine ensure that the workpiece and tool is held tightly.
5. Do not shift or change gears when the machine is running.
6. Adjust correct speed and feed during the operation.
7. Do not measure work or adjust a cutting tool when the lathe is running.

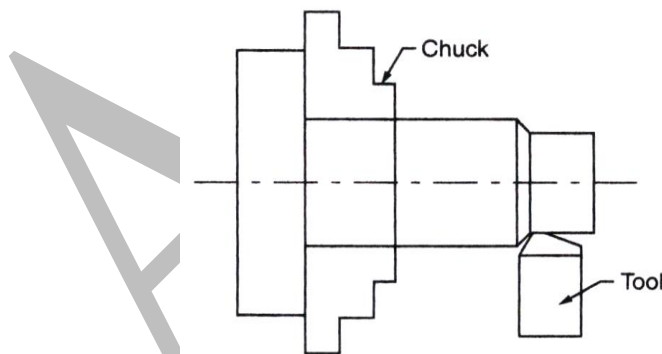
JOB NO-4

Object: Exercise on external turning on the lathe machine.

Requirements:

1. **Material:** A mild steel rod.
2. **Tools:** Scale, vernier calliper, spanner set, callipers, centre drill, single point cutting tool.
3. **Machine:** A centre lathe and power hacksaw.

Theory: It is an operation of removing excess amount of material from the surface of the cylindrical workpiece. During turning the work is held either in the chuck as shown in fig. or between centres and longitudinal feed is given to the tool either by hand or power.



Procedure:

1. Use power hacksaw to cut the M.S. rod as per the given dimensions.
2. Hold the cut piece in the chuck having three or four jaws fitted on the head stock of lathe machine.
3. Face the job by placing a right hand facing tool on the tool holder and set it at an angle of 90° or less with face of work. Start the machine and feed the cutting tool.
4. After facing mark the centre of the job with the help of a centre drill. The drill is held in the drill Chuck and drill chuck is held in the tail stock to ensure the workpiece is in centre.
5. Put a sharp turning tool in the tool post. Adjust the tool for light cut by tightening it with the bolts. For fair cutting adjust the machine at required r.p.m. and check the direction of rotation of the spindle and give few cuts on the job. Give depth of cut and feed of the tool according to the workpiece material and finished required.

Precautions:

1. When working, wear tight fitting clothes.
2. Do not touch or fiddle control panel or control lever or any movable part of machine.
3. For the chip removal, always use brush.
4. Before starting the machine ensure that the workpiece and tool is held tightly.
5. Do not shift or change gears when the machine is running.
6. Adjust correct speed and feed during the operation.
7. Do not measure work or adjust a cutting tool when the lathe is running.

JOB NO-5

Object: Resharpener of single point cutting tool with given geometry.

Requirements:

1. **Tool required:** High speed steel turning tool.
2. **Machines required:** Bench grinding machine and cutter grinding machine.

Theory: The tools which are used for the purpose of cutting the metals in the desired shape and size are called cutting tools. Such cutting tools produce waste materials in the form of chips. Various types of single point cutting tools are used for the different types of machines such as lathe machine, shaper, planer and slotter etc. The common use of single point cutting tool used in lathe are;

1. Turning tool
2. Facing tool
3. Chamfering tool
4. External threading tool
5. Internal threading tool
6. Boring tool

Procedure: Sharpening of tools is done either by hand or machine. Specially designed tool sharpeners are available which are used for this purpose. In their absence, when it is necessary to sharpen the tools by hand, extra care is taken in the operation. While sharpening, the tool is supported on the tool rest and a light pressure is applied to avoid overheating of the cutting edge. The tool is sharpened either wet or dry. While sharpening dry, intermittent dipping in water of the tool should be avoided otherwise it results in appearance of cracks along the cutting edge of the tools. Sharpening is proceeded in a direction against the cutting edge. The tool is set at the centre height and the sharpening of angles are set as given below and shown in Fig.

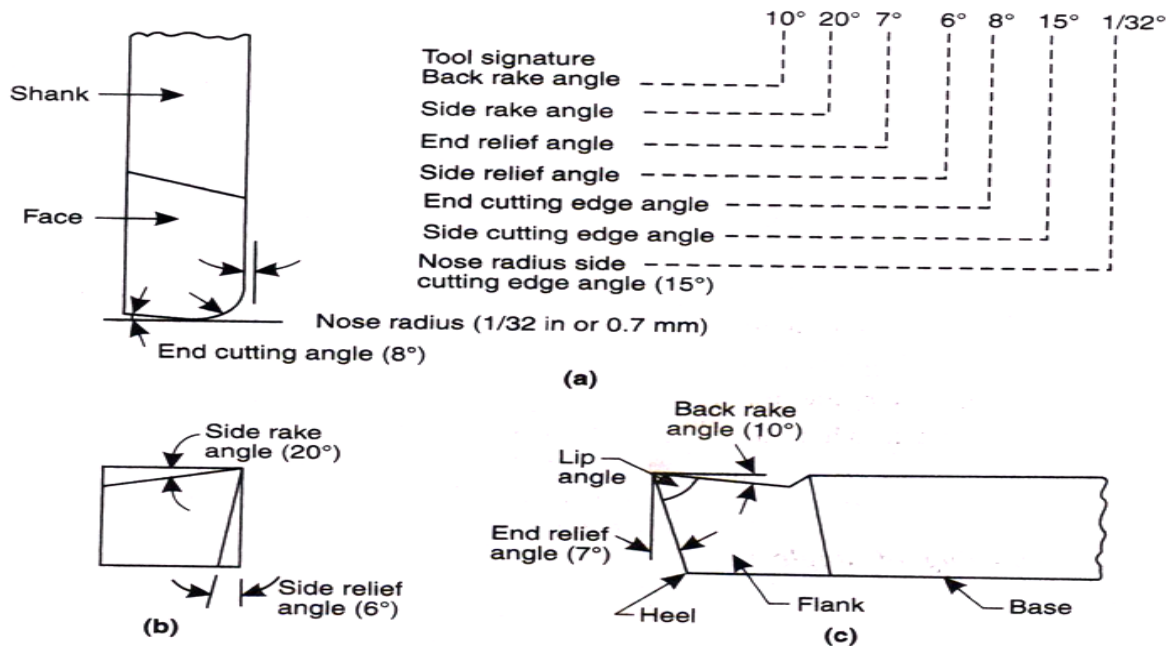


Fig. J-5. A straight-shank, right-cut, single point tool signature.

Precautions:

1. Inspect the sharpening tool for cracks before using.
2. Keep the safety guards and hoods in proper place,
3. Use safety goggles, while sharpening the tool on grinding wheel.
4. Replace the defective or broken grinding wheel.
5. To avoid clothing coming in contact with moving wheel, wear tight clothes.
6. Do not touch the moving wheel.
7. Avoid walking barefooted inside the workshop.
8. Feed the work slowly and gradually.

MACHINE SHOP**JOB NO -1**

Object: Produce a rectangular block by facing on a slotting machine.

Requirements:

1. **Material:** Mild steel square or rectangular rod.
2. **Tool:** Steel rule, spanner set, try square, vernier calliper, face cutter.
3. **Machines:** Power hacksaw and a slotter or slotting machine.

Theory : A slotting machine is a shaping machine in which the cutting tool moves vertically. The ram is mounted on an independent bearing, the upper part of which is pivoted to shift the ram in any angular position. The work table can be given a transverse, longitudinal or rotary movement. A slotter can perform a variety of operations such as the finishing of external and internal plain surfaces in addition to slotting. The working principle of a slotter is shown in Fig, where the cutting tool mounted in the ram moves vertically in a cutting and return stroke. But the cutting of the material is performed during the downward stroke only which is called the working stroke, whereas the upward stroke is the idle stroke.

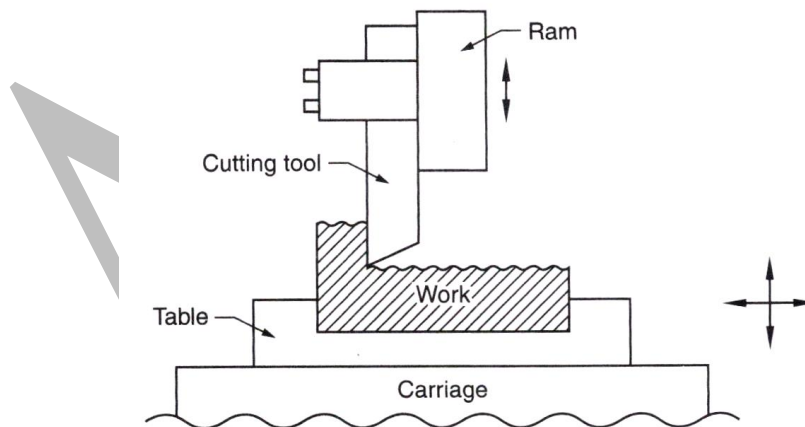
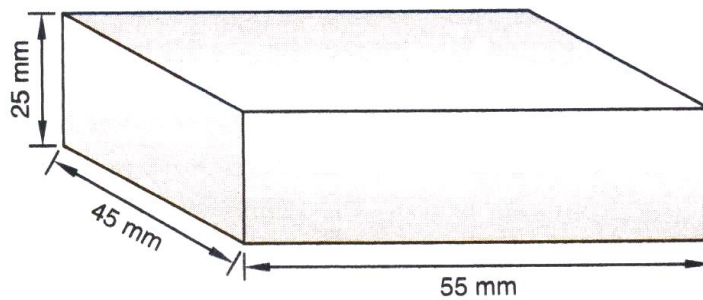


Fig. J-1.1. Slotter principle.

Procedure:

1. Use power hacksaw to cut the M.S. rod as per given dimensions.
2. After cutting the workpiece is held in T-slots on the top of the table.
3. Fix the cutting tool in the ram of the slotter.
4. Start the machine and face the surface.
5. Repeat this process on the rest of the surfaces and produce the rectangular block as shown in Fig.



Precautions:

1. Do not touch any movable part of the machine.
2. Hold the workpiece in the T-slots of the table firmly.
3. Tighten the cutting tool before starting the machine.
4. Use the correct speed and feed.
5. Check surface finish only when the machine is at rest.

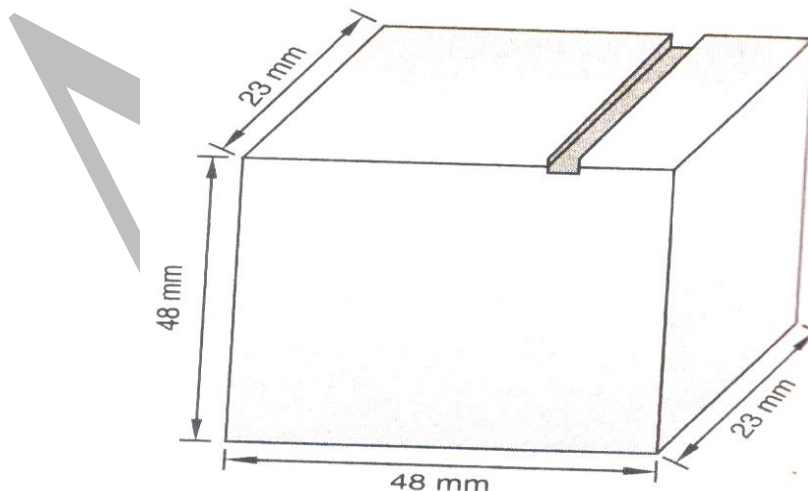
JOB NO-2

Object: Produce a rectangular slot on one face with a slotting cutter.

Requirements:

1. **Material:** Mild steel square rod.
2. **Tool:** Steel rule, spanner set, set square, vernier calliper, slotting cutter.
3. **Machines:** Power hacksaw and a slotter or slotting machine.

Theory : A slotting machine is a shaping machine in which the cutting tool moves vertically. A slotter can perform a variety of operations such as the finishing of external and internal plain surfaces in addition to slotting. The slotting tool cuts the material during the downward stroke only which is called the working stroke, whereas the upward stroke is the idle stroke.



Procedure:

1. Use power hacksaw to cut the M.S. rod as per given dimensions.
2. After cutting the workpiece is held in T-slots on the top of the table.
3. Fix the cutting tool in the ram of the slotter.
4. Start the machine and face all the surfaces.
5. Hold the workpiece in the vertical position.
6. Use the slotting cutter and cut a rectangular slot on one face of the workpiece as shown in fig.

Precautions:

1. Do not touch any moving part of the machine.
2. Hold the workpiece and cutting tool firmly for accurate finishing.
3. Adjust correct speed and feed.
4. Check rectangular slot for correctness only when machine is at rest.

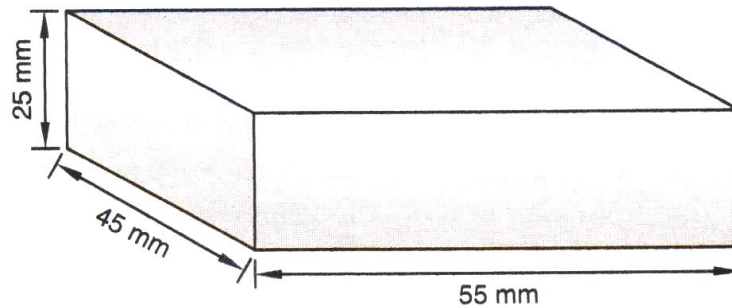
JOB NO-3

Object: Produce a rectangular block using a milling machine with a side and face cutter.

Requirements:

1. **Material:** Mild steel rectangular rod.
2. **Tool:** Steel rule, spanner set, try square, vernier calliper, side and face cutter.
3. **Machines:** Power hacksaw and universal milling machine.

Theory: A machine process in which metal is removed by revolving multiple tooth cutter to produce flat or profiled surfaces, grooves and slots is known as milling and a machine's tool which is used to produce flat or profiled surface, grooves or slots with the help of a revolving multiple cutter is known as milling machine. The revolving cutter is held on a spindle or arbor and the work clamped on the machine table and fed past it to remove the metal in the form of chips to produce the desired shape.

**Procedure:**

1. Use power hacksaw to cut the M.S rectangular rod as per given drawing and dimension.
2. Hold the workpiece in the machine vice on the milling machine.
3. Mount the face cutter on the arbor of milling machine.
4. Start the machine to revolve the face cutter along with the arbor.
5. Touch the job with the cutter by rotating the handle of the table. The table can be raised or lowered on vertical ways on the face of the column as required.
6. Give feed to the job from one end to the other by crosswise direction of the saddle.
7. Repeat the process until the surfaces and sides of the job are completed as shown in Fig.

Precautions:

1. Hold the work piece tightly in the machine vice.
2. Do not fiddle panel and controls.
3. Use brush to remove chips.
4. Use tight fitting clothes.
5. Do not use blunt cutters.
6. Adjust correct speed and feed.
7. Provide coolant in time during operation.
8. Do not touch the cutter edges with fingers.
9. Take measurement when the machine is at rest.
10. Use guards over running cutters.

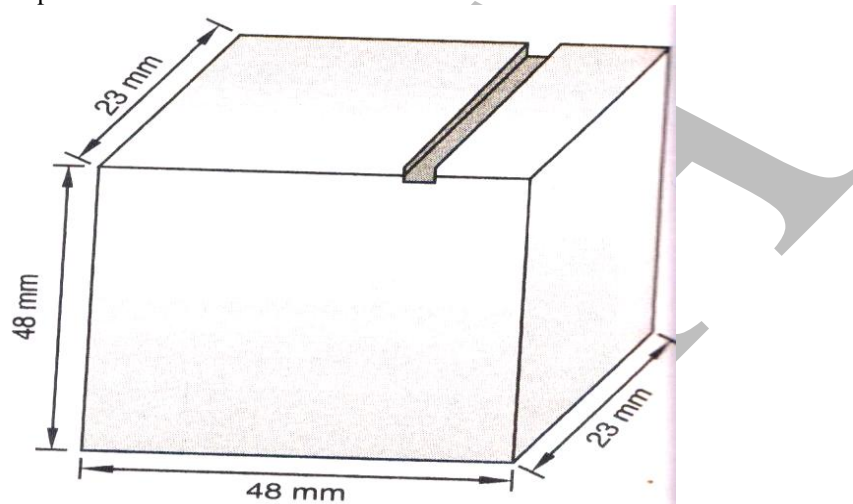
JOB NO-4

Object: Prepare a slot on one face using milling machine

Requirements:

1. **Material:** Mild steel square or rectangular rod.
2. **Tool:** steel rule, spanner set, try square, vernier calliper, face cutter and slotting cutter/side and face cutter.
3. **Machines:** power hacksaw and universal milling machine.

Theory : A machine process in which metal is removed by revolving multiple tooth cutter to produce flat or profiled surfaces, grooves and slots is known as milling and a machines tool which is used to produce flat or profiled surface, grooves or slots with the help of a revolving multiple cutter is known as milling machine. The revolving cutter is help on a spindle or arbor and the work clamped on the machine table and fed past it remove the metal in the form of chips to produce the desire shape.



Procedure:

1. Use power hacksaw to cut the M.S rectangular rod as per given drawing and dimension.
2. Hold the workpiece in the machine vice on the milling machine.
3. Mount the face cutter on the arbor of milling machine.
4. Start the machine to revolve the face cutter along with the arbor.
5. Touch the job with the cutter by rotating the handle of the table.
6. Give feed to the job from one end to the other by cross wise direction of the saddle.
7. Repeat the process until the surface and sides of the job are completed.
8. After producing rectangular or square block by face cutter remove it.
9. Mount the slotting cutter or sides and face cutter on the arbor of the milling machine.
10. Prepare a slot on one face which is similar to the face milling as shown in fig.

Precautions:

1. Hold the work piece tightly in the machine vice.
2. Do not fiddle panel and controls.
3. Use brush to remove chips.
4. Use tight fitting clothes.
5. Do not use blunt cutters.
6. Adjust correct speed and feed.
7. Provide coolant in time during operation.
8. Do not touch the cutter edges with fingers.
9. Take measurement when the machine is at rest.
10. Use guards over running cutters.

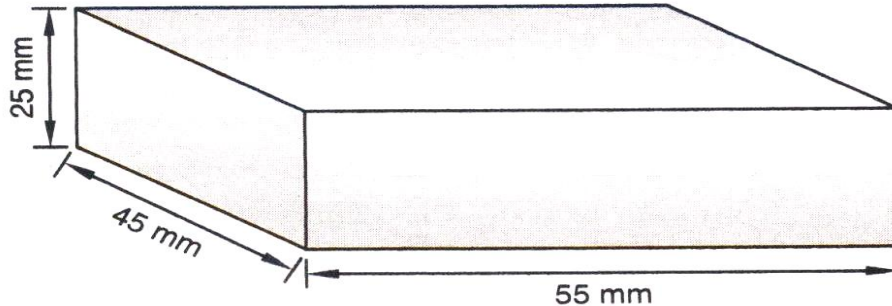
JOB NO.-5

Object: Job on grinding machine using a surface grinder.

Requirement:

1. **Material:** Mild steel flat.
2. **Tools:** Scale, vernier calliper and try square.
3. **Machines:** Power hacksaw and surface grinder.

Theory: The grinder of flat or plane surface is known as surface grinder. The work may be ground by either the periphery or by the end face of grinder wheel.



Procedure:

1. Use power hacksaw to cut the M.S flat as per given dimensions.
2. Hold the workpiece in the magnetic chuck and place the magnetic chuck on the table of the surface grinder.
3. Switch on the electric motor to rotate the grinding wheel in clockwise direction and place the job under the grinding wheel.
4. Move feed handle to provide feed to the grinding wheel in till it touches the workpiece and moves the grinding wheel up and down.
5. Give the reciprocating feed to the table from one end of the job to the other end when grinding wheel touches the job.
6. Repeat the process again and again till the workpiece is complete as shown in fig.

Precautions:

1. Use safety goggles when performing even though the wheel has glass shield
2. Wear tight fitting clothes.
3. Do not touch the moving wheel.
4. Ensure safety equipment like guard and hoods are in their places.
5. Inspect and replace the cracked wheel.
6. Use correct feed and speed.
7. Use brush to remove chips.

JOB NO-6

Object: Prepare a job on cylindrical grinding machine.

Requirement:

1. **Material:** Mild steel rod.
2. **Tools:** Steel rule, vernier calliper, callipers, spanner set and single point cutting tool.
3. **Machine:** Power hacksaw, centre, lathe and cylindrical grinding machine.

Theory: the cylindrical grinding as shown in fig. involves holding the workpiece rigidly on centres, in a chuck or in a suitable holding fixture, rotating it about its axis and feeding a fast revolving grinding wheel against the workpiece. When the surface to be ground is longer than the width of the grinding wheel, the work is traversed past the wheel or wheel past the work.

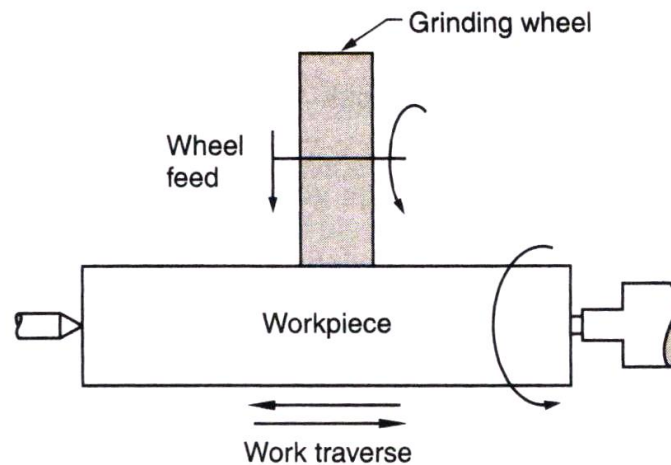
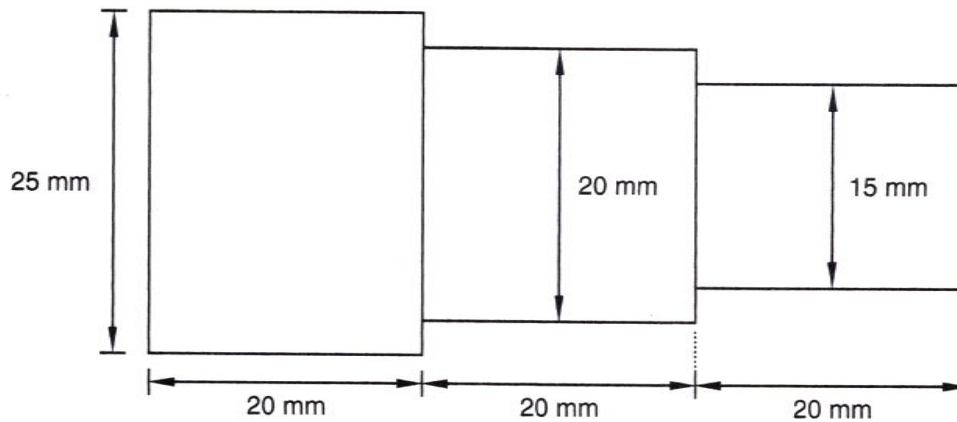


Fig. J-6.1. Principle of cylindrical grinding.

Procedure:

1. Use power hacksaw to cut M.S rod as per given specifications.
2. After cutting hold the workpiece in the chuck of lathe machine or between centres for facing, turning and step turning operations.
3. Hold the job between head stock and tail stock centre on cylindrical grinding machine for grinding operations.
4. Start the machine so that the job and grinding wheel rotate in the same direction.
5. Give feed to the grinding wheel towards workpiece by using the handles till the grinding wheel touches the workpiece.
6. When the job and grinding wheel come in contact with each other, give the traversing feed to the work or table to move it to and fro.
7. Give feed to workpiece from one end to other at the end of each stroke.
8. Repeat the process until the job is completed as shown in fig.



Precautions:

1. Use safety goggles when performing operation even though the wheel has glass shield.
2. Wear tight fitting clothes.
3. Do not touch the moving wheel.
4. Ensure safety equipment like guards and hoods are in their places.
5. Inspect and replace the cracked wheel.
6. Use correct feed and speed.
7. Use brush to remove chips.
8. Measure only when the machine is at rest.
9. Use coolant during operation.

10. Avoid walking bare footed around the machine.

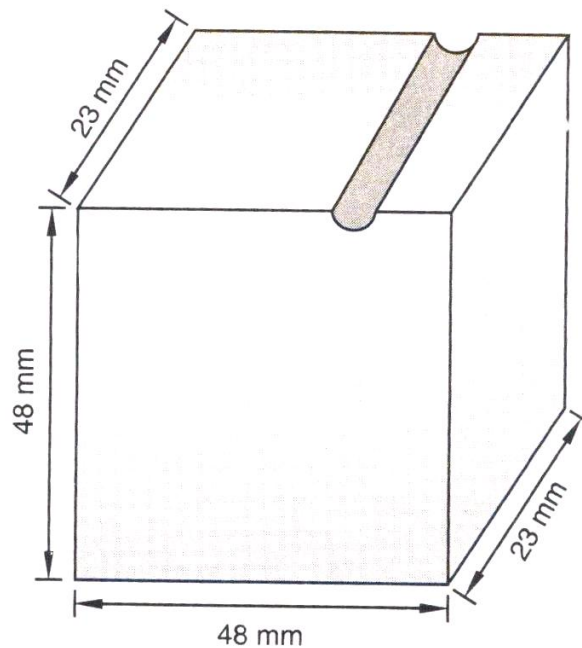
Job No-7

Object: Exercise on milling machine with the help of a form cutter.

Requirement:

1. **Material:** Mild steel square rod.
2. **Tools:** Square set, scale, try square, vernier calliper and form cutter.
3. **Machines:** Power hacksaw and universal milling machine.

Theory : A machine process in which metal is removed by the revolving multiple tooth cutter to produce flat or profiled surfaces, grooves and slots, is known as milling and a machine tool which is used to produce flat or profiled surfaces, grooves and slots with the help of a revolving multiple cutter, is known as a milling machine. The revolving cutter is held on a spindle or arbor and the work clamped on the machine table and fed past it to remove the metal in the form of chips to produce the desired shape.



Procedure:

1. Use power hacksaw and cut M.S rod as per given dimensions.
2. Hold the workpiece in the machine vice on the milling machine tightly.
3. Mount the form cutter on the arbor of the milling machine.
4. Start the machine and revolve the form cutter along with arbor.
5. Touch the job with the revolving the form cutter by using the table handle. The table can be raised or lowered on the vertical ways on the face of the column.
6. Feed the job from one end to other end by the cross wise direction of the saddle.
7. Repeat the process till the job is completed as shown in fig.

Precautions:

1. Do not fiddle with control panel and control lever.
2. Use brush to remove chips from the machine.
3. Use proper working dress in the form of tight clothes.
4. Do not touch any moving part when the machine is in motion.
5. Hold the job tightly in the machine.
6. Hold the cutter tightly on the arbor.
7. Avoid using blunt cutter.
8. Control the feed and speed correctly.
9. Take measurement of the job when the machine is at rest.

10. Use guards over the running cutter.

Job No-8

Object: Exercise on milling machine to produce a spur gear.

Requirement:

1. **Material:** Mild steel gear blank.
2. **Tools:** Square set, scale, vernier calliper, gear tooth vernier and milling cutter.
3. **Machine:** Power hacksaw, lathe machine and milling machine.

Theory: Gear which transmit motion between parallel shafts and whose teeth are parallel to the axis of the shaft are called spur gears as shown in fig. These are the simplest form of gear whose teeth are of involute form. The efficiency of power transmission of spur gears is very high and lies between 96 to 98% under average conditions but they are noisy in operation and wear out more readily in comparison to other types of gears.

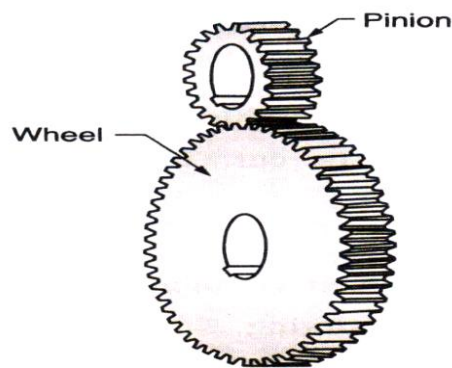


Fig. J-8.1. Spur gears.

Procedure : The gear blank is mounted on a mandrel which is supported between the centre of the dividing head and tooth space is cut by the milling cutter and the dividing head is used to index the job to the next required tooth space.

The cutter is chosen according to the module or diametral pitch and the number of teeth of the gear to be cut. This cutter is mounted on the milling arbor. Before the gear can be cut, it is necessary to have the cutter centre accurately relative to the gear holding mandrel.

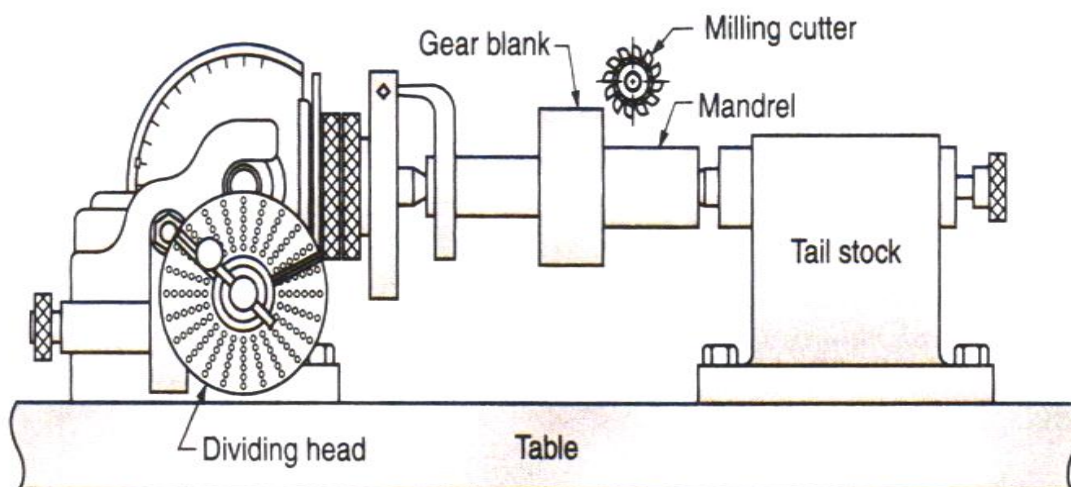


Fig. J-8.2. Milling spur gear on a milling machine.

One way is to adjust the machine table vertically and horizontally until one corner of the cutter just touches the mandrel on one side. Both the dials of the table and knee are then set to zero. The table is then adjusted for the cutter to just touch on the other side of the mandrel with vertical dial showing zero. The reading of the horizontal feed screw is read. This reading dividing by two gives the central position of the mandrel relative to the cutter. When the table is set centrally in this manner, it should be locked in that position. The table is then fed vertically so that the blank just touches the cutter. The vertical dial is then set to zero. This is required to give the depth of cut on the job.

With these settings the machine can be started and traversed along the axis of the job to cut the tooth over the whole width of the gear. Depth is increased slowly until it reaches the full depth of the tooth. With the depth setting the backlash of the gear can be controlled suitably.

After one tooth space is cut, the blank is indexed through $1/n$ revolution by means of the dividing head and 'n' are the number of teeth to be cut. This process is repeated until all the teeth are cut.

Precautions:

1. Do not lean on the machine when it is running.
2. Wear light fitting clothes while working.
3. Do not remove guards when the machine is operating.
4. Use a suitable brush to remove chips.
5. Hold the workpiece rigidly on the work table.
6. Select proper milling cutter.
7. Ensure milling cutter is not blunt.
8. Ensure milling cutter runs true.
9. The correct speed and feed should be selected.
10. Provide coolant in time.

JOB NO-9

Object: Grinding a drill bit on tool and cutter grinder.

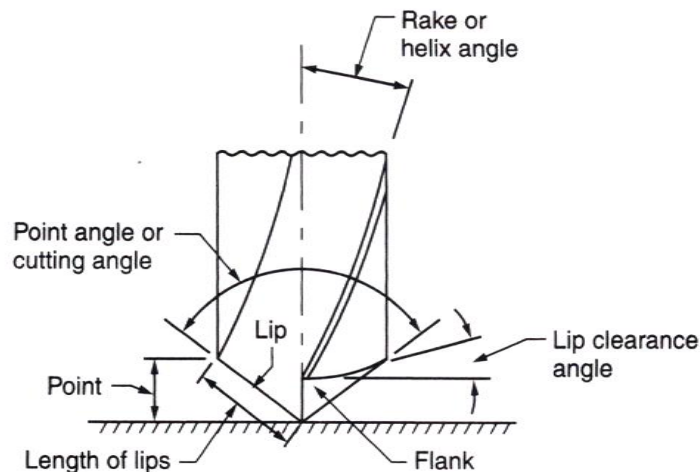
Requirements:

1. **Tools required:** High speed steel drill bit.
2. **Machine required:** Tool and grinder with drill grinding attachment.

Theory: Correct grinding of a drill is important aspect because the tool geometry plays a vital role in metal cutting. Due to constant use the tool geometry changes and the cutting efficiency of the drill lowers. Then, it needs regrinding. The main parameters, which need proper attention while grinding a drill are as shown in Fig.

1. The point angle which is mostly commonly used is 118°
2. Correct location of point.
3. Lip clearance angle is 8° to 12°
4. Length and inclination of lips.

It should be ensured that the length of both the lips is equal and the point is located at the centre.



Procedure: For grinding a twist drill of large and medium size a drill grinding attachment is used as shown in Fig. The drill is held between a bracket at one end and a clamp at the other end, with its tip facing the grinding wheel. The base of the attachment is fitted over a bench at suitable height. The bracket is adjusted to provide the required angle of contact between the face of grinding wheel and the drill point. Feed is provided by the feed screw and nut. This attachment enables correct grinding of the tool geometry. After grinding, inspect the drill for its correct tool geometry by using suitable gauges before it is passed to use on the machine.

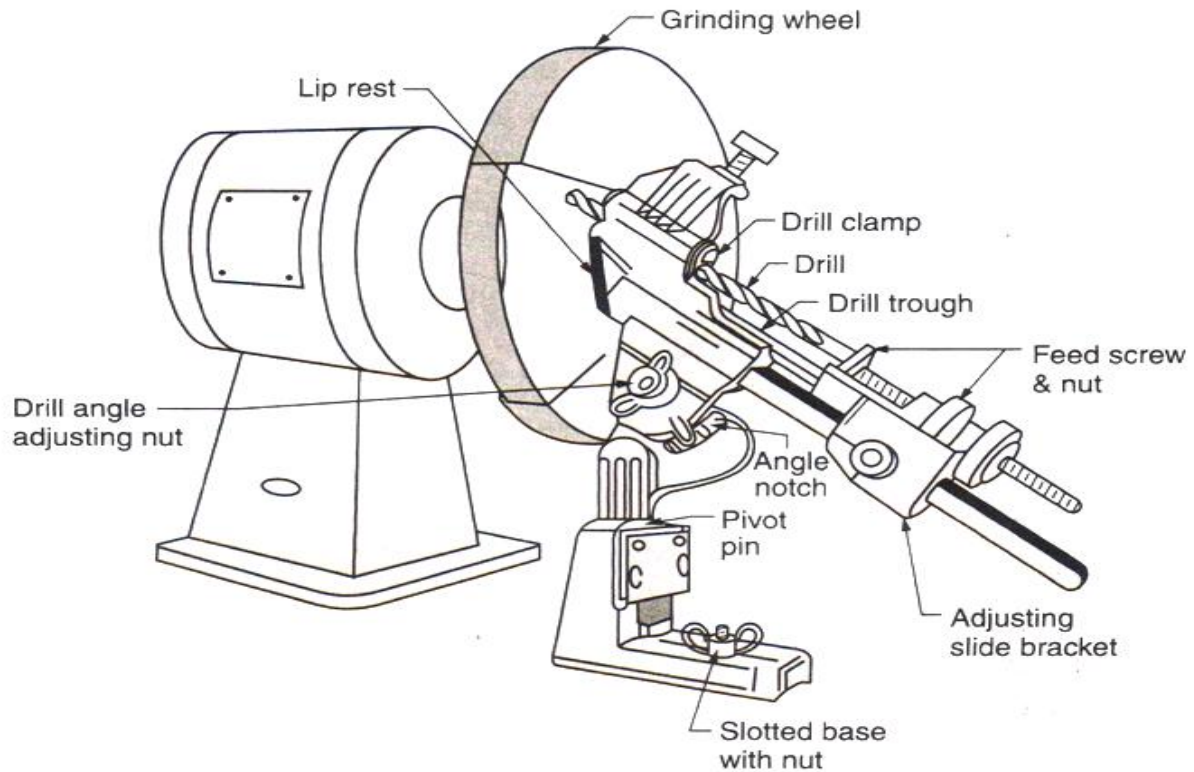


Fig. J-10.2. Use of a drill grinding attachment for grinding a twist drill.

Precautions:

1. Take special care in grinding a drill to ensure that the prescribed drill geometry is correctly restored.
2. While grinding a carbon steel drill, quench it frequently in water to retain its temper.
3. If the drill gets burned during grinding, it should be reground beyond the burned portion.
4. Ensure correct drill geometry especially the lip clearance angle.
5. Use protective eye shields while grinding a drill bit.

JOB NO-10

Object: Exercise on dressing a grinding wheel.

Tools and equipment:

1. Wheel dressers
2. Abrasive sticks
3. Abrasive wheels
4. Diamond tool
5. Crush dressing fixtures

Theory: The process of removing the worn out grains from the surface of the wheel, removing loaded material from the face of the wheel and restoring the original geometric shape and to form the wheel for a specific profile is called dressing of a wheel. As grinding is actually a cutting operation. The small cutting edges on the grains of the grinding wheel are like so many tiny teeth. They must be kept sharp in order to give a free cut and to produce a satisfactory finish on the work. Therefore, wheel dressing becomes the process of resharpening these tiny cutting edges. The

hard diamond point in the dressing tool fractures the grains of the wheel or removes the dull grains entirely and thus, producing new sharp edges. It also cleans out the tiny spaces between the grains removing metallic dust and other particles which eventually clog the pores of the wheel face and make it dull.

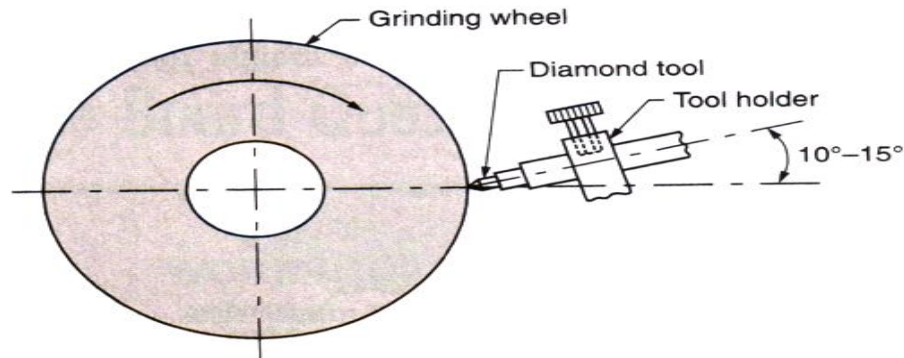


Fig. J-11. Dressing a grinding wheel with a diamond dresser.

Procedure:

1. Mount the grinding wheel either on the tool and cutter grinder or surface grinder motor shaft.
2. Run the machine for a while so that wheel spindle bearings are warmed up before dressing.
3. Fix the diamond tool in the diamond tool holder on the machine table and move it longitudinally so that it touches at the correct position *i.e.* the centre line of grinding wheel as shown in Fig.
4. Mount the diamond tool at an angle to the grinding wheel so that the tool can be turned to keep the sharp point.
5. The angle should point in the same direction as the grinding wheel travels to avoid wheel chatter.
6. While dressing, dress as nearly as possible to working position.

Precautions: Use eye protection while using a grinding wheel.

Computer Aided Drafting Practicals

EXPERIMENT -1

AIM: - AN INTRODUCTION OF CAD SOFTWARE AND ITS UTILITIES IN ENGINEERING FIELDS.

OBJECTIVE: - An awareness about CAD software and its applications.

THEORY: - Drawings are easier to interpret if you set standards to enforce consistency. You can set standards for layer names, dimension styles, and other elements; check drawings against these standards; and then change any properties that do not conform.

1. COMPUTER GRAPHICS: -It refers to the generation of graphical outputs using computer.

Computer graphics techniques are being applied to the making of cartoons. Drawing a series of action sequences which when run at high speed, creates the illusion of moving pictures, appear to move. This is known as animation.

CADD- Computer Aided Design and Drafting.

CAD- Computer Aided Design .

CAM- Computer Aided Manufacturing. CAM uses results of CAD.

CAD is not a substitute for design/ drawing concept. It's only a tool that can be used to supplement traditional methods. It's parallel to use of calculators. They are used for solving mathematics problem but still knowledge of mathematics is required by user to solve it. What is eliminated is the tedious task of performing long hand mathematical manipulations.

Applications of CAD: - An engineer designing a new car body can see the design on the screen. Whenever he needs to make changes he can do it easily and the change can also be stored. He can reduce or enlarge any part of design, change of colors and check pluma. Overall, the design cycle time is reduced drastically. The new car comes on the road in a remarkably short span of time.

2. Application in various fields: -

- a) Mechanical: - design of machine elements, CNC machine tools.
- b) Automotive: - kinematics, Hydraulics & Steering systems.
- c) Electrical: - circuit layout, panel design & control system.
- d) Electronics: - schematic diagram of PC's, IC's etc.
- e) Communication: - communication network, satellite transmitting pictures, T.V. telecasting etc.
- f) Civil: - Mapping, contour Plotting, Building drawing & Structural design.
- g) Architectural: - Town planning, Interior decorations, Modeling, and multistory complexes.
- h) Aerospace: - Design of spacecraft, Flight simulator etc.

3. Advantages of CAD

- a) Combination of human brain and machine speed produces better results in less time.
- b) More accurate, it leads to better quality drawing.
- c) Drawing can be stored in database.
- d) Faster and easy correction/ modifications of a design is possible and drawing errors can be visualize on screen.
- e) Visual modeling of any object / engineering component is possible.
- f) CAD is used for creation, modification, analysis and optimization of designs for improved engineering Productivity.
- g) One can create a library and use a single drawing, a no's of times whenever required.
- h) Color graphics help to display more distinct information on screen.

4. SOFTWARES: -Auto-CAD-2004, Auto-CAD 2007 (Mechanical), AutoCAD 2007(Electrical), Auto-Desk, Inventor PRO -11,Pro-E, STADD, CATIA,I-DEAS etc.

EXPERIMENT -2

AIM: - STUDY OF THE BASIC INITIAL SETTING AND VIEWING OF THE DRAFTING SOFTWARE INTERFACES.

OBJECTIVE: - To learn initial setting and viewing of the drafting software interfaces.

THEORY: To find out Auto-CAD package and set its required setting for drawing in the auto-CAD window.

- How to Start your PC.
- Opening Auto-CAD Window.
- Description of Auto-CAD window.
- Setting GUI (Graphic User Interface) for drawing.

How to Start your PC.

Switch "ON" main switch. Switch "ON" UPS. Switch "ON" CPU and Monitor.

Opening Auto CAD Window.

First go to Start, then go to programme file and then go to Auto-CAD/Auto Desk. Select respective auto-CAD window, click ok.

Open an existing drawing:

To opens an existing drawing select from a list from the fore most recently open drawing. Also display brows button that you choose look for another file.

Start a drawing from scratch

Open a new drawing based on the measurement system you choose-English (inches) or Metric (millimeters) system.

Use a Template:

Open a new drawing based on a template you select from a list. The list display on a template files that exists in the drawing file locations specified in the option dialog box Template files stores all the setting for a drawing.

Setting Drawing Units: Drawing units are sets as per drawing units given in the drawing to be done. It may be in MKS or SI system such as millimeters or in inches in case of distance units and similarly for angular measurements it may be Degree, Radian or Grade e.t.c.

To set drafting Units: In the Drawing units dialog box set the units value for drawing. Type “units” at command window. Press ent. Select units in mm or inches. Select Precision, 0.00 or 0.000 or 0 itself. Ent. Select angular direction, clockwise, leave box blank, for anti clockwise, select/ click ok.

Command: Units

Setting the Limits of Drawing:

Limits of Drawing specify the area in which the drawing is to be drawn.

Command: Limits. Enter.

Specify the lower left corner of the area: say (00,00)

Specify the upper right corner of the area: (297, 420) or (420, 297) for landscape size. Press ent. Write “zoom” . Ent. Type “All” ent.

After specifying the limits we set Grid.

- Setting of Grid Spacing Type grid, press ent. Click on grid dialog box . set grid spacing 5/ 10 / 15 as desired. Press ent.

Setting of Snap Spacing. Click on snap . ent value as 5/10/ 15 as desired. Ent.

This will zoom all the limits of drawing. After this we can draw the required drawing

DRAFTING SOFTWARE INTERFACES

Menus, Toolbars and Tool Palettes..

You can use several menus, shortcut menus, palettes, and toolbars for access to frequently used commands, settings, and modes.

The Command Window.

You can display commands, system variables, options, messages, and prompts in a lockable and resizable window called the command window.

Design Center:

With Design Center, you can manage block references and other content such as layer, definitions, layouts, and text styles etc.

Customize the Drawing Environment.

Many elements of the working environment can be customized to fit your needs.

Pointing Devices:

You can use as your pointing device a mouse, a digitizing puck, and it may have more than two buttons.

You can use several menus, shortcut menus, tool palettes, and toolbars for access to frequently used commands, settings, and modes.

Tool Palettes:

Tool palettes are tabbed areas within the Tool Palettes window that provide an efficient method for organizing, sharing, and placing blocks and hatches. Tool palettes can also contain custom tools provided by third-party developers.

- **Insert Blocks and Hatches Using Tool Palettes**

Tool palettes are tabbed areas within the Tool Palettes window. Drag blocks and hatches from a tool palette to place these objects quickly on a drawing.

- **Change Tool Palette Settings**

The options and settings for tool palettes are accessible from shortcut menus in different areas on the Tool Palettes window.

- **Control Tool Properties** You can change the insertion properties or pattern/

Properties of any tool on a tool palette.

- **Customize Tool Palettes** You can add tools to a tool palette by several methods.

Save and Share Tool Palettes: Save and share a tool palette by exporting it or importing it as a tool palette file.

Toolbars:

Use buttons on toolbars to start commands, display fly out toolbars, and display tool tips. Toolbars

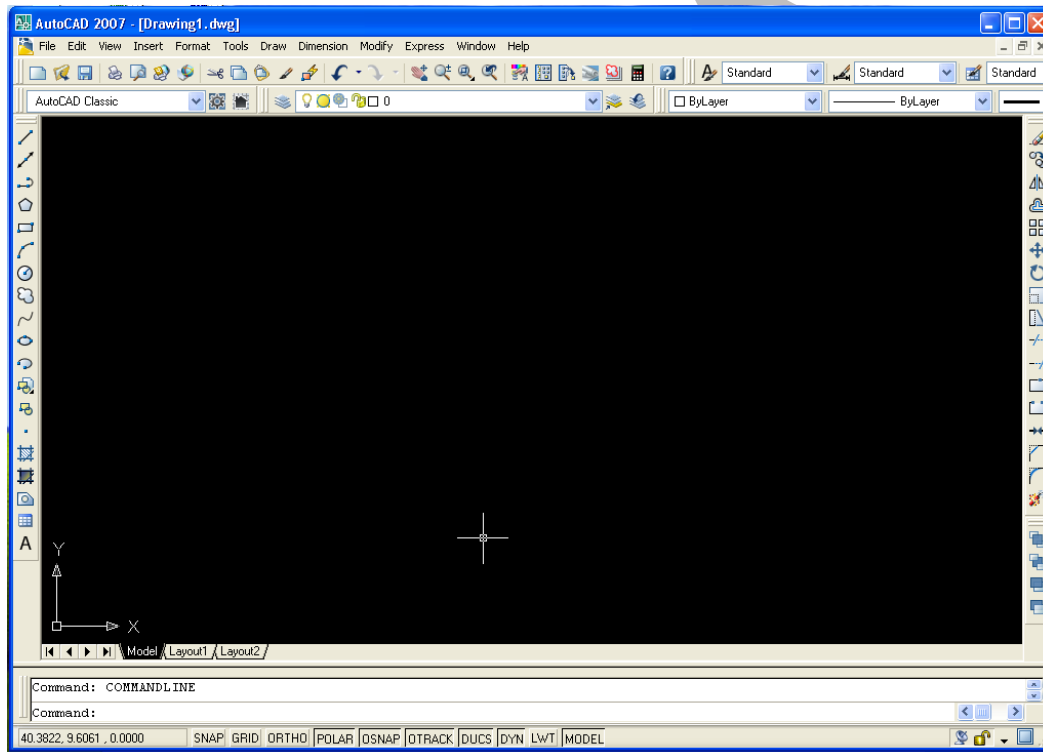
contain buttons that start commands. When you move the pointing device over a toolbar button, the tool tip displays the name of the button. Buttons with a small black triangle in the lower-right corner have fly outs that contain related commands. With the cursor over the icon, hold down the pick button until the fly out appears. The Standard toolbar at the top of the drawing area is displayed by default. This toolbars are Draw tools, Modify tools etc.

Shortcut Menus:

Display a shortcut menu for quick access to commands that are relevant to your current activity.

Menus are available from the menu bar at the top of the AutoCAD drawing area. You can choose menu options in the following ways:

- Click the menu name to display a list of options. Click the option to choose it, or press DOWN ARROW to move down the list and then press ENTER.
Press ALT and then enter the underlined letter in the menu name. For example, to open a new drawing, press ALT and press F to open the File menu. Then press ENTER to choose the highlighted option new.



EXPERIMENT-3

AIM: - STUDY OF VARIOUS TOOLBAR OPTIONS AND EXERCISES TO FAMILIARIZE DRAWING TOOLS.

OBJECTIVE: - To learn different drawing tools commonly used in Auto-CAD.

THEORY: - There are different toolbar options in Auto-CAD. These are the main toolbars:

Standard Toolbar: There are following tools in this option:

New: To create a new drawing.

Open: To open already existing drawing. Click on open icon at menu bar, select desired file and click open.

Save: To save already existing drawing. By save as or by pressing Ctrl+S and give the name of file.

Plot: To plot a drawing, select an existing drawing by pressing Ctrl+A, then go to File in menu bar, select plot and then select type of plotter, give no's of copies and click OK.

Un-do and Re-do: It is used for editing and do and undo the drawing by clicking on undo icon for undoing the latest drawing and click on re-do icon for re-doing the latest drawing.

Cut: It is used to cut or delete the selected part of drawing. Select the drawing to be cut by Pressing Ctrl+A and press cut icon on menu bar (Scissor).

Match Property: It is used to adjust same dimensions and color of a drawing or a part of drawing with existing one. Go to the match property icon and click on it, select the original drawing with whom you like to match and then, click on the drawing to which you like to match.

Pan: It is used to move all the drawing on the screen at a time. Click on Pan icon on menu bar and go to screen and move the mouse by pressing left button. All the drawings will move together.

Zoom: It is used to magnify the existing drawing. Click on the Zoom icon on menu bar or by Scrolling the scroll bar of mouse up or down.

Draw Tools: There are different draw tools to draw different types of drawing i.e. Point, line, curve line, circle, polygon, rectangle, ellipse, arc etc. Each of these will be discuss later on.

Modify Tools: These tools are used for modifying the existing drawing. These are erase, copy, mirror, array, explode, break, trim, extend, fillet & chamfer. Each of these will be discuss later on.

Drawing aids: These are the helping tools used to assist drafter to draw complicated drawing but not a draw tools. These are very helpful to make a drawing easy. These are SNAP, GRID, ORTHO, OSNAP, OTRACK etc.

Snap: It is useful for specifying precise points with the arrow keys or the pointing device.

Grid: It is a rectangular pattern of dots that extends over the area you specify as the drawing limits. Using the grid is similar to placing a sheet of grid paper under a drawing.

Ortho: - This aids to draw horizontal and vertical lines when it is on.

Polar: - It is used to draw lines at an angle to the reference line either clockwise or anticlockwise depending upon the requirement of drafter.

OSNAP (Object Snap) and OTRACK (Object Snap tracking): - This is used to make proper connection / attachment of lines with the other diagram or lines when it reaches to the nearest point. It facilitates to identify the required co-ordinate points such as midpoint, center, end point, and tangents etc which are otherwise very difficult to track and make proper connection of lines or to complete a drawing. It has following features. End point, Midpoint, Center, Node, Quadrant, Intersection, Extension, Perpendicular, Tangent, Nearest point, apparent intersection and parallel.

LWT: - Used to give required thickness of lines as defined in Engineering drawing. e.g. Border line, Title block line, Center line etc.

Model: -This is used to set the drawing sheet as required by the designer to follow standard procedure of drawing.

Toolbars:

These are Draw tools, Modify tools, Layers Blocks, Properties, Dimensioning tools etc.

Draw Tools: These are Lines, Arcs, Circles, Poly-lines, Polygon Rectangle, Ellipse, Text Elliptical Arc, Hatch, Blocks and Region. Details of each of them will be discuss in Exercise no. 05.

Modify tools: These tools are used to modify existing drawing. Commonly used commands are Trim, Cut, Extend, Copy, Move, Erase, Mirror, Offset, Rotate, Chamfer, Fillet and Array. Details of these are explain in exercise No. 06

Layers: These are organizing tools, which are used to print drawing as per required dimension. Such as if we do not required certain types of lines like hidden line, we can take a copy of the existing drawing in required model. These are; State, Name, On/Off, Freeze, Lock, Color, Line type, Line weight, Plot Style and Plot.

On/Off: This is used to put the Layers active or inactive. Click on 'On' icon, it will be active, and click on again it will be inactive.

Name : It give name of the defined layer.

State: It used to set the selected layers as current layers.

Freeze: It is used to freeze selected layers of drawing to make it invisible so that it can speed up rendering processes / Zoom/ Rotate speedily. When Thawed layers are put on it will be active for all type of operations.

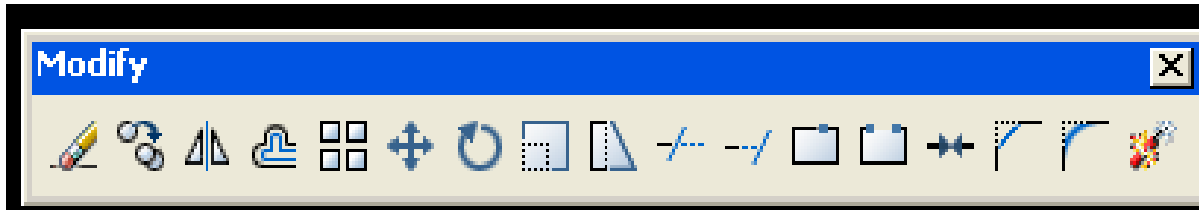
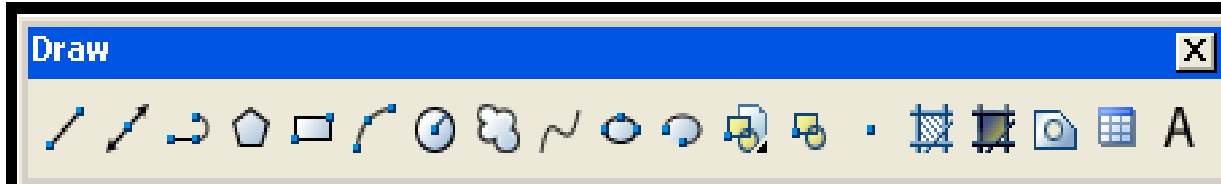
Lock/Unlock: Used to lock the drawing when it is 'ON' . Unlock it for movement.

Colour: To give different Type of colour to different lines, as required. Such as green for centerline, Blue for dimensioning lines etc.

Line Type: Different types of lines (e.g .thickness) with different profile can be made in this tools.

Plot Style: Changes the plot style associated with the selected layers.

Plot: Control whenever the selected layers are plotted.



EXPERIMENT - 4

AIM :- STUDY AND IMPLEMENTING OF CO-ORDINATE SYSTEMS AND UCS.

OBJECTIVE :- An awareness about the different coordinate system

THEORY:-

There are four different types of coordinate systems used in AutoCAD to locate the point on screen. In AutoCAD considering the screen as XY plane does 2D drafting. X-value is consider horizontally and Y- value are taken vertically. By default ,the lower left corner is consider as origin(0,0) AUTOCAD uses the following coordinate systems:

- (a) Absolute coordinate system
- (b) Relative coordinate system
- (C) Polar coordinate system
- (d) Direct Distant Entry System

(a) Absolute coordinate system:

In this method ,the points are locate to draw with respect to the origin(0,0)To mark a point values is given in pairs for X-coordinate value followed by Y-coordinate.

Example:

Draw a line from point (5,5) to Pt (10,10)

Command:- Line
From Pt:- 5,5
To Pt:- 10,10
To Pt:-

(b) Relative Co-ordinates:-

In this method , the points are locate to draw a line with reference to the previous point.

Example:

Draw a line from Pt (2,2) to Pt 5 units in X-axis and 8 units in Y axis relative to first coordinate.

Command: Line
From Pt: 2, 2
To Pt: @ 5, 8
To Pt:

Draw the fig. with help of relative method

Specify First Pt:- 20, 20

Specify next Pt:- @ 60, 0
Specify next Pt:- @ 0, 30
Specify next Pt:- @ -40, 0
Specify next Pt:- @ 0, 20
Specify next Pt:- @ -20, 0
Specify next Pt:- @ 0, -50

©Polar Coordinates:-

The points are located to draw a line by defining the distance of the point from the current position and the angle made to that line.

Specify First Pt:- (20, 20)
Specify next Pt:- @ 60< 0
Specify next Pt:- @ 30< 90⁰
Specify next Pt:- @ 40< 180
Specify next Pt:- @ 20< 90⁰
Specify next Pt:- @ 20< 180 ;
Specify next Pt:- @ 50< 270⁰

Direct DistanceEntry System:- In this method are locat to draw a line using the distance entry in the direction of cursor.Ortho mode is used here (F-8) to draw a drawing

To draw a line using the dist entry in the dir of the cursor.

First Pt : 20, 20 move mouse horizontally right
Next Pt : 60 move mouse vertically up
Next Pt : 30 moves mouse horizontally left
Next Pt : 40 moves mouse vertically up
Next Pt : 20 moves mouse horizontally left
Next Pt : 20 moves mouse vertically down
Next Pt : 50

EXPERIMENT- 5

AIM: - USE OF BASIC ENTITIES IN 2D

OBJECTIVE: - To learn the basics of 2D entities.

THEORY: - In the 2D entities, we can draw different drawings by use of different draw commands.i.e.line arc, circle, rectangle, polygon, ellipse etc. In this exercise we will draw different types of drawing by using these commands with the help of different methods.

PROCEDURE:

The some exercises are drawn with the help of the following commands:

P- Line Command or PL Command: -

A polyline is a connected sequence of line and arc segments. It has feature to change the line width.

Command: P line or PL

Specify the start Pt: select the starting Pt by using mouse.

Select different Pts and press enter. Current line width is 0.000 or change if required. You can change the line to an arc and then to a line of same or different thickness.

Command: – Rectangle

A rectangle is a polyline based on two opposite Corner Pts called diagonal points.

Draw a rectangle defined by diagonal Pt (10, 10) and (30, 20)

Command: - Recta. Ent.

First corner: P₁ (10, 10). Ent.

Second corner: P₂ (30, 20). Ent. (See Fig 03)

Rectangles can be drawn by lines commands also. Line, Ent Pt.

P₁(10,10) Ent

P₂ (40,10) Ent

P₃ (40, 40). Ent
P₄ (10, 40). Ent.
C . Ent. (See Fig 04)

POLYGON:- It enables us to draw a polygon consists of more than four sides of regular size.

(a) Polygon Command: - Edge method

The polygon command is used to draw a regular polygon for a given length of the edge or side.

Command: Polygon

Enter no. Of sides<4>: 6

Specify <center of polygon> or edge: E

Specify first end Pt of edge: select using mouse

Specify second end PT of edge: @30< 0

(b) Draw a polygon of 8 sides with center (50, 50) inscribed in a circle of radius 40 units.

Command: Polygon

No. Of sides: 8

Edge / < center of Polygon>: 50, 50

Inscribed in a circle / circumscribed about circle (I /C) : I

Radius of Circle –40

(c) Draw a octagon with center (140, 50) circumscribed on a circle of radius 40 units.

Command: Polygon

No. Of Sides: 8

Edge / < center of Polygon>: 140, 50

Inc I/C : C

Radius of circle : 40

Circle: -

Circle is a locus point such that it remains at a fixed point from a fixed distance. To obtain a circle a fixed point is taken as a center and at a fixed is taken as a radius.

Circle can be drawn by five methods

(a) Using center and radius

Command: circle

3P / 2P / TTR < center Point >: 6, 6

Diameter / <Radius >: 5

(b) Using center and diameter

Command: circle

3P / 2P / TTR / < center Point >: 6, 17

Diameter / <Radius >: D

Diameter: 10

(c) Using 3 given point 3P

Command: circle

3P / 2P / TTR / < center Point >: 3P

First Pt: (5, 30). Second Pt (4, 6). Third Pt: (10, 25)

(d) Using two given points (2P)

Command : circle

: 2P

First Point on Diameter : (7, 35)

Second Point on Diameter : (7, 47)

(e) Using Tangent, Tangent and Radius (TTR)

You can draw a circle by specifying two lines or two circles or a line and circle and also radius of a circle.

Command: **Circle:** TTR

Select 1st Tangent: Line 1 (using mouse) (16, 4) to (19, 9)

Select 2nd tangent: Line 2 (using mouse) (20, 21) to (21, 7); Radius = 2

Command: circle: TTR

Select 1st Tangent: Point P1 on circle1 (cent 15, 15) radius 2

Select 2nd tangent: Point P2 on circle2 (cent 23, 14) radius 2.5); Radius = 2

Command: Circle: TTR
Select 1st Tangent: Point P1 on circle
Select 2nd tangent: Point P2 on line, Radius = 1.5

Ellipse: -

Two axes that define its length and width determine the shape of an ellipse. The longer axis is called the major axis, and the shorter one is the minor axis. Ellipse can be drawn with 4 methods:

(a) Using major axis end point (10, 20), (60, 20) and minor axis end Pt. (35, 35)

Command: Ellipse
< Axis end Pt> / center: (10, 20), Axis end Pt 2: (60, 20).
< Other axis distance > / Rotation: (35, 35)

(b) Using center of ellipse, end Pt and other axis distance ellipse center (100, 20) major axis end Pt (125, 20) minor axis end Pt (100, 35)

Command: Ellipse
< Axis end Pt 1 > / centre : C
Centre of Ellipse : (100, 20)
Axis end Point 2 : (125, 20)
<Other axis distance> / Rotation : (100, 35)

(c) Using first axis end point and rotation angle of circle around the axis. Draw ellipse using major axis end points (8, 80), (58, 80) & 55° rotation around major axis

Command: Ellipse
< Axis end Point 1 > / Centre : (8, 80)
Axis end Point 2 : (58, 80)
< Other axis distance > / Rotation : R
Rotation about major axis : 55

A rotation angle of 0° produces a circle while a rotation angle of nearly 90° produces an ellipse that is almost flat. The system will not accept the entry of 90°.

(d) Using center, end point and rotation angle of circle around the axis. Draw ellipse with center point (35, 48), major axis end point (60, 48) and 65° rotation.

Command: ellipse
< Axis end point 1 > / center : C
Centre of Ellipse : (35, 48)
Axis end point 2 : (60, 48)
< cott axis distance> / ----- : R
65° rotation around major axis : 65°

Arc: - An arc (usually with arrows at each end) spanning the angle formed by the extension lines of an angle being measured. It can be drawn by different methods)

(a) Using 3 given points (75, 50) (55, 90) (105, 110),

Command : Arc
Centre / < start Point > : (75, 50)
Centre / End / < second Point > : (55, 90)
End Point : (105, 10)

(b) Using start Point center and End Point:

Command : Arc
Centre / < start Point > : (240, 20)
Centre / End / < second Point > : C
Centre Point : (250, 60)
Angle / length of Chord / < End Point > : (250, 100)

(c) Using start point , centre and included angle.

Command : Arc
Centre / < start Point > : 100, 190
Centre / End / < second Point > : C
Centre Point : 40, 190
Angle / length of Chord / < End Point > (40, 190) : A
Included Angle : 90

(+ve angle and -ve angle draws arc in anticlock wise and clockwise direction)

(d) Using start Point , centre and length of chord

Command : Arc

Centre / < start Point > : 140, 10

Centre / End / < second Point > : C

Centre Point : 100, 10

Angle / length of Chord / < End Point > : L

Length of Chord : 45

(These arcs are always drawn in anti clock wise direction)

(e) Using start Point , End Point and Radius; Command : Arc

Centre / < start Point > : 230, 80

Centre / End / < second Point > : E

End Point : 190, 80

Angle / Dir / Radius / < Centre Point > : R

Radius : 22

(f) Using start Point, End Point and included angle

Command : Arc

Centre / < start Point > : 300, 60

Centre / End / < second Point > : E

End Point : 340, 120

Angle / Dir / Radius / < Centre Point > : A

Included angle : 90

(This type of arc is normally drawn in anti clock wise direction from Point to end Point. If -ve sign is specified the arc is drawn clockwise.)

(g) Using start point , end point and starting direction.

Command : Arc

Centre / < start Point > : 40, 170

Centre / End / < second Point > : E

End Point : 70, 230

Angle / Dir / Radius / < Centre Point > : D

Direction from start point : 120

(h) Using Line / Arc continuation

Draw an arc with end point (200, 150) and to the existing line.

Take line from Point (150, 200) to Point (200, 200);

Command : Arc

Centre / < start Point > :

End Point : (200, 150)

HATCH: -

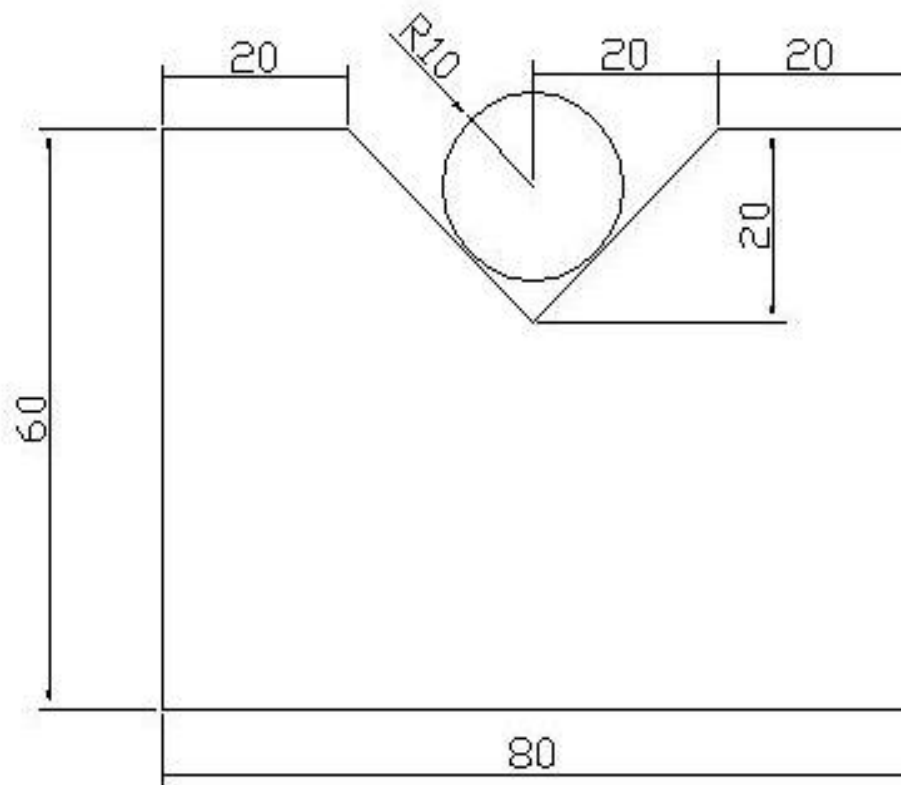
Hatching that conforms to its bounding objects such that modifying the bounding objects automatically adjusts the hatch. Many drafting applications use a process called hatching to fill an area with a pattern. The pattern is used to differentiate components of a project or to signify the material composing an object. You can use a predefined hatch pattern, define a simple line pattern using the current line type, or create more complex hatch patterns.

REGION: -

Regions are two-dimensional enclosed areas you create from objects that form closed loops. Loops can be combinations of lines, polylines, circles, arcs, ellipses, elliptical arcs, and splines. The objects that make up the loops must either be closed or form closed areas by sharing endpoints with other objects.

Regions can be used for

- Applying hatching and shading
- Analyzing properties, such as area, using MASSPROP
- Extracting design information, such as the centroid.



EXPERIMENT- 6

Aim: Draw the following views of the journal bearing:

- a) Front view.
- b) Side view.
- c) Top view.

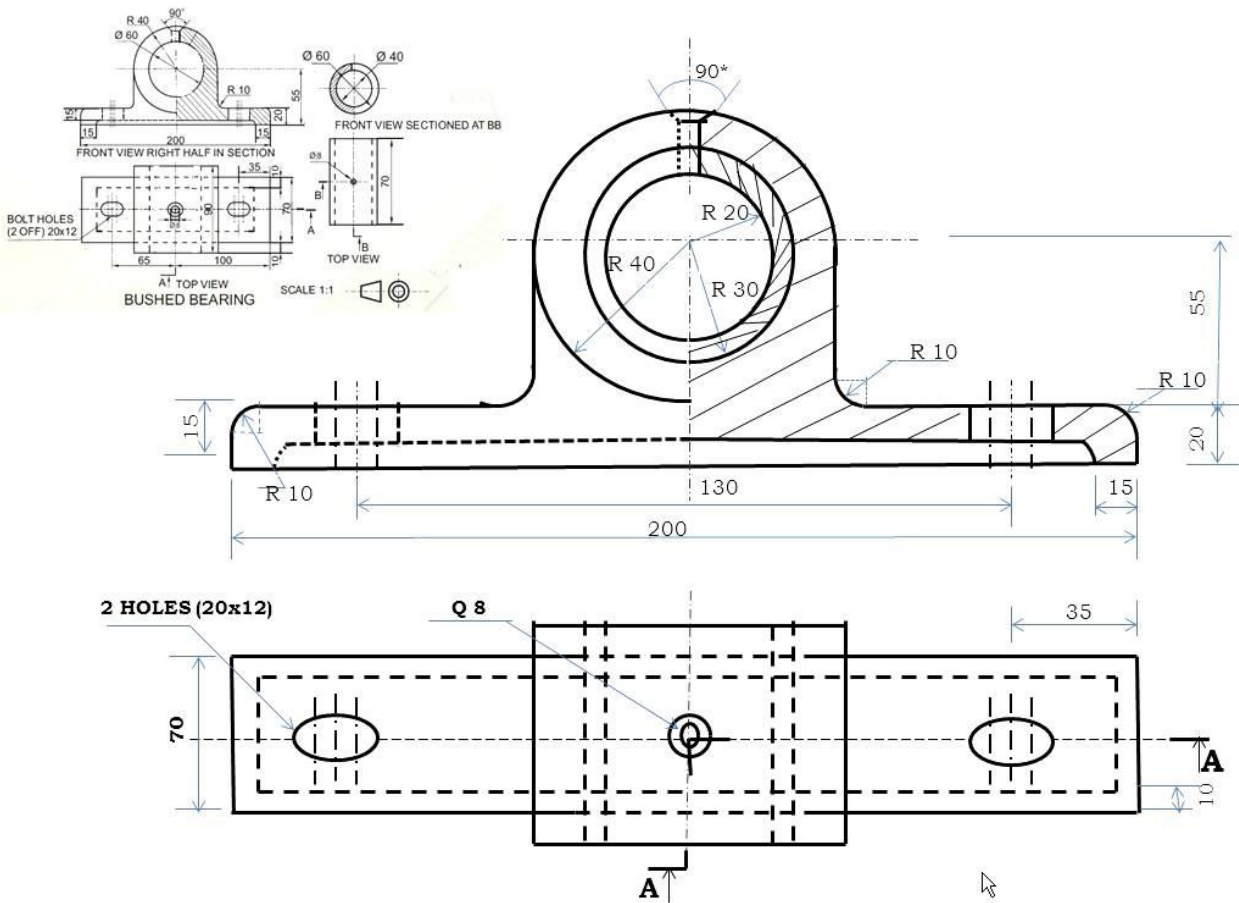
Introduction:

Rotating shafts are supported on bearings. Journal bearing is the part of the shaft. In this type of bearing the supported pressure is perpendicular to the axis of the shaft. If a long shaft is supported only at two ends, it will deflect at its center due to its own weight. So, to have a long shaft straight and its running smooth, the shaft is supported at suitable interval by bearing.

A Bearing should permit free and smooth rotation of the shaft as well. To minimize the frictional resistance due to the rotation of the shaft and also reduce the wear and prevent undue heating and seizing, an adequate arrangement for lubricating the outside surface of the rotating shaft and the inside surface of contact of bearing must be made. Every shaft supported by a bearing should have a 'running fit'

Uses of the journal Bearing:

The drawing of journal bearing is used for workers who works on Lathe Machine and Computer Numerical Control Machine to make the journal Bearing. The Journal Bearing is also use to minimize the frictional resistance due to the rotation of the shaft and also reduce the wear and prevent undue heating and seizing, an adequate arrangement for lubricating the outside surface of the rotating shaft and the inside surface of contact of bearing must be made.



Commands used to make the Journal Bearing:

Line command, Offset command, Circle command, Trim command, Dimensions and Properties of the line. Properties of line are used to change the property of the line, such as from continuous to hidden line or Center line.

EXPERIMENT- 7

Aim: Draw the detail and assembly of the Screw Jack.

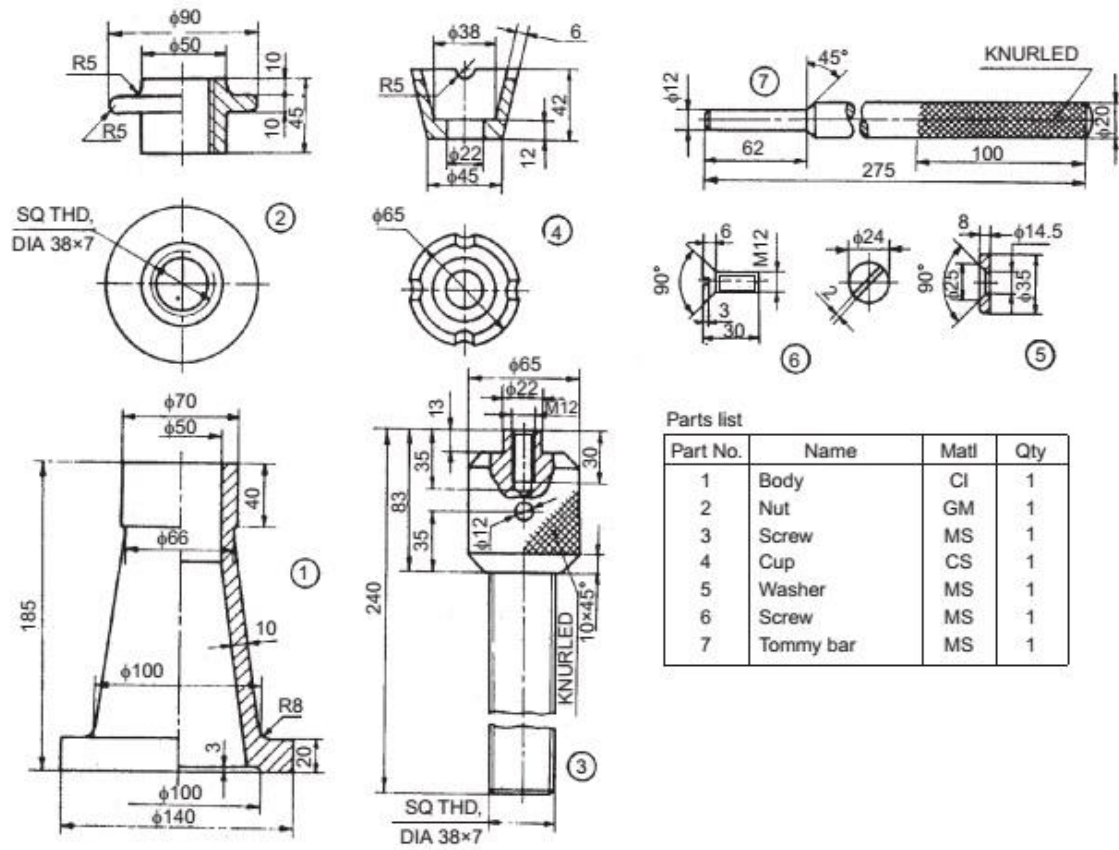
Introduction:

Screw jack is a simple machine, which can raise a very heavy load through some distance by applying, comparatively, small force at the end of a long lever. The simple design is shown in figure can raise the load through a small distance, in a vertical direction, only. These are also design to raise the load vertically and then to carry it horizontal for a small distance. Small jacks are found in every automobile toolbox, which are used to lift the automobile for changing the wheels.

The screw jack consist of Cast Iron body in top flanges of which is fitted a G.M. Nut. In the nut works as M.S. square thread spindle. In the head of the screw is made a through hole, in which the Tommy bar is inserted, for turning the screw. The end of the Tommy bar is knurled to provide good grip for holding. The C.S cap is put on the head of the spindle and I free to rotate about the cylindrical projection on the spindle head. The cup is loosely held in position by a screw and washer. To achieve a good grip of the load on the cup, the upper face of the cup is serrated.

Use of the Screw Jack:

The screw jack is used for lift up the vehicles by applying small effort for changing the tyres.



Commands used to make the Screw Jack:

The following commands are used to make the drawing of the Screw Jack:

Line command, Offset, Circle, Trim, Dimensions, Properties of the line, Hatch, Arc and Polyline.

EXPERIMENT- 8

Aim: Draw the following views of the wall bracket:

- a) Front View, or
- b) Top View.

Introduction:

Some time it is required to support a shaft from the ceiling of a room or from beam. In such cases, shafts are carried by bearing fitted on hanger. These hangers are of various types that are: U Shaped and J shaped. As usual the wall brackets are used to hold the shaft which have carrying the shaft.

A wall bracket holds a bearing, which supports an overhanging shaft, which is parallel to and near a wall. The bearing is bolted to the wall bracket is bolted to a pillar or a wall. Brackets also find their use in holding insulator on electric transmission poles.

There are numerous types of wall bracket but common feature of most of the brackets are, a cast with a vertical plate. Their shapes resemble a cantilever. The vertical plate is bolted to the wall or pillar. A few type of bracket are illustrated in the following figure.

Commands used to make the Wall Bracket:

The following commands are used to make the drawing of the Wall Bracket:

Line command, Offset, Circle, Trim, Dimensions, Properties of the line, Arc.

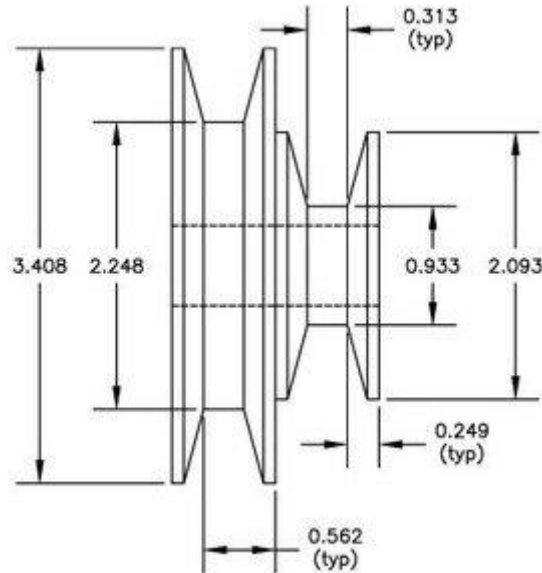
EXPERIMENT- 9

Aim: Draw the views of the Stepped Pulley.

Introduction:

Pulleys with the help of belts and ropes are employed for transmitting the power from one shaft to another, when the shafts are a considerable distance apart. Pulleys may be made of cast iron, wrought iron, steel, wood depending upon size and the condition of the work.

By putting the belts on different speed of the driving or driven shaft can be obtained while the driver shaft runs at constant speed. Figure shows the four speed cast iron, stepped pulley. To reduce the weight the pulley is made hollow.



Commands used to make the Stepped Pulley:

The following commands are used to make the drawing of the Stepped Pulley:

Line command, Offset, Erase, Trim, Dimensions, Properties of the line, Arc.

EXPERIMENT- 10

Aim: Draw the views of the V-belt Pulley.

Introduction:

Pulleys with the help of belts and ropes are employed for transmitting the power from one shaft to another, when the shafts are a considerable distance apart. Pulleys may be made of cast iron, wrought iron, steel, wood depending upon size and the condition of the work.

These pulleys are provided with grooves on the rim to accommodate the rope or V-belt. The shape and size of groove depends upon the rope and belt used. The figure shows the sectional view of the pulley with V-grooves.

Commands used to make the V-belt Pulley:

The following commands are used to make the drawing of the Stepped Pulley:

Line command, Offset, Erase, Trim, Dimensions, Properties of the line, Arc.

EXPERIMENT- 11

Aim: Draw Spur Gear showing few teeth, with the following data:

Number of teeth:

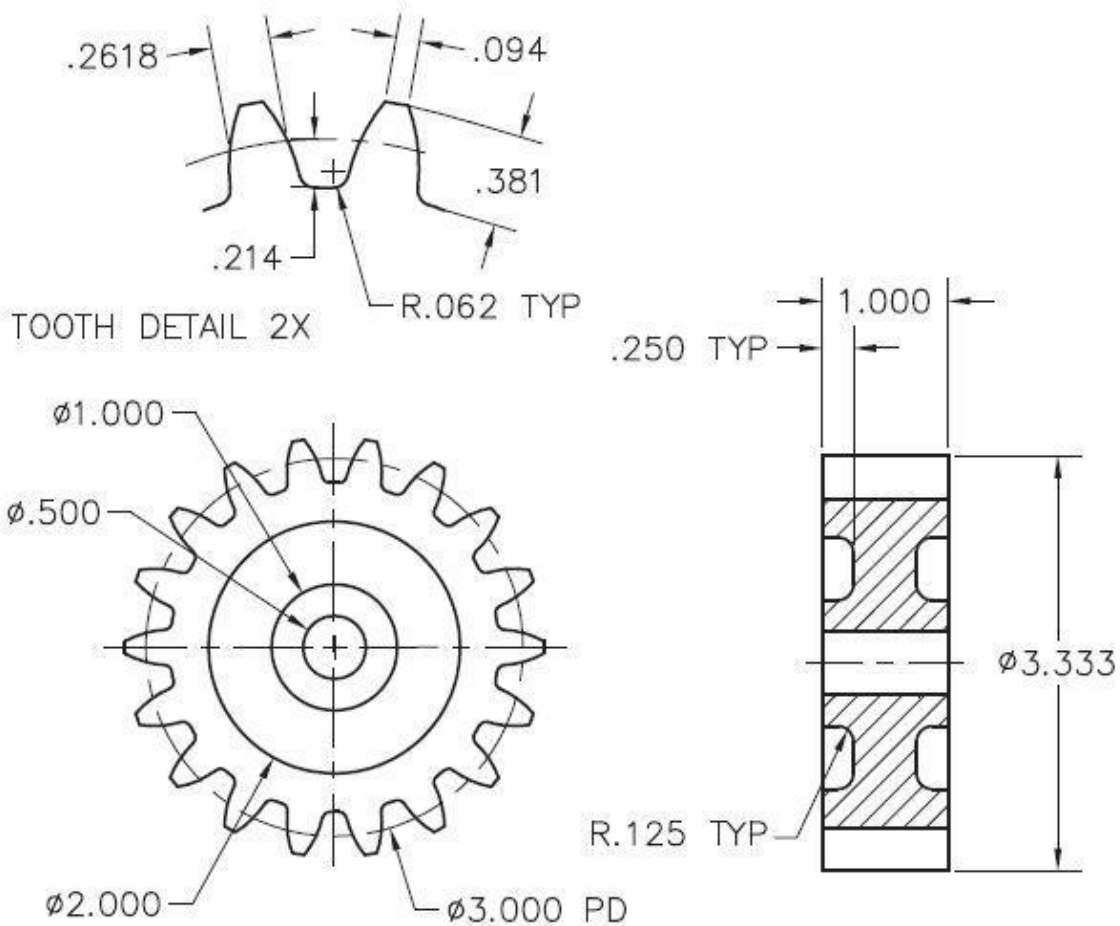
Metric Module:

Introduction:

When the power and the motion are to be transmitted from one shaft to another, which is close enough, the purpose can be met with friction gear. When considering a pair of spur gear we imagine the existence of a pair of rolling cylinders, matting together and having the same velocity ratio as the spur gear. The surface of the smooth cylinder is called Pitch surface and outline or circumference are taken on and from these circles. Thus the diameter of its pitch circles.

Curves use for the profile of teeth:

The colloidal teeth curves, portions are shown in figure and the involutes of a circle, the early part of which forms the working profile involutes tooth. The normal through any point on any of the above curves passes through the point of contact of the corresponding portion of through rolling circle with the fixed line.



Commands used to make the Gear:

The following commands are used to make the drawing of the Spur Gear:

Line command, Offset, Erase, Trim, Dimensions, and Array.

Practicals

PRACTICAL NO. - 1

Object : *Identify various tools of refrigeration kit and practice in cutting, bending, flaring, swaging and brazing of tubes.*

The refrigeration and air conditioning service engineer performs his inspection and routine rectification work mainly with hand tools and instruments. To be successful he must have good tools, good care of them and good skill in their use. Use of poor hand tools leads to poor workmanship. Therefore the refrigeration and air conditioning engineer must have thorough knowledge to adopt correct work procedure with his tools and instruments.

I. Refrigeration tool kit :

1. Gauge manifold set or combination gauge set : Normally small units are not provided with gauges, the service engineer must apply his own gauge manifold set on these units so that the pressure existing in the high and low side can be checked. The gauge manifold set is quite handy and consists of two tee valves and a special tee as shown in Fig. P-1.1 and is so constructed that opening or closing of stem affects only one opening, the other two openings of the valve remain open at all times. The set is used to obtain pressure readings on both high and low sides while ;

- (i) Adding oil to the system
- (ii) Adding or recharging the refrigerant

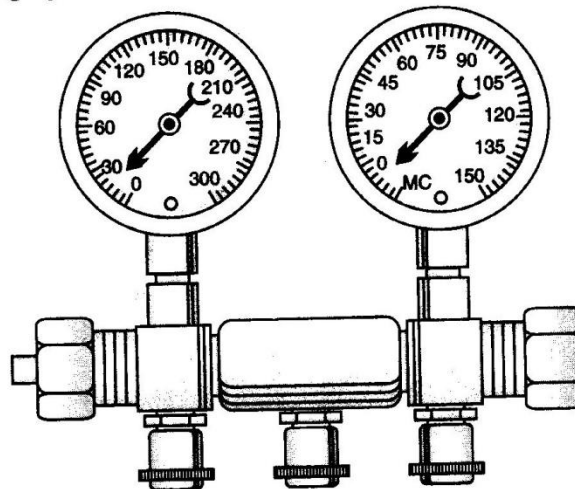


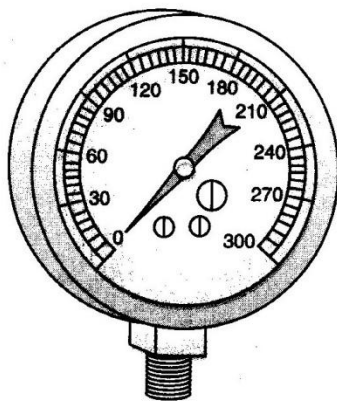
Fig. P-1.1. Combination gauge set.

- (iii) Purging off an excess of refrigerant or air
- (iv) Pumping the refrigerant from one side to the other side of the system.

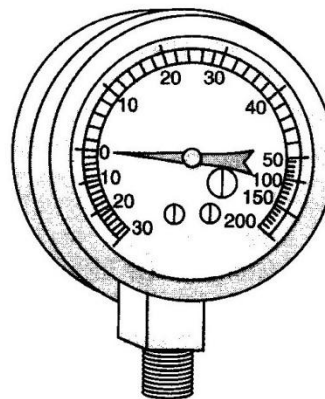
2. Gauges : The gauges used during refrigeration servicing are ;

- (a) High pressure gauge
- (b) Low pressure (*compound*) gauge

The high pressure gauge is equipped with a dial for measuring pressures from 0 to 300 pounds per square inch. The standard type of low pressure gauge is also called a compound gauge because its construction permits a reading of both pressures in pounds per square inch and vacuum in inches of mercury as shown in Fig. P-1.2 (a) and (b). The standard compound gauge dial is graduated to record a pressure range from 30 inches of vacuum to 150 or 200 pounds per square inch and is used on low side of the system. Gauges used in refrigeration service should be graduated to read approximately double the actual working pressure.



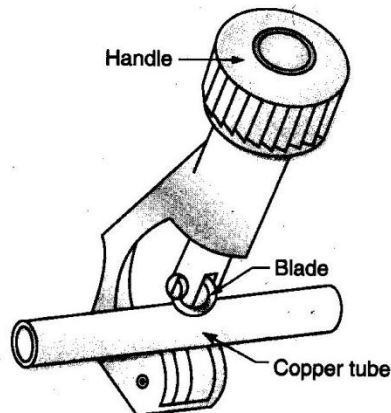
(a) A sketch of high pressure gauge



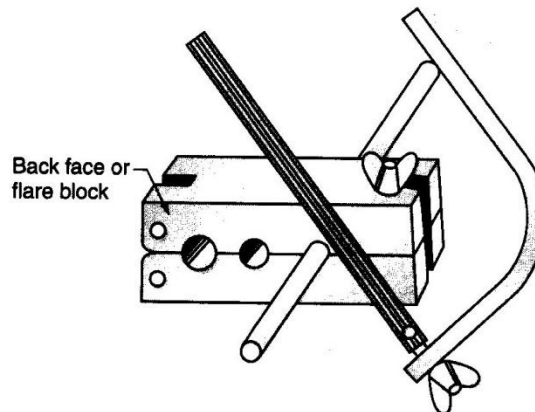
(b) A sketch of low pressure gauge

Fig. P-1.2.

3. Tube cutter : In refrigeration and air conditioning system, two types of copper tubing is used. Commonly the smaller machines utilize soft copper tubing. This tubing can be easily



(a) A sketch of tube cutter



(b) Method of cutting tubing with hacksaw in a flaring block

Fig. P-1.3.

installed because it can be bent around obstructions and elimination of many elbows is also possible. Therefore, while cutting soft copper tubing, an easy and quick method is to apply a tube cutter as shown in Fig. P-1.3 (a). The tube to be cut is held in between the roller and the cutter wheel. High pressure is applied in the lead screw. Revolving the cutter slowly around the tubing and feeding gradually the sharp cutting wheel into the tubing makes a clean right angle cut.

Hard copper tubings are cut by a hacksaw when held in a flaring block as shown in Fig. P-1.3 (b).

4. Flaring Tool : A flaring tool consists of two bars held together by a fly nut and bolt. The bars are provided with holes for the various size of tubing ranging from $\frac{3''}{16}$ (38 mm) to $\frac{5''}{8}$ (125 mm) as shown in Fig. P-1.4 (a). A yoke containing the flare forming die is slipped on the bars and the handle is rotated to produce a flare as shown in Fig. P-1.4 (b). This tool is widely used because of its simplicity and ease of performing the flaring operation. The flares produced by the flaring tool by correct operation forms a gas tight semipermanent joint.

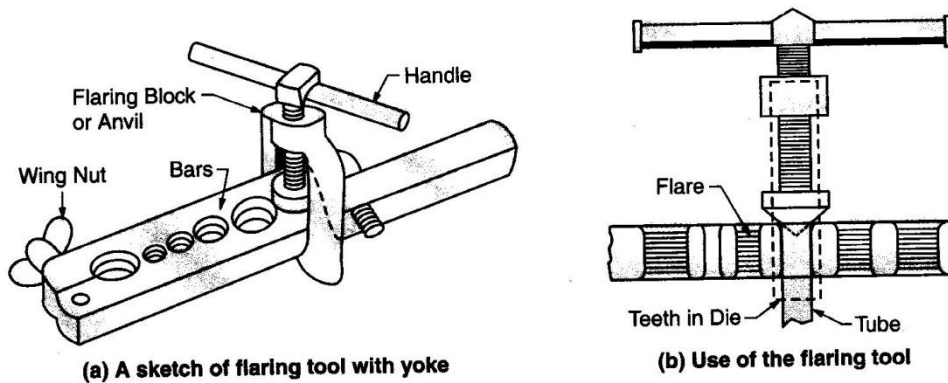


Fig. P-1.4.

5. Tube bender or spring bender : To bend the tube, two types of benders are available. They are spring type bender and pulley type bender. A spring bender can be used for making a bend in the tubing. While using a spring type bender, make sure that tubing should be bent somewhat farther than it is required and then bent upto the proper angle. Then the spring is loosened and can be easily removed as shown in Fig. P-1.5 (a) and (b).

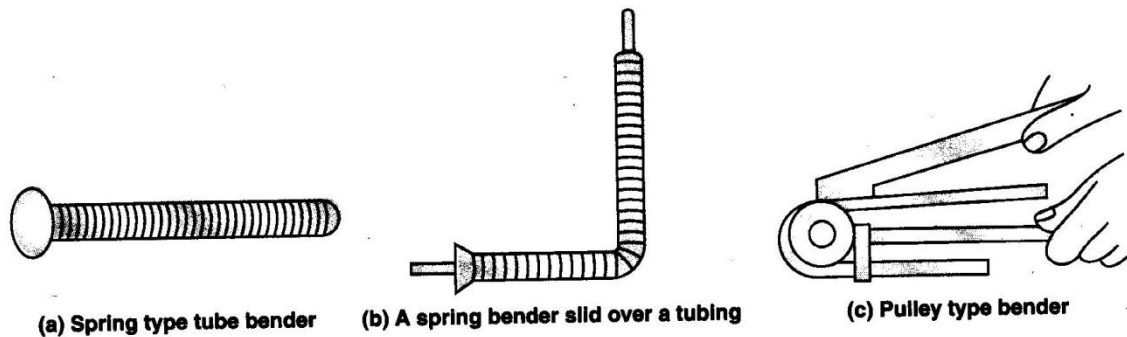


Fig. P-1.5.

A pulley type bender as shown in Fig. P-1.5 (c) is used to form bends upto 180° in one continuous operation. The pulley is calibrated to show the degree of bend attained.

6. Swaging Tool : Swaging is the process of shaping copper tubing so that two pieces can be joined without the use of fitting and the tool used for this process is called the swaging tool and its shape is like a punch. The tube to be swaged is held in the flaring block and the flaring block is held in the vice. The protrusion of the tube above the flaring block is the distance of its diameter added with 3 mm. The swaging tool as shown in Fig. P-1.6. is hammered into the tubing to a depth equal to its original diameter. Once swaged, remove the swaging tool and insert other piece of tubing in the swaged portion and check the looseness. If correct, heat up the joint and add solder or braze it to make a permanent joint.

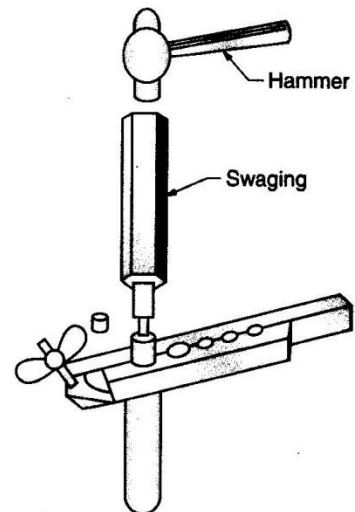
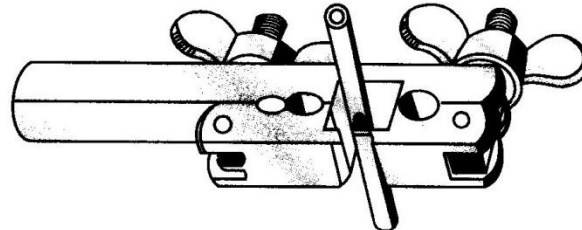
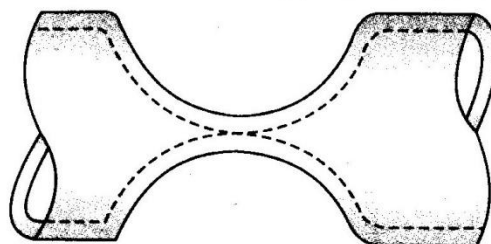


Fig. P-1.6. A sketch showing swaging tool, swaging the open end of a tube.

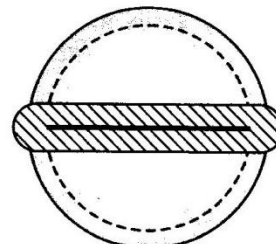
7. Pinching Tool : Large plants are equipped with valves to enable any portion or section to be closed off during repair works without loss of the refrigerant charge. But the smaller plants where the valves are eliminated, makes it difficult during the service period. Therefore to overcome the refrigerant leakage during the change or repair of part, the pinching tool shown in Fig. P-1.7 (a) is used for closing the copper line so that the defective or worn part can be removed and replaced. The pinching tool jaws are so designed that tube is pinched shut but not mashed as shown in Fig. P-7 (b) and (c). After the completion of repair or replacement work, the round opening of pinching tool is used to round up the pinched section.



(a) A sketch of pinching tool



(b)



(c)

Fig. P-1.7. A pinched copper tubing.

8. Halide Leak Detector : Leaks in Freon refrigerant system can be detected by the use of halide leak detector. The leak detector as shown in Fig. P-1.8 is charged with rectified

spirit which on burning produces a colourless flame. Air for combustion is drawn in through a tube fitted at the base of the burner. The flame burns through a small disc made of copper. The tip of the hose is held near the suspected leak point and if any refrigerant is present, it passes through the hose and comes in contact with the red hot copper disc resulting in break down of the refrigerant into its compounds and in doing so, changes the flame from colourless to green for a slight leak and to brilliant purple if the leak is heavy.

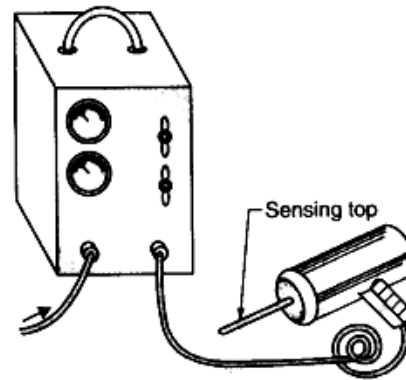
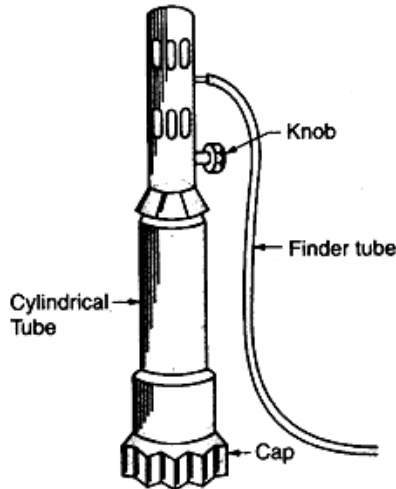


Fig. P-1.8. A sketch of halide torch or leak detector. Fig. P-1.9. A sketch of electronic leak detector.

9. Electronic leak detector : It is an electrical operated instrument used for finding the leakage of freon refrigerants. As shown in Fig. P-1.9, it measures the resistance of gas in air and shows the current on a milli ampere dial scale. It indicates the leaky point of refrigerating machine giving sound or bell.

10. Blow lamp : It is used for soldering brazing and heating purposes. Its construction is similar to cooking stove with a brass tank burner and pump. Kerosene oil as fuel is used and flame can be used in any direction. Fig. P-1.10 shows a blow lamp.

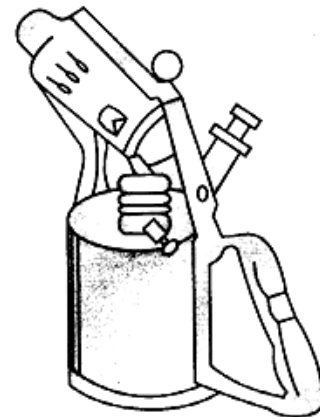


Fig. P-1.10. A blow lamp.

11. Gas cylinder : It is used for storing gas which is to be charged in refrigerating machines. It is made of cast steel with one opening at the service valve and size depends upon the gas which it can store by weight in kilo grams. The larger cylinders are fitted with fusible plug threaded into the bottom so that in case of danger it may not burst. Fig. P-1.11 shows a gas cylinder.

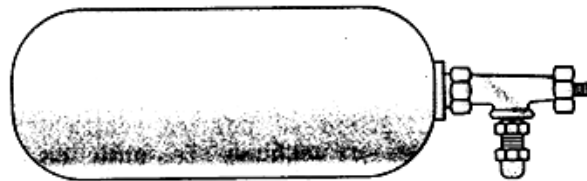


Fig. P-1.11. A gas cylinder.

12. **Soldering iron** : It is used for soldering joints with soldering wire. Rosin or hydrochloric acid is used as flux during soldering. There are two types of soldering iron ; country made or common and electric soldering iron. The first one is heated by a blow lamp or in a furnace and its size depends upon its weight. But in the second, a heating element is provided which heats it up. Its size depends upon the wattage of the heating element. It can be 35 watts or 65 watts. A 65 watts soldering iron is very common for soldering purpose. Fig. P-1.12 shows a sketch for electric soldering iron.

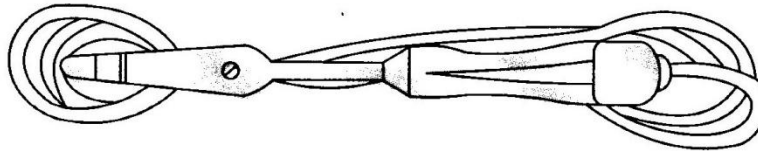


Fig. P-1.12. A sketch for electric soldering iron.

13. **Vacuum pump** : It is a pump used for evacuating air from a refrigerating system equipped with sealed unit before charging gas.

Instruments : Some special instruments are used for checking the internal condition of a refrigerating machine and faults such as.

1. **Stem type refrigeration thermometer** : It is an instrument used for measuring the temperature of various parts of a refrigerating machine. The temperature range of this thermometer is -20°F to 120°F on Fahrenheit scale or -25°C to 50°C on centigrade scale in graduations of two degrees Fahrenheit or centigrade. Sometimes some dial thermometers are also available which show the temperature in degrees directly. Fig. P-1.13 shows a stem type Fahrenheit pocket thermometer.

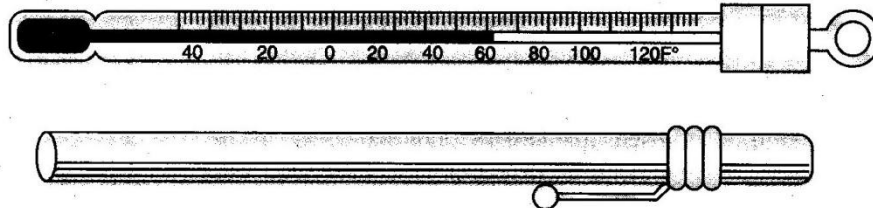


Fig. P-1.13. A stem type fahrenheit pocket thermometer.

2. **Sling psychrometer** : It is an instrument used to measure the percentage of humidity or moisture present in a refrigerated or air conditioned space.

II. Practice in cutting, bending, flaring, swaging and brazing of tubes.

(i) **Cutting of Copper Tubing** : During the fabrication of refrigeration and air conditioning units, different length of tubes and pipes are required. To fulfill this requirement, it becomes necessary to cut tubes or pipes as per design of refrigeration and air conditioning unit.

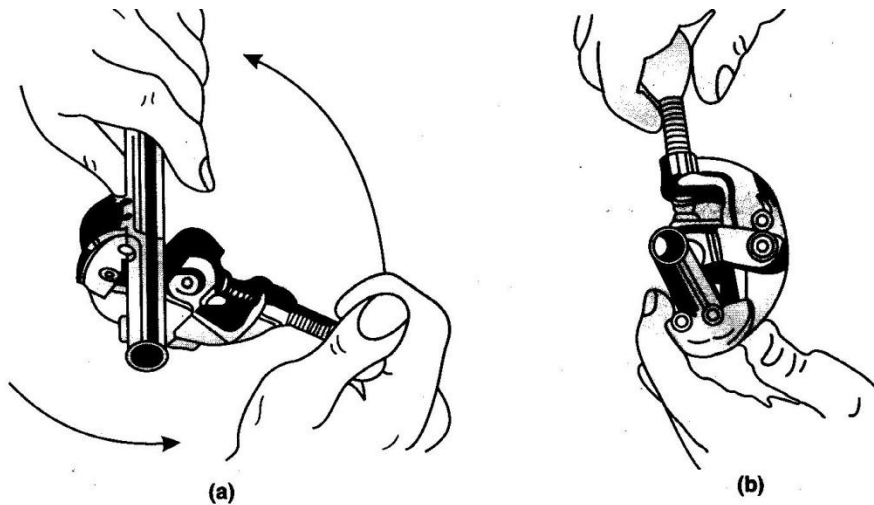


Fig. P-1.14. Tube cutter in use.

Objective : To learn how to cut a copper tubing.

Main items required :

1. Soft tubing of different sizes
2. Tube cutter
3. Steel rule
4. Small triangular file

Working steps :

1. Unroll the required size say 6 mm of soft copper tubing so that the required length say 100 mm piece may be cut.
2. Using steel rule to measure the length of 100 mm and mark it by nicking the surface with a triangular file.
3. Grip the tubing in the V-guide of the cutter.
4. Tighten the thumb screw applying considerable pressure.
5. Revolve the cutter slowly and smoothly around the tubing to feed the sharp cutting wheel gradually in the tubing.
6. After each turn, turn the thumb screw to apply pressure and continue to turn the cutter around the tubing till the tubing is completely cut.
7. Seal the end of the tubing coil after cutting off the required piece.
8. Ream and file the edges of the tubing.
9. Repeat taking different diameters of soft copper tubing.

Precautions :

1. Only the required length of tubing should be unrolled as unrolling and rolling again and again tends to harden and kink the tubing.
2. Make sure no chips enter the tubing while reaming the tubing.
3. While cutting, ensure that the mark coincides with tube cutter blade.

(ii) **Flaring of Copper Tubing** : To connect different components of a refrigerator and air conditioning units, it is essential to have a leak proof mechanical link. Though there are different methods of making joints of copper tubing according to their uses and sizes, yet flaring is the most common and easy. Flaring is done at the end of tubing attaching a flare nut. It is a permanent leak proof joint used during the servicing and repairing of the unit because it is easy to assemble and disassemble as per requirement.

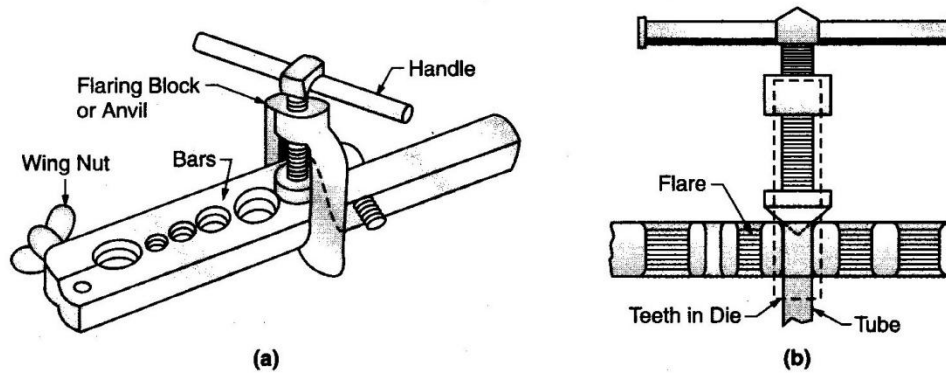


Fig. P-1.15. Flaring tool & use of flaring tool.

Objective : To learn the proper technique of flaring a copper tubing.

Main items required :

1. Flaring tool
2. Tube cutter
3. Triangular file
4. Steel rule
5. Set spanner
6. Soft copper tubing of different diameters.

Working steps :

1. Unroll the required size say 6 mm and required length say 60 mm of soft copper tubing and repeat steps 1 to 9 as mentioned in tube cutting process.
10. Take the required piece and place it in the correct position in the flaring block.
11. Tighten the clamp with the help of spanner or fly nuts if provided.
12. Select the proper yoke for the size of the tubing to be flared and attach it to the flaring block.
13. Turn the cone slowly and smoothly to the end of the tubing.
14. After the flare completion, unscrew the yoke and remove the flared tubing from the flaring block.
15. Check the flare with the flare nut for proper seating.
16. Repeat above steps for different diameters of copper tubing.

Precautions :

1. Always unroll the required length of the tube during cutting and ensure that mark coincides with tube cutter blade and firmly gripped in flaring bar.
2. Protrusion of the tube should not exceed more than 5 mm above the flaring block surface.
3. Apply a little bit of the oil on the tip of the yoke cone.
4. Never rotate the yoke cone continuously in a forward direction. Take a three quarter turn in the forward direction followed by a quarter turn in an opposite direction.

(iii) Bending of Copper Tubing : During fabrication of the refrigeration and air conditioning units, different bends of the tubes and pipes are required. Therefore, it is necessary to learn the technique of bending the tube or pipe matching the design requirement of refrigeration and air conditioning unit.

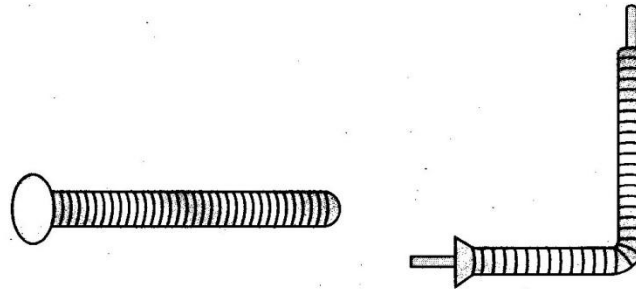


Fig. P-1.16. Spring type tube bender.

Objective : To learn the technique of bending copper tubing.

Main items required :

1. Tube bender spring type for 6 mm diameter and above or pulley bender.
2. Tube cutter
3. Steel rule
4. Triangular file
5. Soft copper tubing of required size.

Working steps :

1. Unroll the required size say 6 mm and required length say 250 mm of soft copper tubing and repeat steps 1 to 9 as mentioned in tube cutting process.
 10. Slip a 6 mm spring bender over a 6 mm tube piece and form the required bend. The 90° bend is shown in the figure.
 11. The tube bender should be bent a little further than that is required and then backed upto the proper angle.
 12. Remove the spring bender slowly by twisting the spring against its spiral.
 13. Repeat the process if different diameters of copper tubings need bending.
-

Precautions :

1. Only the required length of the tube should be unrolled after specifying the length needed while cutting the tube with the tube cutter.
2. Opening of the tubing should be held vertically down while reaming and filing to avoid any chip remaining inside.
3. While removing the spring bender, grip the tube in one hand and rotate the spring against its spiral with the other hand.
4. Always bend the tube into the largest possible radius to avoid the tube to flatten.

(iv) **Joining of Copper Tubing :** When permanent joint between two tubes is required, the method of swedging or swaging is used. By adopting this method, the chances of leakage become less as swedging or swaging is followed by brazing which results in good joint of two tubes. This process is cheaper than the flare fitting.

Objective : To learn the proper technique of swaging of copper tubing before joining.

Main items required :

1. Tube cutter
2. Steel rule
3. Triangular file
4. Flaring bar
5. Swaging tool
6. Spanner
7. Soft copper tubing
8. Silver soldering rod
9. Brazing flux
10. Ball peen hammer
11. Blow lamp or gas welding set
12. Combination plier

Working steps :

1. Unroll the required size and required length of soft copper tubing and repeat steps 1 to 9 as mentioned in the tube cutting process.
10. Take the required piece of the tube and place it in correct position in the flaring block.
11. Tighten the clamp either with spanner or fly nuts.
12. Choose the proper swaging tool for the size of the tubing to be swaged.
13. Clamp the flaring block in the vice, apply a drop of oil on the tip of the swedging tool and slowly hammer the swedging tool.
14. Feed the tool slowly and smoothly into the tubing to a depth equal to its original diameter.

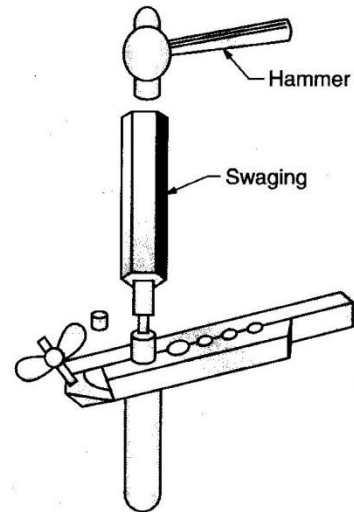


Fig. P-1.17. Swaging tool.

15. After the completion of swedging, remove the tool as well as the swedged tube from the flaring block.
16. Insert another piece of the same size of copper tubing into the swedged copper tube to ensure tightness.
17. Repeat the process if different diameters of copper tubings need swaging.
18. If the tightness of the other piece into the swedged tube, is satisfactory, clean them properly.
19. Hold the job with plier keeping the joint in vertical position.
20. Heat the joint evenly by a blow lamp or a welding torch.
21. Apply brazing flux on the joint while heating.
22. Feed the silver solder all round the connection between the tubing and fitting.
23. After making of a fine layer of the silver solder on the joint, let it be cooled.
24. Repeat the process if different diameters of copper tubings need brazing.

Precautions :

1. Only the specified length of tubing should be unrolled after due decision of the diameter while cutting the tube to avoid kinking of the tubing.
2. A drop of oil should be applied on the tip of the swaging tool.
3. Keep the joint in vertical position while brazing.

(v) **Pinching of Copper Tubing :** In domestic sealed units, there are no valves provided. The pinch off tool offers a mean of closing the copper tube during the replacement of defective or worn out part. It is also used on charging line of a sealed compressor to close the passage after the refrigerant is charged in the system.

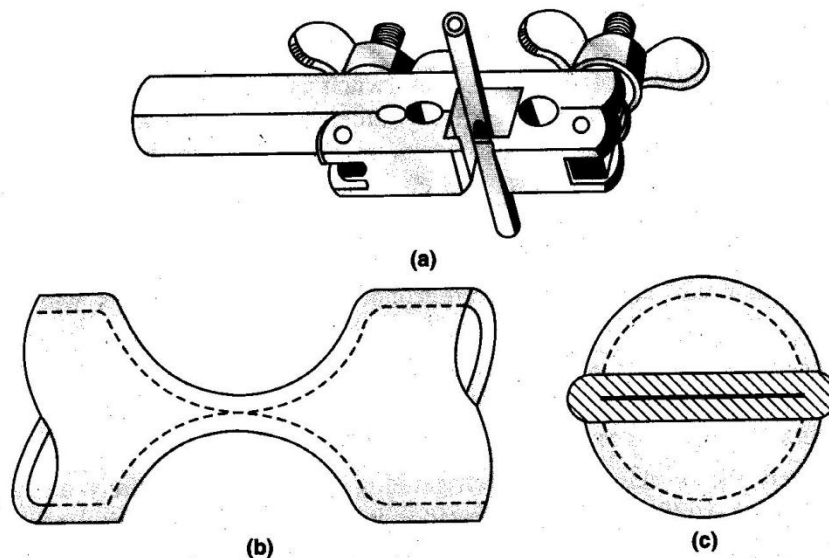


Fig. P-1.18. Pinch off tool.

Objective : To learn the proper technique of pinching copper tubing.

Main items required :

1. Tube cutter
2. Steel rule
3. Triangular file
4. Pinch off tool
5. Soft tubing of required diameter and length.

Working steps :

1. Unroll the required size and length of soft copper tubing and repeat steps 1 to 9 as mentioned in the tube cutting process.
10. Place the copper tube in the pinch off section of the pinching tool.
11. Apply equal pressure by turning both the screws of pinch off tool by hand.
12. Tighten both the screws turn by turn by an equal amount.
13. The tightening process continues until both the blocks are evenly seated.
14. The tube is then called pinched shut.

Precautions : The pinch off tool should not be applied on a surface once used or bent.

PRACTICAL NO. - 2

Object : Study of thermostatic switch, Low pressure/High pressure cut out over load protector, filters, strainers and filter driers.

(i) **Thermostatic switch :** It is that switch which is used to control the temperature of the refrigerated space by making and breaking the electric circuit of compressor motor or solenoid valve in the liquid line.

The constructional feature of the thermostat switch is shown in the Fig. P-2.1. It consists of four main parts *i.e.* thermal bulb, capillary tube, bellows (*Power element*) and electrical contact points. The capillary tube is the medium to attach thermal bulb with the bellows and thermal bulb, capillary tube and bellows are charged with the same refrigerant which is used in the system. Electrical points have the link with the power element and dial knob.

It is mounted with the body of the machine and the thermal bulb is clamped with the last coil of the evaporator and contact points are connected in series circuits with the compressor motor.

As the evaporator temperature increases, bellows expand to complete the electrical circuit and starts the motor. When the evaporator temperature decreases, bellows contract to open the electrical circuit and the motor stops.

In this manner, the working of the refrigerating unit is made entirely automatic to obtain the desired refrigeration effect. The thermostat switch works with certain range of temperature and this temperature range is divided into some divisions on the dial knob which can be easily adjusted by turning against any of the points or division from OFF to ON position. Range

screw is used to increase or decrease the temperature range of the thermostat switch. The differential screw is provided to increase or decrease the *cut in* and *cut out* points.

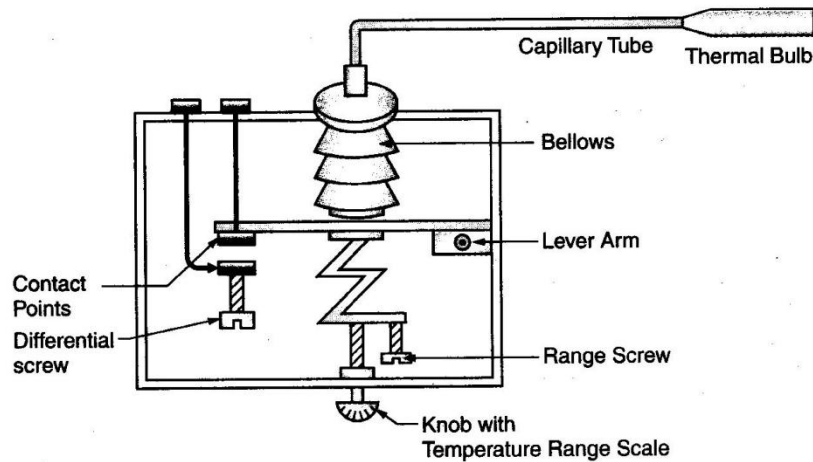


Fig. P-2.1. Thermostat switch.

(ii) **Low pressure/High pressure cut out** : There are two types of pressure controls in use.

1. Low pressure cut out or Low pressure control : The low pressure control is used to control the low pressure side of the refrigerating system. It operates on the pressure difference in the low side. The low pressure control is a switch which controls the low side pressure within certain limits by controlling the working of the compressor motor. Thus it prevents the overload conditions on the motor due to too low back pressure.

The constructional feature of the low pressure control is shown in the Fig. P-2.2. The main parts of the low pressure cut out or control switch are main body, bellows, contact points, knob for adjustment and *cut in* and *cut out* scale. The main body is installed on the condensing unit and the bellow is connected to the low side of the compressor and contact points are connected in the series circuit of the motor.

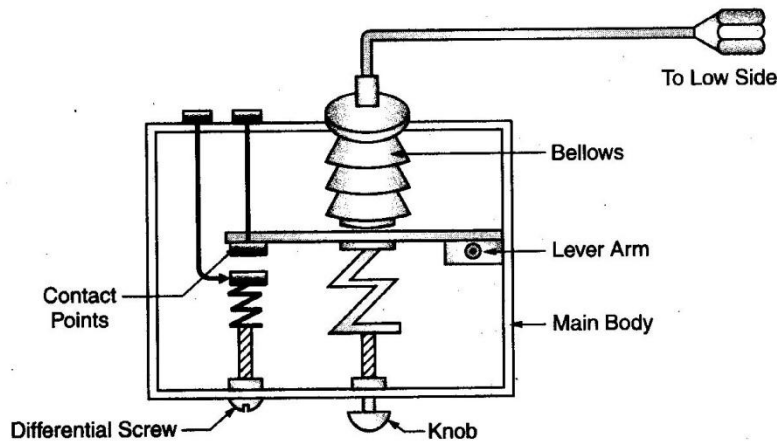


Fig. P-2.2. Low pressure cut out or low pressure control switch.

- During normal operation, when the back pressure remains constant as set on the low pressure control, the compressor motor runs continuously. But once the pressure goes below the cut out setting, the bellows contract and operates the switch to open the electric motor circuit thus stopping the motor. During the stopping period of the motor/compressor, the back pressure increases and this increase in pressure is conducted through the tubing causing the bellows to expand. The expansion is transmitted through the lever arm, closing the electrical contacts. Therefore, the motor circuit is completed and the compressor motor starts. The low pressure control finds its application in commercial refrigerating machine.

2. High pressure cut out or high pressure control : A high pressure control is a switch which controls the high side pressure in certain range by controlling the working of the compressor motor. Thus it prevents the over load conditions on the motor due to excessive high head pressure.

The constructional feature of the high pressure control is shown in Fig. P-2.3. The main parts of the high pressure control switch are main body, bellows, contact points, knob for adjustment and *cut in* and *cut out* scale.

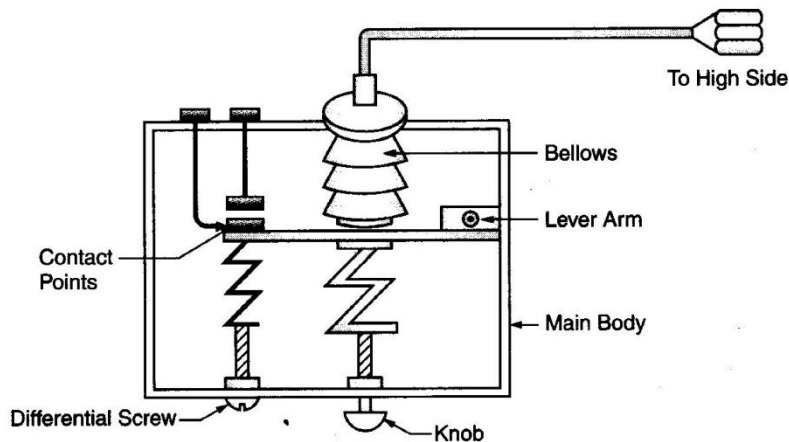


Fig. P-2.3. High pressure cut out or high pressure control.

The main body is installed on the condensing unit. The bellow is connected to the high side of the compressor and contact points are connected in series circuit of the motor.

The working of the high pressure control switch depends upon the pressure difference in the high pressure side of the system. When the high pressure goes above the switch setting, it causes the bellows to expand and disconnect the electrical circuit thus stopping the motor. During the stopping period of motor/compressor the pressure decreases to the normal position causing the bellows to contract. The contraction is transmitted through the lever arm, closing the electrical contacts, thus completing the motor circuit and starting the compressor motor. The high pressure control finds its application in commercial refrigerating machines.

(iii) Overload protector : It is a protective device for the motor. It is commonly used in the sealed units and is either fitted outside or inside the sealed cover. In construction is as shown in Fig. P-2.4 (a). Overload protector consists of a heating coil and bi-metal disc upon which contacts are mounted. It is connected in series circuit with the motor winding. The function of the overload depends upon the operating temperature and current flowing through

the motor winding. When the current in the motor winding increases, the heat developed by the passage of current through the bimetallic overload switch, causes it to bend and open the contacts and stops the motor before any damage occurs. The motor winding connections in the normal condition and hot condition are shown in Fig. P-2.4 (b) and (c) respectively.

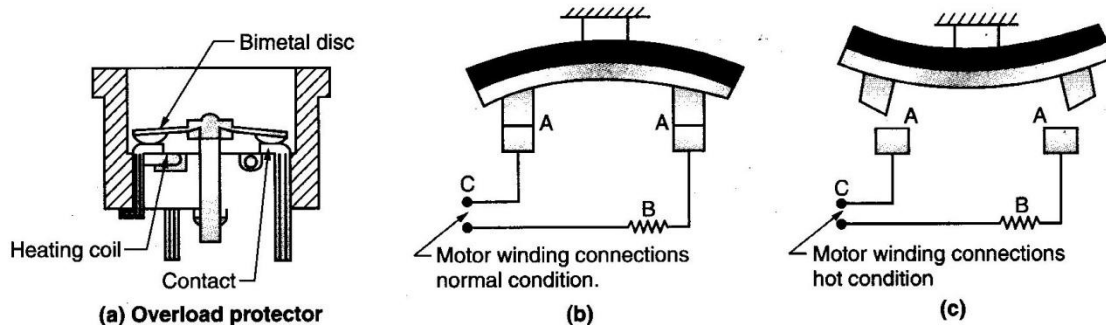


Fig. P-2.4.

N.B. : After sometime the bimetal disc cools and returns the contacts to the closed position. This makes the circuit to the motor winding and the motor restarts. The time required for the overload switch to reset varies with the room temperature.

(iv) **Filters and strainers :** These are fitted on the liquid line to retain the solid particles passing with the liquid through them. They are made in the form of a screen from very fine metallic mesh.

(v) **Filter driers :** The filter drier as shown in Fig. P-2.5 (a) is more popular in use to retain the solid particles and other impurities and also to absorb moisture in filtered in to the system. They are generally made of brass or steel cylindrical shells and have arrangement at both ends for making connections. The desiccant used is either silica gel or activated alumina. The spring helps to compress the desiccant so that its individual particles do not move when the refrigerant passes through it. One metal gauge strainer on the inlet and two metal gauge strainers on the outlet side of the filter drier retain the coarse and fine impurities respectively.

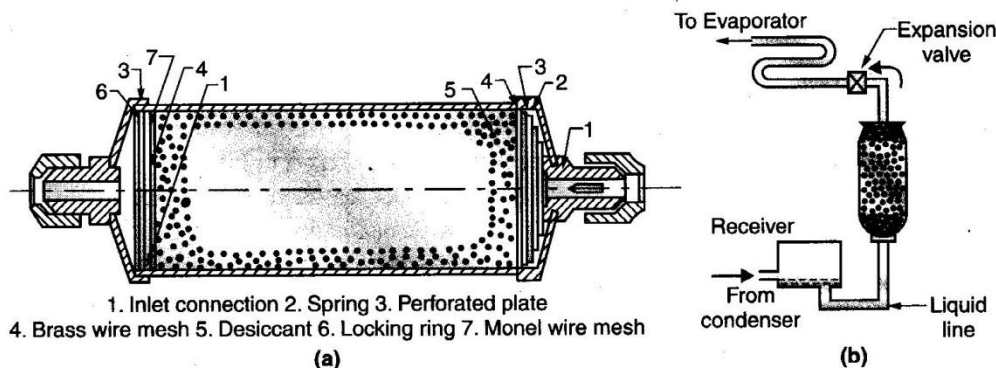


Fig. P-2.5. Filter-drier.

N.B. : The silica gel filter driers are manufactured with permanent charges when the drier volume is 50 to 500 cm³ under working pressure up to 22 bar.

The filter drier fitted on the liquid line after the condenser or the receiver and before the expansion valve is shown in Fig. 2.5 (b).

N.B. : When ammonia or sulphur dioxide is used as refrigerant, the drier is not used.

PRACTICAL NO. – 3

Object : Identify various parts of a refrigerator and window air conditioner.

(i) **Refrigeration :** Now-a-days, the refrigerator has become an essential part of a household and is no more a luxury item as it used to be. It is an enclosed cabinet designed to provide low temperature for preserving perishables food stuffs and medicines etc. Its essential secondary function is the formation of ice cubes for domestic consumption. Refrigerators are available in the range of 65, 90, 135, 165 and 286 litres capacity and the power of compressor may be 75W, 92W, 125W, 180W and 370W etc.

Construction : Normally it consists of a small double wall cabinet equipped with air tight door. The space inbetween the walls is filled with heat insulating material like glass wool, rock wool thermocole or cork etc. To minimise the heat loss, the inner liner and outer surfaces of the cabinet are kept highly polished with shining paints. The inner liner has several shelves for storing the food stuffs. A sketch of a 165 litre refrigerator cabinet with different parts is shown in Fig. P-3.1 (a). Whereas in Fig. P-3.1 (b) the various components and their locations are indicated.

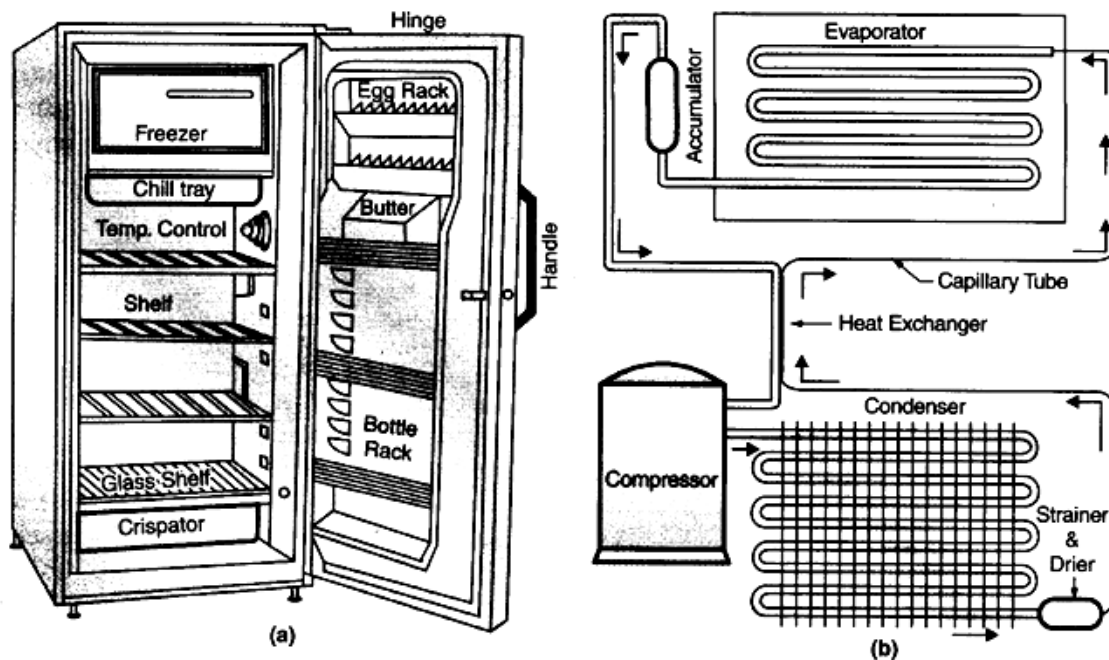


Fig. P-3.1.

The compressor is located at the bottom of the refrigerator frame. The condenser is installed at the back of the cabinet and the evaporator is placed inside the cabinet at the top. The

refrigerant used is normally Freon-12. The refrigerator is equipped with an automatic cabinet light controlled by opening and closing of the door. To control the temperature of the cabinet and making the working of the refrigerator automatic, a thermostat switch is provided on the top of the right hand side of the inner liner.

The mechanism of the refrigerator is illustrated in Fig. P-3.1 (b). The cycle of operation is explained as follows ;

1. The liquid refrigerant usually Freon-12 at low pressure and low temperature enters the evaporator A. It absorbs its latent heat from the walls and surroundings and thus producing refrigerating effect in the evaporator.
2. The refrigerant vapour is sucked by the compressor D through the suction line C. The accumulator B is placed between the evaporator and suction line to collect any liquid refrigerant coming out of the evaporator due to incomplete evaporation if any and thus it safeguards the compressor against damage.
3. The compressor D compresses the low temperature, low pressure vapour to high temperature and high pressure vapour. The compressed vapour flows to the condenser F through the discharge line E. The condenser is normally air cooled condenser.
4. In the condenser, the high pressure and high temperature vapour gives up its heat to the surrounding air and the vapour is condensed back to the high pressure and low temperature liquid.
5. The high pressure and low temperature liquid flows through the drier cum filter G and enters the capillary tube H. The capillary tube is attached to the suction line forming a heat exchanger as it is clear in Fig. P-3.1 (b).
6. The low temperature warm liquid refrigerant passes through the capillary tube gives some of its heat to the cold suction line vapour thus its heat absorbing ability increases. At the same time, the cold vapour gains heat and there is increase in the super heat of the vapour entering the compressor.
7. The refrigerant leaving the capillary tube as *low pressure low temperature liquid* enters the evaporator A, completing one cycle which is repeated over and over again.

Electrical circuit of a domestic refrigerator : A schematic diagram of electric circuit of refrigerator is shown in Fig. P-3.2 with various components.

1. Lamp and switch : When the door of the refrigerator remains closed, a spring loaded switch fitted in series with the lamp remains open as a result, the lamp remains off. As soon as the door is opened, the pressure on the spring gets released and the lamp becomes on. When the lamp is on, it is easy to trace the commodities placed in the refrigerator. Thus unnecessary consumption of electrical energy is not there and the heating effect of the lamp is avoided.

2. Thermostat switch : It is that switch which is used to control the temperature of the refrigerated space by making or breaking the electric circuit of compressor motor. The requisite temperature in the refrigerator freezer is between -7°C to -15°C while temperature of the remaining part of the refrigerator is between 7°C to 15°C . The thermostat switch controls the running and stopping period of the motor *i.e. cut in* and *cut out*. When the evaporator temperature reaches the *cut in* temperature, the circuit is completed and the compressor motor

starts. When the evaporator temperature decreases and reaches the *cut out* temperature, the compressor motor stops. This is all automatically done as per the setting of the thermostat knob.

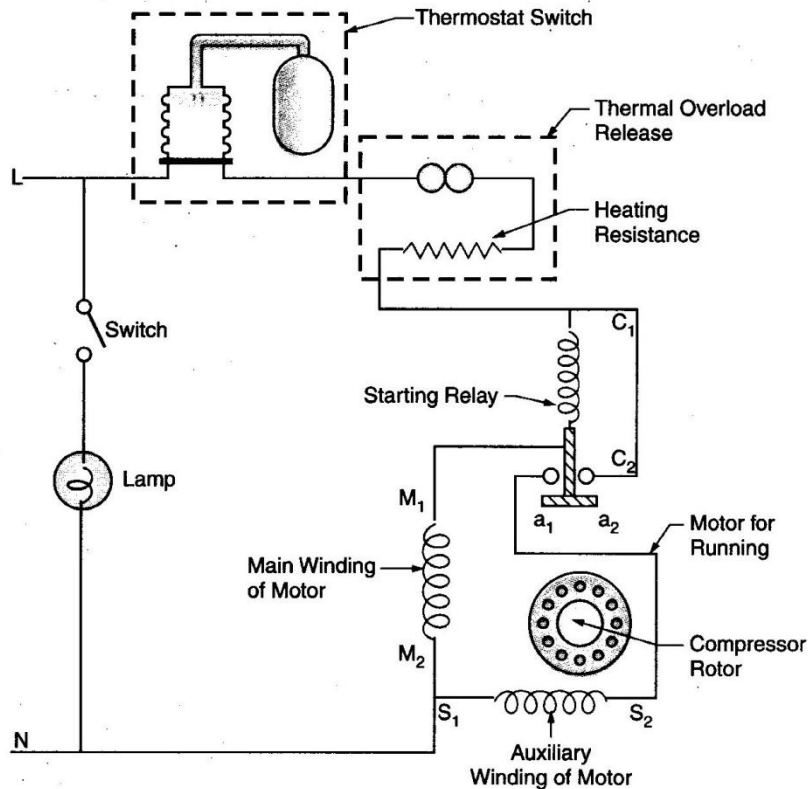


Fig. P-3.2.

3. Thermal over load release : This component is a protective device for the compressor motor and operates under two circumstances *i.e.* first when the temperature of the compressor motor rises beyond a certain value or secondly when excessive current flows in the motor. Under such conditions, the bimetallic strip disconnects the supply to the motor.

4. Starting relay : The function of the starting relay is to start the motor by putting starting winding and auxiliary winding of split phase induction motor across the supply. The main winding is directly connected across the supply through the coil of the starting relay, thermal over load and thermostat switch. If the auxiliary winding of the motor is connected across the supply, the single phase induction motor starts running otherwise this motor does not have any starting torque.

5. Electric motor : Electric motor is a fractional horse power motor. It is single phase split phase type induction motor. The size of the motor depends upon the capacity of the refrigerator.

Working : When the electric supply is connected to the refrigerator, the current passes through the thermostat switch to the thermal over load release coil C₁C₂ of the starting and main winding M₁M₂ of the motor. Since the motor is at rest, it draw heavy current. The heavy current passes through the coil C₁C₂ of the starting relay and the coil gets energised, pulling

the plunger upward connecting points a_2 to a_1 i.e. putting auxiliary winding S_1S_2 also into circuit. The moment both the windings are energised, the motor starts running. When the motor gains normal speed, the current drawn by the main winding also becomes normal. At normal current, the plunger in the coil of starting relay cannot remain pulled up and is released down opening the points $a_1 a_2$, thus auxiliary winding S_1S_2 gets out of circuit. The main function of the starting relay is to put auxiliary windings in the circuit at the time of starting the motor and to disconnect it when the motor gains normal speed. When starting relay does not close, the motor will not start and in case after closing, it does not open, the thermal overload will trip or the fuse will blow off.

General Details of A Refrigerator

1. Sealed Unit :

Motor : Split phase induction motor $\frac{1}{12}$ to $\frac{1}{6}$ H.P.

H.P.	$\frac{1}{8}$	$\frac{1}{6}$
Watts	105	145
Amperes	1	1.2
Cycles	50	50
Voltage	230	230
RPM	2850	2850

Compressor : Reciprocating single cylinder.

Relay : Amperage type, with over load protector.

Refrigerant : Freon-12 (CCl_2F_2) Dichloro-difluoro Methane.

2. Operating temperatures :

Ambient temperature	32.2°C
Evaporating temperature	-20.6°C
Condensing temperature	54.4°C
Liquid temperature	32.2°C
Return gas temperature	25°C
Compressor top shell temperature	70°C

3. Operating pressure

Suction pressure	0.48 to 0.68 bar
Discharge pressure	10.34 to 12.41 bar

4. Size of the capillary tube 0.76 mm, 3.3 to 3.6 m

5. Approximate weight of refrigerant 150 to 200 grams

(ii) Window type room air conditioner : Window type room air conditioner is that machine which is installed in a window and its exterior view is shown in Fig. P-3.3. The various controls are arranged on the front panel for its operation.

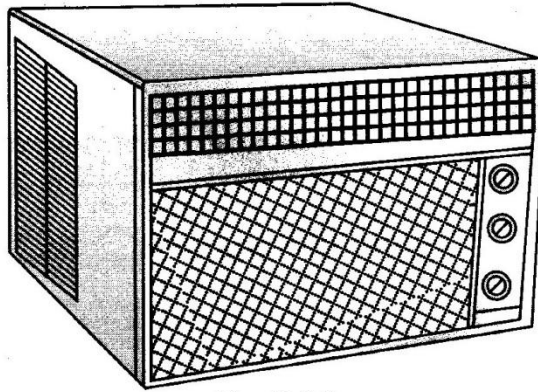


Fig. P-3.3.

(a) **Selector switch** : Whenever the need arises to start the unit, turn the selector switch knob clock- wise on mark '*Fan*'. Allow the fan to operate for two minutes before turning the knob towards mark '*Cool*'.

(b) **Thermostat** : The thermostat switch maintains the constant desired temperature in the room. By turning the thermostat knob towards high or low, the room temperature can be changed.

(c) **Fresh air damper** : To get fresh air in the room, the control knob is turned to the 'open position'. Thus the fresh air will be drawn, filtered, cooled and circulated in the air conditioned room. When the knob is turned to the close position, no fresh air is admitted and normally fresh air damper remains close.

(d) **Exhaust damper** : When we feel the smoke laden and dirty air in the room, turn the control knob at the open position. The dirty air will be exhausted to the outside. This control should also be maintained in the close position.

Construction : It has a chassis made of steel on which a fin and tube type evaporator is fitted at one end and fin and tube type condenser on the opposite end. In between the evaporator

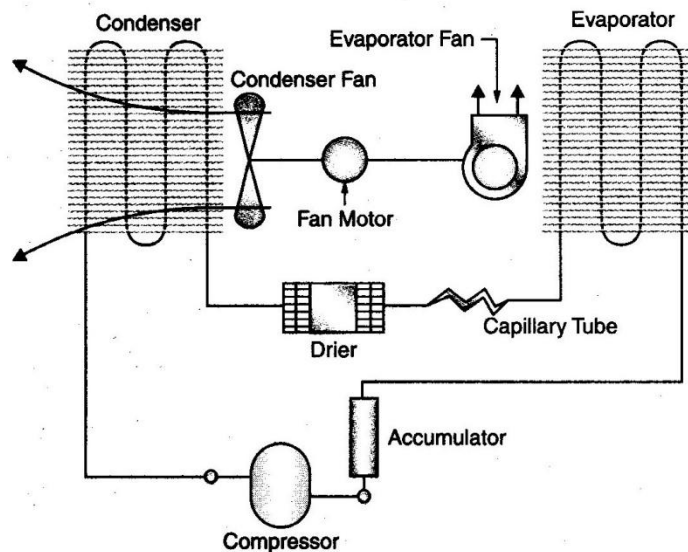


Fig. P-3.4.

and condenser, a sealed unit is installed at one side of the centre line. All the parts like discharge line, condenser, drier cum filter, capillary tube, evaporator, suction line and accumulator are connected in series as shown in the Fig. P-3.4. The complete system is charged with Freon-22 refrigerant. On the centre line, a double shaft motor is fitted. At one end of the motor shaft, a blower is fitted behind the evaporator and at the other end, a fan having a provision of water splashing ring is fitted behind the condenser. Both the bottom trays of evaporator and condenser are interlinked by means of rubber tube so that cold water from the evaporator may come to condenser. Evaporator and blower housing are insulated for preventing heat transmission. An air filter is fitted in front of the evaporator for cleaning air. This complete assembly is covered with a steel cover. The front of the unit is covered by a grille having a provision to change the direction of air. A selector switch fitted on the front operates the sealed unit and fan motor. The thermostat switch maintains the room temperature of 24 to 25°C in summer.

Operation : Reference Fig. P-3.5 during operation, the air conditioner cleans and cool the air of the room by drawing it through the air filter and evaporator with the help of evaporator blower. The evaporator blower has dual function. First it sucks warm air from the room through the filter and evaporator and then it supplies the conditioned air to the room. The compressor and condenser compartment remains outside of the room and is separated from the evaporator compartment with insulated partition to avoid the transfer of heat. The condenser fan draws air in the cover and forces it through the centre of the condenser.

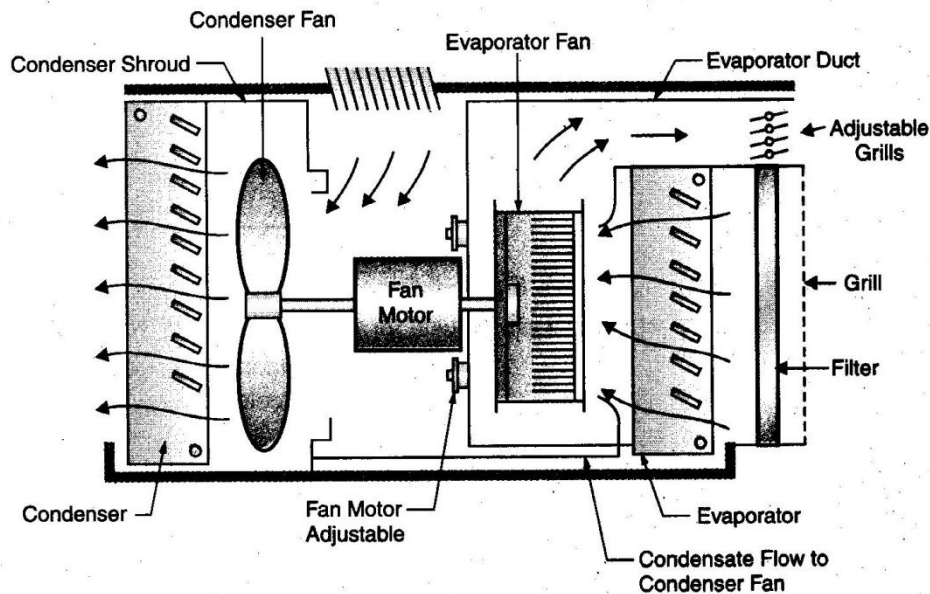


Fig. P-3.5.

Electrical circuit of an air conditioner : Reference Fig. P-3.6, the supply is connected to the thermostat switch at point A which in turn connects to the selector switch. The fan motor and compressor motor are in off position. When the selector switch knob is turned clockwise, the fan motor gets connected across the supply and the fan motor starts working. Normally, two speed selector switch is provided *i.e.* low and high.

Now if the thermostat switch is turned in ON position, the compressor motor starts running as the supply is fed to both running winding and auxiliary winding. The compressor motor is capacitor start, capacitor run type motor. When the normal speed is attained, the voltage relay trips and the auxiliary winding goes out of circuit whereas the running winding continues getting supply till the desired temperature in the room is attained. The thermal bulb of the thermostat switch makes or breaks the electric circuit after sensing the room temperature as per the setting position low cool or high cool. In this manner, the working of the compressor motor *i.e.* starting and stopping becomes automatic. In case the supply voltage falls down, the load on the motor becomes more, the over load release comes into function. Thus the compressor motor gets disconnected from the supply and it becomes quite safe.

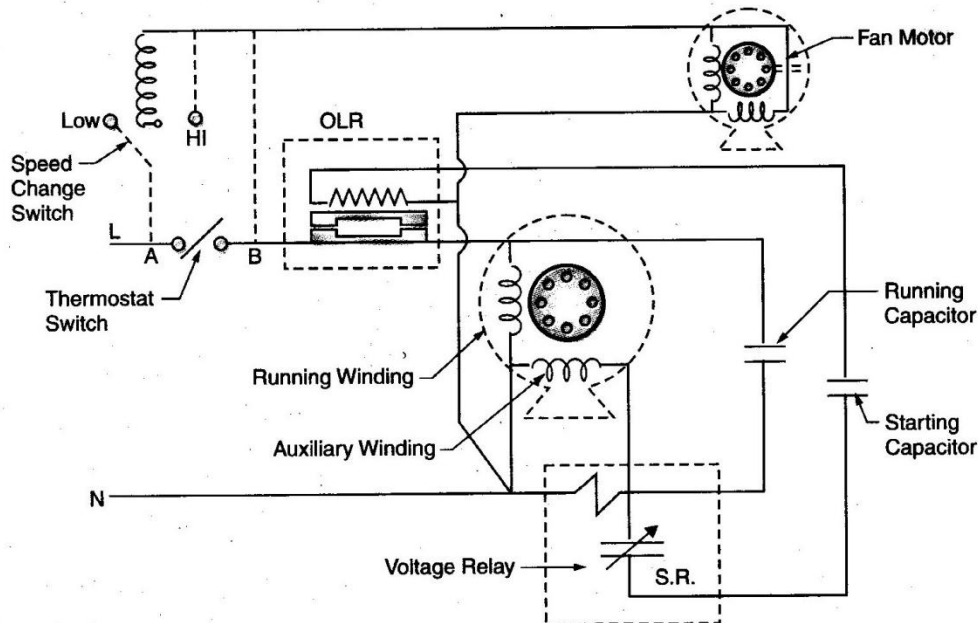


Fig. P-3.6.

Main parts of mechanical refrigeration system in window type air conditioner

- | | |
|--------------------------------------|--|
| 1. Sealed unit | : 1 or 1.5 H.P. motor (<i>capacitor start capacitor run</i>) fitted with reciprocating compressor. |
| 2. Condenser | : Fin and tube type air cooled. |
| 3. Evaporator | : Fin and tube type. |
| 4. Gas filter | : Sealed with brazed joints. |
| 5. Refrigerant | : Freon-22. |
| 6. Refrigerant control device | : Capillary tube. |
| 7. Cooling capacity of 1 ton machine | : 12660 kJ/hour. |

Main electrical components of window type air conditioner

- | | |
|---------------------|---|
| 1. Compressor motor | : Capacitor start capacitor run motor of 1 and 1.5 H.P. |
| 2. Fan motor | : $\frac{1}{6}$ H.P. Double end shaft. |

- 3. Selector switch
- 4. Thermostat switch
- 5. Starting Capacitor : 80 or 110 M.F.D.
- 6. Running Capacitor : 30 or 36 M.F.D.
- 7. Over load protector : 1 or 1.5 H.P.
- 8. Relay : Potential type 1 or 1.5 H.P.
- 9. Electric supply : 220 to 230 volts 50 cycle single phase
- 10. Power consumption for 1 ton machine : 1400 watts

General Details of a Window type air conditioner

1. Refrigeration capacity

Tons	1	1.5
Kilo calories/hour	3025	4535
B.T.U./hour	12000	18000
kJ/hour	12660	18990

2. Sealed unit

Motor	Capacitor start	Capacitor run
H.P.	1.5	2.5
Watts	1440	2250
Amperes	7.2	12.2
Cycles	50	50
Voltage	230	230
R.P.M.	2850	2850
Starting Capacitor	80 M.F.D.	110 M.F.D.
Running Capacitor	30 M.F.D.	36 M.F.D.
Relay	Potential type	
Compressor	Reciprocating single cylinder	

3. Refrigerant F-22 Monochloro-difluoro Methane

4. Weight of refrigerant 700-800 grams 1-1.5 kg

5. Operating temperatures

<i>Ambient temperature</i>	35°C
<i>Evaporating temperature</i>	7.2°C
<i>Condensing temperature</i>	54.4°C
<i>Liquid line temperature</i>	46.1°C
<i>Return gas temperature</i>	35°C

6. Operating pressures

<i>Suction pressure</i>	05.3 bar
<i>Discharge pressure</i>	20.6 bar

7. Capillary size 1.39 × 1013.58 mm 1.62 × 761.98 mm
(Two Numbers)

PRACTICAL NO. – 4

Object : To find C.O.P. of refrigeration system.

Equipment :

- (i) Water cooler
- (ii) Energy meter
- (iii) Voltage stabilizer
- (iv) Thermometer
- (v) Water measuring/weighing arrangement.

Theory : The performance of refrigeration system is expressed by a term called co-efficient of performance.

It is defined as the ratio between the refrigerating effect in the evaporator to the work input *i.e.* heat equivalent of work supplied to the refrigerating machine.

- Let,
- N = Net refrigerating or cooling effect in kJ/s
 - W = Work input to the machine in kJ/s
 - K = Co-efficient of performance of the machine.

$$\therefore \text{COP} = \frac{\text{Refrigeration effect}}{\text{Work done}}$$

or
$$K = \frac{N}{W}$$

Procedure :

- (i) Clean the water cooler tank.
- (ii) Connect energymeter between the mains and the compressor.
- (iii) Pour the measured quantity of water inside the tank.
- (iv) Note the initial reading of energy meter.
- (v) Note the room temperature.
- (vi) Switch on the compressor.
- (vii) Run the compressor for one hour.
- (viii) Note the final temperature of water.
- (ix) Note the final reading on energy meter.

Observations and calculations :

- Let,
- Quantity of water = m kg
 - Initial reading of energy meter = u_1
 - Initial reading of thermometer = $t_1^\circ\text{C}$
 - Final reading of thermometer = $t_2^\circ\text{C}$
 - Final reading of energymeter = u_2
-

$$\text{Fall in temperature} = (t_1 - t_2)^\circ\text{C}$$

$$\text{Energy consumed} = (u_2 - u_1) \text{ kW h}$$

$$\text{Specific heat of water} = S$$

$$\text{Work done on compressor, } W = (u_2 - u_1) \times 3600 \text{ kJ/h} \quad (\because 1 \text{ kW h} = 3600 \text{ kJ/h})$$

$$\text{Refrigeration effect, } N = m \times S \times (t_1 - t_2) \text{ kJ/h}$$

$$\begin{aligned} \text{Co-efficient of performance, } K &= \frac{\text{Refrigeration effect}}{\text{Work done}} \\ &= \frac{N}{W} \end{aligned}$$

Sources of error :

- (i) Loose connections.
- (ii) Heat gain at the time of noting temperature readings.
- (iii) Heat gains through water tank.
- (iv) Voltage fluctuations.

Precautions :

- (i) Ensure water tank is clean and free from dust. The dust reduces the refrigeration effect and reduces the COP.
- (ii) Note temperature reading carefully.
- (iii) Avoid bare and loose connections.
- (iv) Keep thermostat position at maximum low temperature.
- (v) Thermometer bulb should dip in water.

PRACTICAL NO. - 5

Object : To detect troubles/faults in a refrigerator/window type air conditioner.

(i) Troubles/faults in a refrigerator with Sealed Unit

(A) Unit Does Not Run At All

S.No.	Possible Cause	Test and Remedy
1.	No supply	Check supply with test lamp and find out the cause of non availability of supply.
2.	Fuse blown	Check fuse, if it is blown replace with new one.
3.	Broken circuit	Find continuity and repair in case of broken circuit.
4.	Too low voltage	Check voltage at the power plug and compare it with the voltage stamped on the machine.
5.	Thermostat switch defective or in off position	Check thermostat switch for its serviceability and find the cause of remaining in off position.

S.No.	Possible Cause	Test and Remedy
6.	Defective relay	Start the unit without relay, if it starts, replace the relay.
7.	Over load protector burnt or in off position	Check over load protector, if burnt replace it. In case of off position, reduce load on the motor.
8.	Motor burnt out	Check the continuity of the motor winding or short circuiting. If defective, rewind it.
9.	Stuck compressor or motor of sealed unit	Start the sealed unit without relay, if it does not start, dismantle the sealed unit and repair the compressor or motor as it may be.

(B) Unit Runs But Does Not Produce Cooling At All

S.No.	Possible Cause	Test and Remedy
1.	No refrigerant in the machine	Start the machine and check evaporator and condensing temperature. If the condenser is not hot and evaporator is not cool, charge the machine with new refrigerant.
2.	Chocking in the machine	Start the machine and if it does not cool, flush the system and charge with new refrigerant.

(C) Unit Runs But Does Not Produce Proper Cooling

S.No.	Possible Cause	Test and Remedy
1.	Shortage of refrigerant	Start and test the machine, less warm condenser and partial frosting on evaporator shows shortage of refrigerant. Add more refrigerant.
2.	Excess of refrigerant	Comparatively hot condenser and sweating on the suction line shows excess of refrigerant. Purge some of the refrigerant from the machine.
3.	Chock in the system	Cool condenser and improper cooling in the evaporator is the indication of chock in the system. Evacuate, flush and charge new refrigerant.
4.	Inefficient compressor	Cold condenser, warm suction line and poor frosting shows inefficient compressor. Remove and dismantle sealed unit. Repair the compressor and replace the necessary parts.
5.	Poor condensation1	Check the condenser for dust, sun and poor air circulation. Clean the dust and place the refrigerator in a shady place, about 15 cm away from the wall for free circulation of air over the condenser.

S.No.	Possible Cause	Test and Remedy
6.	Wrong adjustment of thermostat switch	Check the stopping and running time of machine. It should be off for 10 to 15 minutes and on for 5 to 10 minutes. If the machine cuts out before reaching the required temperature, the thermostat switch needs adjustment or replacement.
7.	Tripping through over load protector	Check the machine and if it is found tripping through over load protector, reduce the load on the motor.
8.	Door leakage	Check door leakage, adjust the door and eliminate its leakage through it.
9.	Cabinet poorly insulated	Fill proper heat insulating material in the walls of the cabinet and avoid heat leakage.
10.	Interior light remains always on	Check the door switch and its operation with the door. If found defective, replace it.

(D) Interior Light Defective

S.No.	Possible Cause	Test and Remedy
1.	Light remains always off	Test bulb, if it is fused, replace with new one. Check the electric circuit and door switch. If defective, repair or replace.
2.	Light remains always on	Check the door switch and its operation with door. If found defective, repair or replace.

(E) Unit Runs Continuously

S.No.	Possible Cause	Test and Remedy
1.	Poor refrigeration	Test the machine and find the cause of poor refrigeration and repair it as required.
2.	Thermostat switch adjusted at very low temperature or its contact points are stuck closed	Test the thermostat and adjust it, if necessary. If it is beyond adjustment, replace it. Make sure that thermal bulb with the cooling coil is not loose.

(F) Unit Freezes ICE Cubes But Does Not Cool Food Stuffs Properly

S.No.	Possible Cause	Test and Remedy
1.	Restricted air circulation in the cabinet	Check up if the shelves of the refrigerator cabinet are over crowded with dishes or the dishes are covered with covers and the air circulation <i>i.e.</i> convection currents are restricted. Remove covers from the dishes and place the dishes a little distance apart.

S.No.	Possible Cause	Test and Remedy
2.	Excessive frost on the cooling coil	Check if there is excessive frost on the cooling coil which acts as insulator and does not allow the food stuff to cool. Switch off the refrigerator and defrost it.
3.	Door leakage	Check door leakage and adjust the door to remove its leakage through it.
4.	Cabinet poorly insulated	Fill heat insulated material in the walls of the cabinet and avoid heat leakage.
5.	Interior light remains on	Check the door switch and its operation with door. If found defective, repair or replace.

(G) Noisy Refrigerator

S.No.	Possible Cause	Test and Remedy
1.	Improper level of the cabinet	Check the level of the refrigerator cabinet and if necessary, adjust the level by screws provided at the base or give some solid packing under the base as necessary.
2.	Rattling of tubes	Check the tubes, if they are loose or touching each other adjust or clamp them as required.
3.	Interior noise of sealed unit	Operate the machine and find the cause of the noise. If the noise is from the sealed unit, remove the unit, dismantle it, find the fault and fit back after due repair.
4.	Loose sealed unit or condenser mountings	Check the fitting of the sealed unit and condenser. If the fittings are loose, tighten them. This noise appears at the time of starting or stopping of the unit.
5.	Items placed improperly in the refrigerator	Check the over crowding of the shelves with bottles and dishes. Otherwise these will produce noise.

(H) Unit Trips Or Short Cycles Through Over Load Protector

S.No.	Possible Cause	Test and Remedy
1.	Wrong Voltage	Check the voltage at the power plug and compare it with the voltage stamped on the refrigerator. 10% less or more does not have much effect on the working of the machine. If it is more, adjust the voltage as required.
2.	Weak motor	Check the motor windings. If found defective, rewind the motor.

S.No.	Possible Cause	Test and Remedy
3.	Over charged	Operate and test the machine, sweating on the suction line indicates excess of refrigerant. If so, purge some refrigerant from the machine.
4.	Choke in the system	Improper cooling of evaporator and cold condenser shows chocking in the system. If so ; evacuate, flush and charge new refrigerant in the machine.
5.	Poor condensation	Check the condenser for dust, sun and air circulation. If so, clean the condenser with clean cloth, shift the cabinet in the shady place and keep about 15 cm away from the wall for air circulation.
6.	Tight motor or compressor in operation	Remove and dismantle sealed unit. Check up the oil level and cause of tight operation of compressor or motor. Repair it as required.
7.	Defective relay	Test the relay on load, if found defective, replace it with new one.

(ii) Window type air conditioner :

(A) Unit does not start

S.No.	Possible Cause	Test and Remedy
1.	No supply	Check supply with test lamp and find out the cause of non availability of supply.
2.	Fuse blown	Check fuse, if it is blown replace with new one.
3.	Broken circuit	Find continuity and repair in case of broken circuit.
4.	Too low voltage	Check voltage at the power plug and compare it with the voltage stamped on the machine.
5.	Thermostat switch defective or in off position	Check thermostat switch for its serviceability and find the cause of remaining in off position.
6.	Defective relay	Start the unit without relay, if it starts, replace the relay.
7.	Over load protector burnt or in off position	Check over load protector, if burnt replace it. In case of off position, reduce load on the motor.
8.	Motor burnt out	Check the continuity of the motor winding or short circuiting. If defective, rewind it.
9.	Stuck compressor or motor of sealed unit	Start the sealed unit without relay, if it does not start, dismantle the sealed unit and repair the compressor or motor as it may be.

(B) Unit runs but does not produce cooling at all

S.No.	Possible Cause	Test and Remedy
1.	No refrigerant in the machine	Start the machine and check evaporator and condensing temperature. If the condenser is not hot and evaporator is not cool, charge the machine with new refrigerant.
2.	Chocking in the machine	Start the machine and if it does not cool, flush the system and charge with new refrigerant.

(C) Unit runs continuously

S.No.	Possible Cause	Test and Remedy
1.	Poor refrigerant.	Test and find the cause of poor refrigeration.
2.	Thermostat switch adjusted at very low temperature.	Test the thermostate switch and adjust it as required.
3.	Excessive frequency of room door opening.	Control the factor responsible.

(D) Noisy operation

S.No.	Possible Cause	Test and Remedy
1.	Improper level of the cabinet.	Check the level of cabinet and adjust by screws provided at the base.
2.	Rattling of tubes.	Check the tubes, if they are loose or touching each other, adjust or clamp them as required.
3.	Interior noise of sealed unit.	Operate the unit and find the cause of the noise. If noise is from sealed unit, remove the unit, dismantle it, check and find the fault, repair and fit back.
4.	Loose mountings of sealed unit or condenser.	Check the mountings of sealed unit and condenser. If they are loose, tighten them.

(E) Unit trips or short cycles through over load protector

S.No.	Possible Cause	Test and Remedy
1.	Wrong Voltage	Check the voltage at the power plug and compare it with the voltage stamped on the refrigerator. 10% less or more does not have much effect on the working of the machine. If it is more, adjust the voltage as required.
2.	Weak motor	Check the motor windings. If found defective, rewind the motor.

S.No.	Possible Cause	Test and Remedy
3.	Over charged	Operate and test the machine, sweating on the suction line indicates excess of refrigerant. If so, purge some refrigerant from the machine.
4.	Choke in the system	Improper cooling of evaporator and cold condenser shows chocking in the system. If so ; evacuate, flush and charge new refrigerant in the machine.
5.	Tight motor or compressor in operation	Remove and dismantle sealed unit. Check up the oil level and cause of tight operation of compressor or motor. Repair it as required.
6.	Defective relay	Test the relay on load, if found defective, replace it with new one.

(F) Inefficient cooling

S.No.	Possible Cause	Test and Remedy
1.	Shortage of air supply to the evaporator due to : <i>(i)</i> Dirty and blocked filters. <i>(ii)</i> Dirty and blocked cooling coil. <i>(iii)</i> Improperly adjusted dampers. <i>(iv)</i> Fan running in opposite direction.	Ensure enough air supply over evaporator cooling coil <i>(i)</i> Clean or replace filters. <i>(ii)</i> Clean and open the cooling coil. <i>(iii)</i> Adjust dampers properly. <i>(iv)</i> Check the electrical connections and correct.
2.	Shortage of refrigerant due to <i>(i)</i> Less refrigerant in the system. <i>(ii)</i> Choked dehydrator. <i>(iii)</i> Choked expansion device or strainer. <i>(iv)</i> Leakage of the refrigerant.	Check refrigerant pressure and make up deficiency of the refrigerant. Add refrigerant or evacuate and recharge the unit. Heat and strike gently or replace the dehydrator. Replace expansion device or strainer. Check with halide torck, rectify the leakage and add refrigerant.

PRACTICAL NO. - 6

Object : *Charging of refrigerator/window type air conditioner.*

(i) Refrigerator : Before charging the refrigerant, the system should be evacuated, otherwise air or other non condensable gases already present will have mal-function in the system. The vacuum created should stand constant at least for 24 hours before charging.

Objective : To learn the proper technique of removing air from the refrigeration system of hermetically sealed unit.

Main items required :

1. Gauge manifold
2. Flexible charging line
3. Vacuum pump
4. Flaring tool
5. Tube cutter
6. Adjustable wrench

Working steps : Refer Fig. P-6.1, showing a method to evacuate a refrigerating machine equipped with sealed unit.

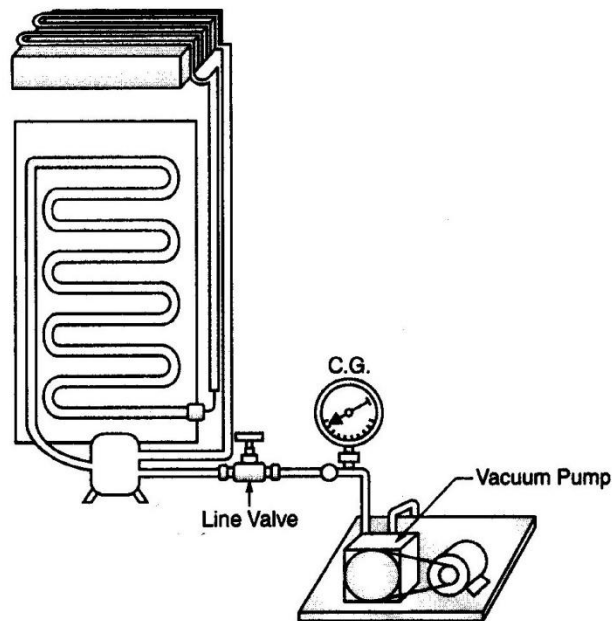


Fig. P-6.1.

1. Connect the suction port of vacuum pump to the charging port of the sealed unit through a line valve and compound gauge.
-

2. Connect the discharge port of the vacuum pump with one end of the flexible line and dip the other end in a container of refrigerating oil.
3. Operate the vacuum pump for 1 to 1.5 hour and see if the compound gauge show about 50 mm Hg of constant vacuum.
4. To assure, see bubbles in the container of oil. If no bubbles appear for a longer time, it means a good vacuum.
5. Heat the entire system during vacuum by a blow lamp.
6. Close the valve and disconnect the vacuum pump.

Proper amount of refrigerant charged in the system will not only increase the life but provides trouble free and satisfactory working of the refrigerating unit.

Objective : To learn the proper technique of charging refrigerant in a hermetically sealed refrigeration system.

Main items required :

1. Weighing machine
2. Halide torch
3. Service cylinder containing refrigerant
4. Pinch off tool
5. Brazing lamp.

Working steps : Refer Fig. P-6.2, showing a method to charge a gas in a refrigerating machine equipped with sealed unit.

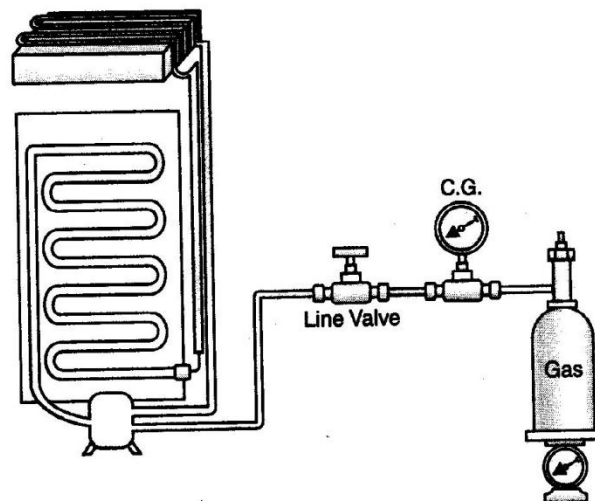


Fig. P-6.2.

7. Read the name plate of the machine and note the refrigerant and its quantity to be charged in the system.
 8. Take a full cylinder of gas required to charge.
 9. Weigh the cylinder and record its weight.
-

10. Connect the gas cylinder with the line valve through the compound gauge with the help of charging line. Open the cylinder valve and purge the charging line.
11. Gently open the line valve and slowly charge gas in the machine.
12. Close the line valve and operate the machine and check up its low side pressure. If it is low, charge an additional amount of gas by opening the line valve.
13. Check up the condenser and evaporator for proper temperature.
14. After full satisfaction, stop the machine and close the line valve, disconnect gas cylinder, pinch the charging line of the sealed unit and braze its end.
15. Check the performance of the machine after running it for hours.

Precautions :

1. Assure that air does not enter after evacuation while connecting gas cylinder and compound gauge for charging gas.
2. Purge air from the charging line.
3. It is better if a drier is connected in the charging line while charging.
4. Charge exact amount of refrigerant as recommended by the manufacturer.

(ii) Window type air conditioner :

Before charging the air-conditioning unit the system must be fully evacuated otherwise, non-condensable gases will result in malfunctioning of the system. The vacuum should stand for at least 24 hours before charging.

Objective : To learn the proper technique of evacuating window type air-conditioner.

Main items required :

1. Gauge manifold
2. Flexible charging line
3. Leak detector
4. One service cylinder with refrigerant
5. Vacuum pump
6. Hand shut-off valve
7. Flaring tool
8. Tube cutter
9. Adjustable wrench
10. Blow lamp

Working Steps :

1. Fix a 1/4" flare nut in the charging line of the unit.
 2. Attach the hand shut-off valve in the charging line of the unit.
 3. Connect the gauge manifold in the system.
 4. Connect the vacuum pump with the unit through the manifold (*centre line*).
 5. Adjust high side manifold hand valve in the closed position.
-

6. Run the vacuum pump for one hour.
7. When the compound gauge indicates 28" of vacuum, close the manifold valve and wait for about half an hour. If the vacuum does not drop, there is no leakage.
8. In case the vacuum drops, proceed as follows ;
 - (a) Charge a little amount of refrigerant into the system.
 - (b) Test for leakage by halide torch and/or soap solution.
 - (c) If leak is detected, do necessary repairing and draw vacuum again.
 - (d) Check again and if the vacuum does not drop there is no leakage.
9. Operate the vacuum pump for about 4 hours.
10. Bake the condenser at about 100°F for about 20 minutes with the help of blow lamp and allow the vacuum pump to run for 2 hours more.
11. Stop the unit and observe whether the vacuum holds or not.
12. If the vacuum holds for 24 hours then proceed for charging.

Charging Refrigerant in a Window Air-conditioning Unit : The room temperature and the grill temperature are affected by the amount of refrigerant charged in the air-conditioning unit. Only the proper quantity of refrigerant charged in the system gives a satisfactory operation.

Objective : To learn the technique of charging refrigerant in a window type air-conditioner.

Equipment required :

1. Gauge manifold
2. Flexible charging lines
3. Leak detector
4. Adjustable wrench
5. Weighing scale
6. Service cylinder with refrigerant
7. Pinch-off tools
8. Welding set
9. Hand shut-off valve
10. Vacuum pump
11. Flaring tool
12. Tube cutter
13. Thermometer

Working Steps :

1. Fix a 1/4" flare nut in the charging line of the unit.
 2. Attach the hand shut-off valve in the charging line of the unit.
 3. Connect the vacuum pump with the unit through the manifold (*centre line*).
 4. Connect the gauge manifold to the system.
 5. Adjust high side manifold hand valve in the closed position.
-

6. Run the vacuum pump for 4 hours to make complete vacuum in the system.
 7. Note the reading in the compound gauge which should show 29" to 30" Hg.
 8. Bake the condenser and allow the vacuum pump to run for another 30 minutes.
 9. Close the low side hand valve of the manifold and wait for 30 to 35 minutes. If the vacuum does not drop, there is no leakage.
 10. If the vacuum drops, then there is leakage in the system.
 11. Check for leakage and repair it by any convenient method.
 12. Draw vacuum again and stop the unit for 2 hours.
 13. Observe whether or not the vacuum holds.
 14. If the vacuum holds for 24 hours, then proceed for charging.
 15. Connect centre manifold gauge line to refrigerant cylinder.
 16. Remove vacuum pump from the system.
 17. Open refrigerant cylinder valve bit.
 18. Purge the lines in proper order.
 19. For faster charging put the cylinder in warm water.
 20. Check that both the high and low side manifold hand valves are closed.
 21. Open the cylinder valve and open the hand valve, place in the suction side gauge manifold.
 22. Charge gas and when a steady pressure of 55 - 65 has been reached, stop charging by closing the gauge manifold hand valve.
 23. Start the blower fan and set it for operation.
 24. Start the unit and see that the low side pressure is around 60. A small amount of refrigerant may be charged to maintaining proper low side pressure.
 25. Record the grill temperature.
 26. Record condenser outlet temperature.
 27. Check the current drawn by the unit. It should be less than that indicated on the name plate.
 28. Check the room temperature after running the system for about an hour.
 29. Check for the proper working of thermostat.
 30. Check the condition of the filter. If required, clean it.
 31. Close cylinder service valve.
 32. Close low side manifold hand valve.
 33. Close hand shut-off valve installed in the charging line of the unit.
 34. Test the leakage by halide torch after stopping the unit.
 35. Remove gauge manifold apparatus and charging lines.
 36. Pinch off the charging line of the unit and remove the hand shut-off valve.
 37. Braze the charging line and remove the flare nut.
 38. Finally, check for any leakage by halide torch or soap solution.
 39. Check for any noise and vibration from the unit.
-

Precautions :

1. Maintain adequate ventilation during charging.
2. Dehydrator should be connected in the charging line while charging.
3. Charge the proper quantity of refrigerant.

PRACTICAL NO. - 7

Object : *Disassembly and assembly of a single cylinder open type compressor.*

(i) Disassembly of a Reciprocating Compressor : The compressor is considered to be the heart of mechanical refrigeration cycle. It provides the system with the force to draw the vapour from the evaporator, pumps it into the condenser and finally keeps this circulation going.

The low temperature vapours from the evaporator flow through the suction line to the compressor. The compressor compresses the low temperature vapours, thus raising the pressure and temperature. The high pressure refrigerant then flows through the condenser where it gives up heat and in turn condenses to a liquid.

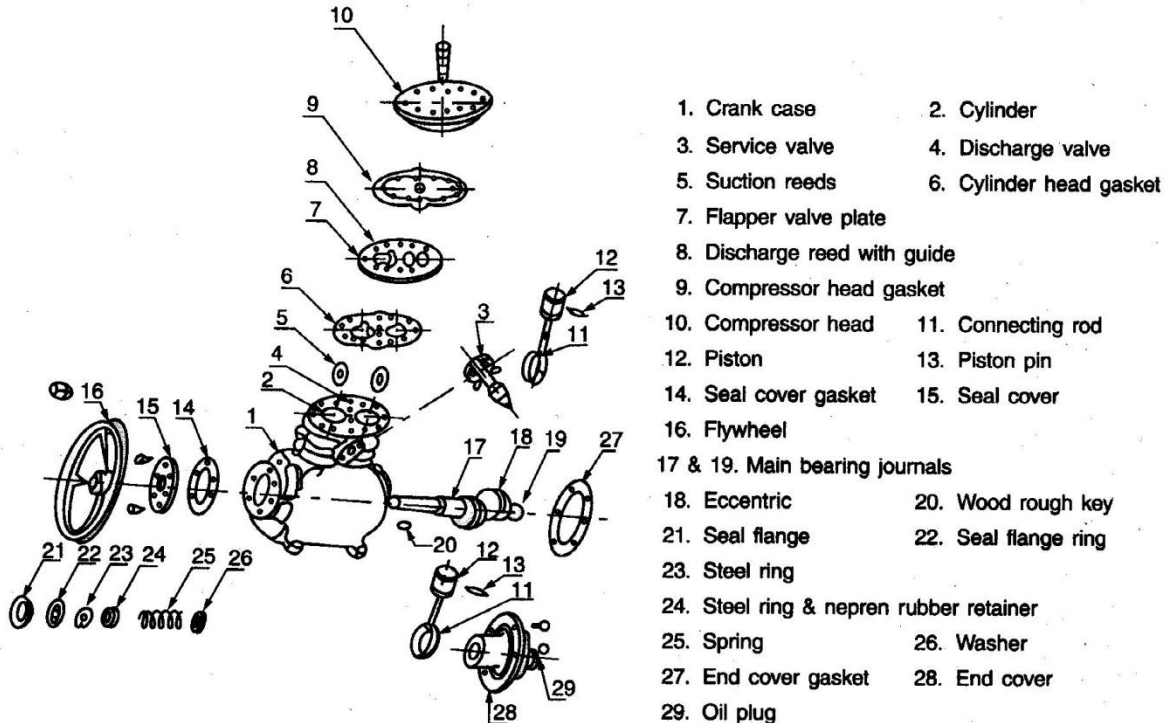


Fig. P-7.1. A reciprocating compressor.

Objective : To understand the working of reciprocating refrigeration compressor by disassembling it.

Equipment required :

1. Box spanner
2. Mallet

3. Double ended spanner
4. Ball peen hammer
5. Wheel puller
6. Screw driver
7. Steel ruler
8. Ratchet wrench
9. Seal ring puller
10. Adjustable wrench
11. Plier

Procedure :

1. Clean the compressor thoroughly from outside.
 2. Place the compressor on the work bench before starting and then work on it.
 3. Open the oil plug and drain out the oil.
 4. Loosen the flywheel retaining nut without removing it.
 5. The retaining nut should be left on the threads to prevent splitting the flywheel at the end of the shaft.
 7. Remove the retaining nut and place it in the tray.
 8. Remove the flywheel and put it in the tray.
 9. Remove the woodruff key and put it in the tray.
 10. Remove service valves and gaskets.
 11. Mark on the cylinder head and valve plate side with the help of a file.
 12. Loosen all the bolts by just turning these 1/4 turn diagonally before taking any one of them all the way out.
 13. Take out all the bolts one by one and put them in the tray in an orderly manner.
 14. If the cylinder head and valve plate are not loose, push the valve plate with a light blow at side with the mallet.
 15. Carefully preserve the gaskets.
 16. Put marks on the seal plate and on the compressor body with a file.
 17. Loosen the bolts carefully and place them in the tray.
 18. Remove the parts of the seal and note the order of assembly and put them in the tray.
 19. Invert the compressor on work bench by putting clean cloth in-between the two.
 20. Put light marks on the cylinder blocks and the cover.
 21. Loosen the bolts and put them in the tray.
 22. If it is crankthrow type shaft, the connecting rod must be unbolted first and then the front main bearing housing should be removed.
 23. If it is an eccentric type shaft, the set screw must be loosened and removed.
 24. The crankshaft may then be pulled out.
-

25. Mark the connecting rod and the connecting rod bolt for their proper places.
26. Remove the piston pin and separate connecting rod and piston.
27. Place all the parts carefully in the tray.
28. Remove the suction reed from the valve plate.
29. Disassemble the discharge reed from the valve plate.
30. Inspect the reeds and if found defective, replace them with the new ones.

Precautions :

1. Weight should not be put on compressor flywheel as this may damage the seal.
2. A proper size of wrench should be used.
3. Be careful in protecting the seal collar and ring from scratches.

(ii) **Assembling a Reciprocating Compressor :** When the piston of a reciprocating compressor is at the top of its stroke, the position is known as Top Dead Centre. At this position, the suction valve is held closed due to the pressure in the clearance space between top of the piston and cylinder head. As the piston moves downwards, the pressure in the cylinder becomes slightly less than the suction pressure. The suction valve opens and vapours enter the cylinder. This flow continues until the piston reaches the bottom of the stroke. When the piston starts compression stroke, the volume of the refrigerant in the cylinder will decrease and the pressure of the trapped vapour will rise. When the pressure in the cylinder becomes greater than that on the top of the discharge reed, it will open and the vapours will be discharged into the condenser. The cycle is then repeated for every two strokes of piston or each revolution of crank shaft.

Objective : To understand the working of a reciprocating compressor by assembling it.

Equipment required :

1. Box spanner set
2. Double ended spanner set
3. Ball peen hammer
4. Screw driver
5. Bench vice
6. Ratchet wrench
7. Adjustable wrench
8. Piler
9. Torque wrench

Working steps :

1. Fit the piston and the connecting rod with the help of piston pin.
2. Check for wear and scratches.
3. Check for scratches on crankshaft bearing.
4. Adjust the connecting rod on the shaft.

5. Adjust screw or make sure that the main bearing housing bolts are tightened evenly.
6. Tighten the bolts evenly and slowly.
7. Check seal for any scratches on the seal collar and ring.
8. Fit the seal assembly on the shaft properly.
9. Put one new gasket between seal housing and the housing cover.
10. Fit the seal housing cover after aligning the marks properly.
11. Tighten the bolts evenly with a torque wrench.
12. Place new gasket between the body and the back plate.
13. Place the thrust bearing at its proper place.
14. Place the back plate after properly aligning the marks.
15. Inspect suction and discharge reeds for any scratches.
16. Check valves plate ports ; if necessary do lapping of valve plate with fine grinding paste and compressor oil.
17. Fix the suction and discharge reeds at their proper places.
18. Check the reeds for leaks by putting kerosene oil.
19. Put new gasket between the cylinder head and valve plate.
20. Place the valve plate on the gasket.
21. Place new gasket between the valve plate and cylinder head.
22. Place cylinder head on the gasket.
23. Place and tighten the bolts evenly with a torque wrench.
24. Place the woodruff key on the shaft.
25. Place the flywheel on the crankshaft.
26. Tighten the retaining nut with even pressure.
27. Place gaskets under the service valves.
28. Fit the service valves at their proper places.
29. Tighten the bolts evenly with a torque wrench.
30. Move the flywheel and make sure that it is free.
31. Charge the requisite amount of refrigeration oil in the crankcase.

Precautions :

1. Make sure for the proper fitting of parts.
 2. Extreme care must be taken in assembling the crankshaft.
 3. Do not pound on the wrenches and do not apply a jerk motion.
 4. The bolts should not be overtightened.
 5. The oil should not be overcharged in the compressor.
-

PRACTICAL NO. - 8

Object : Visit to an ice plant or cold storage or central air conditioning plant.

(i) Ice Plant : It is that plant in which ice is produced in large scale. It has an insulated big freezing tank called brine tank usually fabricated of 6 mm thick mild steel plates and coated with water proof paint. The tank is insulated on all the four sides and from the bottom. The freezing tank is provided with suitable frame for supporting ice cans. The insulated wooden lids are provided to cover the top in segments for easy removal or replacing of ice cans. The ice cans are dipped into the brine filled freezing tank through the frame of ice can. The ice cans are filled with water. The depth of tank is such that the brine level is around 25 mm higher than the water level in the cans. The ice cans are fabricated from galvanised steel sheets and given chromium treatment to prevent corrosion due to chemical reaction. It also prevents corrosion from reaction with ammonia in case it leaks from the system. Each ice can is covered with wooden lid independently. The freezing tank is equipped with an agitator for keeping the brine in motion. The agitator can be either horizontal or vertical and is operated by means of an electric motor. The brine temperature is maintained by the refrigeration plant at -6°C to -12°C .

Water cooled ammonia condensing unit is fitted in a separate room and water cooled condenser in an open atmosphere. The high temperature, high pressure ammonia vapours are condensed in a condenser which may be shell and tube or evaporative type. The condensed liquid ammonia is collected in the receiver and then expanded through the expansion valve. Due to the expansion, the pressure of the liquid ammonia is considerably reduced. It then passes through the evaporator coils surrounding a brine tank in which the brine solution is filled. Low pressure liquid ammonia absorbs heat from the brine solution equivalent to its latent heat of vapourisation, gets converted to vapour state and goes back to the compressor to complete the cycle. The layout of ice plant is shown in Fig. P-8.1.

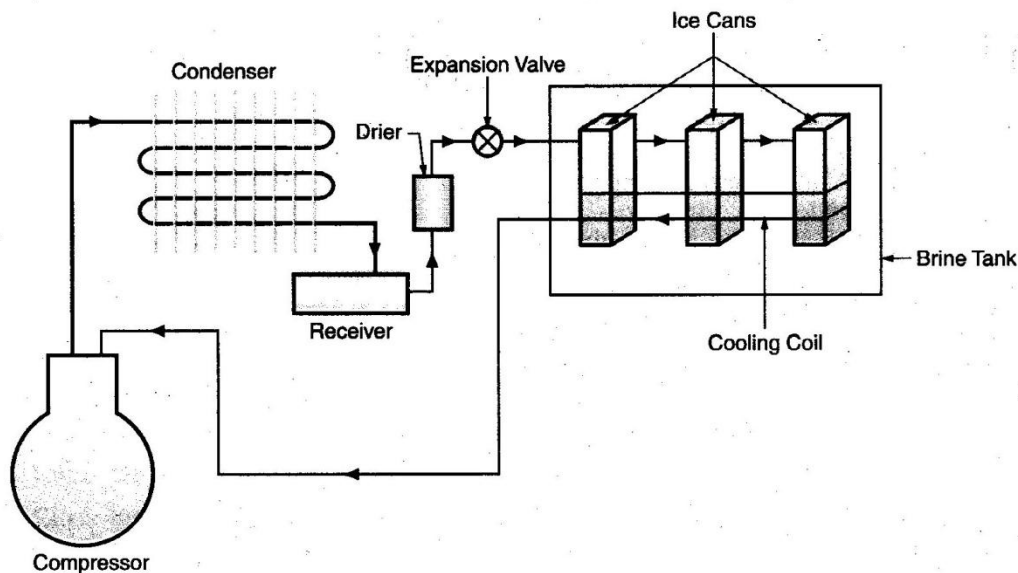


Fig. P-8.1.

The time taken by the ice to freeze depends upon the temperature of brine and thickness of the ice slab. The common size of ice can is 25 cm × 55 cm at the bottom and 28 cm × 57 cm at the top whereas the height of the can is 125 cm and capacity of the can is about 150 kg. However it takes 24 hours to freeze in general. When the freezing operation of ice is completed, the cans are lifted out of brine tank with the help of a hoist arrangement provided over the brine tank under the ceiling and given a dip in the hot water. The tank containing this hot water is called a thawing tank and the operation is known as thawing. Hot water helps to remove the ice from the can easily.

General details of ice plant

Name of machine	Ammonia refrigeration plant
Capacity of machine	15 tons
Gas charged	Ammonia (approximately 60 kg)
Head pressure	14 to 17.5 kg/cm ²
Back pressure	2 to 2.5 kg/cm ²
Main parts	Compressor, Oil separator, Condenser, Receiver, Metering device, Surge tank and Cooling coil

Specification of Compressor

1. Make of compressor	FRICK
2. Type of compressor	Reciprocating ammonia compressor
3. Size of compressor	178 mm × 178 mm
4. Number of cylinders	2
5. Cooling system	Water cooled
6. Wheel outer dia	112 cm
7. Wheel groove	4 B
8. R.P.M.	450
9. Quantity of oil in Sump	24 kg
10. Oil pressure	2 to 2.5 kg/cm ²

Specification of Motor

1. Type of motor	Slip ring motor
2. Power of motor	70 H.P.
3. Current	81 ampere
4. Voltage	440 V
5. Phase	3
6. R.P.M.	1460
7. Pully outer dia	35 cm
8. Pully groove	4 B

Specification of Condenser

1. Type of condenser	Water cooled atmospheric type
2. Size of tube	5 cm O.D.
3. Length of tube	48 pipes, each of 6 m length

Specification of Receiver And Metering Device

- | | |
|------------------------------|-------------------------------|
| 1. Receiver | 2.5 m × 35 cm |
| 2. Type of metering device | Hand operated expansion valve |
| 3. Size of inlet connection | 12 mm O.D. |
| 4. Size of outlet connection | 12 mm O.D. |
| 5. Orifice | 6 mm |

Specification of Brine Tank

- | | |
|------------------------------------|---|
| 1. Material used | 6 mm mild steel plate |
| 2. Capacity of tank | 200 ice cans |
| 3. Ice can made of | G.I. sheets |
| 4. Brine used | Sodium chloride |
| 5. Gravity of brine | 1150 to 1170 |
| 6. Temperature of brine | -30°C |
| 7. Size of ice cane | 25 × 55 cm at the bottom
28 × 57 cm at the top |
| 8. Length of ice cane | 125 cm |
| 9. Weight of ice block | 150 kg |
| 10. Time taken to freeze ice block | 12 hours |
| 11. In general time taken | 24 hours |

Specification of Pipe Used

- | | |
|---------------------------|------------|
| 1. Pipe Material | Steel |
| 2. Size of discharge line | 50 mm O.D. |
| 3. Size of liquid line | 12 mm O.D. |
| 4. Size of suction line | 50 mm O.D. |

Operating of Ammonia Ice Plant

For operating an ammonia ice plant, proceed as follows ;

1. First of all, operate the water pump used for cooling the condenser.
2. Open king valve on receiver.
3. Open discharge line valve on the compressor manifold.
4. Switch on the compressor motor.
5. Open suction line valve on the compressor manifold.

For stopping the ice plant, proceed as follows ;

1. Close the king valve of receiver.
 2. Close the suction line valve on the compressor manifold.
 3. Close the discharge valve line on the compressor manifold.
 4. Stop water pump used for cooling the condenser.
-

(ii) **Cold Storage Plant** : It is that plant in which perishable food stuffs are preserved on a large scale by refrigeration.

The cold storage is a big two or more storey insulated and air tight building designed to store perishable food stuffs in large scale for a period of season. The walls of the building are insulated with thermocole slabs for preventing heat leakage through the walls. Each storey of the building is inter connected to provide air circulation.

The layout of cold storage plant is shown in Fig. P-8.2. The essential components of a cold storage plant are the same as in any other mechanical refrigeration plant. The components are compressor, condenser, expansion device and evaporator. So far the cooling system is concerned, water cooled condensing unit is fitted in a separate room, water cooled condenser in outside open air and the evaporator in the cold store which is to be cooled. A blower is provided behind the evaporator to throw air into the cold store through the evaporator *i.e.* the warm air from the room is drawn in at the bottom, it passes over the coils of evaporator and chilled air is blown out in the room through the directing louvers.

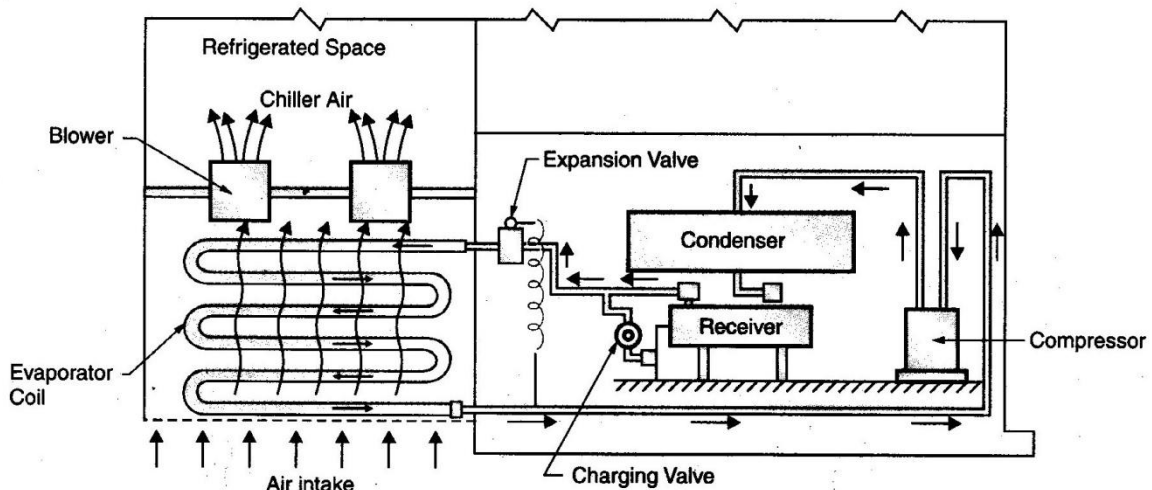


Fig. P-8.2.
Cold Storage Temperatures

Articles	Temperature in °C
Vegetables	
1. Potatoes	2 to 4°C
2. Cabbage	1 to 1.5°C
3. Carrots	1 to 1.5°C
4. Dried peas	1.5 to 4°C
5. Dried beans	0 to 4°C
6. Onions	2°C
Meat	
1. Fresh meat for short period	-0 to -2°C
2. Meat to be frozen for long period	-10°C

Wheel outer dia	91 cm
Wheel groove	4 B
RPM	300
Oil charged in the sump	Capila D. York Company
Oil pressure	2 to 3.5 kg/cm ²

Specification of Motor

Power	20 H.P.
Current	26 ampere
Voltage	440
Phase	Three
R.P.M.	1440
Pulley outer dia	20 cm

Condenser Specification

Type of condenser	Water cooled open air
Size of tube	50 mm
Length of tube	36 tubes each of 6 m

Specification of Metering Device

Type of metering device	Low side float valve
Size of inlet	12 mm
Size of outlet	12 mm

Specification of Evaporator

Type of evaporator	Fin and tube type fitted with a blower
--------------------	--

Specification of Pipe Used

Material of pipe	Steel
Size of discharge line	32 mm O.D.
Size of liquid line	25 mm O.D.
Size of suction line	32 mm O.D.

(iii) Central air conditioning plant :

Air conditioning plant : It is a machine which controls the condition of air by performing the following functions :

1. It cleans and purify the air.
 2. It cools the air in summer.
 3. It decreases the humidity in summer.
 4. It warms the air in winter.
 5. It increases the humidity in winder.
 6. It smoothly circulates and equally distributes the air.
 7. It eliminates odour.
-

Central air conditioning plant : When the air handling unit is separated from the condensing unit, such arrangement is called central air conditioning plant.

Since central air conditioning plant is used for large cooling capacity, so the condenser used for it is water cooled. The heat carried by the water during its circulation through the condenser is rejected in the cooling tower but the heat exchange at the evaporator coil may be achieved by two ways;

(a) **Direct expansion system :** In this system, the air conditioning machine whose complete water cooled condensing unit including evaporator is located in the basement and the conditioned air is forced by a blower into the various rooms through ducts. In summer the air is cooled directly by passing it over the coil surface of the evaporator but in winter for heating, electrical heating strips are used in front of blower which throws air through these heating strips and heats the room as shown in Fig. P-8.3.

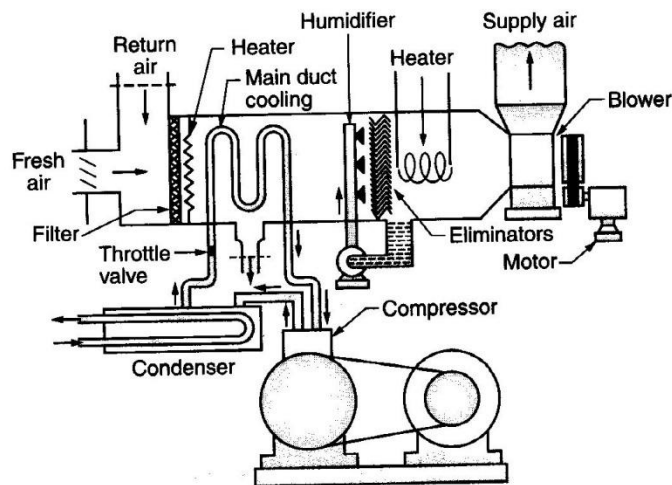


Fig. P-8.3. Central air-conditioning system.

(b) **Chilled water system or indirect air conditioning system :** In this system all the major component like compressor, condenser, expansion device and water chiller are placed in one room, mainly the basement and the cooling tower is installed as per the situation. Water is chilled in a chiller by water cooled condensing unit is fitted in the same room. This chilled water is circulated through pipe coils fitted in various rooms. The air is forced by independent blowers through these chilled water pipe coils into the room to be cooled. This system is used

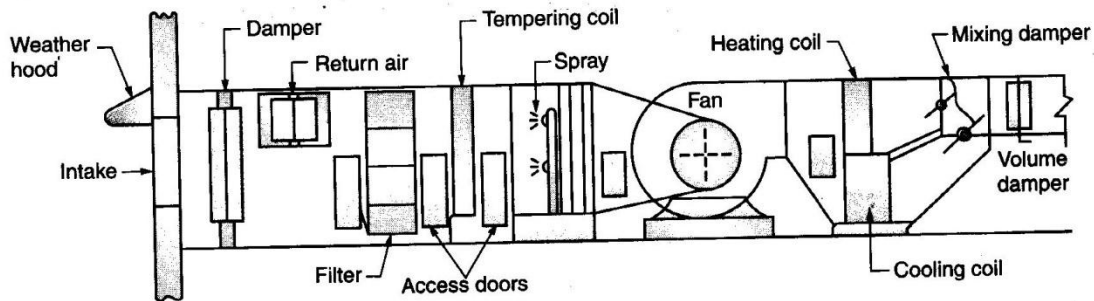


Fig. P-8.4. Central air conditioning unit.

in multiple air conditioning and industrial processing installations. Thus the central air conditioning system has many advantages as shown in Fig. P-8.4.

1. The space occupied by the equipment *i.e.* basement is less valuable in comparison to conditioned space.
2. For a large conditioning load, the equipment cost is less.
3. Maintenance and inspection of a central system does not disturb people in the conditioned area.
4. Exhaust air can be returned and partly reused with saving in heating and refrigeration.
5. Mostly the central system has year round control.

Details and Data of the central air-conditioning unit : The following studies should be made :

1. General Details

- | | |
|--|-------------------------|
| (a) Manufacturer of the unit (Make) | (b) Capacity in tons |
| (c) Area and number of rooms to be conditioned | |
| (d) Temperatures to be maintained | (e) Refrigerant charged |
| (f) Head pressure | (g) Back pressure |
| (h) Main parts | |

2. Specifications of Compressor

- | | |
|----------------------|--|
| (a) Make | (b) Size |
| (c) No. of cylinders | (d) Cooling provision (Air cooled or water cooled) |
| (e) Wheel outer dia | (f) Wheel groove |
| (g) RPM | (h) Oil charged in sump |
| (i) Oil pressure | (j) Swept volume |

3. Specifications of Motor

- | | |
|------------------------|----------------------|
| (a) Power (H.P. or kW) | (b) Current |
| (c) Voltage | (d) Phase |
| (e) RPM | (f) Pulley outer dia |
| (g) Type of motor | |

4. Specification of Condenser

- | | |
|---------------------------------------|--------------------------|
| (a) Type (Water cooled or air cooled) | (b) Size of tube |
| (c) Length of tube | (d) Metal used for tubes |

5. Specification of Metering Device

- | | |
|-----------------------------|-----------------------|
| (a) Type of metering device | (b) Size and capacity |
|-----------------------------|-----------------------|

6. Specifications of Evaporator

- (a) Type of evaporator

7. Specifications of Pipe used?

- | | |
|-------------------------|----------------------------|
| (a) Material of pipe | (b) Size of discharge line |
| (c) Size of liquid line | (d) Size of suction line |

In addition to above details of the receiver tank, filters etc. should also be obtained.

Practicals

PRACTICAL-1

Dismantle a two stroke engine. Note down the function and materials of each part and Reassemble the engine.

OBJECTIVE : To learn the proper technique of dismantling a two stroke engine for study of function, material and serviceability of each part. Reassembly of serviceable parts for proper functioning of the engine.

TOOLS AND EQUIPMENT : A two stroke petrol engine as shown in Fig. P-1 and a kit of tools consisting socket, spanner set, ring spanners, double ended spanners, spark plug spanner, feeler gauge, combination plier, nose plier, circlip plier, piston ring ,clamp, bearing puller, screw driver, mallet, steel tray, brush, diesel oil, cotton waste, clean rags, lubricating oil and grease etc.

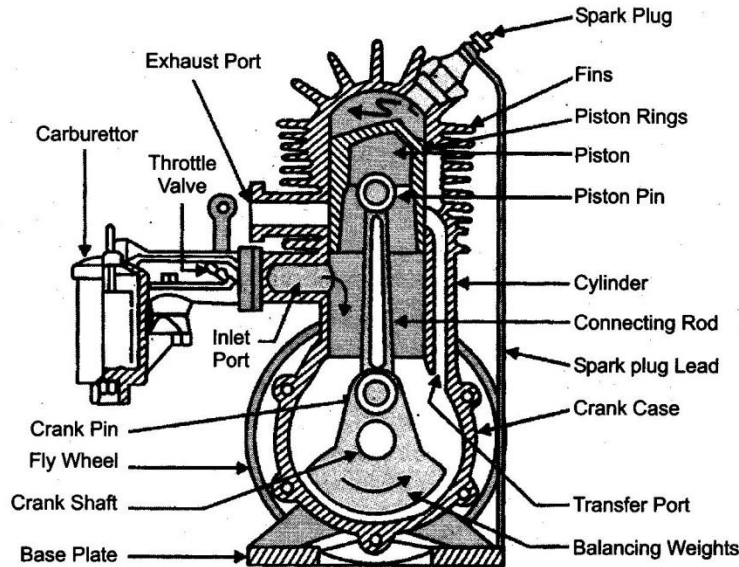


Fig. P-1 : Two stroke petrol engine

THEORY : A two stroke petrol engine, is generally used for scooters and motor cycles. These are small power output, light weight and the compact size air cooled engines, which work on the Otto cycle *i.e.* Constant Volume Cycle. The indicator diagram along with the line diagram of a two stroke petrol engine is shown in Fig. P-1.1. Points 1 and 2' represent the opening and closing of the exhaust port respectively *i.e.* the line 1-2' is the process during which exhaust occurs.

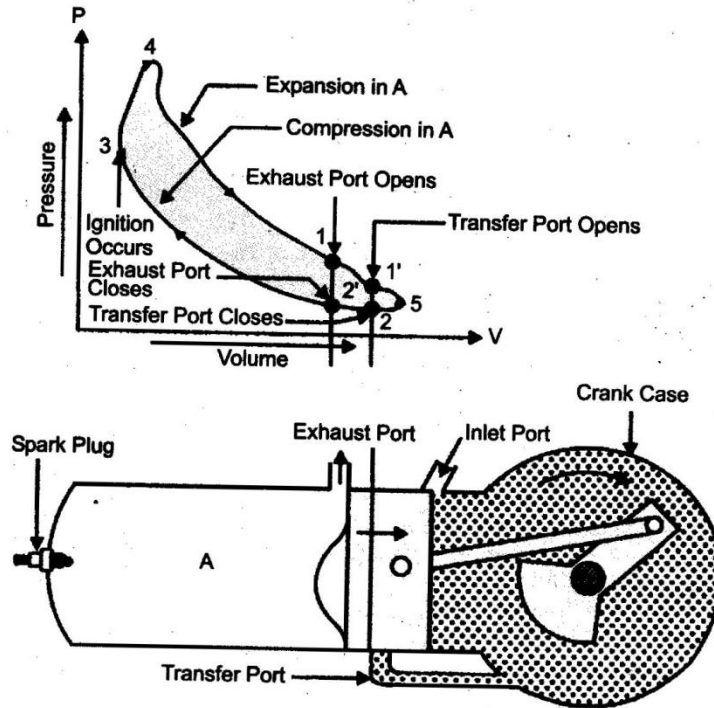


Fig. P-1.1 : Actual indicator diagram and line diagram (Two Stroke Petrol Engine)

Similarly ; points 1' and 2 represent the opening and closing of the transfer port respectively *i.e.* the line 1'-2 is the process during which air fuel mixture is transferred to the cylinder.

Line 5-3 represents the compression process of the mixture in the cylinder A.

Point 3 represents the occurrence of a spark at the spark plug.

Line 3-4 represent the burning process of the air fuel mixture with increase in pressure at constant volume.

Line 4-5 represents the expansion of the gases in the engine cylinder A.

The arrangement of exhaust and induction processes occurs over a small portion of the stroke and over, lap the expansion and compression stroke. During expansion process 4-5 from point 1 to 1', exhaust occurs while from point 1-1' to 5, both exhaust and induction occurs.

Similarly, during compression stroke from point 5 to point 3, the exhaust and induction processes occur up to point 2 and from point 2 onward to point 2', only exhaust takes place along with slight compression.

WORKING PRINCIPLE : When the piston moves from B.D.C. to T.D.C. position on the compression stroke and covers the transfer port, the process 2 - 3 *i.e.* volume of the air fuel mixture is

duced resulting in increase of temperature and pressure. The volume decreases in the ratio of about 5-8 while the pressure and temperature increase from 1 bar (*abs*) to 6 to 12 bar (*abs*) and 250 - 300°C respectively.

At point 3, the spark occurs and the process 3-4 is the combustion process of the air fuel mixture during which the chemical energy of the fuel is released. The pressure and temperature rises to about 30 to 40 bar and 1800 to 2000 °C respectively while the volume remains constant.

During the process 4-5, the piston moves from TDC to BDC on the power stroke and the expansion of the gases occurs with increase in volume and decrease in pressure and temperature. At point 1, the exhaust port is uncovered and the pressure of about 4-5 bar (*abs*) pushes about 60% of the burnt gases into the exhaust pipe, thereby decreasing the pressure to the atmospheric pressure at point 5. Immediately, after the exhaust port is uncovered the transfer port is uncovered at point 1' and the compressed charge in the crank case enters the cylinder upto point 2 till the port is covered on the compression stroke.

Thus, when the piston moves from BDC to TDC, the compression stroke is completed but when the piston moves from TDC to BDC, the power stroke, exhaust stroke and induction stroke are completed. Therefore in one revolution of the crankshaft the two strokes of the piston cover all the four processes.

DISMANTLING PROCEDURE :

1. Drain oil from the gear box.
2. Remove the carburettor and put it in a clean tray.
3. Loosen the spark plug with the spark plug spanner and keep it aside.
4. Remove the cylinder head and cylinder block.
5. Remove the magnet assembly with a special puller.
6. Remove the clutch assembly.
7. Remove the gear shifter.
8. Remove the crankcase bolts, to have access to the crankshaft, connecting rod and piston.
9. Remove the circlips of the gudgeon pin and separate the piston from the connecting rod small end.
10. Remove the compression rings using ring expander.
11. Remove the crank shaft bearings with the puller and remove the connecting rod.

Thus the engine parts are almost dismantled. Clean all the parts for review to replace or service for assembly.

MAIN PARTS :

S.No.	Name of part	Function	Material	Method of manufacture
1.	Cylinder head	It is a cover for closing one end of cylinder and accomodates the spark plug.	Aluminium alloy	Casting and machining
2.	Cylinder	It acts as an enclosure for the air fuel mixture for compression and ignition, to librate heat for mechanical energy.	Aluminium alloy	Casting and machining

3.	Piston	It is the reciprocating part in the cylinder to suck, compress and exhaust the charge and converts pressure energy of the ignited charge into mechanical energy of the crank shaft.	Aluminium alloy	Casting and machining
4.	Piston rings	These prevent the leakage past the piston and cylinder wall.	Cast iron	Centrifugal casting
5.	Gudgeon pin	It acts an inter link between piston and small end of connecting rod.	Case hardened steel or Alloy steel	Machining
6.	Connecting rod	It acts an inter link between piston and crankshaft to transmit the mechanical energy of the piston to the crank shaft <i>i.e.</i> the reciprocating motion of the piston into rotary motion of the crankshaft.	Alloy steel	Forging and machining
7.	Crankshaft	It converts the reciprocating motion of the piston received by the connecting rod into rotary motion.	Alloy steel	Forging and machining
8.	Fly wheel cum Fan	It provides energy to the piston to perform power consuming operations <i>i.e.</i> suction, compression and exhaust. It also makes the crankshaft torque uniform and provides fanning action to cool the engine and magnet assembly.	Aluminium alloy	Casting and machining
9.	Main Bearings	These act as a support for the crank shaft between the crankshaft and the crank case by providing needle bearing or ball bearing.	Steel	Machining
10.	Spark plug	It ignites the compressed charge of air fuel mixture with the help of spark produced between the electrodes.	Central electrode enclosed with porcelain insulation and steel body	Machining and casting
11.	Ignition System	It consists of the magnet assembly having primary coil, secondary coil, CB points, ignition coil and permanent magnet to produce the high tension current to ignite the mixture of air fuel.	Steel magnet, copper winding of coils with aluminium condenser	Joining of coils with wire and condenser with screw fastening
12.	Carburettor	It is a device to mix air and fuel in proper ratio and supply to the cylinder at proper time.	Aluminium body gun metal	Die casting and machining

13.	Air cleaner	It removes dust and dirt from the incoming air.	jets Perforated paper	Sheet fabrication screwed with paper and rubber
14.	Gear box	It consists of clutch assembly shaft, main shaft and cluster assembly for power trasmission to the wheel.	Steel	Forging and machining

REASSEMBLY : It is the reverse process of dismantling *i.e.* the part removed in the beginning is fitted in the last.

PRECAUTIONS :

1. During the dismantling and reassembling work, use proper tools to avoid damaging of the nuts and delicate parts. Use new gasket kit during assembly.
2. Never use excessive pressure while tightening the parts, but try to use torque wrenches for safety.
3. While fitting piston and connecting rod assembly with the cylinder, smear with sufficient engine oil.
4. While fitting piston rings into the groove, use piston ring expander to avoid breakage of the rings.
5. While fitting piston into the cylinder, use the ring clamp.
6. Make sure that C.B. points gap and spark plug gap are properly adjusted after due cleaning.
7. Fill the correct grade of lubricant with correct quantity in the gear box.

efficiency. It works on diesel cycle *i.e.* constant pressure cycle. The indicator diagram along with the line diagram of a four stroke diesel engine is shown in Fig. P-2.1. (a) and (b). It completes one cycle of working in four strokes of the piston and two revolutions of crankshaft.

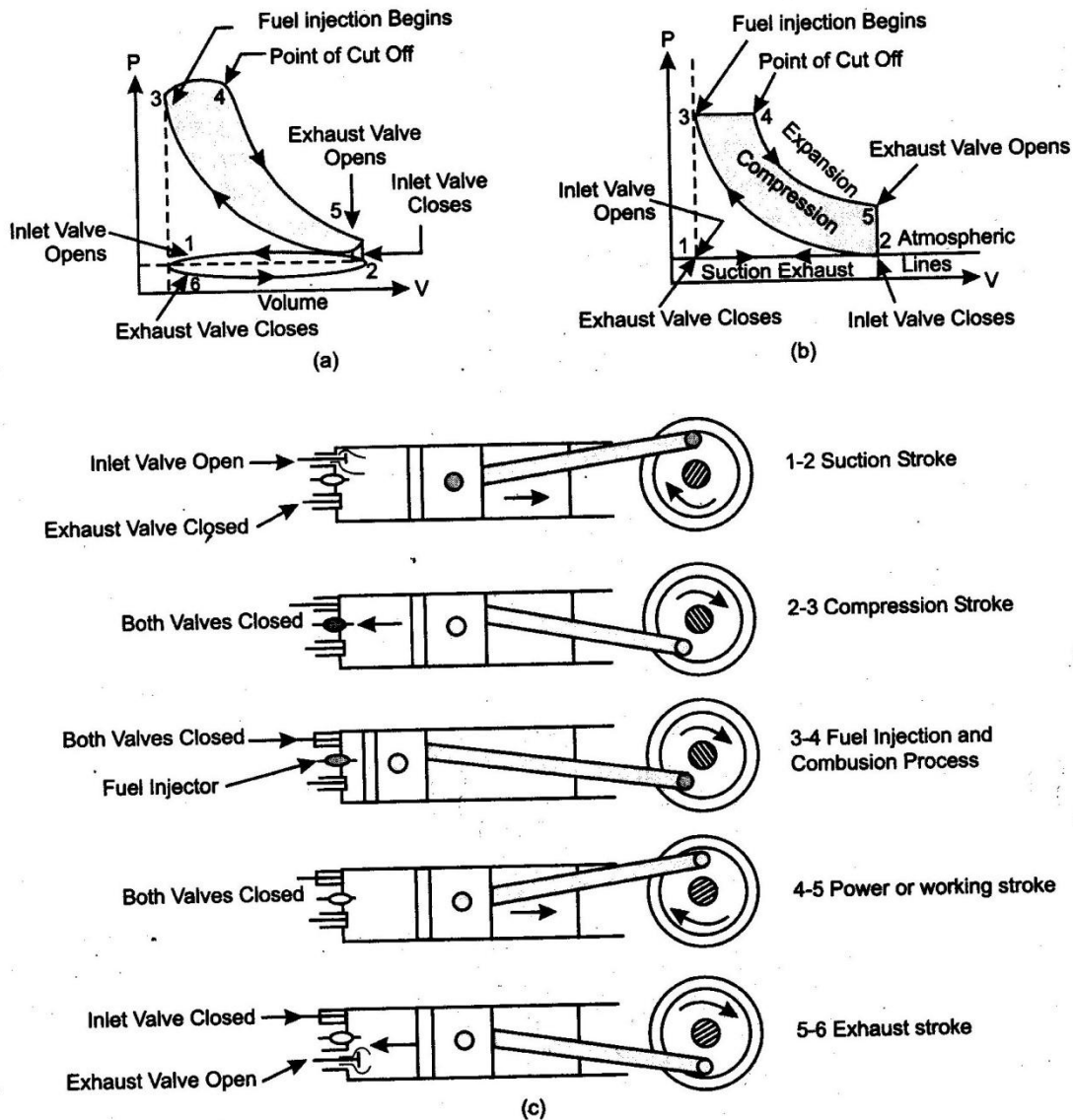


Fig. P-2.1 : Actual, indicator, ideal and line diagrams

These strokes are :

- (i) Induction stroke or suction stroke
- (ii) Compression stroke

- (iii) Power stroke or expansion stroke and
- (iv) Exhaust stroke

Point 1 represents the opening of the inlet valve and point 2 represents the closing of the inlet valve. Thus the line 1-2 represents the suction or induction process of air only. Line 2-3 represents the compression process of the air. Point 3 represents the commencement of the fuel injection. Point 4 represents the fuel cut off point. Thus line 3-4 represents the fuel injection process and fuel burning at constant pressure.

Line 4-5 represents the expansion process. Points 5 and 6 represent the opening and closing of the exhaust valve respectively. Thus line 5-6 represent the exhaust process of the burnt gases.

WORKING PRINCIPLE : When the piston moves from TDC to BDC on the induction or suction stroke, air is admitted in the cylinder at a pressure little below the atmospheric pressure. This process is indicated by the line 1-2. The line 2-3 represents the compression process. During this process, the air is compressed according to the compression ratio, which is about 14 to 22. At point 3 *i.e.* end of compression process, the pressure and temperature rises high enough as 40 bar absolute and 700°C respectively. This temperature is enough to ignite the fuel injected at point 3. The temperature at point 4 is about 1300 °C. The line 4-5 is the expansion process. During expansion, the temperature and pressure decrease but the volume increases. The line 5-6 is exhaust process during which the exhaust gases are pushed against the atmospheric pressure.

DISMANTLING PROCEDURE :

1. Drain oil from the sump.
 2. Remove the rocker box and rocker assembly.
 3. Remove the push rods.
 4. Remove the air cleaner and silencer along with elbow pipes from the cylinder head. Disconnect the high pressure line to the injector and take out injector.
 5. Remove the inlet valve, exhaust valve, valve springs and valve cotters.
 6. Remove the side cover and loosen the big end of the connecting rod and take out the piston along with connecting rod.
 7. Use ring expander to remove the oil and compression rings.
 8. Remove the circlips from the piston using circlip plier. Push out the gudgeon pin and separate the connecting rod from the piston.
 9. Remove the cylinder block.
 10. Remove the timing cover and take out camshaft and crankshaft gears.
 11. Remove the fuel injection pump.
 12. Remove the side cover of the fuel injection pump.
 13. While removing the cam shaft, make sure that the tappet rollers for inlet valve, exhaust valve and fuel injection pump donot fall in the sump.
 14. Remove the fly wheel with puller.
 15. Remove the front and rear covers housing ball bearings for the journals.
 16. Remove the oil filter and plunger type oil pump and take out the crank shaft from the crank case. Thus the engine parts are almost dismantled. Clean all the parts for review to replace or service for assembly.
-

MAIN PARTS :

S.No.	Name of part	Function	Material	Method of manufacture
1.	Engine cylinder or cylinder block	It is an enclosure for the air compression and combustion of fuel to librate heat for generation of mechanical power of the piston.	Grey cast iron	Casting and machining
2.	Cylinder head	It accommodates the inlet and exhaust valves and the fuel injector. It also acts as cover for closing one end of the cylinder.	Grey cast iron	Casting and machining
3.	Piston	It is the sliding part in the cylinder which helps in sucking, compressing and exhausting processes of the cycle and converting pressure energy into mechanical energy of the crankshaft.	Aluminium alloy	Casting and machining
4.	Piston rings			
(a)	<i>Compression rings</i>	Compression rings prevent leakage of the charge from the cylinder to the sump.	Cast iron	Casting and machining
(b)	<i>Oil rings</i>	Oil rings remove surplus oil from the cylinder wall after it has served the purpose of lubrication.		
5.	Gudgeon pin or Piston pin or Wrist pin	It connects the piston and small end of the connecting rod with a close running fit.	Case hardened steel	Machining
6.	Connecting rod	It is a link between the piston and crankshaft. The small end is connected to the piston through the gudgeon pin and the big end is connected to the crank pin. It converts the reciprocating motion of the piston into rotary motion of the crankshaft.	Alloy steel	Forging and machining
7.	Crankshaft	It takes the motion of the piston through the connecting rod and crank mechanism to convert the reciprocating motion of the piston into the rotary motion.	Alloy steel	Forging and machining

8.	Cam shaft	It carries cams for controlling automatically the various operations like valves and fuel injection pump. It always rotates at half the speed of the engine.	Forged steel	Forging and machining
9.	Bearings	They support the rotating shafts. Main bearing support the crankshaft. Cam shaft has separate set of bearings. Connecting rod ends also have bearings for piston pin and crank pin. Rocker arms also have their own bearings.	Babbit and white metal	Machining
10.	Valves	The valves are operated by the camshaft.	<i>Inlet valve</i> ; Nickel chromium alloy steel.	Forging and machining
(a)	<i>Inlet</i>	The inlet valve controls the air supply during suction stroke.	<i>Exhaust valve</i> ; silcrome steel <i>i.e.</i> silicon and chromium	
(b)	<i>Exhaust</i>	The exhaust valve allows the exhaust gases to discharge to atmosphere.	Spring steel	Spring steel wire coiled by machining
11.	Valve springs	They store energy during inlet and exhaust operations for automatic closing of the valves as the operation ends.		
12.	Fly wheel	It stores the surplus energy during the power stroke and supplies it to the idle strokes <i>i.e.</i> suction, compression and exhaust and keeps the crank shaft torque uniform.	Cast iron	Casting and machining
13.	Fuel injector or Atomiser	It provides the fuel under high pressure in the atomised form at the end of compression against the cylinder pressure.	Steel body and nozzle alloy steel.	Die-casting and machining
14.	Fuel injection pump	It provides the fuel under high pressure to the atomiser at the proper time regulated by governor.	Steel body with alloy steel plunger and rack	Die-casting and machining
15.	Air cleaner	It removes dust and dirt from the incoming air during suction.	Dry type has rubber foam felt and perforated paper etc.	Rubber foam felt and perforated paper are screwed to the steel body

16.	Inlet and exhaust manifolds	These are the inlet and exhaust passages controlled by the valves at the cylinder ends.	Grey cast iron	Casting and machining
17.	Timing Gears	The crankshaft transmits motion to camshaft through timing gears. Crankshaft gear has half the number of teeth of the cam shaft gear.	Grey cast iron	Casting and machining
18.	Governor	This automatically controls the speed of the engine at various loads and does not allow the speed to increase beyond limit.	Grey cast iron	Casting and machining
19.	Crank case	This is the base of the engine, supports crank shaft and camshaft in the suitable bearings. The bottom of the crank case is reservoir for the engine oil called oil pan or sump.	Grey cast iron	Casting and machining
20.	Gaskets	These are the packing materials provided at the joints to prevent leakage.	Copper and Asbestos	—————

REASSEMBLY : It is the reverse process of dismantling *i.e.* the part removed first is fitted in the last after thorough wash, clean, review, repair and adjustment if required before the serviceability assured.

PRECAUTIONS :

1. During dismantling and reassembling work, always use proper tools to avoid damaging of the nuts and delicate parts. Use new gasket kit while assembling.
2. Never use excessive pressure while tightening the parts but try to use torque wrenches for safety.
3. While fitting piston and connecting rod assembly into the cylinder, use ring while fitting piston rings in the ring grooves use ring expander and smear them with sufficient engine oil.
4. Use piston ring clamp for compressing the rings into grooves while lowering the piston into the cylinder.
5. Check the serviceability of fuel injection pump and injector before fitting to the engine.
6. Tighten the cylinder head and big end bearings as per the specifications.
7. Use valve spring compressor for valve assembly.
8. Fill the correct grade of oil with correct quantity in the sump, but never forget to change the oil filter.

PRACTICAL-3

Dismantle solex and amal carburettors. Locate and note down the function of various parts. Reassemble.

OBJECTIVE : To learn the proper technique of dismantling solex and amal carburettors required.

during servicing and maintenance as well as to study the function, material and serviceability of each part. Reassembly after replacement of worn out parts for proper function on the engine.

EQUIPMENT AND TOOLS REQUIRED : A solex and amal carburetors, double ended set and ring spanner set, screw driver set, long nose plier, a steel tray, hair brush, petrol and clean rag.

THEORY : A carburettor is a device used to mix up the fuel with air, to supply to the petrol engine. It measures the required quantity of fuel to atomise into minute particles to mix with correct quantity of air as per the load conditions of the engine.

AIR FUEL RATIO : A mixture of air fuel ratio of 15 : 1 means that the mixture strength is having 15 parts of air and one part of petrol by weight. There is, however a range of air fuel ratio within which combustion of fuel can occur. This range of air fuel ratio lies from 8 : 1 to 22 : 1. This range of air fuel ratio also has the limit between which combustion takes place *i.e.* the lower limit and the upper limit. Under lower limit, air fuel ratio lies between 8 : 1 to 10 : 1 by weight and the mixture is called **rich mixture**. Whereas under the upper limit, the air fuel ratio lies between 20 : 1 to 22 : 1 by weight and the mixture is called **lean or weak mixture**. The carburettor supplies varying proportion of air fuel ratio to have maximum performance of the engine under all operating conditions.

The various air fuel ratios are :

1. *Air fuel ratio for starting* :- 10 : 1.
2. *Air fuel ratio for idling* :- 10 : 1 to 11 : 1
3. *Air fuel ratio for economy running i.e. cruising* :- 15 : 1 to 17 : 1.
4. *Air fuel ratio for power* :- Additional fuel for enriching the mixture for extra power along with economy running.
5. *Air fuel ratio for acceleration* :- Enriching the mixture for a short while during acceleration.

SOLEX CARBURETTOR : The solex carburettor as shown in Fig. P-3 with various circuits marked, is generally fitted in most of the Indian cars like Premier and Ambassador.

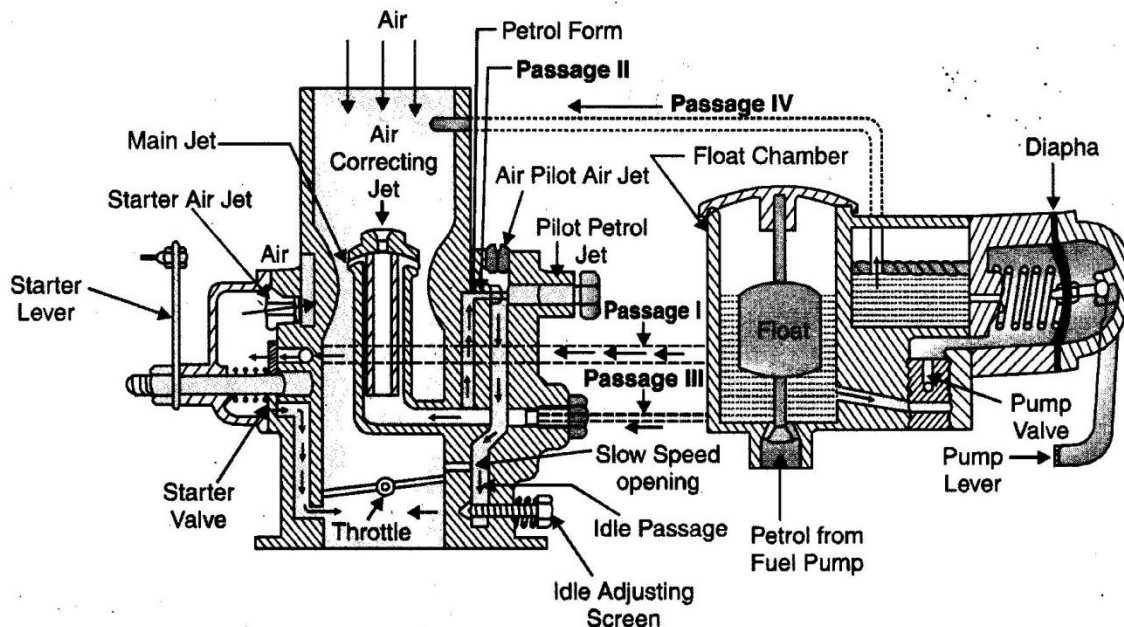


Fig. P-3 : Solex carburettor

It is equipped with all special mechanical devices to fulfil the additional requirements like :

- (i) Uniform supply of fuel during idling.
- (ii) Rich mixture while starting from cold.
- (iii) Proper mixture during normal running.
- (iv) Additional quantity of rich mixture during acceleration.

The various circuits of the solex carburettor with their passages are shown in the Fig.

1. Passage I is the cold starting circuit.
2. Passage II is the running circuit.
3. Passage III is the accelerating circuit.
4. Passage IV is the idling circuit.

DISMANTLING PROCEDURE AND REVIEW OF SOLEX CARBURETTOR :

1. Dismantle the float chamber by opening the four screws of the top cover and take out the float and needle valve. Check for the wear of the needle and seat.
2. Remove the air horn body. Check up the movement of the operating lever, spring and circular disc with the passages of cold starting circuit.
3. Dismantle the accelerating assembly and check the diaphragm, diaphragm spring, non return valves, free movement of the operating lever on the pivot and the inlet and outlet passages.
4. Dismantle the main jet assembly and check for wear of the jet, if any. If worn, replace with new one.

RE-ASSEMBLY OF SOLEX CARBURETTOR : It is the reverse process of dismantling, each circuit after thorough wash, clean, inspection and adjustments is reassemble for satisfactory function.

AMAL CARBURETTOR : Amal carburettor is used in small petrol engines like, motor cycles

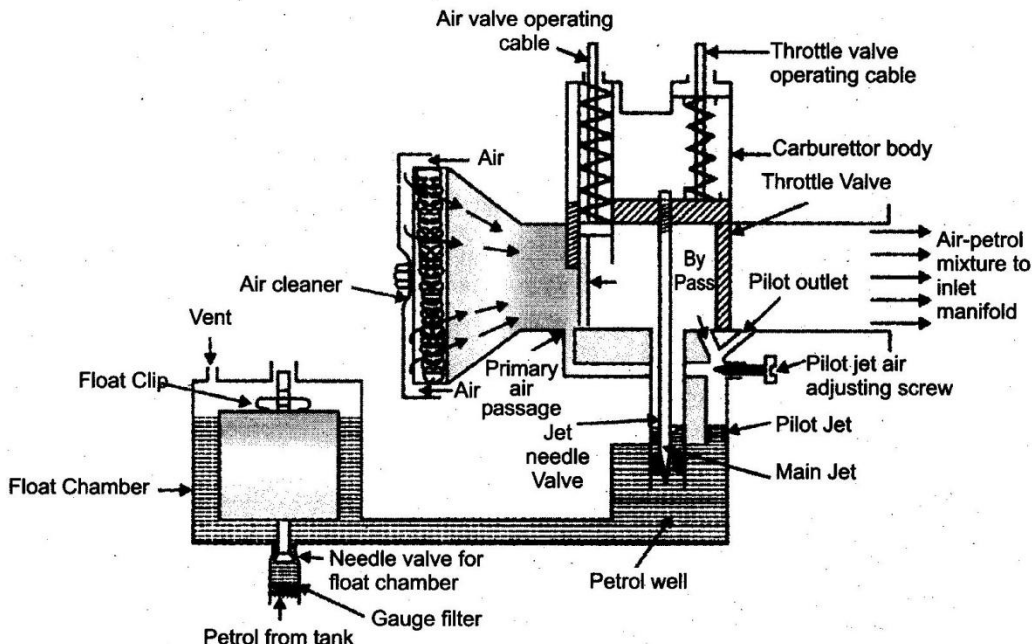


Fig. P-3.1 : Amal carburettor (Simplified schematic diagram)

object of these circuits is to produce high voltage electric current to produce a spark at the spark plug by jumping across the spark plug electrodes at the appropriate time *i.e.* one spark is produced at each cylinder during two revolutions of the crank shaft. The engine employed with this system of ignition is called spark ignition engine.

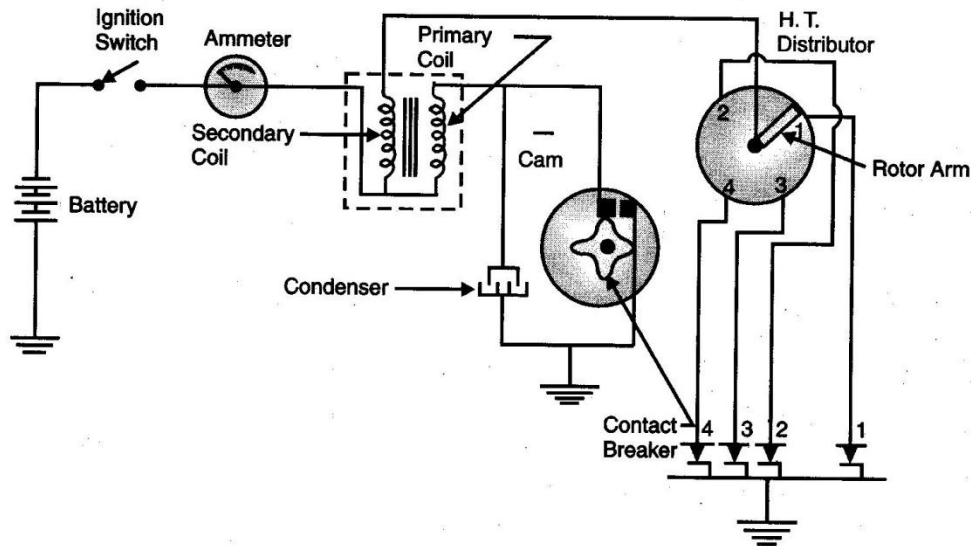


Fig. 4 : Coil ignition system of a four cylinder engine

An ignition switch, ammeter, primary winding in the ignition coil, contact breaker points and the capacitor fall under the primary circuit, whereas secondary winding, distributor, rotor, distributor cap and spark plugs fall under the secondary circuit.

A 6 or 12 volt battery is connected to the primary circuit. When the switch *i.e.* ignition switch is ON and the C.B. points are closed, current from the battery flows through the switch, ammeter, through the primary winding and through the C.B. points is earthed. A capacitor or condenser is connected in parallel to the C.B. points. Flux is produced in the primary winding which has 200–300 turns of copper wire of 20 gauge and 1.15 Ω resistance. When the C.B. points open, a collapse of flux in the primary winding occurs, which produces high tension current in the secondary winding which has about 21 thousand turns of copper wire of 38–40 gauge. Its one end is earthed and the other end is connected to the central electrode of the distributor cap which links to the rotor through the carbon brush. When the rotor comes in contact with distributor cap electrode, current through the high tension lead, which is connected to the spark plug earths to the earth electrode from the central electrode. Thus a spark is produced at the spark plug to ignite the mixture. If the engine is four cylinder, a four lobed cam is provided on the distributor shaft which four times makes and breaks the circuit in two revolutions of the crankshaft and four independent sparks are produced.

STRESSING ON IGNITION TIMING : The spark must occur in each cylinder at a definite time and this is accomplished by timing the engine. Therefore, the timing method, employed for coil ignition system depends upon the type and design of the engine. Firstly, the manufacturer's recommendations should be followed to time the engine, otherwise the common method to time the engine is followed as :

- 1. Stress on the contact breaker gap adjustment :** The importance of the correct cam angle lies in the fact that during the time the points are closed, the coil builds up and when they are open,

the proper amount of high tension current is available at the spark plug. If the C.B. points gap is less, the engine will not run evenly and if the C.B. points gap is more, the engine will miss at high speed. Therefore the stress on the contact breaker gap adjustment is very essential. If the maker's manual is not available, the general gap lies between 0.35 to 0.45 mm. To adjust this gap, rotate the engine with the distributor cap removed and when the points are fully open, insert the feeler gauge of the required thickness. If it has sliding fit, the gap is correct, otherwise adjust it by loosening the movable point in the slot provided. When the correct measurement of the gap appears, then lock the movable point by tightening it.

Now for ignition timing.

2. Open the tappet cover of the engine as well as the distributor cap.
3. Rotate the engine and bring no. 1 cylinder on TDC for compression stroke. This can be checked by removing the spark plug and inserting the screw driver and feeling it. If so, both the valves are closed and the push rods are free to rotate.
4. Locate the timing mark provided either on the crankshaft pulley against the pointer or bob mark on the flywheel seen through the inspection cover against the pointer.
5. At this position, the C.B. points should be in fully open position with the correct gap.
6. Fix the rotor cap and see the position of no. 1 electrode and connect it to no. 1 spark plug.
7. Connect rest of the high tension leads in the direction of rotation of the rotor arm to no. 3, no. 4 and no. 2 spark plugs respectively.

FIRING ORDER : The sequence in which the power impulses occur in the engine is called *firing order*.

PRECAUTIONS :

1. Use proper tools.
2. Open and close the parts gently.
3. Use proper feeler gauge blade while measuring C.B. points gap.
4. Do not apply undue pressure while using feeler gauge.
5. Connect the leads in the correct firing order of the engine.

PRACTICAL-5

Study of cooling System of I.C. engine.

OBJECTIVE : To learn the principle of cooling system in I.C. engines through study of the various parts involved in cooling system.

TOOLS AND EQUIPMENT : An air cooled I.C. engine, multicylinder water cooled I.C. engine, set of tools (*sockets, ring spanners, set spanners, screw drivers, cleaning material, grease and old rags*) etc.

THEORY : The ignition causes combustion and during combustion of diesel or petrol, a large amount of heat is produced. In I.C. engines, this heat energy is converted into mechanical energy. No heat engine can convert the whole of the heat energy fed to it to its equivalent mechanical work. Generally about 30% of the total is converted into useful work and out of remaining 70%, the heat

carried away by the exhaust gases is about 40%. The balance about 30% of heat transfers through the cylinder walls. Therefore this, 30% heat is dissipated to the surroundings by some method of cooling. For this, two systems are adopted. These are :

- (i) Air cooling system
- (ii) Water cooling system

(i) **Air cooling system or direct cooling system** : This cooling system is adopted in scooters, motor cycles and small air craft engines. The outer surface area of cylinder barrel is increased by providing fins as shown in Fig. P-5. The air current is made to flow over the fins. Thus, it radiates the heat to the surrounding air.

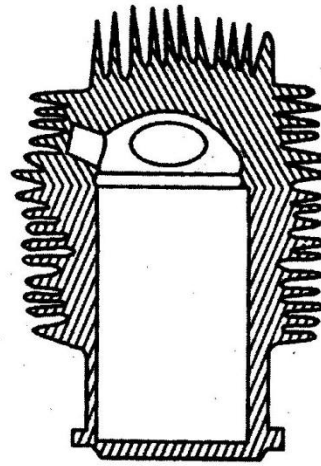


Fig. P-5 : Section of air cooled cylinder

(ii) **Water cooling system or indirect cooling system** : In water cooling system, the cylinder barrel heat is transferred to the water and the water heat is dissipated to the surrounding air. Because of this, the system is called indirect cooling system. This system is more efficient than air cooling system and is generally used for power I.C. engines like cars and buses etc.

Fig. P-5.1 shows the water cooling system, with various parts such as water jackets, rubber hoses, radiator, water pump fan and thermostat. In this system, the water is circulated to the water jackets around the cylinder barrel, combustion chamber and valves. The heat gained by the water during circulation from the water jacket is liberated to the radiator and recirculated by the water pump. The water pump is located in front of the engine behind the radiator and driven by the engine crankshaft with 'V' belt, the pump forces the hot water to the upper tank of the radiator. and dismantling of the

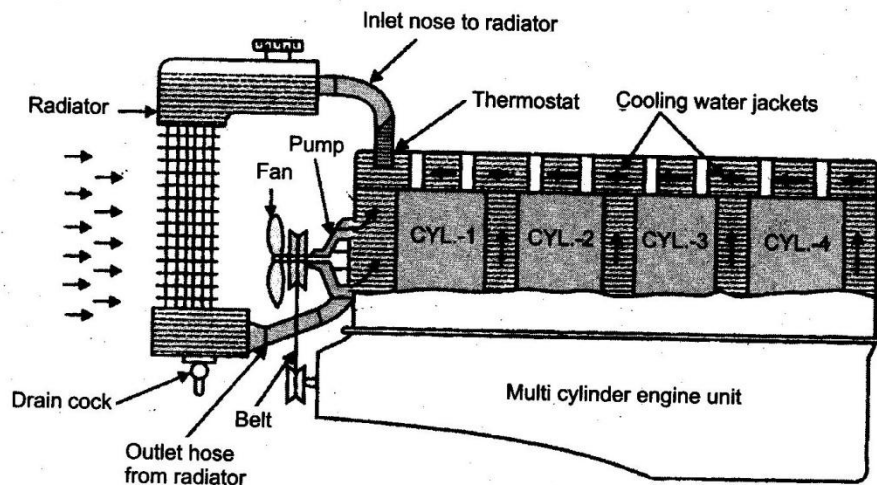


Fig. P-5.1 : Water cooling system for a Multi-cylinder I.C. Engine

various parts and fault rectification from where it flows to the lower tank. The large amount of cooling surface of the radiator provides the air stream to cool the water efficiently. Fan fitted behind

the radiator accelerates the rate of dissipation of heat by circulating enough air through the radiator core. A thermostat placed in the water circuit regulates the water temperature by controlling the water flow from water jacket to the radiator core. It normally operates at a temperature of 70 ~ 80°C.

DISMANTLING, ASSEMBLY AND FAULT CHECK PROCEDURE :

1. Before dismantling any part of the cooling system, drain water from the radiator and cylinder block.
2. Before removing the radiator, loosen the hose clamps ; upper and lower and free the radiator. Loosen its mounting and remove it. Give a thorough wash with the reverse flow and clean it with the compressed air before mounting it back.
3. Loosen the fan belt tensioner to remove fan belt.
4. Loosen the fan hub pulley and fan and remove the fan belt. Check its condition. Replace it if required.
5. Loosen the water pump mountings and take it out. Dismantle the water pump and check for the wear of the impeller shaft, blades and bearings. Use new shaft seal while assembling and check for end play and free movement.
6. Check the operation of thermostat. Replace, if defective.
7. Tighten the hose clamps. Fill water and check for any leakage.

PRECAUTIONS :

1. Use proper tools during dismantling.
2. Wash the parts before assembly.
3. After fitting the belt, do not over tension it.

PRACTICAL-6

Study of lubrication system of I.C. engine.

OBJECTIVE : To learn the working principle of lubrication system of I.C. engine and the components involved.

TOOLS AND EQUIPMENT : A multi cylinder I.C. engine, a set of tools (*ring spanners, set spanners, screw drivers*) cleaning material, hair brush, mallet and clean cloth.

THEORY : Lubrication is the process of reducing friction by inserting a thin film of oil between the moving parts. When one surface slides over the other surface, friction is developed. This friction in I.C. engines is quite large due to numerous rotating and sliding parts, which causes wear and tear of the components and absorbs a fraction of the power developed by the engine. Also the friction generates heat and the temperature of various components rise. To overcome this friction and its effects to some extent, the oil film is made to travel through the moving and sliding components of the engine. The oil as it travels, picks up considerable amount of heat and transfers to the oil pan, where the oil is cooled by the air passing under the bottom of the oil pan.

LUBRICATION SYSTEMS OF I.C. ENGINES : *A system of an engine which forces oil, regulates its flow and purifies it, to have proper lubrication to all the moving parts producing friction, is known as lubrication system.*

The various lubrication systems used in I.C. engines are :

- (i) Petroil lubrication system, (ii) Splash lubrication system, (iii) Pressure lubrication system

- (iii) Oil pump
 - (iv) Pressure relief valve
 - (v) Oil pressure gauge
 - (vi) Oil filter
 - (vii) Oil dip stick
1. Loosen drain plug of oil sump and drain oil.
 2. Loosen sump bolts and remove sump.
 3. Oil strainer, oil pump, main bearings, big end bearings, connecting rod, bottom of piston and exposed cylinder walls are visible for review.
 4. Remove oil strainer, wash it in diesel or petrol and blow it with dry compressed air.
 5. Remove oil pump if needed for dismantling to check the gear teeth for wear and tear and regulating valve for spring and ball tension and seating respectively.
 6. Remove oil filter and discard it to replace with new one.
 7. Remove the dip stick and check its marking.
 8. Check oil pressure gauge for correct reading.
 9. Check big end of connecting rod with a screw driver for its end play.
 10. Assemble the dismantled parts in the reverse order after cleaning.
 11. Tighten the sump bolts evenly, use the new gasket.
 12. Tighten the drain plug and fill oil in the sump.
 13. Using dip stick, measure the level of oil in the sump.

PRECAUTIONS :

1. Use proper size and type of tools.
2. While dismantling any component, dismantle systematically.
3. Parts of various components should be thoroughly cleaned.
4. Use torque wrenches with correct torque to avoid breakage.

PRACTICAL-7

Determination of B.H.P. by dynamometer.

OBJECTIVE : To learn the technique to determine B.H.P. by dynamometer.

EQUIPMENT REQUIRED : An I.C. engine fitted with brake dynamometer having brake drum cooling arrangement, tachometer and loading arrangement etc.

THEORY : Brake power is the net power available at the crankshaft of the engine for doing useful work. It is measured with the help of a braking device and hence called Brake Horse Power or Brake Power.

The simple method adopted to measure B.P. by the rope brake arrangement is shown in Fig. P-7. The rope makes one complete turn around the rim of the brake drum attached to the crankshaft of the engine. One end of the rope carries the dead weight load and the other end is connected to the spring balance. The direction of rotation of the brake wheel is opposite to the pull of the dead weight load.

i.e. anticlockwise direction. The engine is started without load. Different loads are applied at the dead

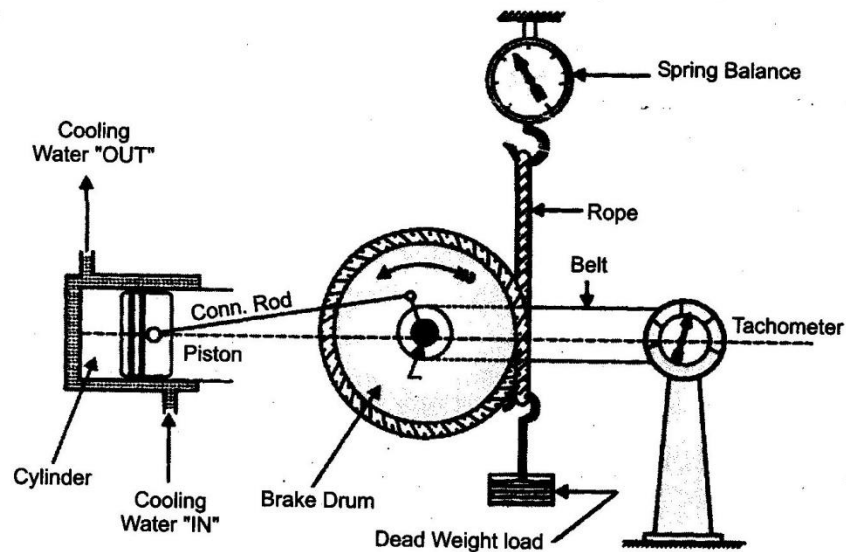


Fig. P-7

weight load hanger. At any steady load when the engine runs as steady speed, the speed of the engine is measured with the help of tachometer, the calculations are carried out as ;

$$\text{BHP} = \frac{(W-S)2\pi RN}{4500} \text{ in MKS units}$$

Where,

- W = Dead weight load in kg and
- S = Spring balance reading in kg
- R = Mean radius of the brake drum in m.
= Radius of the drum plus radius of the rope
- N = Speed of the crankshaft in r.p.m.
- T = Net torque applied
= (W - S) × R Nm

PROCEDURE TO FIND BHP OF THE ENGINE :

1. Start the engine without load.
2. Put some dead weight on the hanger of the rope brake system.
3. Bring the engine to steady conditions *i.e.* running at constant speed.
4. Note down the r.p.m. of the engine as given by the tachometer. Also note down the dead weight load on the brake and spring balance reading on the brake.
5. Either change load or speed of the engine and bring it to constant speed under the changed load and speed. Again, note down the corresponding value of speed, spring balance reading and the dead weight value.

PROCEDURE :

1. The engine under test is coupled to a suitable dynamometer and its brake power is determined, say its value is B.
2. Now the first cylinder is made inactive by short circuiting the spark plug and the load is adjusted to keep the speed constant as it was during first reading. The brake power B_1 under new conditions is determined from the new brake load.
3. The first cylinder is now re-introduced and the second cylinder is cut off. The engine speed is kept at its original value by adjusting the brake load if required. The brake power B_2 of second cylinder made inactive is determined.
4. The similar procedure is adopted for each cylinder in turn.

Then I.P. of the engine = I.P. of first cylinder + I.P. of second cylinder + I.P. of third cylinder + I.P. of fourth cylinder

$$= (B - B_1) + (B - B_2) + (B - B_3) + (B - B_4) = I_1 + I_2 + I_3 + I_4$$

OBSERVATIONS :

S.No.	Dead current reading	Spring balance reading	Net load	Steady special	Brake Power	Indicated Power	
	(W) W (N)	(S) (N)	(W - S) N	(N) (r.p.m.)	B.P. $= \frac{(W - S)2\pi RN}{60 \times 1000} \text{ kW}$	B - B ₁ to B ₄	I.P.
1.					B		
2.					B ₁	B - B ₁	I ₁
3.					B ₂	B - B ₂	I ₂
4.					B ₃	B - B ₃	I ₃
5.					B ₄	B - B ₄	I ₄

\therefore Total I.P. = $I_1 + I_2 + I_3 + I_4$

PRECAUTIONS :

1. Start the engine without load and keep it in running for sometime.
2. Put certain load on the brake *i.e.* the loading of the engine from no load should be gradual.
3. Note down the readings when the engine attains steady speed.
4. While performing practical, observe safety precautions.
5. Take all the readings at the same speed so that the frictional loss approximately will be the same.

PRACTICAL-9

Local visit to Roadways or Private automobile workshops.

OBJECTIVE : A local visit to roadways automobile workshop to broaden the vision of the students and to become familiar with the practical field and assess their knowledge imparted in the laboratory.

PROCEDURE :

1. Obtain permission from the General Manager through correspondence.
2. The General Manager sanctions the permission and sends it to the works manager for implementation.
3. The teacher incharge on the sanctioned data, is required to take the students to the workshop in the disciplined way.
4. The teacher should immediately meet the works manager to fulfil the requirements.

OBSERVATIONS : Workshop and repair shops are arranged in a systematic way as :

1. Start from the engine shop where the major repair works are carried out.
2. The engine completely stripped and all components found lying in different trays as per the different systems.
3. Different components should be reviewed for their constructional features, materials and functions.
4. Different passages of lubrication and cooling systems can be seen.
5. All adjustments should be understood and then move to the next shop *i.e.* gear box.
6. Similar to the engine shop, the gear box primary, main and lay or counter shafts and their gear arrangements should be studied and understood for their power flow and gear ratio in different gears.
7. Study the synchromesh system *i.e.* clutch hub, clutch sleeve, synchronizer rings, keys and key springs practising their assembly and disassembly and the necessary adjustments. Then move to the differential shop.
8. Observe the function of the differential after reviewing the crown, pinion, sun gears, stars or pinions on straight drive, while taking a turn.
9. Similarly see on the vehicle the front axle, rear axles and its floating system along with brake system and type of assistance used.
10. Take all observations of the steering system on the vehicle itself. Then move to the diesel section.
11. Here the fuel injection pump phasing and calibration work is done. Understand thoroughly and then see the atomiser test rig and setting of the atomiser.
12. Finally go to the electrical shop, where battery charging and repair of electrical works are carried out.

PRECAUTIONS :

1. Do not handle any item without knowledge.
2. Observe all safety precautions while moving from shop to shop.

PRACTICAL-10

Study of steam turbines through models and visits.

OBJECTIVE : To learn the working of steam turbines.

EQUIPMENT REQUIRED : A working model of a steam turbine and steam supply.

THEORY : A steam turbine is a prime mover to obtain rotary motion by gradual change in momentum of the steam. The nozzles transform the steam energy into the kinetic energy and then the

kinetic energy of the resulting jet is converted into force, doing work on the rings of blades mounted on the rotating shaft as shown in Fig. P-10.

According to the manner of steam expansion, the steam turbines are of two types :

(a) Impulse turbines (b) Reaction turbines

In an impulse turbines, the steam expands in the nozzles only, when passing over the blades, the pressure remains constant.

In reaction turbines, the steam is not expanded in the nozzles but expands as it passes over the blades, the blades act as nozzles.

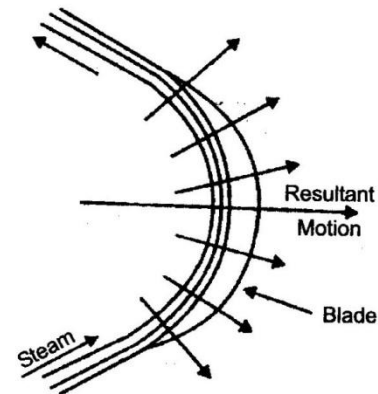


Fig. P-10

PROCEDURE : Fig. P-10.1 shows the constructional details of the two stage impulse turbine. It consists of one row of nozzles and other row of fixed blades attached to the casing and has two rows of moving blades attached to the periphery of the rotor fixed to the shaft.

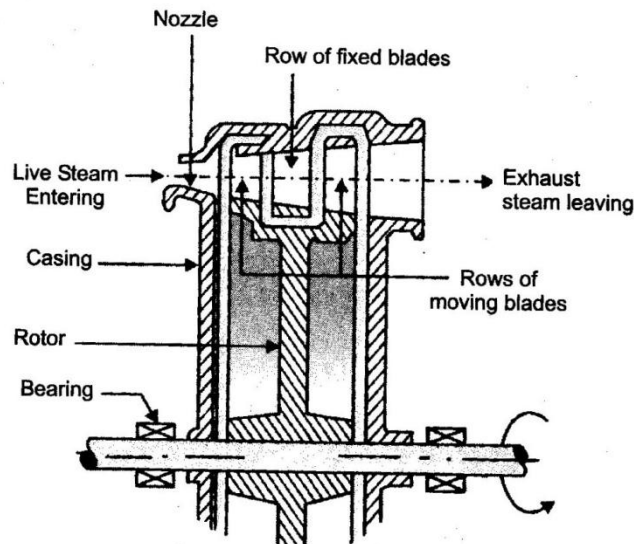


Fig. P-10.1

When the steam is supplied to the turbine, it starts flowing through the turbine. The expansion of steam takes place in the nozzles and changes into high velocity, which imparts a portion of its kinetic energy when passing over the first row of moving blades. Then the steam passes over the fixed set of blades, where only change of direction of steam takes place without much loss in velocity. Then the jets of steam pass on to the other row of moving blades where further drop in kinetic energy occurs and finally the steam exhausts.

PRECAUTIONS :

1. Avoid use of wet steam in the turbine
2. For better efficiency, use super heated steam.
3. Ensure that steam pipes and turbine are heat insulated.

condenser. The jet condensers are sub-divided into :

- (a) Parallel flow jet condenser (b) Contra flow jet condenser

(ii) **Surface condenser** : In this type of condenser, the exhaust steam and the cooling water do not come in direct contact with each other. It is generally used where large quantities of inferior water is available and good quality of feed water to the boiler must be used most economically. The steam to be condensed is made to flow over the outside of the tubes through which the cooling water circulates.

The surface condensers are sub divided into :

- (a) Down flow surface condenser. (b) Central flow surface condenser.
(c) Inverted flow surface condenser. (d) Evaporative surface condenser.

Down flow surface condenser : The commonly used surface condenser is the down flow surface condenser as shown in Fig. P-11.1, in which the steam enters at the top and flows down over the tubes through which water is circulated. It consists of a cylindrical shell having a large number of parallel tubes fixed between two water boxes in the condenser shell. The water box on the left hand side is shown in the figure, in which cold water enters at the bottom and flows through the lower set of tubes till it reaches the other end of the shell. It then rises up and travels in the opposite direction through the upper set of tubes and finally comes out through the outlet. The distance travelled by the water through the tubes is twice the length of the tubes in the shell. The steam enters at the top and flows downward coming in contact with the cold outside surface of the tubes and gets condensed. The temperature of the cooling water rises due to heat gained from the hot exhaust steam. The condensate extraction pump fitted at the bottom collects the condensate and sends it to the hot well for onward feed to the steam generator.

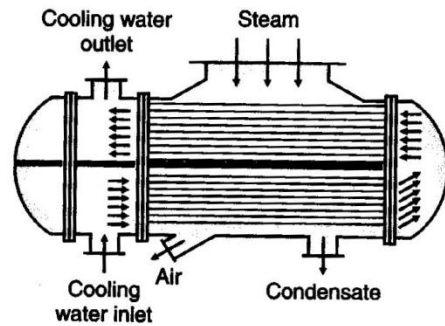


Fig. P-11.1 : Down flow surface condenser (longitudinal section)

PRECAUTIONS :

To increase the efficiency of the steam condenser ; following precautions are to be observed.

1. The air should not be present in the condenser. If so, the main sources of air entering the condenser are :
 - (i) The feed water supplied to the boiler may contain certain amount of air dissolved into it, which is carried by steam to the engine or turbine and therefore to the condenser in the exhaust steam.
 - (ii) Air also leaks from the atmosphere to the various joints or the parts, where the pressure is less than that of atmosphere.
 - (iii) In jet condenser, the injection water brings certain amount of air dissolved into it.
2. Check the vacuum in the condenser on the vacuum gauge to ensure the function of the air pump.
3. Ensure the working of cooling pond or cooling tower by checking the water temperature.
4. Ensure that the air extraction pump, condensate extraction pump, boiler feed water pump, make up water pump and condenser cooling water pump function satisfactory.