WIREMAN

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

SECTOR: POWER

(As per revised syllabus July 2022 - 1200 hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Power

Duration : 2 Years

Trade : Wireman - 2nd Year Trade Practical - NSQF Level - 4 (Revised 2022)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai has now come up with instructional material to suit the revised curriculum for **Wireman 2nd Year Trade Practical NSQF Level - 4 (Revised 2022) in Power Sector.** The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Director General, Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Shri. Atul Kumar Tiwari, *I.A.S*
Secretary
Ministry of Skill Development & Entrepreneurship,
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August 2023
New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi (NSQF LEVEL - 4) under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **Wireman 2nd Year NSQF Level - 4 (Revised 2022)** under **Power** Sector for ITIs.

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NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Wireman** Trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022)

The manual is divided into Ten modules

Module 1	-	Commercial Wiring
Module 2	-	Industrial Wiring
Module 3	-	Illumination
Module 4	-	CFL & LED Lamps & DC Regulated Power Supply
Module 5	-	Solar Power Plant
Module 6	-	Cable Joints
Module 7	-	Electric vehicle
Module 8	-	Domestic Appliances
Module 9	-	Basic Electrical Wiring and Winding
Module 10	-	Wiring Installation

The skill training in the shop floor is planned through a series of practical exercises centered around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE PRACTICAL

The manual of trade Practical consists of theoretical information for the course of the **Wireman 2nd Year NSQF Level - 4 (Revised 2022)** in **Power** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade Practical has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No.	Learning Outcome	Ref. Ex.No.
1	**Plan, draw, install and test different types of Commercial wiring including advanced systems. Install temporary electrical wiring at construction site. (Mapped NOS: PSS/N1707)**	**2.1.109 - 2.1.118**
2	**Plan, draw, estimate material/ cost, install and test different types of industrial wiring system as per IE rules. Layout cables for various purposes including cable management. (Mapped NOS: PSS/N1707)**	**2.2.119 - 2.2.133**
3	**Plan, install and test illumination system including domestic, commercial and industrial requirements. Connect, program and operate PAR light on DMX controller (Stage light control). (NOS: PSS/N1707)**	**2.3.134 - 2.3.141**
4	**Assemble simple electronic circuits, repair CFL, LED lamps and DC regulated power supply. (Mapped NOS: PSS/N6002)**	**2.4.142 - 2.4.149**
5	**Assist in Installation and commissioning of small solar plant, solar pumps and construct Solar DC appliances. (Mapped NOS: PSS/N6003)**	**2.5.150 - 2.5.157**
6	**Plan, prepare and carry out jointing of LT/HT underground cables with due care and safety. (Mapped NOS: PSS/N2512)**	**2.6.158 - 2.6.164**
7	**Install Electric Vehicle charging stations and carry out preventive/ breakdown maintenance.**	**2.7.165 - 2.7.167**
8	**Install and repair domestic appliances viz., electric kettle, food processor, fan, washing machine, geyser, water pump etc. including repair of electrical faults in refrigerator, window and split AC. (Mapped NOS: PSS/N6003, PSS/N4402, PSS/N1711)**	**2.8.168 - 2.8.177**
9	**Perform winding of small transformers and motors viz., ceiling fan, table fan, mixer/grinder, submersible pump, etc. (Mapped NOS: PSS/N4402)**	**2.9.178 - 2.9.184**
10	**Carry out Estimation & costing for different wiring systems and ready to adopt structured / smart wiring concept for automation and IoT applications.**	**2.10.185-2.10.188**

SYLLABUS FOR WIREMAN

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 115 Hrs; Professional Knowledge 30 Hrs	Plan, draw, install and test different types of Commercial wiring including advanced systems. Install temporary electrical wiring at construction site. (Mapped NOS: PSS/N1707)	109.Practice wiring for communication circuits and computer networks using UTP, STP, Co-axial and optical fibre cables. (11 hrs) 110.Wire-up lighting system for control using motion detector. (12 hrs) 111.Wire-up panel board for control of lights and fans from wireless remote. (12 hrs) 112.Demonstrate wiring and components of fire alarm system, interior siren, control & signalling using visual aids. (12 hrs) 113.Practice installation of 1 ϕ & 3 ϕ online/ offline UPS wiring and test. (12 hrs) 114.Install and wire up CCTV camera. (08 hrs) 115.Install inverter and carry out wiring. (12 hrs) 116.Demonstrate wiring plan, lighting fixtures, receptacles and sensors for bathing area. (12 hrs) 117.Demonstrate multi- storeyed building wiring. (12 hrs) 118.Install temporary LV electrical panels and lighting arrangements for construction site. (12 hrs)	**Commercial Wiring:** Wiring in commercial building- their special precautions as per I.E. rules. Different types of wiring - Power, control, Communication and entertainment wiring. Wiring circuits planning, Cabling in healthcare facilities; importance of grounding, shielding and routing in accordance with life safety codes to minimize interference with medical equipment. GFCI (Ground-fault circuit interrupter) receptacles. (30 hrs)
Professional Skill 110 Hrs; Professional Knowledge 28 Hrs	Plan, draw, estimate material/ cost, install and test different types of industrial wiring system as per IE rules. Layout cables for various purposes including cable management. (Mapped NOS: PSS/N1707)	119.Identify accessories and tools required for industrial wiring. Demonstrate various switchboards, switchgears, industrial control panels and accessories. (06 hrs) 120.Demonstrate cable tray, raceways, auxiliary gutter, cable bus assembly, trench for passing of cables. (06 hrs) 121.Determine minimum ampacity and size of conductors for continuous and non-continuous loads. (06 hrs) 122.Practice installing cables in conduit as per IE rules. (06 hrs) 123.Practice cutting, threading and bending of metallic conduit. (08 hrs)	**Industrial Wiring:** Adverse conditions likely to affect the installation. Degree of mechanical and electrical protection necessary. Peak-Non-peak Loads in Office Buildings Lighting Design; lighting power density, Estimation of load, cable size, bill of material and cost. Inspection and testing of wiring installations. Special wiring circuit e.g. hospital, godown, tunnel and workshop, etc. Danger notice as per IE rules **Cable Management:** Types of cables, their use, Various cable glands

		124.Identify different bus bars, practice joining and installation including overhead bus bar system as per IE rules. (10 hrs) 125.Prepare bill of material, plan and practice wiring of an institute and workshop as per IE rules. (16 hrs) 126.Demonstrate Hospital, Tunnel and Godown wiring using visual aids. (06 hrs) 127.Practice testing / fault detection of industrial wiring installations and repair. (14 hrs) 128. Practice laying of cables in raceways and trenches. (05 hrs) 129. Demonstrate various cable glands. Practice cable entry on a switch cabinet wall. (05 hrs) 130.Practice passing of cables through cable entry plate for standard cables without connectors, up to IP 68 rated protection. (05 hrs) 131.Practice split cable entry for multiple pre-terminated cables, up to IP 65 rated protection. (05 hrs) 132.Demonstrate bonding and grounding of raceways, cable assembly and panels. (04 hrs) 133.Demonstrate use of earth rods. Test underground cables for faults and remove the fault. (08 hrs)	Introduction to IP ratings (Ingress protection) and IP Codes format. Importance of Bonding and grounding, various types. Testing of cables, locating faults, open circuit, short circuit and leakage in cables.(28 hrs)
Professional Skill 60 Hrs; Professional Knowledge 20 Hrs	Plan, install and test illumination system including domestic, commercial and industrial requirements. Connect, program and operate PAR light on DMX controller (Stage light control). (NOS: PSS/N1707)	134.Group different wattage of lamps in series for specified voltage. (03 Hrs) 135.Practice on low voltage track system, mains voltage track system and LED battery powered lighting. (07 hrs) 136.Prepare decorative lamp circuit to produce rotating/ running light effect. (08 Hrs) 137.Install different display spotlights and LED downlights. (08 Hrs) 138.Demonstrate kitchen under- cabinet lighting, shelf lighting, closet lighting and cove lighting. (05 hrs) 139.Practice installation of various lamps e.g. fluorescent tube, HP mercury vapour, LP mercury vapour, HP sodium vapour, LP sodium vapour, metal halide, LED lights, pendant lighting. (15 hrs) 140.Assemble, program and Practice on DMX controller for operation of PAR lights. (10 hrs) 141. Visual demonstration of LED video wall panel installation, hardware & software setup. (04 hrs)	**Illumination & Stage Light Control:** Laws of Illuminations. Types of illumination system. Illumination factors, intensity of light. Type of lamps, advantages/ disadvantages and their applications. Calculations of lumens and efficiency. Spotlights, downlights, Strip lights Various reflectors; PAR (Parabolic aluminized reflector), MR (Multi-faceted reflector) LED video wall panel applications. (20 hrs)

Professional Skill 65 Hrs; Professional Knowledge 20 Hrs	Assemble simple electronic circuits, repair CFL, LED lamps and DC regulated power supply. (Mapped NOS: PSS/N6002)	142.Determine the value of resistance by colour code and identify types. (05 hrs) 143.Determine V-I characteristics of semiconductor diode. (05 hrs) 144.Identify circuit components and their terminals viz, diode, transistor, capacitors, regulator. (06 hrs) 145.Construct half wave, full wave and bridge rectifiers. (15 hrs) 146.Practice soldering on basic electrical and electronic circuits. (06 hrs) 147.Troubleshoot defects in simple power supplies. (05 hrs) 148.Identify different components and circuits of CFL & LED lamps. (08 hrs) 149.Check faulty section/ components of LED & CFL and practice for repairing. (15 hrs)	**CFL/LED Lamps & DC regulated power supply;** Resistors; colour code, types and characteristics. Diode; P-N junction, classification, specifications, biasing and characteristics. Rectifier circuit; half wave, full wave, bridge rectifiers and filters. Active and passive components. Functioning of components used in CFL and LED circuits. CFL and LED lamp's circuit. Safety and disposal procedure (20 hrs)
Professional Skill 80 Hrs; Professional Knowledge 20 Hrs	Assist in Installation and commissioning of small solar plant, solar pumps and construct Solar DC appliances. (Mapped NOS: PSS/N6003)	150.Construct a solar lantern using Solar PV panel (15W), Charge controller (6V, 5A), output control circuit for variable illumination, Rechargeable battery (6V, 7Ah) and DC LED lamp (5W). (15 hrs) 151.Construct a Solar Day lighting using manual charge controller (12V, 10A), Solar battery (12V, 100Ah), Solar panel (75 W) and 4X LED light (12V DC, 5W). (10 hrs) 152.Construct a Solar Street light using dusk to dawn charge controller (12V, 10 A), Solar battery (12V, 100 Ah), Solar panel (75 W) and 4X LED light (12V DC, 5W). (10 hrs) 153.Construct a Solar water pump using a DC pump (24 V), Solar Panel (250 W), Charge controller (24 V, 10 A). (12 hrs) 154.Connect a Solar panel (10W), Solar charge controller (12V, 10A), Solar battery (12V, 100 Ah) and a normal inverter and convert to a solar inverter. (10 hrs) 155.Prepare bill of material for a 1 KW solar PV installation. (10 hrs) 156.Demonstrate through audio visual aids; automatic manufacturing of solar panels, installation of solar street light, solar fertilizer sprayer, solar water pump and solar traffic light. (09 hrs) 157.Demonstrate synchronization between Solar Panel & AC grid supply using visual aids. (04 hrs)	**Solar Power Plant:** Solar energy fundamentals. Study of Sun path (east to west, North to south and south to north movement). Study of daily and seasonal changes of sunlight. Angle of inclination of radiant light and its relation with latitude and longitude of different locations on Earth. Solar DC domestic application: Making of solar lantern. Solar Day lighting. Solar Garden Lights. Safety in DC system. Quality standards List out the inventory list of equipments. Solar DC industrial application: Solar street light. Solar home lighting system. Solar Security system. Solar DC water pump. Differentiate AC and DC solar pumps and their PV requirements for various HP capacities. Solar PV e-learning software. (20 hrs)

Professional Skill 85 Hrs; Professional Knowledge 20 Hrs	Plan, prepare and carry out jointing of LT/HT underground cables with due care and safety. (Mapped NOS: PSS/N2512)	158.Identify different parts of various underground cables. (05 hrs) 159.Practice preparation of cables for termination and joining. (12 hrs) 160.Demonstrate termination kits and practice on terminations of LT/HT cables. (15 hrs) 161.Practice discharging procedure of underground cables. (08 hrs) 162.Make straight joint of different types of underground cable. (25 hrs) 163.Demonstrate jointing of XLPE cables using audio- visual aids. (12 hrs) 164.Demonstrate various tests on underground cables. (08 hrs)	**Underground cable joints:** Need of cables, advantages and disadvantages, various types viz., PVC, XLPE, PILC, oil filled, etc. Cable insulation & voltage grades. Joints and terminations; pre- moulded, heat shrinkable, extrusion molded joints Slip on, cold shrink terminations. Types of connectors used in the cable, current path. Methods of conductor connection, contact resistance. Galvanic corrosion and use of bimetals. Connectivity for cable screen and armour, mechanical protection Kits for joints and terminations. Cable termination to equipment Standards and testing; type, routine, field test, Stress control (20 hrs)
Professional Skill 20 Hrs; Professional Knowledge 05 Hrs	Install Electric Vehicle charging stations and carry out preventive/ breakdown maintenance.	165.Demonstrate different charger specifications. (04hrs) 166.Perform installation of EV charging Station for Public places. (08 hrs) 167.Perform installation of Home EV charging stations. (08 hrs)	EV scenario in India and EV Charging basic theory. EV Charging safety requirements. (05 hrs)
Professional Skill 135 Hrs; Professional Knowledge 40 Hrs	Install and repair domestic appliances viz., electric kettle, food processor, fan, washing machine, geyser, water pump etc. including repair of electrical faults in refrigerator, window and split AC. (Mapped NOS: PSS/N6003, PSS/ N4402, PSS/ N1711)	168.Service and repair of bell/ buzzer. (06 hrs) 169.Service and repair of electric iron, electric kettle, cooking range and geyser. (15 hrs) 170.Service and repair of induction heater. (06 hrs) 171.Service and repair of mixer/grinder and food processor. (20 hrs) 172.Service and repair of fan, blower, cooler, etc. (15 hrs) 173.Service and repair of semi- automatic washing machine. Demonstrate components of fully automatic top & front load washing machine using visual aids. (15 hrs) 174.Service and repair of refrigerator. (15 hrs) 175.Demonstrate installation and repair of pump set and submersible pump. (15 hrs) 176.Carry out repair of electrical circuit of window and split AC. (20 hrs) 177.Demonstrate installation and maintenance of split AC using visual aids. (08 hrs)	**Domestic appliances:** Working principles and circuits of common domestic electrical appliances; Bell, buzzer, electric iron, kettle, cooking range, geyser, induction heater, mixer, grinder, juicer, food processor, fan, pump set, washing machine, refrigerator and air conditioner etc. Concept of Neutral and Earth. (40 hrs)
Professional Skill 130 Hrs;	Perform winding of small transformers and motors viz., ceiling fan, table fan, mixer/grinder,	178.Practice winding of single- phase transformer. (12 hrs) 179.Practice on ceiling fan and table fan motor winding. (12 hrs)	**Winding:** Concentric/ distributed, single/ double layer winding and related terms. Troubleshooting of single-phase

Professional Knowledge 35 Hrs	submersible pump etc. (Mapped NOS: PSS/N4402)	180.Carry out maintenance, service and repair of single- phase AC motors viz., mixer/grinder, table fan pumps etc. (25 hrs) 181.Practice on single/double layer and concentric winding for AC motors and testing. (30 hrs) 182.Carry out maintenance and servicing of universal motor. (12 hrs) 183.Carry out winding of submersible pump. (15 hrs) 184.Practice winding of small 3-ϕ AC motor. (24 hrs)	AC induction motors and universal motor. (35 hrs)
Professional Skill 40 Hrs; Professional Knowledge 10 Hrs	Carry out Estimation & costing for different wiring systems and ready to adopt structured / smart wiring concept for automation and IoT applications.	185.Perform estimation and costing for different types/scheme of wiring for labour, materials and accessories as per layout. (25 hrs) 186.Demonstrate structured wiring/ smart wiring for home & office automation through visual aids. (05 hrs) 187.Visual demonstration of IoT based home automation/ control of electrical appliances through smartphone. (05 hrs) 188.Demonstrate software available for electrical wiring and circuits. (05 hrs)	Concept and Principles of estimation and costing. Different wiring layouts and Bill of material; domestic, commercial, and industrial wiring. Smart wiring concept Procedure for taking wireman permit and competency certificate. (10 hrs)

Practice wiring for communication circuits and computer networks using UTP, STP, Co-axial and optical Fibre cables

Objectives: At the end of this exercise you shall be able to

- **prepare a UTP cross cable ends for making connections to the computer**
- **identify different cables used in OFC**
- **identify different connectors used in OFC**
- **practice on crimping of coaxial cable**
- **install the RJ 45 co axial cable for OTH termination to TV**
- **make the termination of RJ 45 cable, by using crimping fool**

Requirements

Tools/Instruments

- Cable cutter 150 mm - 1No.
- Cable stripper 150 mm RJ45 (3 in 1 Modulars) - 1No.
- Crimping tool - 1No.
- Insulated combination pliers 200mm - 1 No.
- Electrician knife 100mm - 1 No.

Equipment /machines

- Desktop computers - 2 Nos.
- LAN tester - 1 No.

Materials

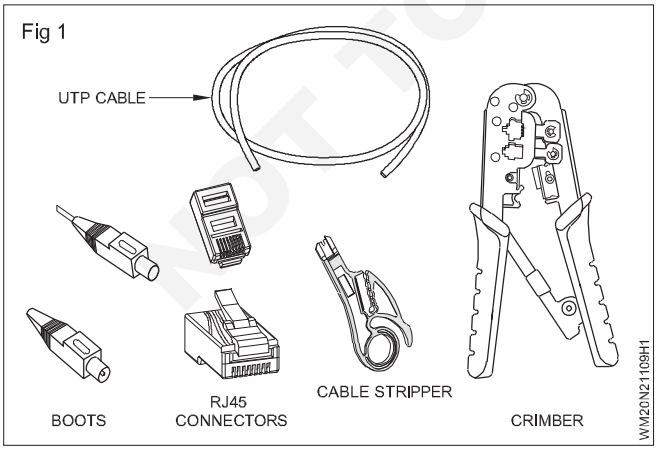
- Assorted UTP,STP cables - as reqd.
- Assorted OFC connectors - as reqd.
- Assorted OFC cables - as reqd.
- RJ 45 Co axial cable - as reqd.
- Video RF cable - as reqd.
- Cable connector plug - 1 No.
- RJ 11 coaxial cable - as reqd.
- M10 cover with LAN board Assembly - as reqd.

PROCEDURE

TASK 1: **Prepare a UTP cross cable ends for making connection to the computer**

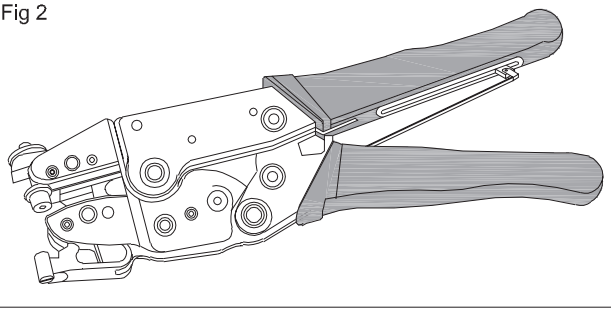
The instructor has to arrange the required length of cross cable, the tool for crimping and two computer for making connection as shown in Fig 1.

Fig 1



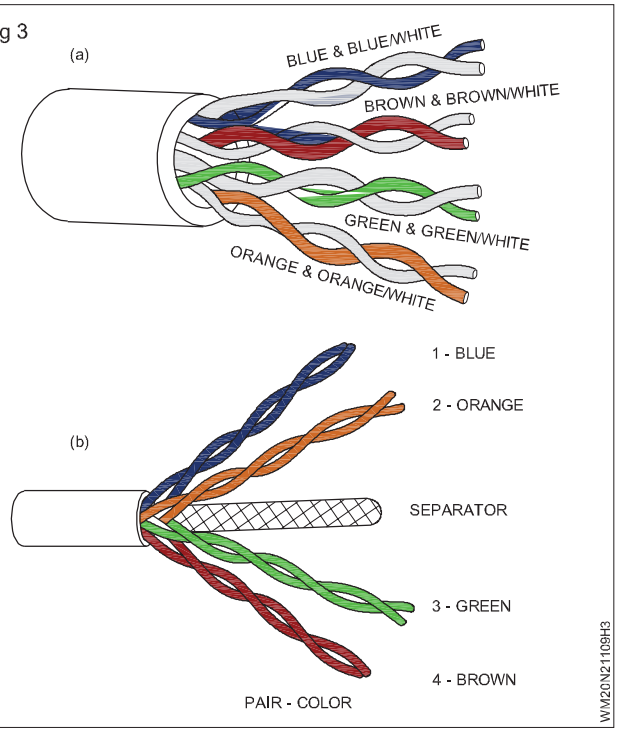
1 Use crimping tool as shown in Fig 2 to cut through a cable and strip the cable jacket/insulation using cable stripper/crimping.

Fig 2



Crimp tools have two blades. One designed to cut the cable and other to strip the jacket. While stripping the cable care should be taken not to cut the internal wires. Remove the jacket insulation about an inch. When the jacket insulation removed you will find eight wires twisted into four pair for CAT 5 cable as in Fig 3a and a separator inside the CAT6 cable as shown in Fig 3b.

Fig 3



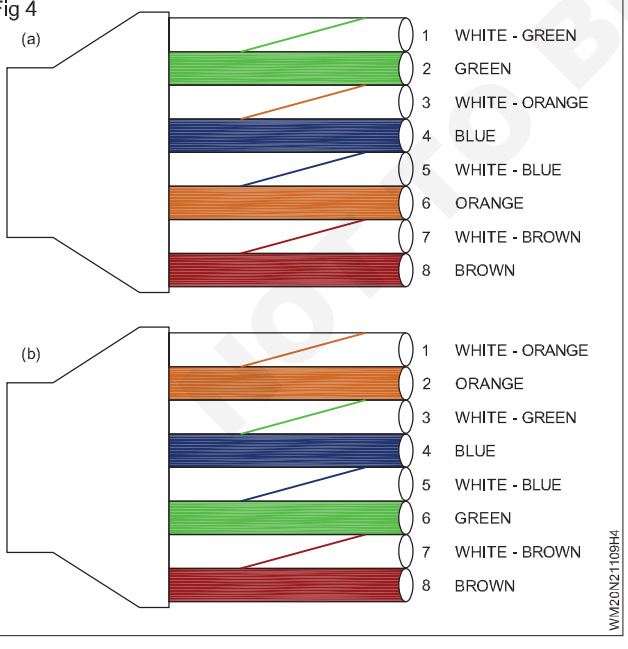
2 Cut the separator off and untwist the wires back to within one-eighth inch of the jacket.

3 Arrange the wires from left to right in the order they are to be crimped. The normal crimping order for cross cable is shown in Fig 4a & Fig 4b.

The colour code wiring order is different for both ends in cross cable

- Cross over cable
- One end

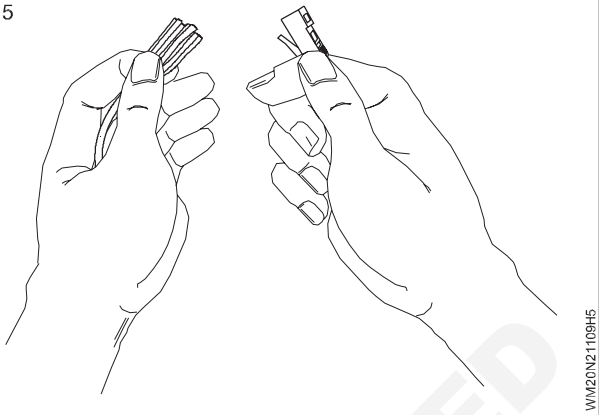
Fig 4



4 Grasp the wires firmly between your fingers and flatten them to remove the curliness

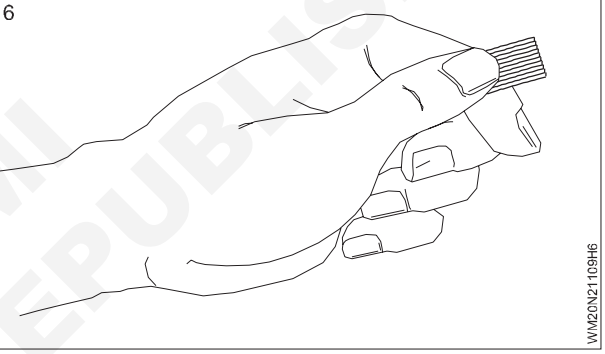
The wires must lay flat and together aligned as closely as possible in order. when finished the cable should look like as shown in Fig 5.

Fig 5



5 Cut a few mm while holding them firmly, so they are all of the same length as shown in Fig 6.

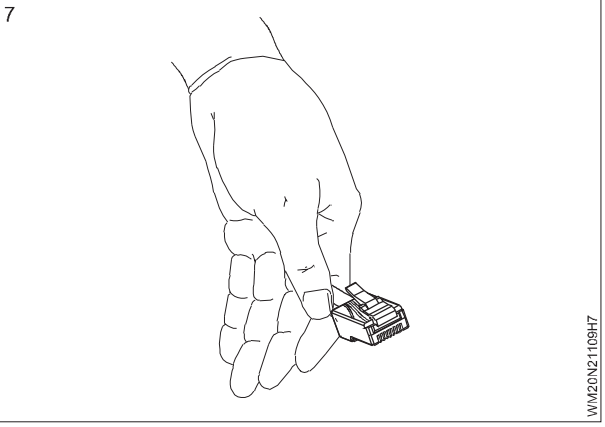
Fig 6



6 Slide the RJ45 connector on to the wires making sure the wires stay lined up

Try to make each wire fits in the slot of the connector and make each wire reach the end of its slot. The cable jacket/insulation should reach just beyond the end of the crimp point as shown in Fig 7.

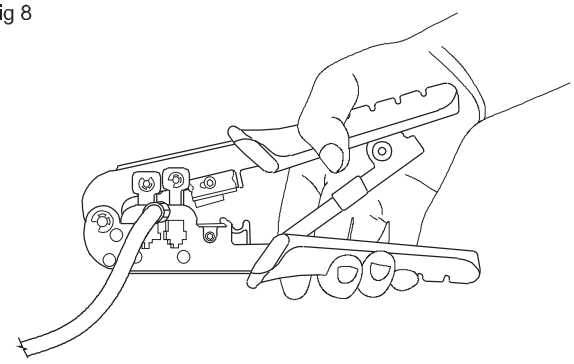
Fig 7



7 Verify all the wires are in the correct order, and insert the connector in to the crimping tool and press to crimp as shown in Fig 8

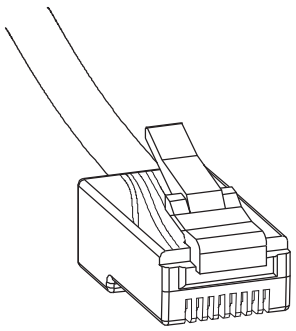
Now half of the work done. The cable should look like as shown in Fig 9. The process must be repeated for the other end of the cable.

Fig 8



WM20N21109H8

Fig 9



WM20N21109H9

TASK 2 : **Identify different cables used in OFC**

1 Pick any one of the labelled optical fiber cable from the given assorted cables.

2 Identify the name/type of cables used by referring to the data manual.

3 Record the name and its application in the table 1.

4 Repeat above steps for all other labelled cables.

TABLE 1

Sl. No.	Name/Type of the cable	Application

TASK 3 : **Identify different connectors used in OFC**

1 Pick any one of the connector from the given assorted OFC connectors.

2 Identify the name / type of connectors by referring the data manual used in OFC.

3 Record the name and its application in the TABLE 2.

4 Repeat above steps for all other connectors.

TABLE 2

Sl. No.	Name/Type of the cable	Application

TASK 4: **Practice on crimping of coaxial cable**

1 Collect the required length of coaxial cable. (Fig 1)

2 Cut the end of the cable using small sharp wire cutter.

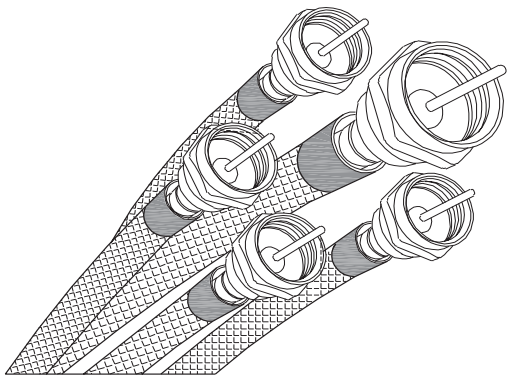
3 Create a squared off surface and mould the ends of coaxial cable using fingers.

4 Insert the coaxial cable into loan shipper tool. (Fig 1)

Make sure that the end of the coaxial cable is flush against wall or guide on the tool.

5 Spin the tool around the coaxial 4 or 5 times (or) until, lear no sound of the metal scaring.

Fig 1



WM20N21109J1

Do not apply any force which may cause for the damage of insualtion.

6 Pull off the material gently using fasten after mainly 2 cuts, and remove the outer insulation (layer of fault) have conductor will expose.

7 Tear of the exposed foil (metal wash) under the metal mesh left around the inner insulation.

8 Bend the mesh all the way back so that it is molded over the end of the outer insulation.

9 Press the end of the coax into the back of an 'F' connector.

Use straight pressure only do not twist the coax in line body of the connector.

10 Place the 'F' connector into the coax crimping tool, and squeeze fully the tool handle and release.

11 Remove the finished crimp connection from the tool.

12 Show the crimped coaxial cable to your instructor for approval.

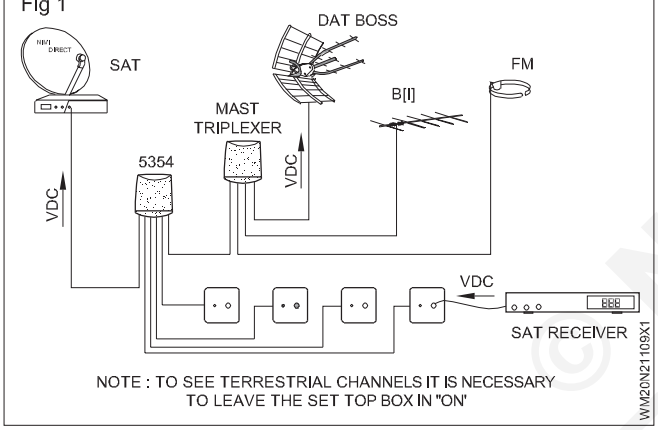
— — — — — —

TASK 5: **Install DTH to television using coaxial cable**

1 Select the location and position of DTH termination end to TV.

2 Prepare an estimate to install DTH to TV and measure the length of coaxial cable required. (Fig 1)

Fig 1



3 Install a ground block in convenient location any where between the dish and prior entering the game.

4 Install a copper wire (#10) between home ground point.

Use spread clamp desigrad for this purpose to connect the # 10 wire to the house ground point. Leave enough ground wire to the end through each ground block terminal.

5 Rotate the cable and secure with stapler to the mounting surface and tighten the ground terminal screw to the ground wire.

6 Lay, coax cables from each of the dishes output terminal into due ground block.

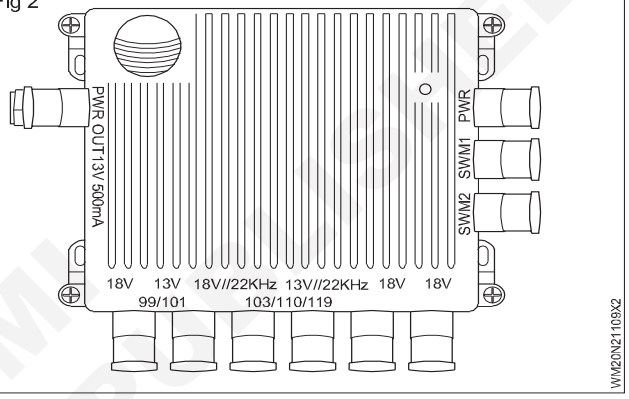
7 Run a cable from any roof top antenna to the side of ground block.

8 Run the same number a cables into the ground black between ground block and control location.

9 Run cables from each turner to the central location.

10 Select a multi switch Fig 2 to determine number of inputs and outputs required.

Fig 2



The number of outputs of the multi switch equals to the number of turner not the number of set top boxes. Multi switch must have extra outputs to unconditional recerien.

11 Install the multi switch and connect the dish coaxial cables to the dish input connector and the antenna.

12 Check connection and hardware until satisfied.

13 Connect the coaxial cable from the receivers to the multi switch output connection.

14 Connect coaxial cables to each turner input at the receiver end.

15 Switch 'ON' the supply and change the channels to test both turners for TV and DVR.

Use recievers set up box to view signal strength of each satilite and turner.

16 Inspect the DTH termination end to lay the co-axial to TV.

17 Make an estimation to the total length required to connect DTH to TV.

18 Lay the co-axial cable from DTH end to TV point through the channles already existing.

19 Connect the cable connector plug to the co-axial cable end.

20 Test the wiring installation for its working condition.

Do not tie RJ45 cable, co-axial cable together with supply line & wires.

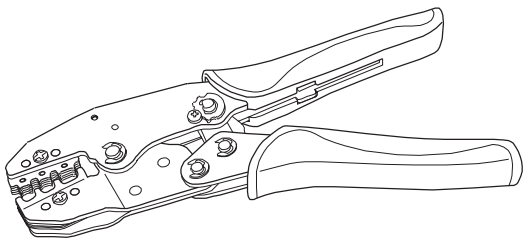
Coaxial Crimping Tool (Fig 3)

RG59/6 Coaxial Ratchet Crimping Tool

RF59/6 Ratchet Crimping Tool. RG58 / 59 / 62/ 6 Belden 8279.8.1mm (0.319 inches); 6.5mm (0.256 inches); 5.41mm (0.213 inches); 1.72mm (0.068 inches)

Crimp Tool for stripping cable RG58-RG59-RG62

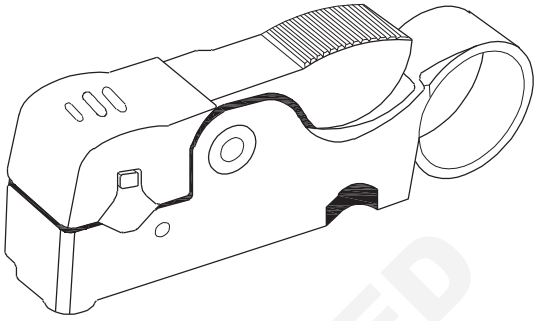
Fig 3



WM20N21109X3

For stripping RG cable: RG-58/59/62/6/6QS/3C/4C/5C. Manufacturer No: HT-332. Stripping Length: This stripper can strip cable in four lengths 4;6;8 and 12mm/ The stripping length is preset to 6mm. Strip other lengths; adjust the balde's position.

Fig 4



WM20N21109X4

TASK 6: **Make the termination of RJ45 cable, by using RJ45 crimping tool**

The Instructor has to arrange the required length of RJ45 cable and the tool for crimping.

1 Use RJ45 crimping tool blade to cut through, a cable and strip the cable jacket / insulation.

2 Cut the separator (outer sleever) off and untwist the wires back to with 25mm.

3 Arrange the wires from left to right in the order they are to be crimped. The normal erimping order for cross cable is shown in 1a & 1b.

4 Slide the connector on to the RJ45 cable wires making sure the wires stay lined up.

5 Verify all the wires are in the correct order, and insert the RJ45 connector in to the RJ45 crimping tool and press to crimp.

Fig 1a

Fig 1b

Wire up lighting system for control using motion detector

Objectives: At the end of this exercise you shall be able to
- **motion detector installation**
- **wiring diagram and working systems of motion detector**
- **double motion detectors wiring.**

Requirements

Tools/Instruments

- Trainees tool kit -1No.
- Screw driver 200 mm with 5mm blade -1No.
- Screw driver 150mm with 3mm -1No.
- Combination plies 200mm -1 No.
- wire stripper / wire cutters -1 No.

Equipment /machines

- Motion detectors -3 Nos.
- Hand drilling machine capacity 6 mm - 1 No.
- motion Activated flood light - 1 No.

Materials

- PVC pipe 19mm - as reqd.
- PVC Terminal box - 4 Nos.
- Flush type 2 way switch 6A /250 - as reqd.
- PVC shethed cu.cable,1.5 sq.mm 250V grade - as reqd.
- PVC insulation tape - as reqd.

PROCEDURE

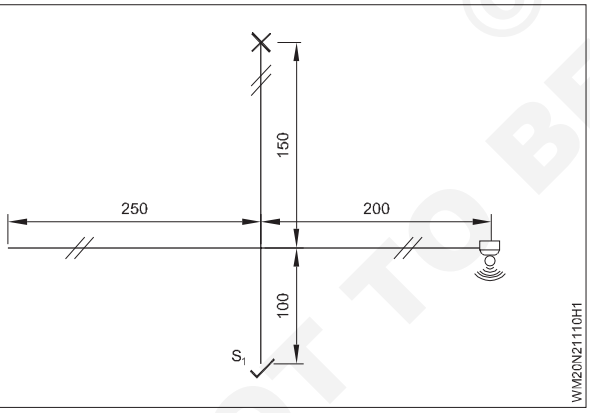
TASK 1: **Lighting system for control using motion detector**

1 collect, the tools and material required for the task

2 Draw the layout diagram.

3 draw the wiring diagram based on fig 1

Fig 1



4 Estimate the material required for wiring referring to the layout as well as wiring diragram.

5 Prepare the PVC conduit frame as per the layout plan.

6 Mark the motion detector position, lighting system and fix them as per the layout plan.(Fig 2 & 3).

7 Fix the conduit pipe with the help of shaddles.

8 Insert the wire into the conduit pipe.

9 Draw the cable as per the wiring diagram.

10 After getting the approval of the instructor, connect the main supply and test the circuit.

Fig 2

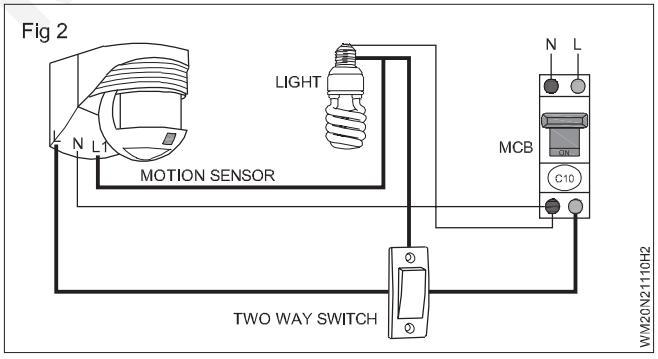
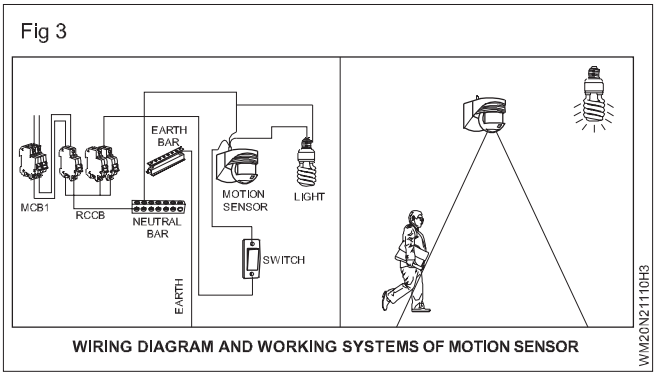


Fig 3



WIRING DIAGRAM AND WORKING SYSTEMS OF MOTION SENSOR

Wire up panel board for control of lights and fans from wireless remote

Objectives: At the end of this exercise you shall be able to
- **explain how to control a fan from remote place**
- **explain how to control a lamp from remote place.**

Requirements

Tools/Instruments

- cutting pliers 200mm -1No.
- screw driver 200mm -1No.
- connector 100mm -1No.

Materials

- 1.5 sq mm PVC copper wire - as reqd.
- smart ceiling fan wall switch - 1 No.

PROCEDURE

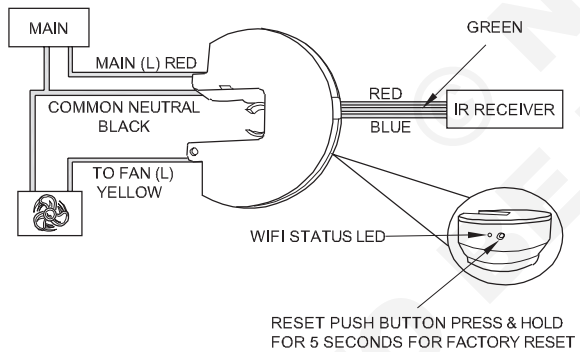
1 Collect the receiver from your instructor

2 Turn power off at the circuit breaker.

3 Remove ceiling fan canopy from the mounting bracket. (Fig1).

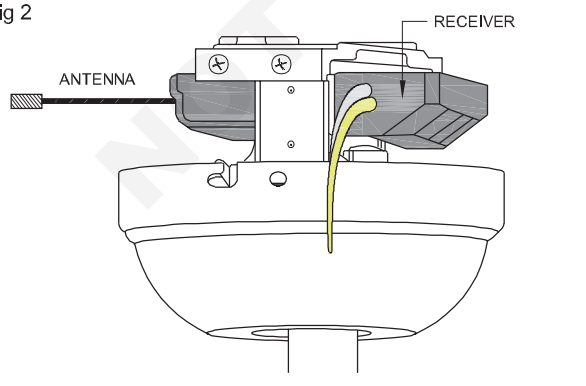
4 Slide the receiver into the mounting bracket being carefull not to pinch the antenna wire (Fig2)

Fig 1



ELECTRICAL INSTALLATION GUIDE

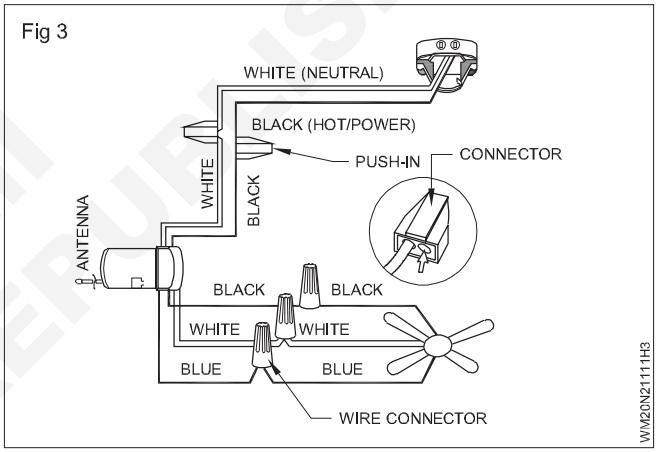
Fig 2



NOTE: INSERT THE RECEIVER INTO THE MOUNTING BRACKET WITH THE FLAT SIDE FACNG THE CEILING

5 Make wiring connections (Fig 3)

Fig 3



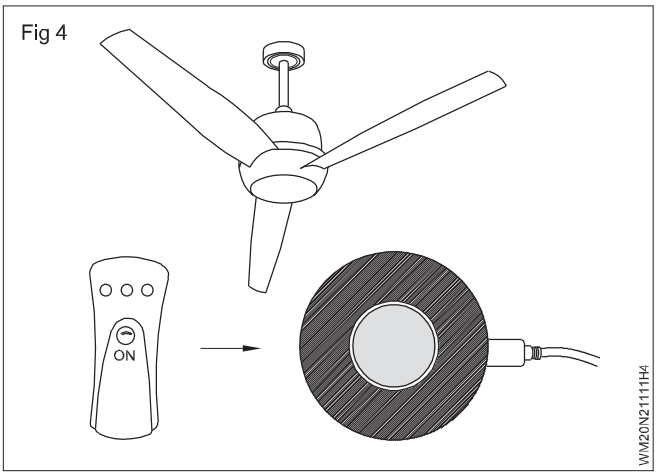
6 Push all connected wires back into to junction box and re-install the canopy onto the mounting bracket.

7 Switch power back on at the circuit breaker.

8 using fan regulator, set fan speed to high and light to on.

Note: once remote is installed donot use regulator to change speed or light settings.

Fig 4



Transmitter Operation (Fig 4)

1 To operate the fan using the remote, make sure fan pull chain is on high and light is turned on. Then press and release the following buttons.

- **Fan Off** -Turns the power to fan off
- **Light Control**-Turns the light on and off. Press and hold to dim or brighten lights (for dimmable bulbs only).
- **High Speed**-Turns on fan at high speed.
- **Light Delay** - Light stays on for 60 seconds to allow for safe exit from room. Tap Light Delay once to activate. Fan light blinks once to confirm Light Delay is active. Press any button to cancel
- **Medium Speed**-Turns on fan at medium speed.
- **Variable Breeze** -Simulates a breeze in nature. Press and hold button to activate Press any fan speed button to cancel
- **Low Speed**-Turns on fan at low speed.
- **Home Shield**-Simulates occupancy while away from home. Fan remains off and the light randomly turns on for a minimum of five times and a maximum of 20 minutes. The light remains off for 60 minutes between events. Press and hold button to activate. Light will blink twice to confirm Home Sheild is active. Press any button to cancel.
- **LED indicator**-should illuminate when any remote button is pressed. If not. replace the DC3V, CR2032 batteries.

Trouble shooting

- Is the wall switch turned on? Is power turned on at the circuit breaker?
- Is it wired correctly and receiving power? Are the wire connectors tight for each wire connection?
- Is the fan pull chain set to High and light pull chain set to the On position?
- Is the transmitter battery new and fully charged?
- Syncing process between fan and transmitter may not have been successful see ACTIVATE THE SYNCING PROCESS
- Won't operate at a distance-make sure antenna wire is not obstructed.

Fig 5

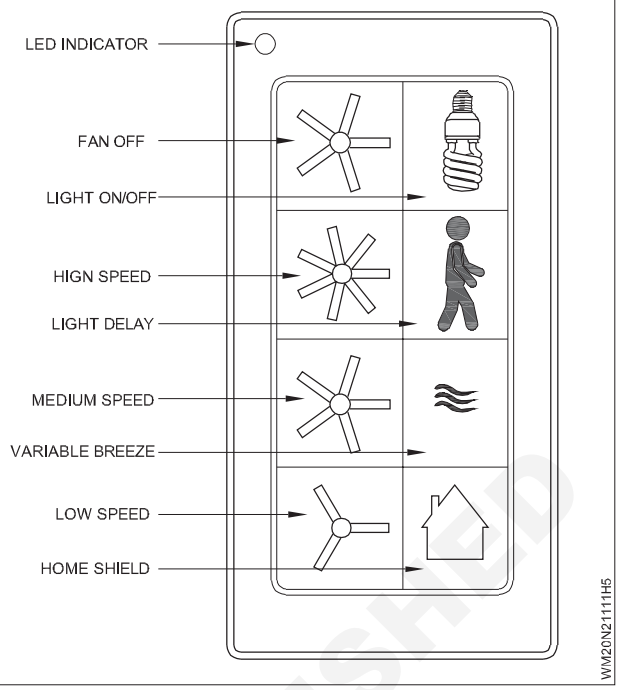
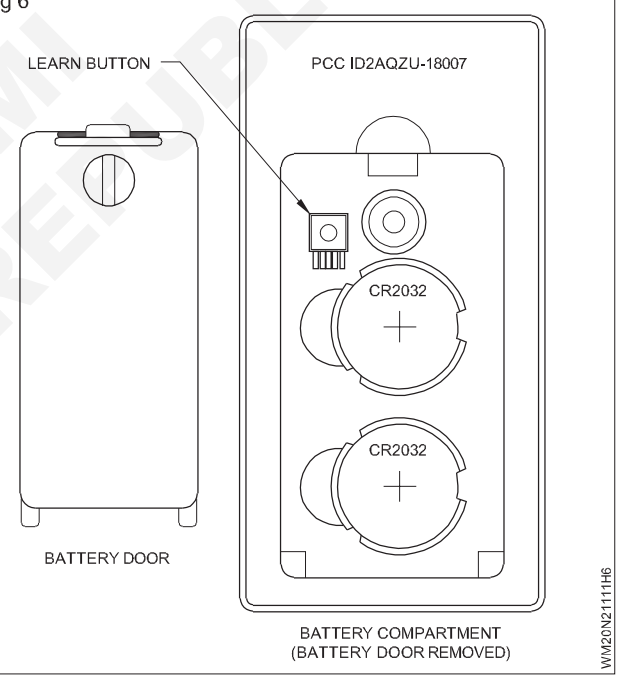


Fig 6



Demonstrate wiring and components of fire alarm system, interior siren, control & signalling using visual aids

Objectives: At the end of this exercise you shall be able to
- **understand the components of fire alarm system & interior siren control.**

Requirements - Visual aids

The instructor may arrange the visual aids, anddemonstrate fire alarm system & Interior siren

Installation of single phase and 3 phase on line / off line UPS wiring and test

Objectives: At the end of this exercise you shall be able to
- **install single phase UPS wiring to home**
- **install 3 phase UPS wiring and test it.**

Requirements

Tools/Instruments

- Cutting plier 200 mm - 1 No.
- Hack saw frame with blade - 1 No.
- Ball peen hacksaw 500 gm - 1 No.
- Rawl jumper No. 14 - 1 No.
- Screwdriver 100 mm - 1 No.
- Screwdriver 200 mm - 1 No.
- Steel rule 300 mm - 1 No.
- Hand drilling machine LPMH - 1 No
- DE knife 100mm - 1 No.
- Measuring tape 5m - 1 No.

Equipment/Machines

- Single phase ON line/OFF line UPS unit 240V/AC
- 50 Hz 300 VA - 1 No each.
- Unit battery 12V/120 AH -5 KVA - 1 No.
- 3 Phase UPS 415V/5KVA - 1 No.
- Connecting wires - as reqd.
- UPS components - 1 No.

PROCEDURE

TASK 1: **Installation of single phase UPS and test it**

1 Select the correct capacity of UPS for the required load by following the steps given below.
- List all the equipment to be protected by the UPS for single and two room.
- List the voltage and current rating of each device in single and two room.
- Calculate the total VA capacity by multiplying voltage and current of each device.
- Add 10 to 20% of load for future extension.

2 Select the size of the cable based on the full load current.

Size of the cable should be from battery to UPS, not below 25 mm² to 35 mm².

3 Select the best location and design the space for the selected UPS system prior to install.

— — — — — —

TASK 2: **Wiring for ON line UPS (single and two rooms)**

1 Read and interpret the name plate details of the given ON line UPS.

2 Note down in Table 1

Table 1

Mode	_____
Type	_____
Panel rating	_____
Input and output voltage	_____
Battery rating	_____

3 Identify the input and output terminals and interpret the centre UPS.

4 Connect the wiring supply to main double pole switch (DP) input terminals. (Fig 1)

Use red wire for phase and black wire for neutral.

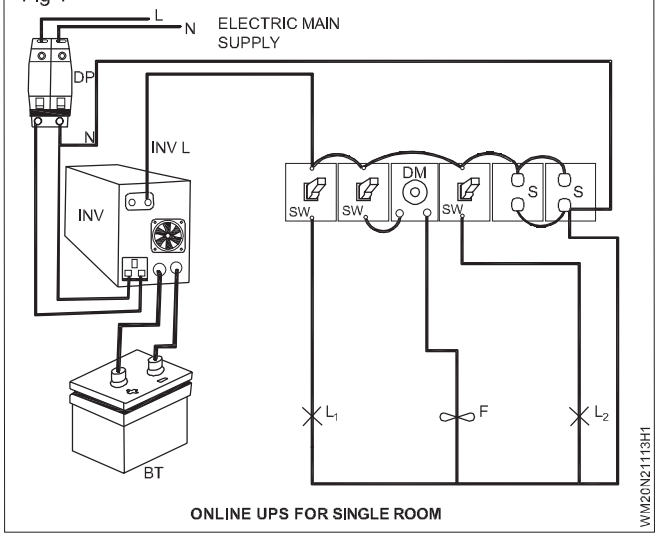
5 Connect the output terminals main supply to input terminals of the UPS. (Fig 1)

6 Connect the outgoing phase (L) wire directly to the incoming terminals of the switches of the given load (for one room) Fig 1.

7 Connect the neutral from the outgoing terminal from UPS to the socket outlet neutral point and loop to all the load. (Fig 1)

8 Connect the battery to UPS as in Fig 1.

Fig 1

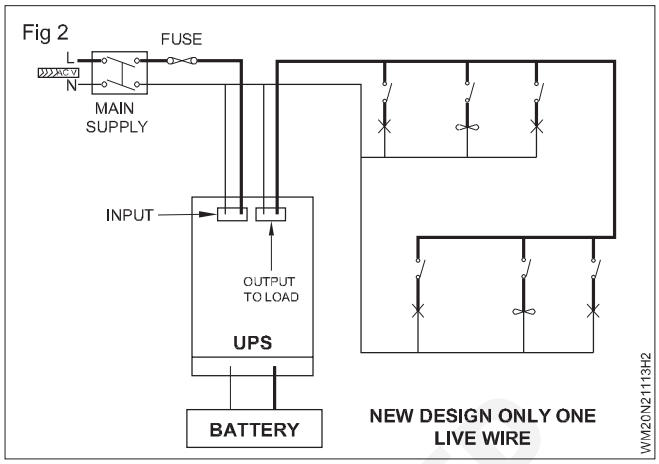


ONLINE UPS FOR SINGLE ROOM

9 Complete the connection of UPS with loads for one room as in Fig 1.

10 Repeat the above steps from 1 to 9 as in Fig 2 and complete the wiring for 2 rooms considering the locals and size of the UPS.

Fig 2



11 Test the wiring installation with UPS.

12 Get it approval by your instructor.

— — — — — —

TASK 3: **Wiring for OFF line UPS to single and two rooms**

1 Read and interpret the name plate details of OFF line UPS.

2 Note down in Table 1.

Table 1

Model	_____
Type	_____
Panel rating	_____
Input and output voltage	_____
Battery rating	_____

3 Identify the input and output terminals of OFF line UPS. (for one room)

4 Connect the incoming supply to main double pole switch (DP) input terminals. (Fig 1)

5 Connect outout of DP to input of UPS terminals.

6 Connect the output live (phase) terminal only of UPS to the incoming of switch (SW1).

7 Take neutral connection from the output of main DP switch.

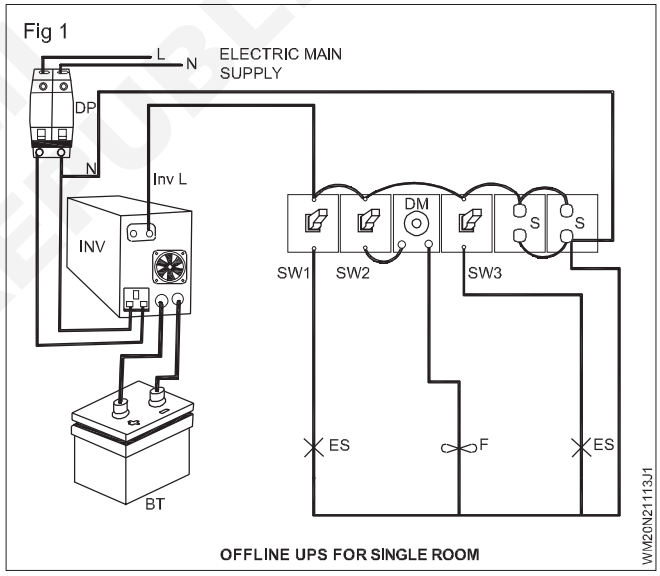
Do not take neutral from output neutral terminal of UPS. Neutral connection is taken directly from supply mains only.

8 Connect the phase connection of each loads through switches and neutral from socket and lets as in Fig 1.

9 Complete the wiring for one room as in Fig 1.

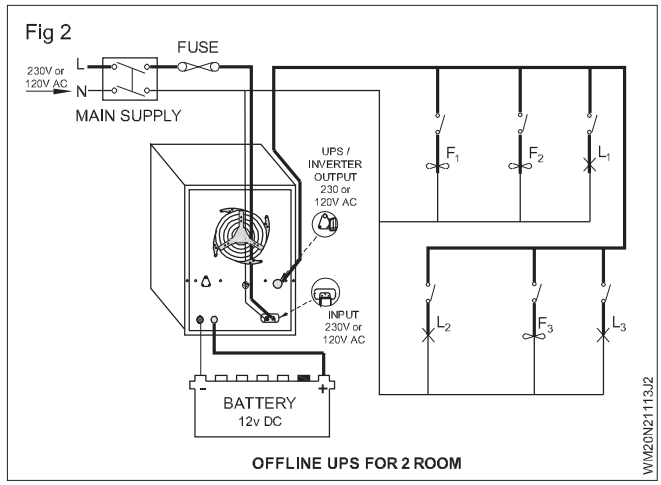
10 Repeat the at one 8 km steps (3 to 9) and complete the OFF line UPS wiring for 2 room as in Fig 2.

Fig 1



OFFLINE UPS FOR SINGLE ROOM

Fig 2



OFFLINE UPS FOR 2 ROOM

11 Test the completed wiring installation.

12 Get it approved by your instructor.

Caution: Do not connect an off-line and an online through a changeover circuit, because output wiring of two are different. In off-line input and output neutral are common. In online inlut and output have different neutrals. Higher capacity on line systems are using 60A connector for inputs and outputs higher capacity on line systems (above 5 KVA) are going for three phase on-line systems.

— — — — — —

TASK 4: **Wiring installation for 3 phase OFF line UPS for office building**

1 Collect the connected load required details of the office building for the selection of 3 phase UPS.

2 Select the correct capacity of 3 phase UPS unit by consideny the following points.

- List all the equipment to be protected by the each phase of 3 phase UPS.

Consider if the connected loads are connected 3 single phase simply select 3/1 mode UPS. (Input is 3 phase and output in single phase supply). If the loads are connected in 3 phase 3 wire system, then select 3/3 mode UPS (V) Input in 3 phase output also in 3 phase supply.

- Calculate the VAO capacity of each device and obtain the total VA capacity of the connected load.
- Add 10 to 20% of total connected load for future extension.

3 Select the size of the cable based on the maximum load connect of each phase.

4 Select the best location and disign the space for the selected 3 phase UPS system prior to twisted.

Wiring for 3 phase UPS for OFF line 3 rooms office buidling.

1 Read and interpret the name plate details of the given OFF line 3 phase UPS.

2 Record the details in Table 1.

Table 1

Type of UPS	_____OH/OFF line
Supply	_____ 3 phase/ single phase
Model	_____
Mode	_____ 3/3 or 3/1
Power rating	_____KVA
Battery rating	_____
Back up Hrs	_____

3 Identify the input and output terminals of 3 phase UPS.

4 Connect the output terminals of MCCB main switch of each phase terminals (RYB) to the cares pending phase input terminals of UPS (RYB) as in Fig 1.

5 Connect the each phase output terminals (RYB) of UPS to the corresponding sub circuit distribution copper and bar of each phase (RYB) as in Fig 1.

Connect the red colour cable to red phase and similarly for yellow and blue phases.

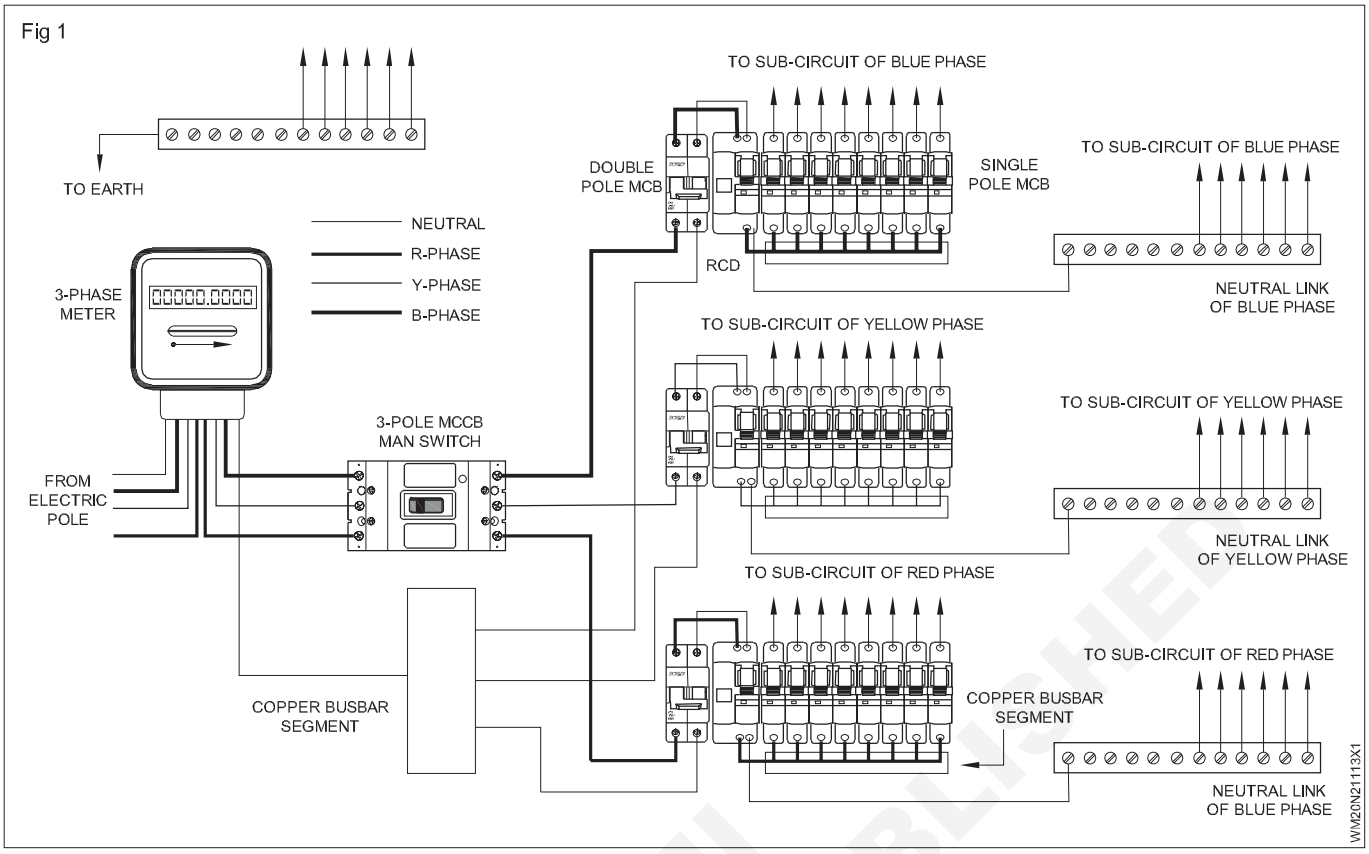
6 Take separate neutral lines for each phase as in Fig 1.

7 Complete the wiring installation of UPS for the office building.

8 Test the completed UPS using installation for its function.

— — — — — —

Fig 1



Install and wire up CCTV camera

Objectives: At the end of this exercise you shall be able to
- **explain installation of CCTV camera.**

Requirements

Tools/Instruments		Materials	
• CCTV camera	-1No.	• Adopter	-1 No.
• Monitor	- 1No.	• Power splitter	-1 No
		• Cables	- as reqd.
		• Conncectors	- as reqd.

PROCEDURE

Follow the instruction below as shown in fig -1 for surveillance camera installation.

1 First of all, check all the cameras before installation to make sure they all are working properly.

2 Connect the video and power BNC and cables connectors to “CAMERA ONLY” labeled an d power respectively. for tight connection, twist and lock the camera BNC connectors. in fig, the yellow connector from dome cameras and bullet cameras are connected to the yellow to the DVR and red cable as power connection from camera to the 12v dc power adopted connected to the 120V or 220V AC power supply.

3 Connect the video connector labeled as “DVR ONLY” to the rear /back side of DVR in the Camera input slot(s). in fig below, the yellow camera connected by extension wire labeled as “Video to DVR” is shown which can be connected to one of the 16 video imput slots in the DVR. In the audio enabled cameras, the white RCA cable ahould be connected to the audio signal transmission.

4 Now , connect all the remale power supply connector from the camera to the male connectors of power supply.

5 Connect the all the power splitter from the camera to 12V DC power supply adopter.

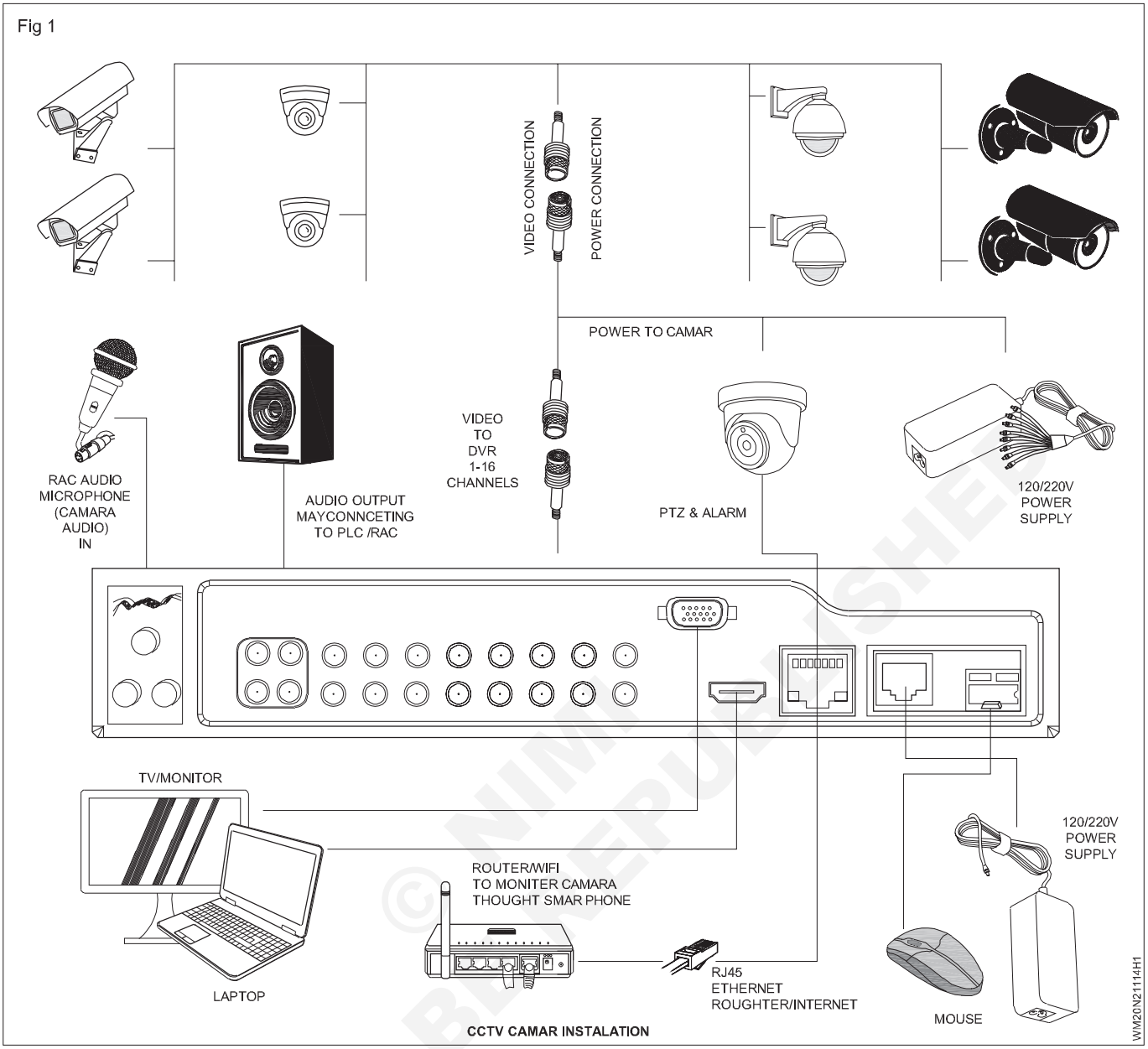
6 Connect the monitor /LCD or PC and laptops through VGA cables. For HD, use the HDMI cables and connect to the PC and DVR HDMI slot in DVR.

7 Now, connect the power adopter to the 120V AC (220V in EU) by connecting the three pin plug of power adopter into therrpin socket. For 24/7/365 security system, it is recommended to connect the camera and DVR to the UPS (Uninterrup table Power Supply System).

8 Finally, connect the DVR power adopter to the 120V/220V AC supply as shown in fig below. You have done. Check the system if it works properly by viewing the LCD screen which shows the live camera recording.

The following fig shows a typical CCTV camera security system with DVR. (Fig 1)

Fig 1



Install an inverter and carryout wiring

Objectives: At the end of this exercise you shall be able to
- **select the proper rating of inverter to install**
- **select suitable place for the inverter in the house**
- **select a correct rating of battery and the place to keep with inverter**
- **install the inverter and make connection to the load**
- **test the inverter for its good performance in 'off' and 'on' supply mains.**

Requirements

Tools/Instruments

- Trainees kit - 1 Set.
- Portable electric drilling machine 6mm - 1 No.
- Star head screw driver set (set of 6mm) - 1 No.
- Rawl jumper No.8 - 1 No.
- Cutting plier 150mm - 1 No.
- D.E spanner set 6mm-25mm - 1 Set
- Ballpein hammer 0.75 kg - 1 No
- Single phase energy meter 250V/15A - 1 No
- Multi pin socket 3/5 pin 250V/6A - 1 No.

Equipments/Machinery

- 200W/250V/6A -inverter - 1 No.
- Battery 12V/120AH - 1 No.

Materials/Components

- 4 way MCB -20A - 1 No.
- 1.5mm2 P.V.C. copper (1/18)wires - as reqd.
- Auto wires (stranded) - as reqd.
- I.C.D.P switch 16A/250V - 1 No.
- 4 way MCB/ICDP20 A switch - 1 No
- Power socket 250 V/16A - 1 No
- Multi pin wall socket 250V/6A (2 in one)with switch - 1 No
- Grease/Vaseline - as reqd.

PROCEDURE

TASK 1: **Select, install inverter with battery to connect in domestic wiring**

1 Select the suitable rating of the Inverter considering the total connected load in that house, like fan, lamp etc.

The rating of the inverter should not exceed 60% capacity of the inverter key. (for a 100w inverter, total load should not be more than 60W).

2 Select the right place to install the inverter, where good ventilation is available.

The place for installation for inverter should be nearer to the D.P switch and the energy meter position.

3 Select the correct place to install battery, which is nearer to the inverter and to the ventilation.

4 Install the inverter and battery close to each other.

Do not provide the battery away from inverter. If should be closed to the inverter because it helps in reducing the current loss due to resistance of wire.

5 Make wiring connection to the inverter with 1.5 mm2 wire.

6 Connect the three pin output socket from the mains supply (Fig 1)

7 Connect the positive terminal of the battery (i.e red wire) to the place provided for the positive terminal on the Inverter.

8 Connect the negative terminal of the battery (i.e black wire) to the place provided for the negative terminal of the inverter.

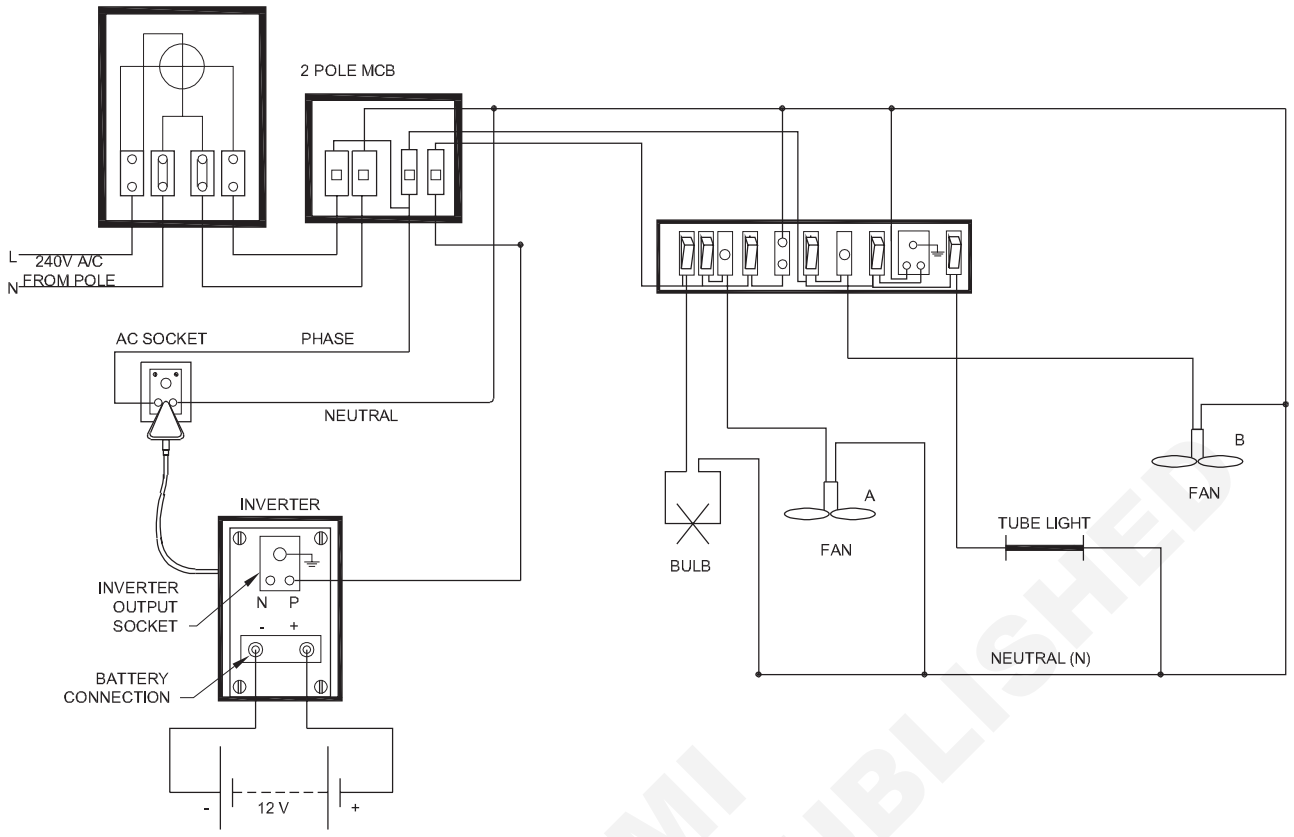
When connecting battery terminals to the inverter use special auto wires, do not use common 3/20 (or)7/20 wires and ensure that the battery is fully charged.

9 Put grease (or) vaseline on the battery terminals for reducing the terminal corrosion.

10 Complete the connection Take the output from the inverter output socket and use it to power the load.

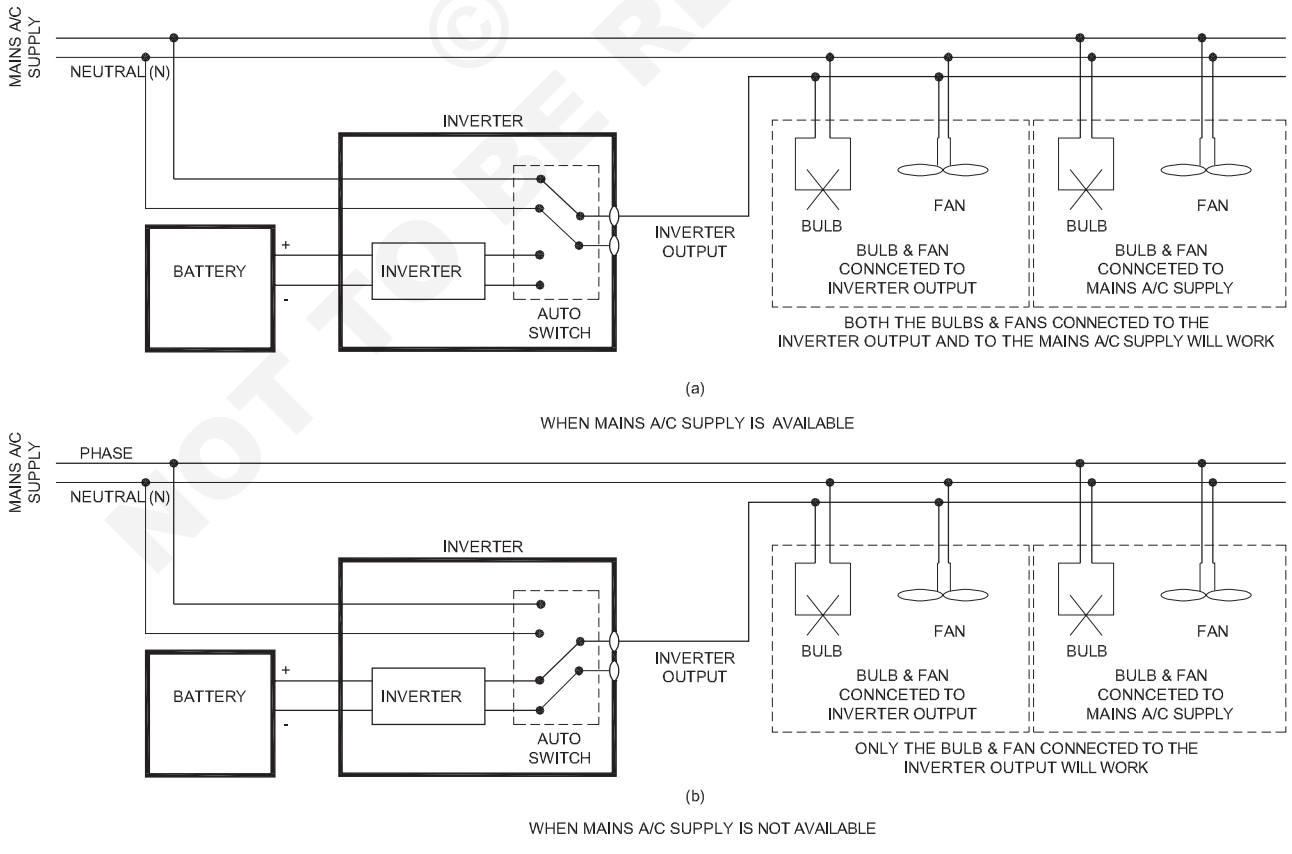
To connect the inverter output to the load use only 1/18 wire, and do not use 3/20 or 7/20 wires.

Fig 1



INVERTER INSTALLATION

Fig 2



11 Connect the ON/OFF switch on the wall panel from the phase output pin of inverter output socket (Fig 1)

12 Connect one common Neutral line of both inverter output and mains AC supply.

13 Connect only one wire for the phase line from the inverter output socket to the switches.

14 Give connection to one bulb, one fan (A) and 2 pin socket only to the inverter output as in Fig 1.

15 Connect the other devices in the room i.e the tube light, fan (B) and 3 pin socket directly to the mains AC line.

Low wattage load only to be connected on the two pin socket during the power 'off' time. Heavy load should not be connected to this socket., such as heater, geyser, motors in HP etc.

16 Show the connection and get it approved by your instructor.

17 Check the operation of inverter during power 'Off' and then power returns.

If the main supply is 'ON' the load connected to the inverter will get the main AC supply and the other devices which are directly connected to the mains AC supply will also work on the main supply. (Fig 2a)

During power shut down, the devices which are directly connected to the mains AC will stop functioning and the devices connected to the inverter will keep on working on the inverter output . when the mains AC supply returns the inverter will again connect the load to its output. (Fig 2b)

— — — — — —

Demonstrate wiring plan, lighting fixtures receptacles and sensors for bathing area.

Objectives: At the end of this exercise you shall be able to
- **identify the components of bathing area**
- **wiring diagram of bathing area**
- **layout diagram of bathing area .**

Requirements

Tools/Instruments

- Cable cutter 150mm - 1 No.
- Cable striper 150mm - 1 No
- Crimping tool 1.0 to 6.00 m^2 - 1 No.
- Insulated combination pliers - 1 No.
- Electrician knife 100mm - 1 No.

Equipments/Machinery

- Varity lights - 10 Nos.
- Motion sensors - 4 Nos.
- Receptacles - 4 Nos.

Materials/Components

- PVC pipe 19mm - as reqd.
- PVC terminal box - 10 Nos.
- Flush mounting 2way switch - 10 Nos.
- Flush mounting 1 way switch - 10 Nos.
- PVC shealthed cu cable 1.5mm 250V grade - as reqd.
- PVC insulation tape - 3 rolls.

PROCEDURE

TASK 1: **Identify and demonstrate wiring plan for battering area. (Fig 1,2 and 3)**

1 select the lighting fixtures and sensors required for the tSSask

The Instructor may arrange and provide the various types of lighting fixtures, receptacles and sensors.

2 Draw the layout diagram

3 Draw the wiring diagram based on layout diagram.

4 Estimate the material required for wiring installation by referring to the layout as well as wiring diagram.

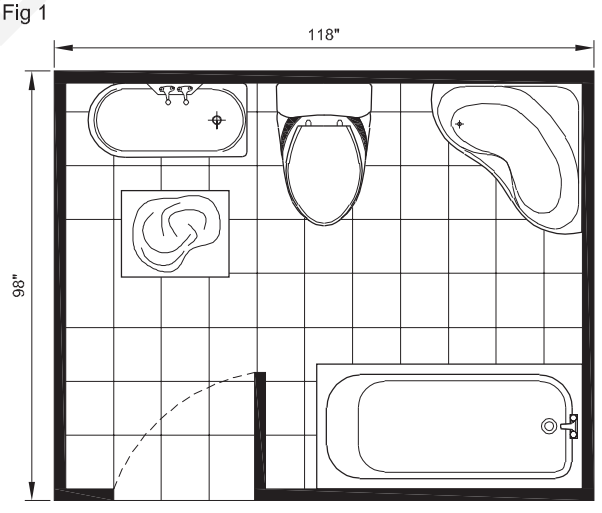
5 Prepare the PVC conduit frameas per the layout

6 Mark the location of the lighting fixtures, receptacles and sensors and fix them as per the layout plan.

7 Complete the wiring as per the wiring diagram.

8 After getting the approval of the instructor, connect the main supply and test the circuit.

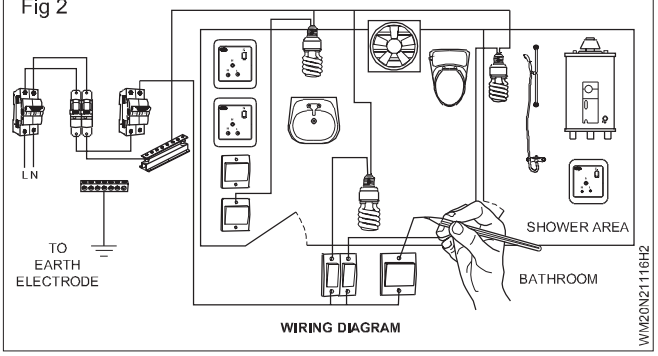
Fig 1



BATHROOM LAYOUT DIAGRAM

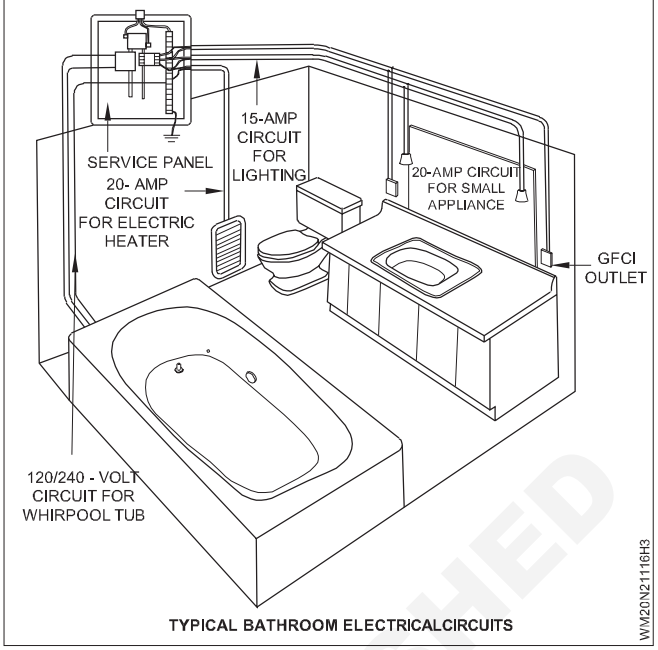
WM20N21116H1

Fig 2



WIRING DIAGRAM

Fig 3



TYPICAL BATHROOM ELECTRICALCIRCUITS

Demonstrate Multi -storeyed building wiring

Objectives: At the end of this exercise you shall be able to
- **explain Multi - storeyed building wiring**

Requirements

Materials/Components

• Drawing sheet	- 1 No.	• Eraser	- 1 No.
• Pencil	- 1 No.	• Scale 300mm	- 1 No.

PROCEDURE

TASK 1: **Demonstrate Multistoreyed building wiring**

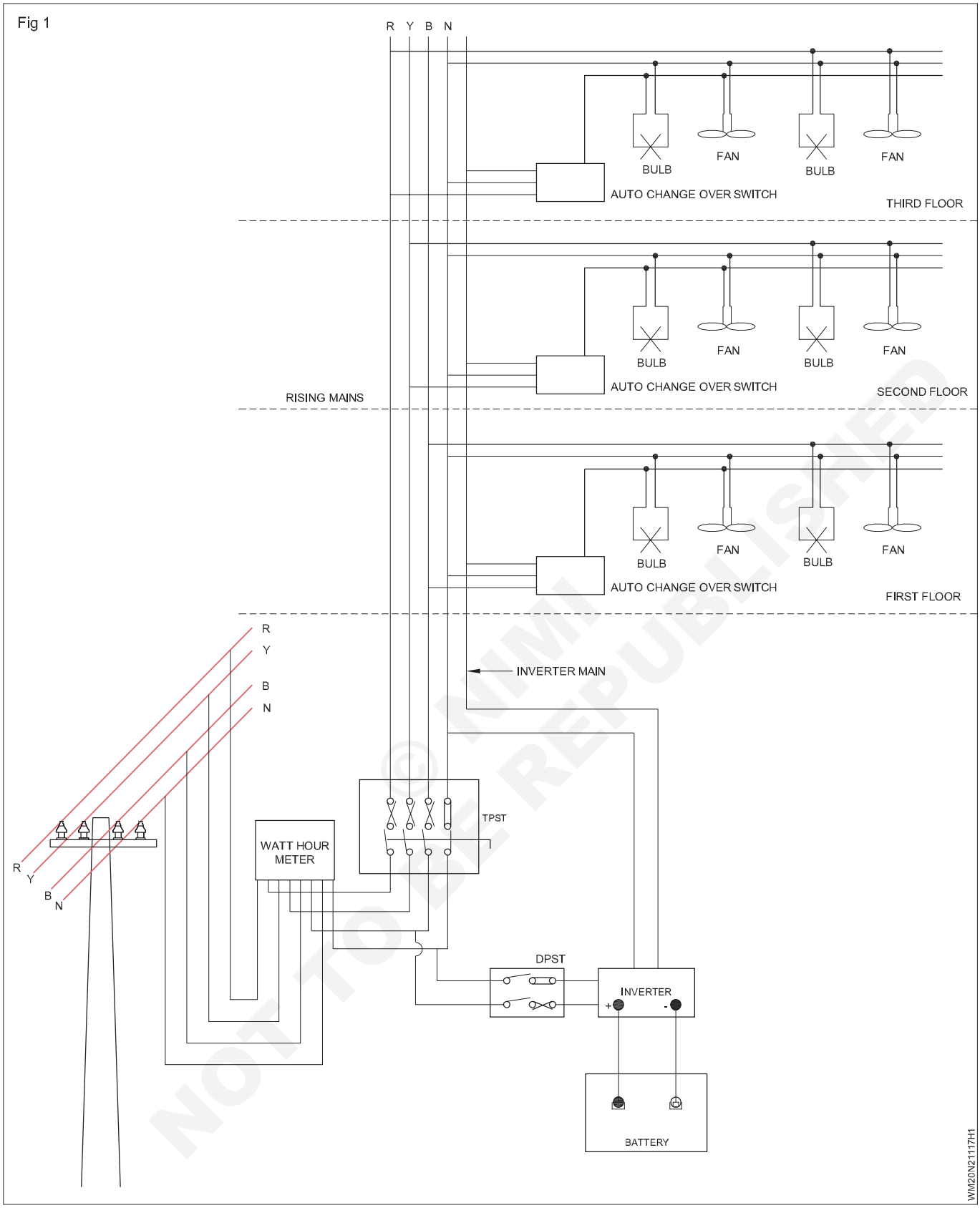
1 Draw a plan of the complete multi story building as shown Fig1.

Instructor may take the trainees to a mearest multi storeyed building and explain various switch gears like, distribution boards and earth connections. Before entering multi storeyed building, the instructor should explain to the trainees various safety regulations pertaining to multistoreyed building.

2 Visit a multi storeyed building and observe how wiring is installed in that building

3 Show the wiring diagram drawn by you to the instructor and get it approval.

Fig 1



Install temporary LV electrical panels and lighting arrangements for construction site

Objectives: At the end of this exercise you shall be able to
- **make a LV panel board**
- **install temporary lighting arrangements for construction site.**

Requirements

Tools / Instruments

- Trainee tool kit - 1 No.
- Cutting plier 200m - 1 No.
- Screw driver 200mm - 1 No.
- Wire cutter - 1 No.

Equipment / Machines

- Electrical hand drilling machine - 1 No.
- Teak wood wiring board 3'x2' -1 No.

Materials

- ICDP 250V, 6A -1 No.
- IC cut out 16 A -1 No.
- Kitkat Fuse 16 A -3 Nos.
- Battern lamp holder 6A , 250V -1 No.
- 100w Bulb -1 No.
- Connecting wires - as reqd.
- Wood screws -as reqd.
- PVC conduitpipe 25 mm -12 metre.
- PVC conduit shaddle - as reqd.
- 4"x4" PVC box -3 Nos.
- SPT switch 6A, 250V -3 Nos.
- 1.5 sq mm PVC copper wire - as reqd.
- 4 sq mm PVC copper wire - as reqd.
- Scale 300mm -1 No.

PROCEDURE

TASK 1: **Install temporary LV electrical panel.**

1 Collect required materials from the section.

2 Place the ICDP, IC cutout, fuse carrier and battern-holder on the teak wood panel board

3 Mark their positions on the teak wood board.

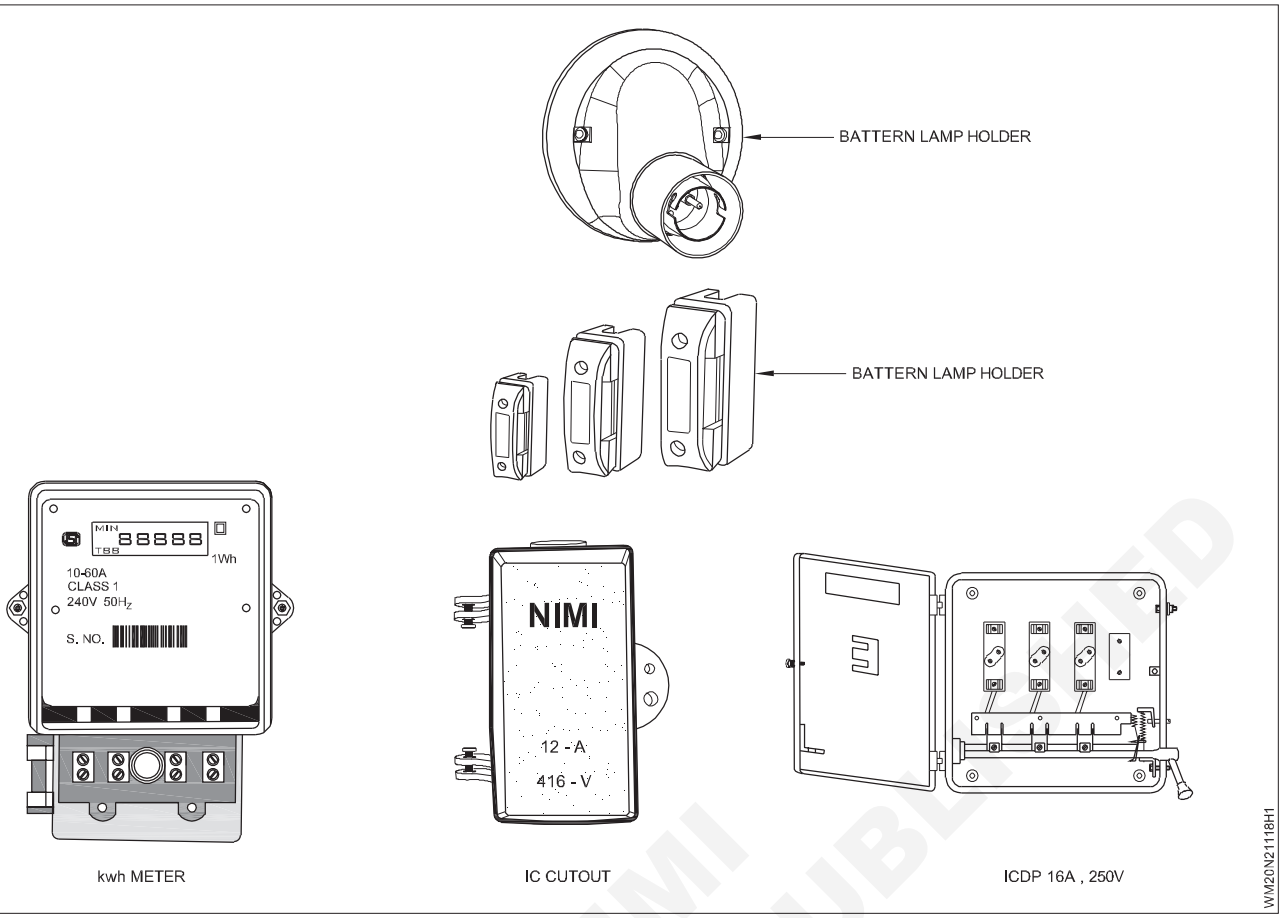
4 Drill suitable holes on the teak wood board.

5 Fix the items on teak wood board with suitable screws.

6 Connect all the items with 4 sq mm pvc copper wire.

7 Fix the teakwood board on the wall at suitable place.

Fig 1

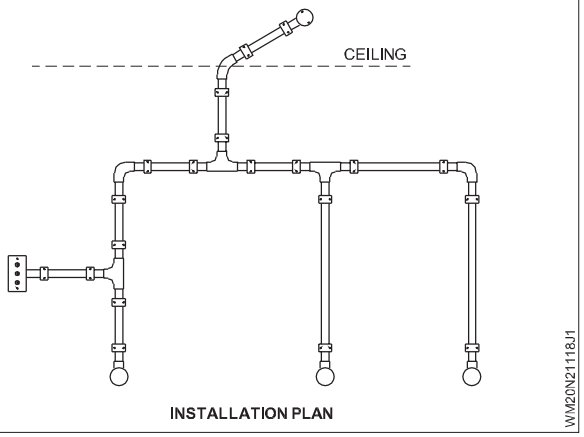


kwh METER IC CUTOUT ICDP 16A , 250V

TASK 2 : **Wiring installation & testing**

1 Draw the layout diagram
2 Get circuit approval by the instructor
3 Select and cut the pvc pipe for required length
4 Fix the pvc pipe on the wall it it is there with clamsps
5 Draw the wire into the pipe.;
6 Fix pvc box at the pipe end.
7 Give connect supply and test for proper working.

Fig 1



INSTALLATION PLAN

identify accessories and tools required for industrial wiring. demonstrate various switch boards, switch gears, industrial control panels and accessories

Objectives: At the end of this exercise you shall be able to
- **identify and name of the power accessories**
- **write the specification and uses of the power accessories.**

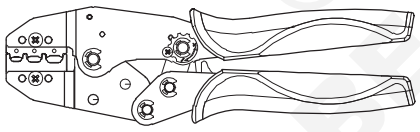
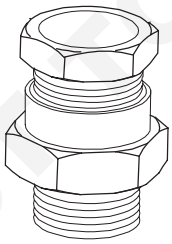
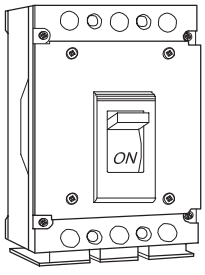
Requirements

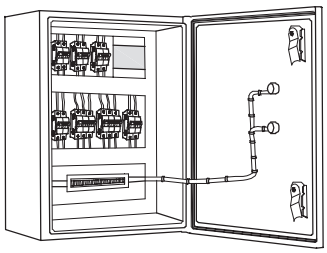
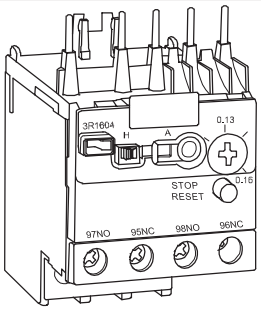
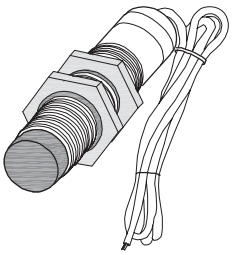
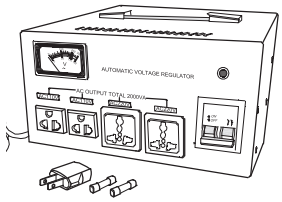
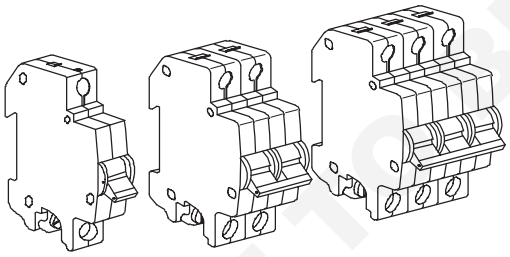
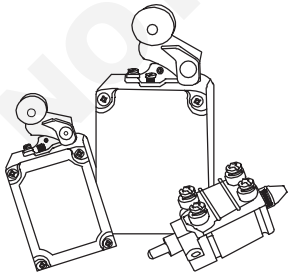
Tools/Instruments

- Electrician tool kit - 1 No.
- Insulated connector screw driver 400mm x 100mm -1No.
- Neon tester 0-500V - 1 No.
- Combination plier 150mm - 1 No.

Materials

- Tumbler switch 5A, 230V - 1 No.
- Flush type switch 5A (230V) - 1 No.
- Knife switch 5A, 230V - 1 No.
- ICDP Main switch 16A, 250V- 1 No.
- Pendant, batten holder 6A, 250V - 1 No.
- EV charging station unit for public - 1 No.
- 3 pin plug 5A, 230V - 1 No.
- 3 pin walls socket 5A, 230V - 1 No.
- Adapter 5A, 230V - 1 No.
- Kit kat fuse 15A, 230V - 1 No.
- Cartridge type fuse 32A, 230V - 1 No.
- Control panel size (300x300x50mm) - 1 No.
- DP switch 15A, 230V - 1 No.
- 12V, DC cutout relay - 1 No.
- Proximity sensor (size 180mm sensing range-6mm) - 1 No.
- Automatic voltage stabilizer AC230V,15A - 1 No.
- Ceiling fan regulator 5A, 230V - 1 No.
- MCB (1 pole, 2 pole, 3 pole) - 1 No each.

Sl.No	Wiring accessories	Name & specification
1		
2		
3		

4		
5		
6		
7		
8		
9		

Demonstrate cable tray, race ways, auxiliary gutter, cable bus assembly, trench for passing cables

Objectives: At the end of this exercise you shall be able to
- **explain application of cable tray**
- **explain application of cable bus bar assembly**
- **explain application of auxiliary gutte**
- **explain application of cable trench.**

Requirements

Tools/Instruments

- Work bench 6'4'4 - 1 No.
- Sheet metal tray - 1 No.

Materials

- cable tray - 1 No.
- race ways - 1 No.
- auxiliary gutter - 1 No.
- cable bus bara assembly - 1 No.
- cable trench wall chart - 1 No.

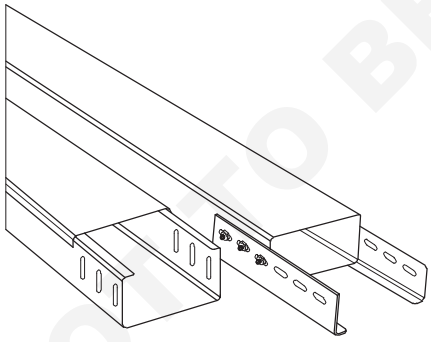
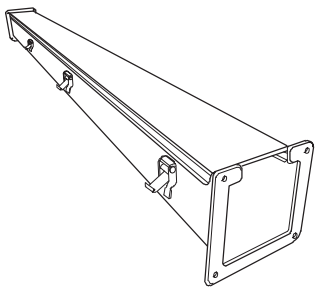
PROCEDURE

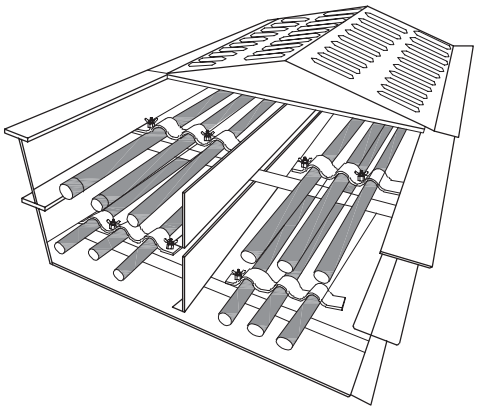
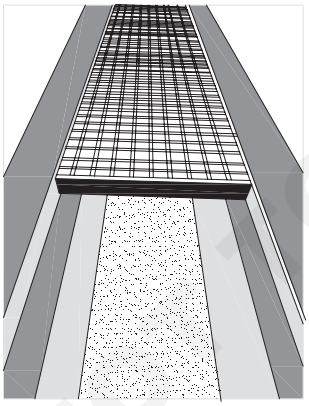
TASK1 **Identify the accessories required for cable laying**

Instructor may arrange the available different types of accessories required for cable laying on the table provide wall chart of cable trench Instructor may also explain uses and application of accessories of cable laying

1 Identify the different types of accessories required for cable laying

2 Write the name of accessories for fig 1 to 5 uses in the space provided aginst each fig in table 1.

Sl.No	Figure	Name of the accessories	Use of accessories
1	 CABLE TRAY		
2	 CABLE RACE WAY		

3			
4	 CABLE BUD ASSEMBLY		
5	 CABLE TRENCH		

Determine minimum ampacity and size of conductors for continuous and non continuous loads

Objectives: At the end of this exercise you shall be able to
- **determine the value of current for extended circuit to a given load**
- **compute the permissible voltage drop in the cable**
- **determine the size of the cable.**

Requirements

Tools/Instruments

- Measuring tape 0 - 20 m - 1 No.

PROCEDURE

TASK 1: **Determine the ampacity and size conductor for continuous and non - continuous load**s

1 Determine the full load current for the 1.5 ton air - coditioner either from name-plate details or from the existing 1.5 ton air -conditioner of the same make, say the load current is 16 amps.

2 The diversity facotor for power us 100% for current up to 10 amps, 50% for current above 10 amps safe current

For 16 amps ---> 10 x 100% = 10 amps

6 x 50% = 3 amps

13 amps

3 Refer to Table 5 of the Trade theory. the current of 13 amps coulld be safety carried by 3/0.91 copper cable whose cross -section is 2 sq. mm and its nominal current carrying capacity is 15 amps. However, the NE code does not recommended conductors of area of cross - section less than 2.5 sq. mm. Refer to Ex.526. As such it is better to go for the next size i.e 7/7.074 size cable whose nominal cross-sectional area is 3 sq.mm.

However, the wattage rating of a 1.5 ton air-conditioner will be

E.I cos θ = 230 x 16 x 1 (Assumption PF is unity)

= 3680 watts

which is within the capacity of 7/0.74 cable.

4 Calculate the length of the cable run from the main switch to the point of installation of the air-conditioner. is assume 20 meters.10% adding allowance say 22 meters.

5 Calculate the voltage drop in 22 metre run for 7/0.74 cable referring to Table 5 of Trade Theory.

$$= \frac{2.64 \times 22}{10} = 508 \text{ volts}$$

6 Calculate the permissible voltage drop as per BIS 732. Permissible voltage drop 3% of the supply voltage (240 V)

Hence the permissible voltage drop

$$= \frac{240 \times 3}{100} = 7.2 \text{ V}$$

7 Compare the expected voltage drop in the cable with the permissible voltage drop. If the expected voltage drop is less than the permssible voltage drop the cable selected (7/0.74) will be suitable**.**

If the cable length increases beyond a certain length, say 30 meters for the above load, the cable size selected may not be suitable as the actual voltage drop. (ie. 2.64 x 30/10 = 7.92 v, which is above the permissible voltage drop.

8 Check the following in the installation befor effect supply to the air-conditioner and write your reply in space given below.

i Check whether the service line cables could can the additional load of the air-conditioner.

ii Check whether the energy meter has the capacitor to take up the additional load.

Practice installing cables in conduit as per I.E. rules.

Objectives: At the end of this exercise you shall be able to
- **cut conduit pipes to the required dimensions**
- **fix the conduit with the necessary clamps and spacers on girder accordance with the B.I.S. recommendations**
- **draw cables in the conduit pipes**
- **bond the conduit pipes at joints and junctions.**

Requirements

Tools/Instruments

- Screwdriver 200mm with 5mm blade - 1 No.
- Connector screwdriver 100mm with 3mm blade - 1 No.
- Metre scale 300mm - 1 No.
- Plumb bob with thread - 1 No.
- Electrician's knife - 1 No.
- Ball pein hammer 500g - 1 No.
- Hand drilling machine 6mm capacity with 4mm drill bit - 1 No.
- Combination plier 200mm - 1 No.
- Hacksaw frame 300mm with blade (24 TPI) - 1 No.

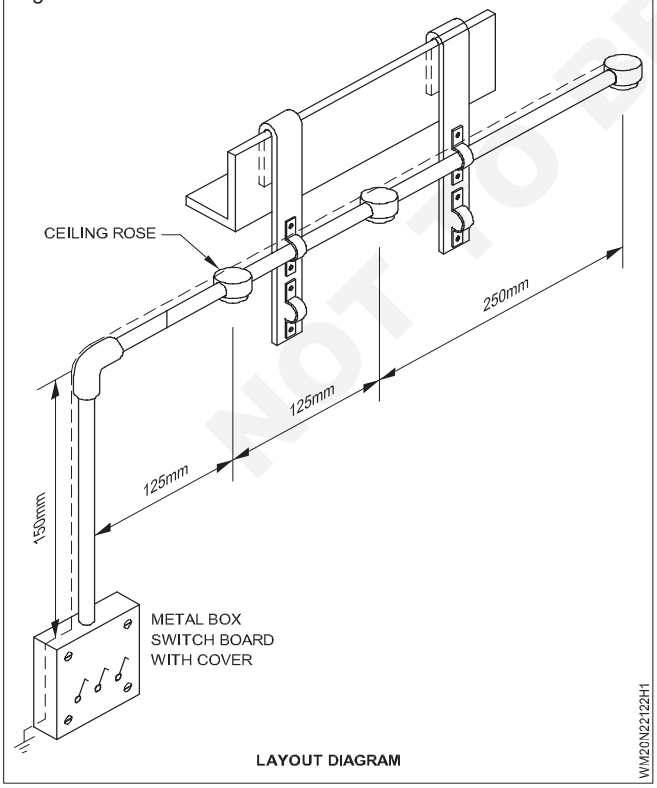
Materials

- Conduit pipe, heavy gauge 20mm dia - 8m
- Conduit one-way junction box 20mm - 1 No.
- Conduit bend 20mm - 1 No.
- Tinned copper wire 14SWG - 9m
- Earth clamps, tinned copper s
- PVC aluminium cable 1.5 sqmm 250V grade - 35m
- SPT switch 6A 240V - 3 Nos.
- Ceiling rose 2-way 6A 240V - 3 Nos.
- Colour chalk -1 piece
- GI wire 14SWG - 9 m
- PVC bushes suitable for 20mm pipe -10Nos.

PROCEDURE

1 Mark the layout on IPC (Internal panel cubical) as per the layout given in Fig 1.

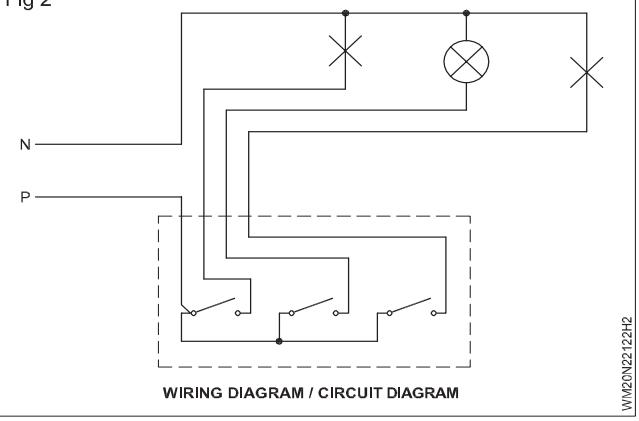
Fig 1



2 Get the circuit approved by the instructor.

3 Form the circuit with the required wiring accessories as per the circuit diagram (Fig.2) on the workbench.

Fig 2



4 Select the required conduit fittings as per the layout.

5 Measure the length of the conduit pipes required for each run as per the layout.

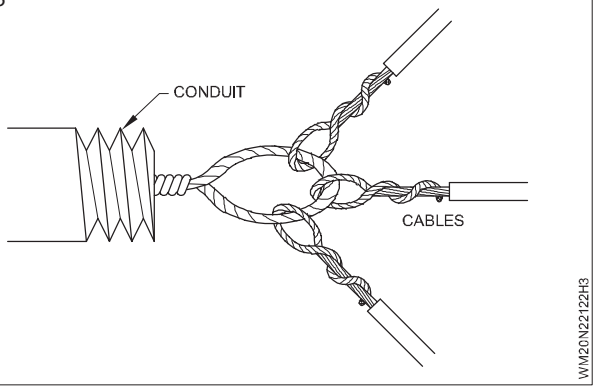
6 Cut the length of conduit as per the markings and remove the burs.

While marking on the conduit pipe for cutting, consider the economical way to utilize the pipes without much wastage in the lengths.

7 Fix the conduit pipe and conduit accessories as per the layout.

8 Measure and cut the cables as per the cable route given in the wiring diagram(Fig 3).

Fig 3



9 Insert the given fish wire in the pipe run for drawing the cables.

Drawing of the cables should be done stage by stage, taking each run one by one, and consolidating the number of cables in each run.

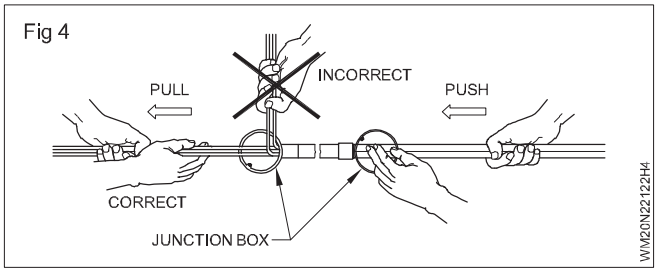
10 Skin the cables and mark each cable legibly at both ends.

11 Group the cables as per the cable route, cable runs and fasten them to the fish wire as shown in Fig 3.

Check the continuity of cables before fastening the cables to the fish wire.

12 Pull the cables by means of the fish wire and at the same time push the cables from the other end as shown in Fig 4.

Fig 4



You may require a helper while drawing cables. There should not be any kink or twist in the cables while drawing the cables through the conduit pipe. For long conduit runs, it is better, the drawing of the cables is done in stages, firstly from one end to the inspection type accessory, and then from the inspection type accessory to the end of the conduit, and so on.

13 Prepare the cable ends and terminate them in the accessories as per Fig 3

14 Fix the accessories with machine screws.

15 Close the inspection windows of the inspection type accessories.

16 Run the given earth wire along the conduit pipe by means of earth clamps and terminate at the junction boxes and metal boxes.

17 Connect the cables to the ceiling rose.

18 Check the insulation value by megger after completion of the wiring installation and test the wiring circuit.

Demonstration and practice in cutting threading and bending of metallic conduit

Objectives: At the end of this exercise you shall be able to
- **measure and cut the conduit pipe according to the requirements**
- **prepare the conduit pipe ends for threading, and fasten in a pipe vice**
- **cut the threads on heavy gauge metal conduit according to requirement using a conduit die set**
- **mark the position of bending on the conduit pipes**
- **bend the conduit pipe by manual cold bending**
- **set the bending machine according to the size of the conduit pipe**
- **bend the conduit pipe according to the requirements with the bending machine**
- **prepare the conduit for manual hot bending (filling and plugging).**

Requirements

Tools/Instruments

- Pipe vice 50 mm - 1 No.
- Steel rule 300 mm - 1 No.
- Hacksaw with 24 teeth per 25 mm blade (24 TPI) - 1 No.
- Blow lamp, 1 litre, with kerosene - 1 No.
- Flat file bastard 200 mm - 1 No.
- Half round file bastard 200 mm - 1 No.
- Reamer 16 mm - 1 No.
- Oilcan 200 ml - 1 No.
- Conduit stock and dies for 20mm conduit - 1 Set.
- Wire brush 50 mm - 1 No.
- Conduit bending machine (bench type) with 20 mm collet and guide - 1 Set.

Materials

- Conduit pipe 20 mm dia. 3 m long - 1 No.
- Lubricant - coconut oil (for a batch of 16 trainees) - 100 g.
- Chalk piece - 1 No.
- Cotton waste - as reqd.
- Matchbox (for a batch of 16 trainees) - 1 No.
- Wooden plugs suitable to plug 16 mm holes - 2 Nos.
- River sand (for a batch of 16 trainees). - as reqd.

PROCEDURE

TASK 1: **Preparation of conduit pipe for cutting**

Assume the job needs a 300 mm long conduit drop, and a standard length pipe of 3000 mm is only available. Normally both the ends of the standard length will have threads. To make the required conduit drop the standard length of 3000 mm pipe is to be cut for a length of 300 mm and threaded again at one end.

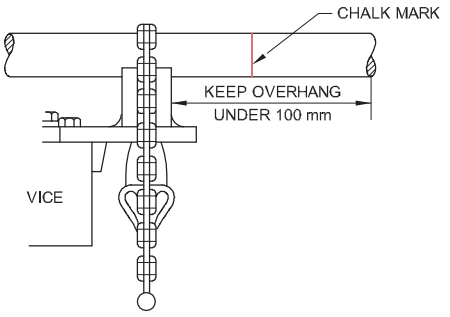
Cutting could be done either by pipe cutters or with a hacksaw. In practice cutting with a hacksaw is popular and the method is explained belwo.

1 Measure 300 mm from the threaded end of the pipe and mark it with chalk.

2 Open the jaw of the vice and insert the pipe so that it is horizontal and parallel to the jaw serration.

3 Keep the chalk mark of the pipe within 100 mm of the vice as in Fig 1.

Fig 1



GRIP THE PIPE IN THE VICE FOR SAWING OPERATION

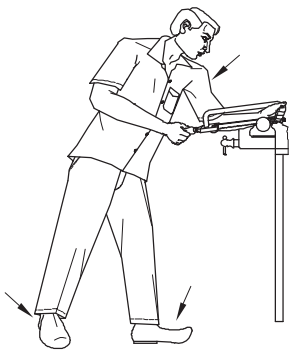
4 Close and tighten the vice jaw.

5 Select a hacksaw with a blade having 24 teeth per 25.4 mm (24 TPI)

Check that the hacksaw blade is firmly tightened in the frame and that the teeth point in the forward direction.

6 Take up the hacksaw and position yourself as in Fig 2 with your left shoulder pointing in the direction of the cut.

Fig 2



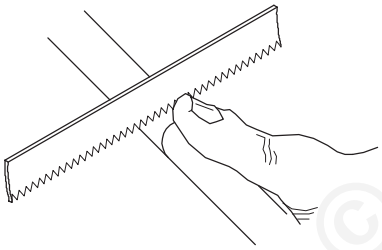
HACK SAWING - POSITION OF SAWING

WM20N22123H2

Note the position of the feet, which allows for free and controlled movement of the body when cutting.

7 Prepare to cut by guiding the blade with the thumb of your left hand exactly on the cutting line against the saw blade as in Fig 3.

Fig 3



USE THUMB AS A GUIDE INITIALLY

WM20N22123H3

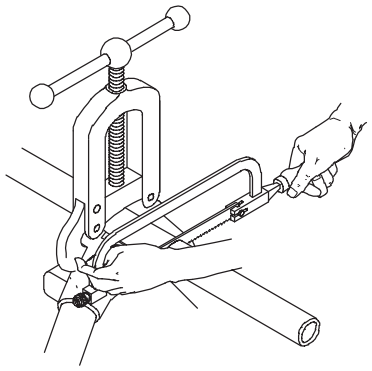
8 When the initial cut has been made, move the left hand to the front end of the hacksaw frame and use both hands for the cutting operation as in Fig 4.

9 Saw with steady even strokes, keeping the blade upright and square to the out.

10 When getting near to the end of the cut, the must be supported with your left hand as un Fig 5.

Support the conduit free end to prevent blade of the hacksaw from being damaged.

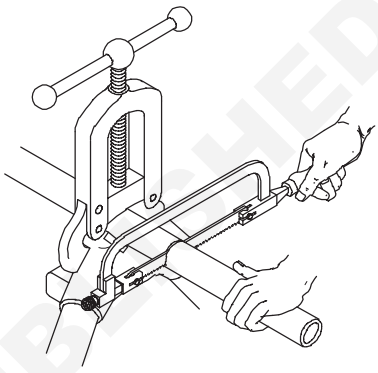
Fig 4



HOLDING SAW WHILE SAWING

WM20N22123H4

Fig 5



END OF SAWING

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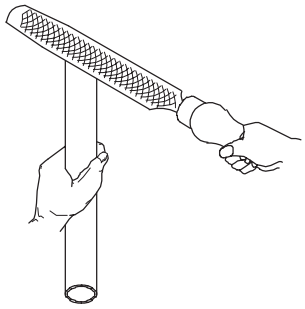
Fig 6



REMOVAL OF SHARP EDGES

WM20N22123H6

11 Use the flat portion of a half round file to smoothen sharp edges. (Fig 6)

12 Clean the hacksaw and vice and keep them in respectively places.

TASK 2: **Threading of the conduit pipe**

1 Open the jaw of the vice and insert the pipe so that it is horizontal and parallel to the jaw serrations.

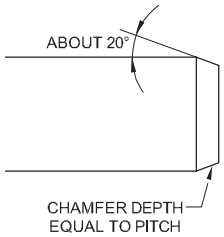
2 Keep the end of the tube within 150 mm of the vice.

3 File and end of the tube flat and chamfer the outer edge to an angle of about 20º as in Fig 1.

Make the depth of the chamber equal to the pitch of the thread (1.5 mm for conduit)

4 Choose the correct die and stock suitable for the pipe to be threaded.

Fig 1

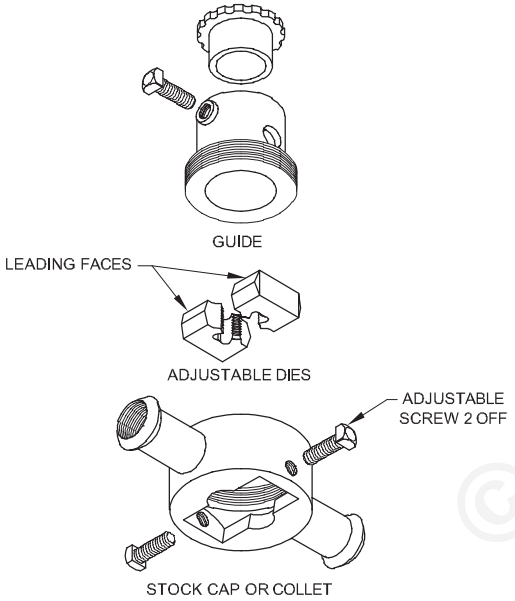


BEFORE THREADING, CHAMFER THE EDGE OF THE PIPE

WM20N22123J1

Assembly drawing for the quick cut stock and dies is given in Fig 2. Die size is engraved on the die itself. Check the size with that of the pipe. (Handle of the stock is not shown in the figure).

Fig 2



DIE SET (HANDLE NOT SHOWN)

WM20N22123J2

5 Insert each half of the die in the cap (stock) with the chamferred threads (leading faces) being adjacent to the guide.

6 Screw the guide into position.

7 Adjust each adjusting screw equally to make the die halves centralized to the pipe axis.

8 Slide the stock guide over the end of pipe, adjust the adjusting screws such that the dies just grip the pipe evenly on both sides.

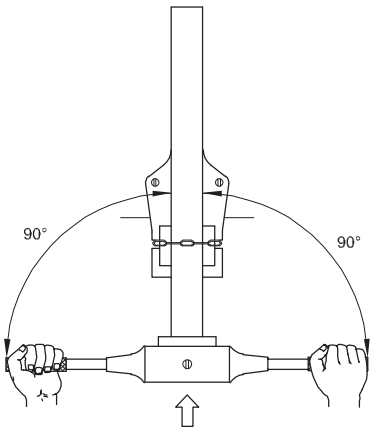
9 Apply pressure to the stock and keep the handles at right angles to the pipe as in Fig 3.

10 Rotate the handles clockwise in a plane at right angles to the pipe axis as in Fig 4.

11 Apply a lubricant to the part to be threaded after the thread has been started.

The lubricant allows the die to cool of the heat developed. Thereby the edges stay sharp and produce a better finish of the reach.

Fig 3

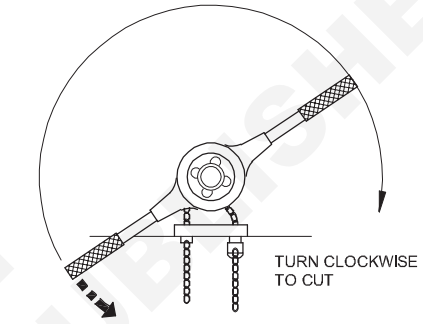


PRESS IN AS YOU ROTATE HANDLES CLOCKWISE

MOUNTING THE DIE SET IN THE CONDUIT

WM20N22123J3

Fig 4



THREADING PROCESS

WM20N22123J4

12 Make one or two complete turns in clockwise direction.

13 Frequently, as indicated by the increased resistance of rotation, ease the handle back in anticlockwise direction for half a turn.

Reverse turning is necessary to break off long cuttings and to clear the cutting edges of the die.

14 Apply the lubricant at frequent intervals.

Use a brush to remove the metal burrs from the die.

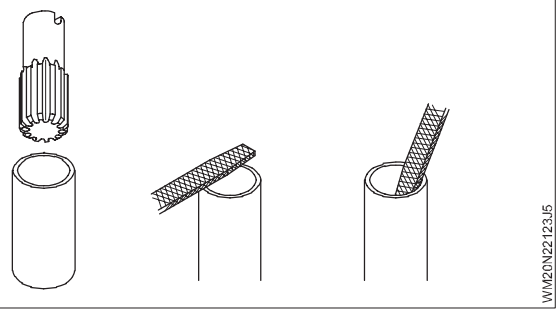
15 Remove the stock. Check the length and fit of the thread by screwing on the female fittings (coupling etc).

The length of thread should be sufficient to fit half way into the couplings and fully into the other fittings.

16 If the thread is not smooth (i.e. tight in the fittings) mount the stock and tighten the adjusting screws by half turn evenly and repeat working steps 9 to 14.

17 Remove any burrs or sharp edges from inside the end of the pipe with a reamer or a round file as in Fig 5 and file off any sharp edges.

Fig 5



WM20N22123J5

18 Clean the die stock and the vice. Keep them in the respective places.

— — — — — — — — —

TASK 3: **Preparation of conduit pipe for bending**

METHOD 1: **Bending the conduit pipe by manual method (Cold bending using bending block)**

1 Mark the place of bending in the conduit pipe with chalk.

Poorly seam-welded pipes are not suitable for bending as they may split while bending.

2 Decide the angle of bending according to the type of job.

For easiness you can draw a sketch on the floor showing the required bend.

3 Choose a wooden block, approximately having dimensions 1500 x 150 x 50 mm.

4 Bore a hole in the centre of the block at a distance 1/3rd length from the top using a drill 2 mm larger than the conduit to be bent.

5 Chamfer both sides of the opening in the block.

6 Insert the conduit into the hole such that the marked portion is just in the centre of hole.

7 Place the hands on the conduit close to the wooden block. This prevents the conduit from bending where not required.

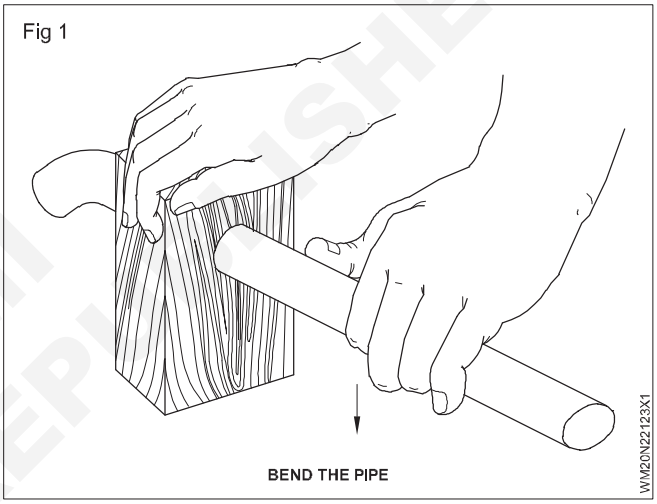
8 Press downwards bending the conduit only slightly.

9 Move the conduit through the hole for a very short distance. Keep the conduit in the same line, and do not rotate it in the hole.

One way of doing this is to draw a line long the axis of the conduit with chalk and to position the conduit.

10 Bend the conduit slightly as before as in Fig 1.

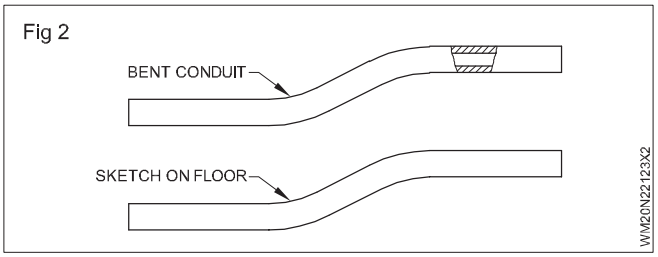
Fig 1



WM20N22123X1

11 Continue this procedure until the bend has been completely formed as per requirement. Check the angle of bend with the sketch on the floor. Fig 2

Fig 2



WM20N22123X2

Ensure that the conduit does not twist during the bending operation.

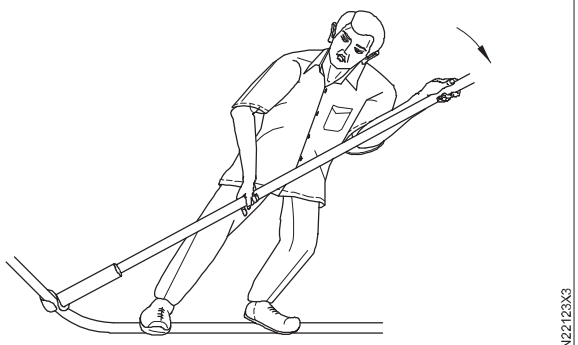
— — — — — — — — —

METHOD 2: **Bending the conduit pipe by manual method (Cold bending using a hickey)**

1 Hold the conduit firmly to the ground with your feet and give enough leverage to the hickey stick to form the bending as in Fig 3.

2 Slightly move the hickey and repeat the process till the complete bend is formed.

Fig 3



BEND PIPE USING HICKEY

WM20N22123X3

— — — — — — — — —

METHOD 3: **Bending the conduit pipe by bending machine (Cold bending)**

There are several types of bending machines available. They are classified as portable, bench-fitted, hydraulic etc. Here a bench-fitted bending machine is used.

1 Mark the place of bending in the conduit with chalk.

2 Decide the angle of bending according to the requirement.

3 Choose the correct collet (Former) and guide and fix it in the bending machine.

Each bending machine ahs certain limitations with respect to the diameter of the pipe.

Follow the manufacturer's instruction for fitting the collect and guide.

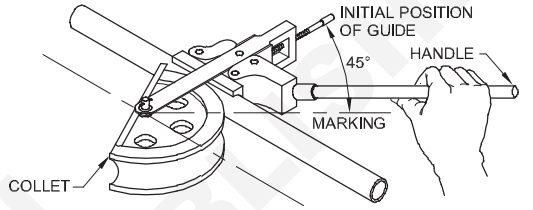
4 Insert the conduit between the collet and the guide.

5 Position the conduit pipe such that the marking is place at 45º to the initial position between the collet and guide as in Fig 4.

6 Rotate the handle in the indicated direction Fig 5 form the bend.

Stop rotation when the angle of bend is sufficient.

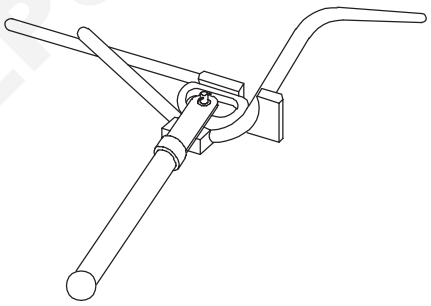
Fig 4



OPERATING A PIPE BENDING MACHINE

WM20N22123Y1

Fig 5



BENDING THE PIPE USING THE BENDING MACHINE

WM20N22123Y2

7 Loosen the handle and remove the conduit by sliding out.

— — — — — — — — —

METHOD 4: **Bending the conduit pipe by manual method (Hot bending)**

This method of bending is useful for heavy gauge pipes or for seam welded pipes of poor quality.

1 Mark the place of bending in the conduit with chalk.

2 Determine the angle of bend according to the requirement.

3 Prepare two wooden plugs.

4 Plug one end of the conduit with a wooden plug tightly as in.

5 Fill the conduit pipe with dry river sand tightly and plug the other end of the pipe with the other wooden plug. (Fig 6).

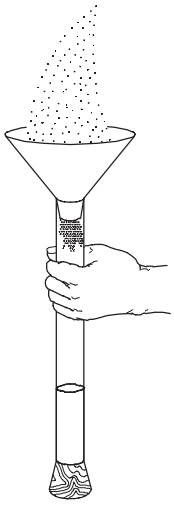
Do not use wet sand as the steam generated during the heating of conduit may cause and explosion.

6 Use a blowlamp to heat the portion to be bent as in Fig 7.

7 Bend the conduit slowly and steadily using a wooden block or hickey when the conduit is still hot.

8 After the bend is completed unplug the pipe and remove the sand.

Fig 6

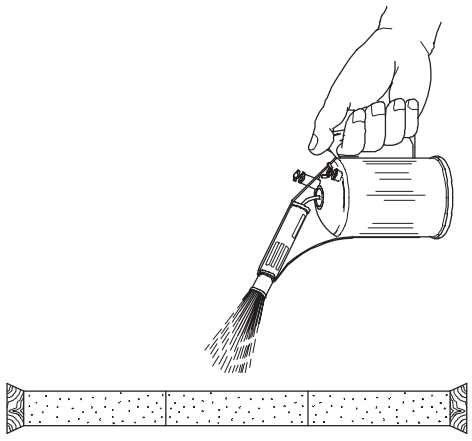


FILLING SAND

WM20N22123Z1

Collect the sand in a bucket. The sand will be very hot and may cause injuries to someone who comes in contact with it.

Fig 7



HOT BENDING OF CONDUIT

WM20N2212322

9 Insert a small ball of cotton waste in the conduit and push it to the other end of the conduit with a stiff rod to clean the inner surface of the conduit.

10 Remove the cotton waste.

Identify different busbars, practice joining and installation including overhead busbar system as per IE rules

Objectives: At the end of this exercise you shall be able to

- **determine the location for installing bus bar and select the bus bar with bus coupler**
- **mount and fix the bus bar**
- **insert the plug -in-boxes in the bus bar system and also bus coupler**
- **test for earth continuity of bus bar and for insulation resistance.**

Requirements

Tools/Instruments

- Electrician tool kit - 1 No.
- DE spanner set (6 mm to 25 mm) - 1 Set
- Crimping tool up to 16mm^2 - 1 Set
- Ladder with adjustable height - 1 No.
- High stool - 1 No.
- Hand hacksaw frame 300 mm - 1 No.
- Megger 500V - 1 No.

Materials

- Busbar of available current rating and standard length / current rating - 2 Nos.
- Plug - in boxes 32A - 2 Nos.
- Busbar brackets, M.S flat, for suspending the bus bar or GI pipe for supports and all supporting accessories - as reqd.
- Nut and bolts size and quantity for busbar extension standard accessories - as reqd.
- Bus coupler - 1 No.

PROCEDURE

1 Trace the workshop layout and calculate the total electrical capacity of machines, main power supply entry point and determine the rating.

2 Determine the busbar layout and the required length of the busbar.

3 Determine from the site what type of support is required to lay the busbar.

4 Mount and fix the busbars to the supporting structure. (Fig 1 and Fig 2).

5 Insert the plug - in-boxes in to the plug -in-points. (Fig 1)

Fig 1

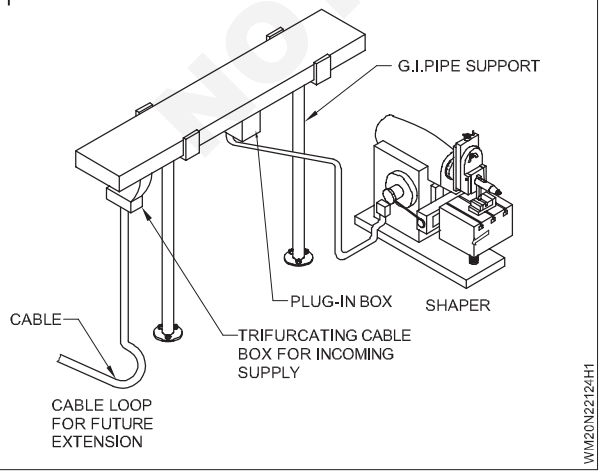
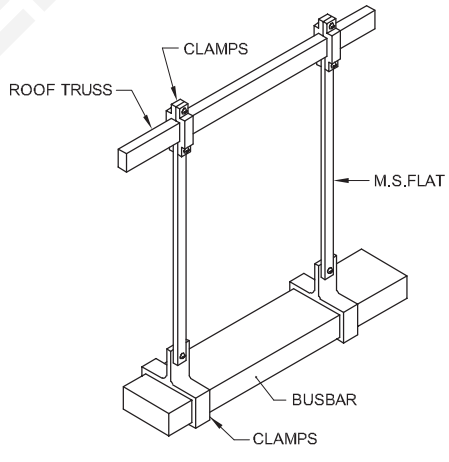
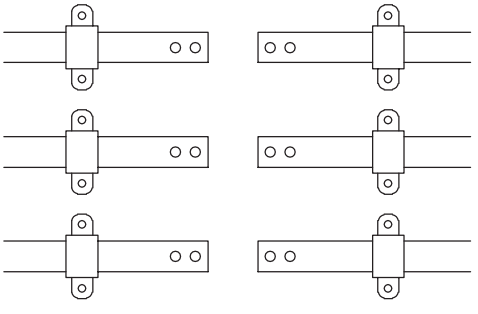


Fig 2



6 Couple the new busbar mechanically and electrically by using bus coupler, if another length is needed. (Fig 3)

Fig 3



If any over lapping ends of the busbar join by bolting together.

7 Secure busbar with screws locking plates.

A connector - assembly which is commercially available comprises of

- **rubber locating ring,**
- **busbar insulating tube**

If connector insulating tube in knocked out condition. While coupling, make sure that the connector - assembly is properly secured.

8 Terminate the plug in boxes to the loads through metal conduit runs and suitable cables.

9 Test the bus bar system for earth continuity.

10 Test the system for continuity and insulations.

11 Connect the busbar to the incoming supply cable through trifurcating box. After ascertaining test results are ok. (Fig 3)

Prepare bill of material, plan and practice wiring of an institute and work shop as per IE rules

Objectives: At the end of this exercise you shall be able to
- **calculate the total load in sub-circuit**
- **select the size of cable in the sub circuits**
- **estimate the quantity of materials**
- **estimate the cost of wiring**
- **draw the single line diagram of power wiring in workshop**
- **connet the accessories as per circuit**
- **test the circuits.**

Requirements

Tools/Instruments

- Measuring tape 0-25 m - 1 No.
- SWG - 1 No.
- Steel rule 300 mm - 1 No.
- Micrometer 0-25 mm - 1 No.
- Power drilling machine 6mm with 5 mm drill bit - 1 No.
- Combination pliers 200 mm - 1 No.
- Side cutting pliers 150 mm - 1 No.
- Electrician's knife - 1 No.
- Bradawl 150mm - 1 No.
- Ball peen Hammer 250 gm - 1 No.
- Hacksaw with 24 TPI blade - 1 No.
- Firmer Chisel 6 mm - 1 No.
- Neon Tester 500V - 1 No.
- 3 ϕ Energy meter 30A, 440V - 1 No.

Equipment / Machines

- 5 HP 3f 440V AC motor - 1 No.
- 3 HP 3f 440V AC motor - 1 No.
- 1/2 HP 1f 240V AC motor - 1 No.
- 1 HP 1f 240V AC motor - 1 No.
- Star Delta starter 4, 5V 50 Hz - 2 Nos
- DOL starter 1f, 10A, 250 V - 2 Nos.

Materials

- A-4 Paper - as reqd.
- Pencil/HP - 1 No.
- Eraser - 1 No.
- PVC pipe 20 mm - 10 m
- PVC ways junction box - 20 Nos.
- TW box 200 X 150 X 40 mm - 3 Nos
- TW box 300 x 200 x 40 mm - 4 Nos.
- TPIC 16A - 415V - 2 Nos.
- DPIC 16A, 250V - 2 Nos.
- Saddles 19 mm - 50 Nos.
- Wooden gutties - 50 Nos.
- Conduit bend 19 mm - 10 Nos.
- Angle Iron frame 50 x 30mm - 5 Nos.
- Fish wire - as reqd.
- PVC sheathed aluminium cable 4 Sq mm 250 V - 60 m
- Copperwire 14 SWG - 15 meter
- PVC Elbow 20 mm - 25 Nos.
- Distribution box 4 ways 200x150x40mm - 1 No.
- TW wooden spacer - 30 Nos.
- Wood screws 25 x 6 mm - 1 Box
- Wood screws 12 x 6 mm - 1 Box
- Surface mounted kit kat fuse 16A 250V - 4 No.

PROCEDURE

Task 1 : **Estimate cost/bill of material and practice wiring of an institute (assume one of the I.T.I institue plan)**

1 Obtain the building plan as shown in Fig.1

2 Collect the requirements of lights, fans, lighting and power sockets etc.

3 Mark the location of switch board, Power loads and DB in the plan.

The wall thickness - 40 cm

The height of roof from ground - 3.5 m

Height of conduit run - 3 m

Height of main board - 2.5 m

Height of switch - 1.5 m

Height of light brackets - 3 m

Height of main board - 3 m

The details of standard requirement of Power loads are given in Table - 1

Fig 1

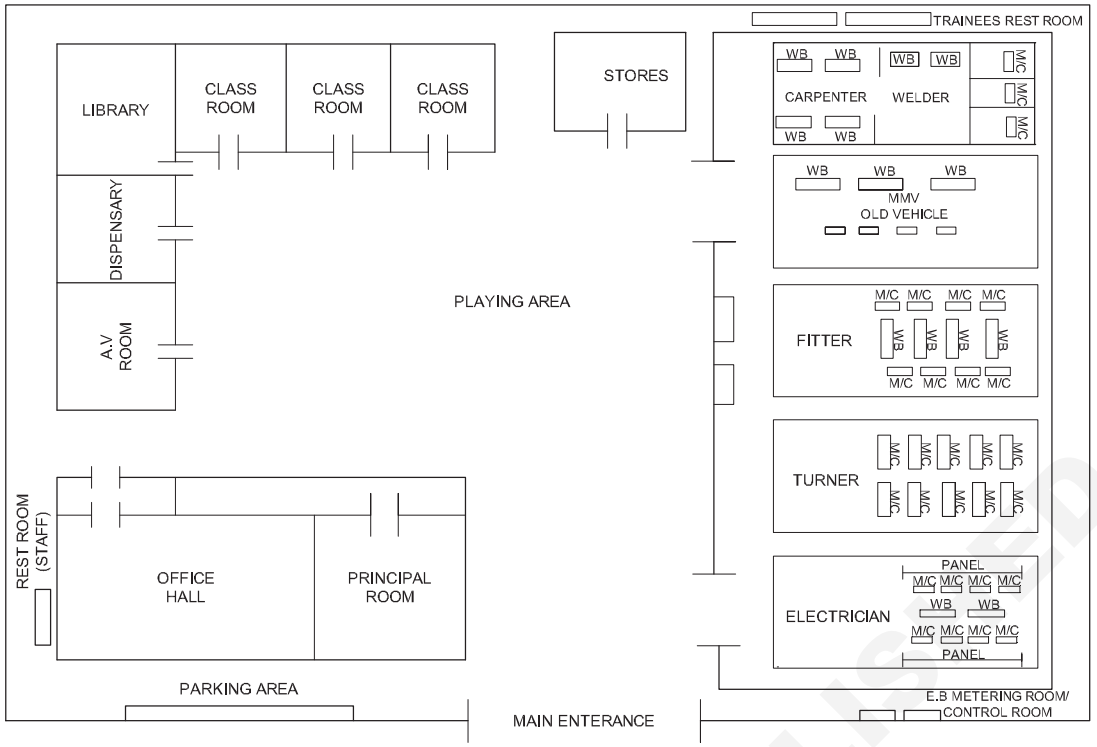


Table - 1

Location	Light (20 W)	Fan (80 W)	6A Plug Point (80 W)	16A Power Plug (1000 W)	Distribution boards & phase
Official principal	6	5	5	3	NIL
Class room	5 x 5 = 25	5 x 5	5 x 1	1	NIL
Work shops	5 x 10	5 x 6	2 x 5	5 x 2	5 x 10
Drawing Room	10	6	1	1	NIL

4 Calculate the number of sub circuits required for the above load as per IE rules.

Indian electricity rule states that there should be separate sub circuits for light/fan loads and power loads. Therefore 6A plug points (Sockets) are considered as light / fan load points as they are meant for connecting table fan /table lamp etc. 16A power plug are considered as power points as they are used for connecting heavy loads like heaters, kettles etc.

Total wattage of light points	= 51 x 20	= 1020 W
Total wattage of fan points	= 61 x 80	= 4880 W
Total wattage of (6A) sockets	= 13 x 80	= 1040 W
Total 125 Nos		= 6940 W

As there are 17 points, we need two sub - circuits. The division of outlets on each sub circuit is made more or less uniform, ie., 8 & 9. Refer Fig 2

5 Draw the layout of conduit, switch board, loads and DB as shown in Fig 3.

6 Calculate the size of each cable as shown below.

i current through subcircuit-1

$$= \frac{(5 \times 60) + (2 \times 80) + (2 \times 80)}{230} = 2.696 \text{ A}$$

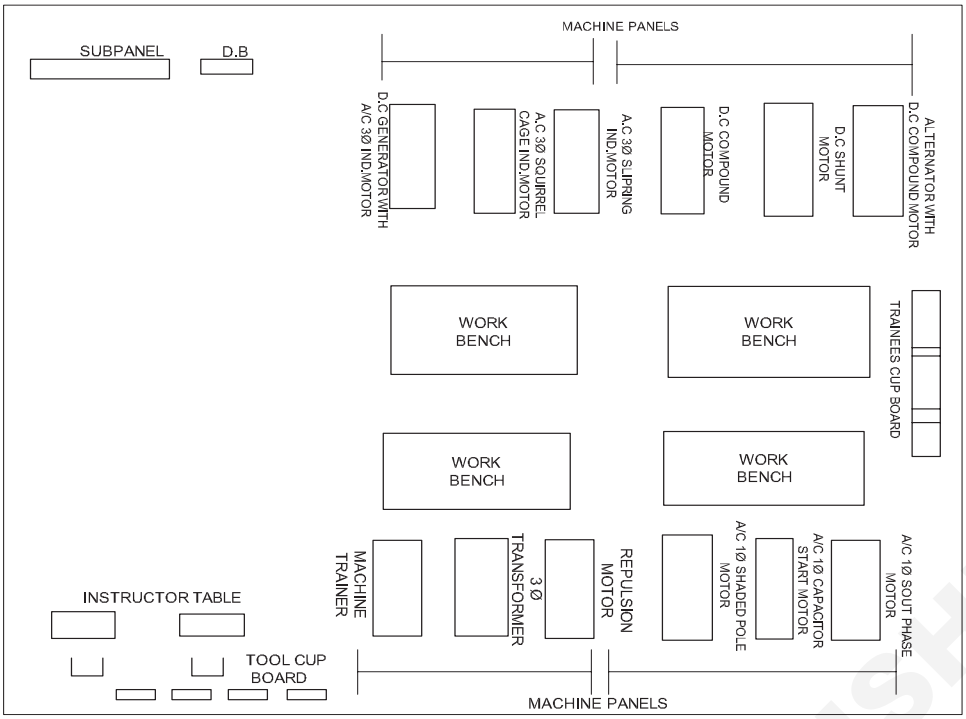
ii Current through subcircuit -2

$$= \frac{(3 \times 60) + (3 \times 80) + (2 \times 80)}{230} = 2.522 \text{ A}$$

iii Current through sub circuit 3 $= \frac{2000}{230} = 8.696 \text{A}$

Total current = 2.696+2.522+8.696 = 13.9 A

Fig 2



16A, 250V flush type DP main switch is sufficient

7 Calculate the length of PVC conduit and cable as shown below.

19mm conduit can be used up to ABC length and for remaining length, 12mm conduit is sufficient.

Horizontal runs

19mm conduit for length of each class room = 6 m

19mm conduit for length at (wall thickness) = 0.4 m

19 mm conduit for principal and office room = 6 m

19 mm conduit for each workshop = 50 mm

19 mm conduit or Drawing room = 20 m

Five class room 5 x 50 = 250 m

Five class rooms 5 x 6 = 30

Total wall thickness 12 x 0.4 = 4.8 m

Total = 380.8

Distribution board to LED tubelight junction box = 2 m

Junction box to all light fan = 15 m

for all class rooms (6 x 17) =102 m

Total 19 mm conduit length = 380.8 +102 m

= 482.8 m

Wastage 10 % = 48.3 m

= 531.1

Approximately = 532 m

12 mm conduit

For class room

Junction box to lamp 1 = 2 m

Junction box to lamp 2 = 2 m

Junction box to lamp 3 = 2 m

Junction box to lamp 4 = 2 m

Junction box to lamp 5 = 2 m

Ceiling Fan 1 = 2.5 m

Ceiling Fan 2 = 2.5 m

Ceiling Fan 3 = 2.5 m

Ceiling Fan 4 = 2.5 m

Ceiling Fan 5 = 2.5 m

= 22.5 m

Five class rooms (5 x 22.5) = 112.5 m

Drawing room = 23 m

Principal office room = 35 m

= 170.5

12 mm conduit for each work shop:

ceiling from distance from wall to ceiling point is 4m for 4points = 16m

4.5m for 2points = 9 m

Five work shops (5 x 25) = 125 m

wastage 10% = 12.5 m

= 137.5 m

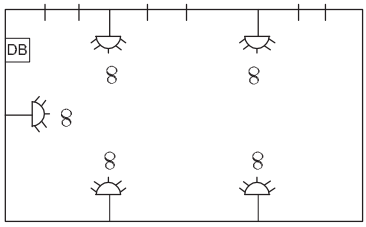
Total 12 mm conduit (112.5+23+35+137.5+532) =840m

cable for su circuit =(840 x 3) =2520m

1.0mm^2 copper wire is 2520m

Cable for main control panel to each sub circuit is 2.00 mm^2 copper wire (approxmatly) = 162m

Fig 3



Power cable for motors

Bus bar covers all the motors in each work shop (approxnately) 60m

Three wires (3 x 60) = 180m

five work shops (5 x 180) = 900m

For bus bars 10mm^2 pvc aluminium cable is required

Bus bar to motor starter and motor =5m for ten motors (10 x 5) = 50m

2 mm^2 pvc coper cables (R,Y,B) 50 x 3 = 150m

For fove work shops (5 x 150) = 750m

labour cost:

Meter board = 2 points

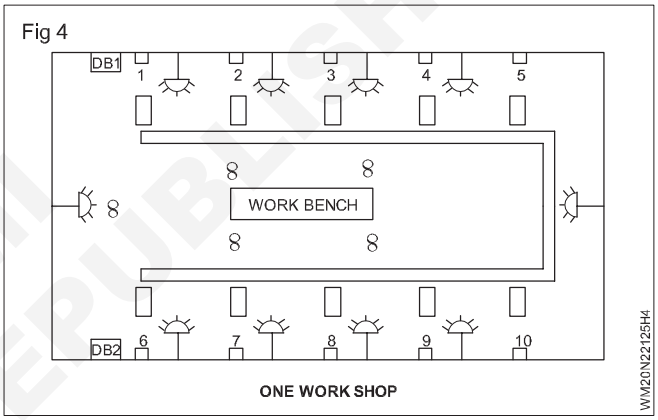
distribution boards = 16 points

light and fan = 127 points

bus bar instatation and itarter box = 50 points

= 185 points

Fig 4



TASK 2 : **Practice wiring of an institue**

1 Draw the wiring diagram based on Fig 1 Task.1

2 Mark the layout based on above figure

3 Prepare the pvc conduit frame as per layout

For power line separately consturct pvc conduit frame

4 Draw the copper canle in the conduit

5 Construct aluminimu cable bus for power line

6 Make cable end termination and connect to all centroling devices

7 Check the wiring by meggar and test the wiring.

Trainee shall select the cable size by refering the table given in related theory

8 Calculate the labour cost.

Meter board	= 2 Points
Distribution board	= 2 Points
Light / fan	= 17 Points
Power	= 2 Points
Total points	= 23 Points

Labour cost / point should be taken by referring the local rate list.

For example, take the labour cost is Rs.100/point

Then, total labour cost is 185 x 100 = Rs.18500/-

9 Prepare a list of “material of schedule and cost” as shown in Table-2.

Table 2

Material of schedule and cost

Sl.No.	Material Specification	Qty.	Rate Cost			
			Rs. Ps.	Per	Rs. Ps.	Remarks
1	D.P Main switch 10A, 240V flush type	1 No	.....	each	.....	ForM.B For power load
2	Control panel	1 No	.....	each	.....	power load
2	I.C cut out 16A, 240V	1 No	.....	each	.....	
3	Flush type fuse unit 16A	1 No	.....	each	.....	
4	Flush type fuse unit 6A	2 Nos	.....	each	.....	
5	PVC conduit 19 mm (heavy guage)	532 m	.....	length	.....	1 length = 3 m
6	PVC conduit 12 mm (heavy guage)	840 m	.....	length	.....	1 length=3m
7	1.0mm2 multistrand copper, VIR cable	2520 m	.....	100m	.....	
8	10 mm aluminium VIR cable	900 m	.....	100m	.....	
9	2 sq mm copper VIR cable	150 m	.....	100 m	.....	From M.Bto D.B
10	Switches 6A, 240V one way flush type	86 Nos	.....	each	.....	
11	2-pin sockets 6A, 240V	21 Nos	.....	each	.....	
12	3 -pin sockets 16A, 240V with switch and neon	15 Nos	.....	each	.....	
13	Ceiling rose 2 - plate 6A 240V	200Nos	.....	each	.....	
14	PVC junction boxes 25 mm 4 - way	50No	.....	each	.....	
	12 mm 3-way	20 Nos	.....	each	.....	
	12 mm 2-way	25 Nos	.....	each	.....	
15	PVC bends 12 mm	40 Nos	.....	each	.....	
16	PVC reducers (25 mm to 12 mm	40 No	.....	each	.....	
17	Saddles 25 mm	2 box		Doz	.....	
	12 mm	2 box		144 Nos	.....	
18	Wooden boards (a) 30 x 30 Cm	2Nos13	.....	each	.....	For M.B &D.B For S.D's
	(b) 18x10 Cm	13 Nos	.....	each	.....	
19	Wooden gutties/plugs 9cm2 x 4 cm2 x50 mm	30 doz		doz	.....	For boards
20	Nails 25 mm	1 kg		kg		Per conduit
21	Wooden screw 60 mm	2Kg		100		For boards
	Wooden screw 12 mm	2 Kg		100	....	For holders
22	Copper wire (16SWG) for earth	10 Kg		kg	.....	
	(GI WIRE 14 SWG)	10 Kg		kg		
23	Earth set (Pipe, salt, coal)	7 set		...	.....	
24	Cement	2 box		kg		
25	Labour cost				.....	
	Total				.....	
	Contingency 10%				.....	
	Grand Total					

The rate of each material shall be obtained from the price list of the branded items.

TASK 3 : **Estimate the cost / bill of materials for wiring of workshop**

1 Obtain the floor plan of the workshop.

2 Mark the positions of motors on the floor plan with the consultation of the customer.

A sample requirement is given below for trainee's reference

1 One 5HP, 415V 3 phase motor

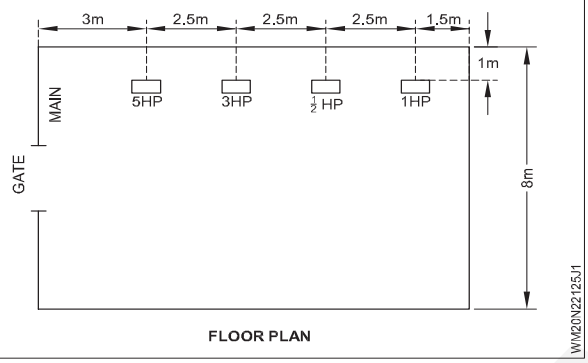
2 One 3HP, 415V 3 phase motor

3 One ½ HP, 240V 1 phase motor

4 One 1HP, 415V 3 phase motor

The motors are to be arranged as shown in Fig.1

Fig 1



The main switch, motor switch and starters are assumed to be mounted at a height of 1.5m from the ground level.

Height of horizontal run from ground level will be 2.5 m

The cost of motors and starters are not to be included in the estimate.

3 Calculate the size of cable

Assuming the motor efficiency to be 85% power factor to be 0.8 and supply voltage is 400 V for all the motors.

FL current of 5HP motor = $\frac{5 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 7.806A$

FL current of 3HP motor = $\frac{3 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 4.68\ A$

FL current of ½ HP motor = $\frac{0.5 \times 735.5}{240 \times 0.85 \times 0.8} = 2.25\ A$

FL current of 1HP motor = $\frac{1 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.8} = 1.56\ A$

The main switch and the cable from meter to main switch should be capable of handling starting current of one motor of high rating plus full load current of the all other motors.

i.e, 15.6+4.68+2.25+1.56 = 24.9A

4 Prepare a table showing cable size of each motors to be installed as shown in Table 1.

Table 1

Sl.NO	Motor	FL current IL (A)	Startng current IS = 2IL (A)	Recommended cable size
1	5HP motor	7.5	15.0	2.0mm² copper conductor cable (17A) or 2.5 mm² aluminium conductor cable (16A)
2	3 HP motor	4.68	9.36	2.0mm² copper conductor cable (17A)
3	1/2 HP motor	2.25	4.5	1.0mm² copper conductor cable (11A) minimum recommended cable
4	1 HP motor	1.56	3.12	1.0mm² copper conductor cable (11A) minimum recommended cable

The type and gauge of cable shall be selected by referring the table given in related theory

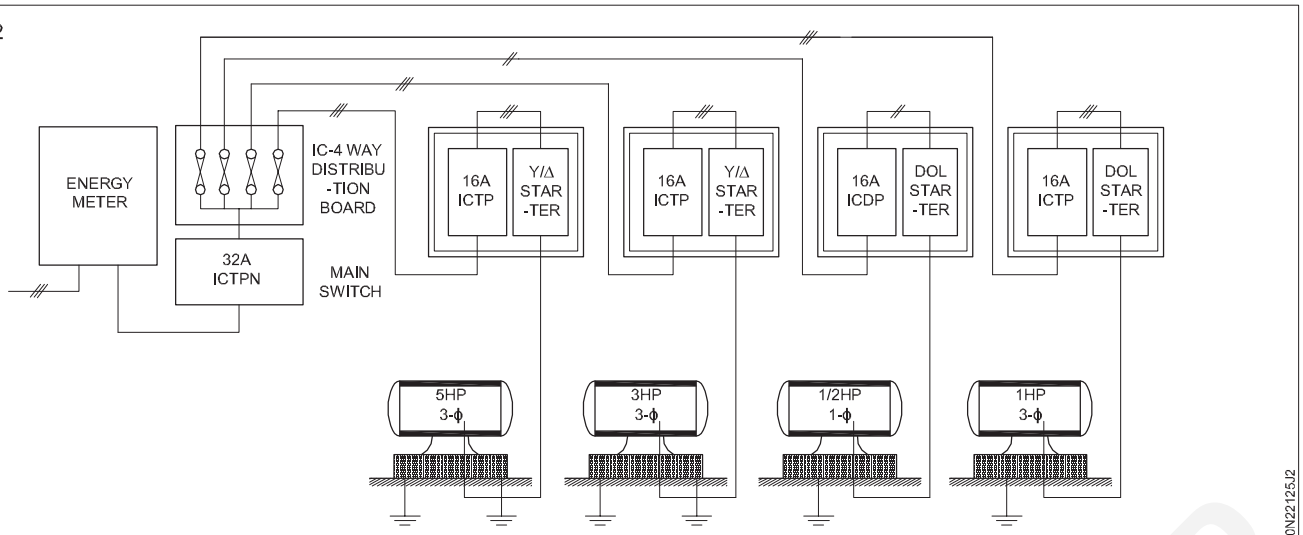
5 Select the suitable switches and distribution board

- 32A, 415V ICTP switch with fuses can be used as main switch.
- 16A, 415V, ICTP switches with fuses can be used for 5HP, 3HP, & 1HP motors.
- 16A, 240V, ICDP switch with fuses can be used for ½ HP motor.
- 415V, 4 way, 16A per way IC distribution board with neutral link can be used for power distribution.

6 Draw the single line diagram of power wirings as shown in Fig 2.

7 Calculate the size and length of conduit.

Fig 2



SINGLE LINE DIAGRAM OF POWER WIRING IN WORKSHOP

19mm heavy gauge conduit should be used for 3 cable runs and 25 mm heavy gauge conduits should be used for 6 cable runs.

- 19 mm heavy gauge conduit

Length from main board of 5HP motor starter

= 1+1+3+1 = 6.0m

Length from main board to 3HP motor starter

= 1+1+5.5+1 = 8.5m

Length from main board to ½ HP motor base

= 1+1+8+1+1.5+1.5 = 14.0m

Length from main board to 1HP motor base

= 1+1+10.5+1+1.5+1.5 = 16.5m

Total = 45.0 m

10% wastages = 4.5m

Total length = 49.5m, say 50.0m

- 25.4 mm heavy gauge conduit.

Length from meter to main switch = 0.75m

Length from 5HP motor starter to 5HP motor base (1.5 +1.5) 3.0 m

Length from 3HP motor starter to motor base = 3.0 m

Total = 6.75 m

10% wastage = 0.67 m

Total = 7.42m, Say 8.0m

- 25 mm flexible conduit for 5HP & 3 HP motor (0.75+0.75) = 1.5, Say 2.0m

8 Calcualte the length of cables.

2.0mm2 copper conductor from main board to 5HP motor terminals = 3(1+1+3+1) + 6(1.5+1.5+0.75) = 40.5m

15% wastages & end connections = 7.2 m

Total = 55.2m , Say = 56.0m

1.0mm2 copper conductor from main board to 1/2 HP motor terminals

= 2(1+1+8+1+1.5+1.5+0.75) = 29.5 m

15% wastages & end connections = 7.76m

Total = 59.51m, Say 60.0m

9 Calculate the labour cost as per the local rate and rules for calcualting number of points.

10 Prepare “Schedule of material and cost as shown in Table 4.

Table 4

Material of schedule and cost

Sl.No.	Specification of material	Qty.	Rate Rs. Ps.	Cost Per	Rs. Ps	Remarks
1	32A, 415V- Iron -clad triple - pole (ICTPN) switch with fuses	1 No.	.....	each	.....	
2	16A, 415V, Iron- clad triple -pole switch with fuses	3 Nos.	.....	each	.....	
3	16A, 240V, Iron -clad double - pole switch with fuses	1 No.	.....	each	.....	
4	4-Way distribution box, 415V, 16A	1 No.	.....	each	.....	
5	Conduit heavy gauge .....19 mm	50 m	.....	m	.....	
	25mm	8 m	.....	m	.....	
6	Flexible conduits .....19 mm	2 m	.....	m	.....	
	25 m	2 m	.....	m	.....	
7	2.0 mm2 copper conductor single core (17A)	47 m	.....	100 m	.....	
8	1.0mm2 copper conductor single core (11A)	56 m	.....	100 m	.....	
9	1.0mm2 copper conductor single core (11A)	34 m	.....	100 m	.....	
10	1.0mm2 copper conductor single core (11A)	60 m	.....	100 m	.....	
11	Angle iron frame 50 x 30 m	5 Nos.	.....	each	.....	For M.B & D.B
12	Conduit bends 19mm	10 Nos.	.....	each	.....	
	25 mm	2 No.	.....	each	.....	
13	Saddles .....19 mm	150 Nos	.....	100	.....	
	25 mm	25 No.	.....	100	.....	
14	Conduit couples 19mm	6 No.	.....	each	.....	
	25 mm	1 No.	.....	each	.....	
15	Wooden gutties	120 No	.....	doz	.....	
16	Earth wire, GI, 8 SWG	40 m	.....	kg.	.....	1kg. 10 m
17	Lugs for connecting leads to motors	17 No.	.....	each	.....	(6+6+2+3)
18	Earthing pipe perforated 25.4mm dia	2.5 m	.....	m	.....	Two earths
19	Coal	40 kg.	.....	kg.	.....	
20	Salt	40 kg.	.....	kg.	.....	
21	Funnel with wire mesh	1 No.	.....	each	.....	
22	Labour charges for earthing (Civil work)	2 Nos.	.....	pit	.....	
23	Caution plate	1 No.	.....	each	.....	
24	Nails 25.4 mm	2	.....	kg.	.....	
25	Shock treatment chart	1	.....	each	.....	
26	Labour cost	-	.....	point	.....	
	Total	.....	.....	.....	.....	
	Contingency 10%	.....	.....	.....	.....	
	Grand total	.....	.....	.....	.....	
	Say	.....	.....	.....	.....	

TASK 4 : **Practice wiring of work shop as per IE rules**

1 Obtain the floor plan of the work shop (Fig 1 task 3)

2 Mark the position of motors on the floor plan with the consultation of the customer

3 Draw the wiring diagram based on above Fig 2

4 Mark the layout based on Fig2, Task3

5 Prepare the PVC conduit frame as per layout

6 Draw the copper cable in the conduit

7 Make cable end termination and connect to all accessories

8 Check the wiring by using megger and test the wiring.

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Demonstrate hospital, tunnel and go down wiring using visual aids

Objectives: At the end of this exercise you shall be able to

- **mark the layout on the wiring board/installation practice cubicle (IPC) for each wiring A to I**
- **cut the P.V.C. pipes for the required length as per the layout**
- **fix the accessories to the P.V.C. pipes according to the layout**
- **draw the wires into the P.V.C pipe and fix with shaddle**
- **connect the wires with accessories**
- **wire up for the domestic light and fan wiring circuits in open P.V.C conduct**
- **test the wirings for their function.**

Requirements

Tools/Instruments

- Trainees tool kit - 1 No.
- Cross pein hammer 250 gms - 1 No.
- Screwdriver 200 mm with 5 mm blade - 1 No.
- Screwdriver 150 mm with 3 mm blade - 1 No.
- Electrician's knife (100 mm) - 1 No.
- Connector scrwdriver 100mm - 1 No.
- Gimlet 5mm dia. 200 mm long - 1 No.
- Hand drilling machine 6 mm capacity - 1 No.
- Drill bit 3 mm to 5 mm - 1 each.
- Try square 150 mm - 1 No.
- Brawdal 150 mm - 1 No.
- Combination pliers 200 mm - 1 No.
- Hacksaw frame with blade (24 TPI) - 1 No.
- Steel rule (300 mm) - 1 No.

Materials

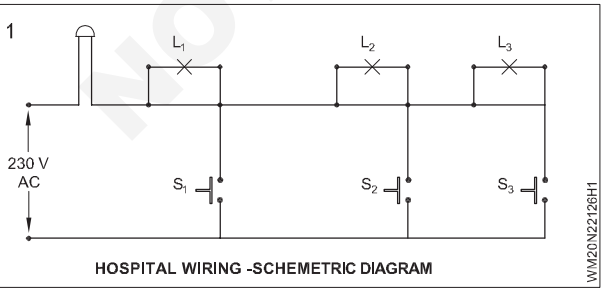
- PVC pipe 19 mm - as reqd.
- PVC terminal box - 4 Nos.
- Wood screws No. 6x12 mm - as reqd.
- Wood screws No. 6x20 mm - as reqd.
- PVC sheathed aluminium cable 1.5 sq.mm. 250V grade - as reqd.
- Flush mounting two-way switch 6A, 250V - as reqd.
- One way switch 6A/250V - 4 Nos.
- Batten lamp-holder, brass 6A, 250V - as reqd.
- Terminal plate 2-way - 1 No.
- Bulb 40W, 250V, BC type - as reqd.
- PVC round block (90mm x 40 mm) - as reqd.
- PVC 'Tee' bends and elbow (Each) - as reqd.
- Marking Pen/Pencil/Chalk - as reqd.
- Marking thread - as reqd.
- PVC insulation tape - 1 Roll.
- Self tapping screw (20 mm) - as reqd.
- Intermediate switch 6A/250V - 1 No.
- ICDP switch 16A/250V - 1 No.

PROCEDURE

TASK 1: **Wireup the lighting circuit for hospital wiring in P.V.C. conduit**

1 Form the circuit with required wiring accessories as per the schematic diagram Fig 1 on the work bench.

Fig 1

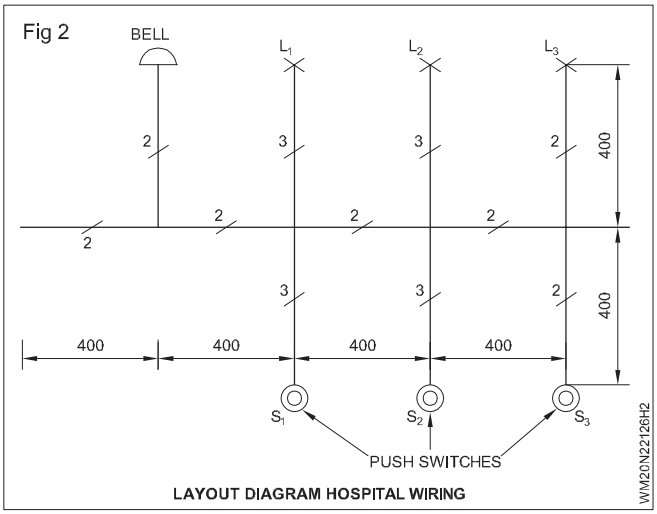


HOSPITAL WIRING -SCHEMETRIC DIAGRAM

2 Get the circuit approved by the instructor.

3 Mark the layout on teh I.P.C as per the layout as in Fig 2.

Fig 2



LAYOUT DIAGRAM HOSPITAL WIRING

4 Select and cut the pipe for required length and fittings as per layout.

5 Cut the length of the conduit as per markings and remove the burrs.

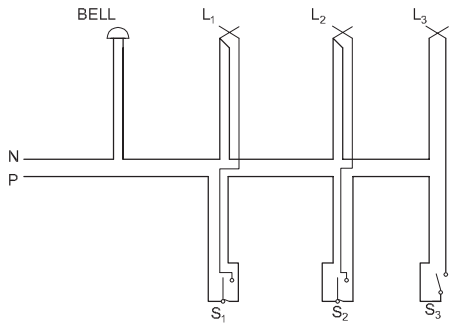
6 Fix the P.V.C. conduit accessories as per the layout with a shaddles.

7 Run the wires as per the circuit diagram as in Fig 3.

8 Get the wiring checked by the instructor.

10 Test the wiring installation for its functioning.

Fig 3



WIRING DIAGRAM HOSPITAL WIRING

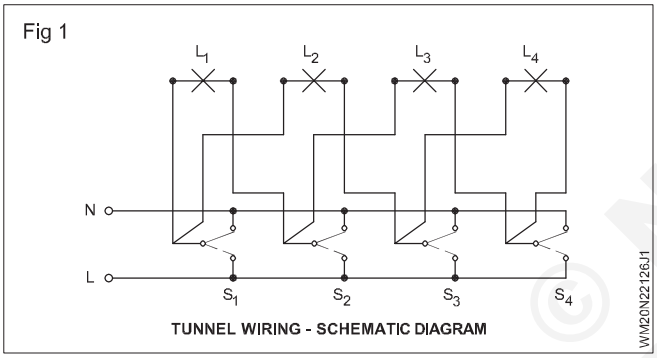
— — — — — — — — —

TASK 2: **Wire up the lighting circuit of a tunnel wiring in P.V.C. pipes**

1 Draw the layout and schematic diagram and estimate the material required with full specification and quantity required within, say, 30 minutes.

2 Form the circuit with the required wiring accessories as per the schematic diagram (Fig 1) on the work bench.

Fig 1



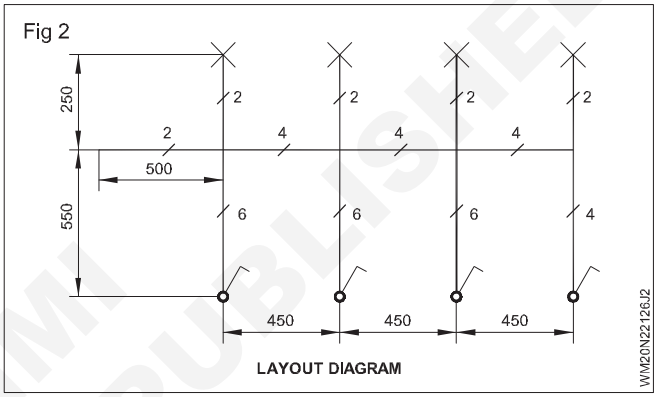
TUNNEL WIRING - SCHEMATIC DIAGRAM

3 Mark the layout on the I.P.C as per layout given in Fig 2.

4 Measure and cut the cables as per the cable route given in wiring diagram (Fig 3).

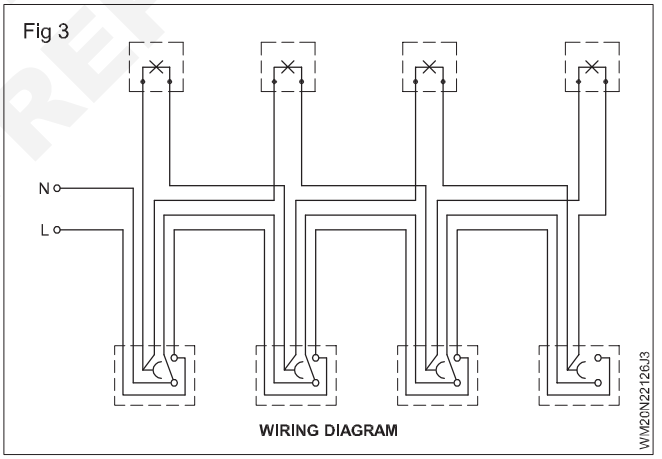
5 Repeat the steps 3 to 9 from Task 1.

Fig 2



LAYOUT DIAGRAM

Fig 3



WIRING DIAGRAM

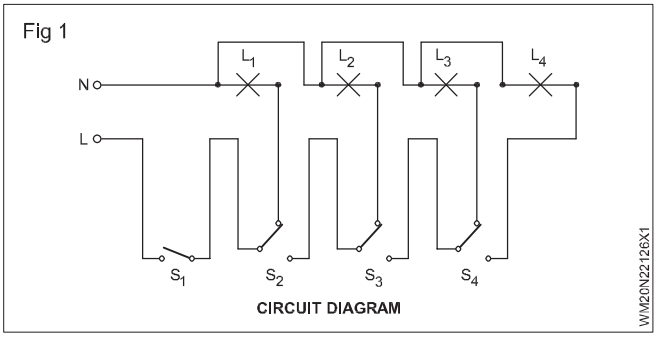
— — — — — — — — —

TASK 3 : **Demonstrate the go down wiring**

1 Form the circuit with required wiring accessories as per the schematic diagram Fig 1 on the work bench

2 Repeat the steps 3 to 9 from Task 1.

Fig 1



CIRCUIT DIAGRAM

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Practice testing /fault detection of industrial wiring installation and repair

Objectives: At the end of this exercise you shall be able to

- **detect and repair open circuit fault in domestic and industrial wiring**
- **detect and repair shortcircuit fault in wiring**
- **detect and repair earth fault in wiring**
- **prepare the flow chart for location rectification of fault in domestic wiring installation.**

Requirements

Tools/Instruments

- Connecting screw driver 100 mm - 1 No.
- Cutting plier 150 mm - 1 No.
- Screw driver 200 mm - 1 No.
- Neon tester 500 V - 1 No.
- D.E. Electrician knife100 mm - 1 No.
- Multimeter Digital - 1 No.
- Megger 500V - 1 No.

Materials

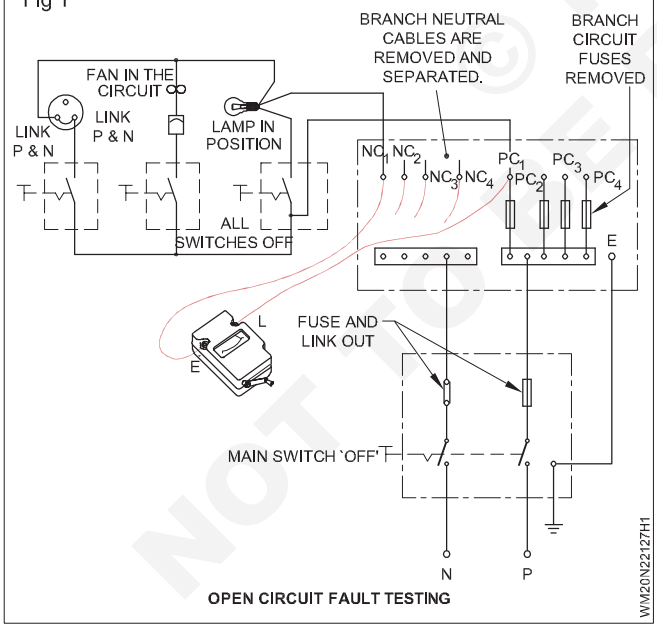
- Test lamp 100W, 240 V - 1 No.
- Crocodile clip 15A - 2 sets
- PVC flexible cable 1.5sq.mm, 660 V - 10m

PROCEDURE

Open Circuit Fault

1 Consider the circuit as shown in Fig 1 in a domestic installation.

Fig 1



OPEN CIRCUIT FAULT TESTING

For open circuit fault removal of fuses, etc are to be done before doing the test by using megger.

2 Check whether the cables used in an installation have proper continuity or not by using megger.

3 Check circuit fuses whether in order or not, if not, rewire the fuses.

4 Check one circuit at a time and then proceed step by step.

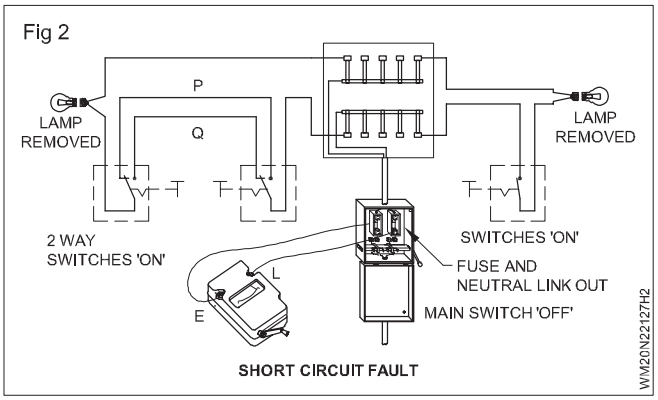
5 Check the circuits having 2 way switches, the concerned switches may be operated alternately to ensure the correct test result.

6 Check the defective fan, regulators or lamps by shorting the suspected appliance if necessary and then retest it.

Short circuit fault

1 Make the circuit as shown in Fig 2 and connect the megger, if it shows continuity in both ON and OFF positions of the switch, this indicates short in circuit.

Fig 2



SHORT CIRCUIT FAULT

2 Check insulation resistance between the cables of the installation and earth.

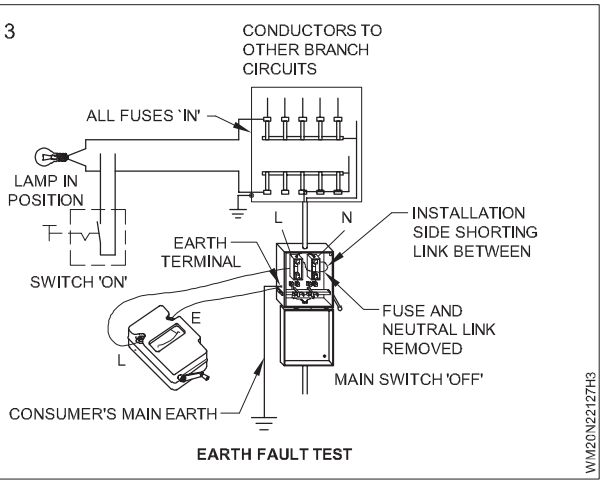
3 Connect the megger terminal ‘E’ to the live wire and L to the corresponding neutral wire, the megger will read zero or very low value of insulation resistance and confirms the short circuit.

4 Repeat the test procedures in each and every circuit and locate the shorting point of the live and neutral wire by inspection and remove it by insulating the bare conductors.

Earth fault

1 As per the circuit as shown in Fig 3 keep all the fuses, switches bulbs etc in closed position as indicated in the figure.

Fig 3



EARTH FAULT TEST

Isolate the live conductor from neutral, remove all other lamps and other equipments connected with wiring.

2 Switch ‘ON’ all the switches.

3 Using Insulation resistance Tester, terminal ‘E’ of the megger connect to the earth point of the system provided at the Meter Board and Terminal ‘L’ of the megger with each conductor in turn at the main board cut-out terminal and rotate the handle of the megger to send current through closed circuit formed between conductor and earth.

4 Note down the reading of the meter which gives directly the insulation resistance between the conductor and earth.

5 Repeat the step 3 and 4 for other circuits, subcircuits, live conductors and main switch board etc.

Practice laying of cables in race ways and trenches

Objectives: At the end of this exercise you shall be able to
- **demonstrate laying of cables in race ways.**

Requirements

Tools/Instruments

- combination plier 200mm - 1 No.
- heavy guage screw driver - 1 No.
- D.E.Spanner set - 1 No.
- Hammer 500 g - 1 No.

Materials

- Drilling machine with various bits - 1 No.
- Cutting &grinding machine - 1 No.
- Ladder - 1 No.
- Hand shovels - 1 No.
- Plastic buckets - 1 No.
- Wheel barrow - 1 No.

PROCEDURE

TASK 1: **Prepare race ways for laying of cables**

1 Mark the route of cable race ways as per approved drawing

2 Minimum space from the building structure (200mm from the nearest point) to facilitate easily handle and maintenance to cables

If possible, don not install cable trays below water /sewage pipes

3 The location of hangers and support should be carefully marked as per approved specifications.

4 Required sizes of holes should be marked and drilled by using a drilling machine.

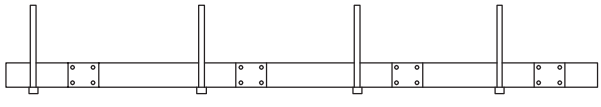
5 The thread rod (M12 steel) or specified rod should be fixed carefully in to the anchor for a balance smooth twist.

The threaded rod should be necessary thickness and length. It should be done is such a way as to avoid damage to threaded rod.

6 Trays and ladders shall be securely anchored to support.

7 Tighten hanger load nut and washer securely to ensure proper hanger performance. Tighten upper nut after adjustment. as show in Fig 1&2

Fig 1



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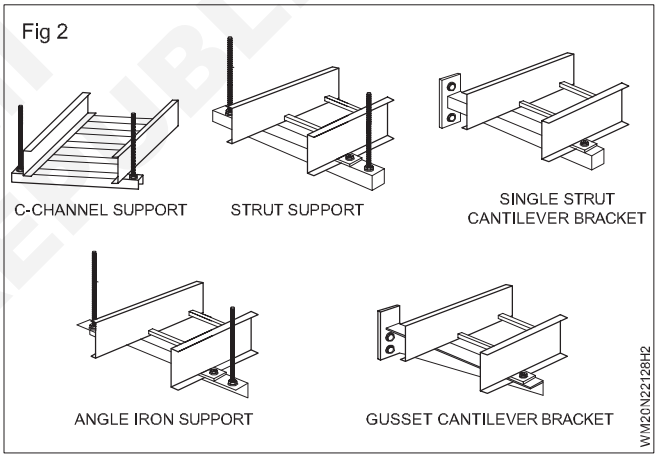
8 At every maximum of 1200mm horizontally and 1500mm vertically supports should be installed.

Fig 2



9 The hanger, hanging support, cable tray bracket and the ladder should be trimmed to required size and galvanizing paint should be applied on the edges

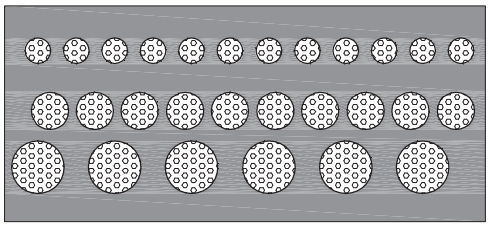
Do not cut or drill structural building members (e.g I - beams) without approval by the main contractor. Do not use a cable race way or cable tray as a walkway, ladder or support for people

10 In which cables are layered depends on cables priority. cables with higher priority are laid first followed by cables with lower priority (smaller cables) of shown Fig 3.

11 There are number of different cable winches available for cable pulling to be used when laying installing cables.

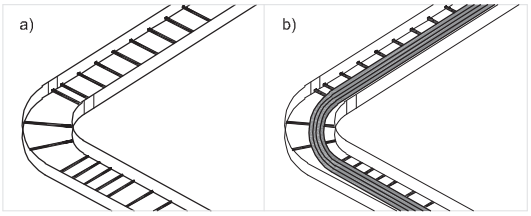
12 After laying of cables nearby dressed with cable ties to avoid loose connections. complete view of cable race is as shown in Fig 4

Fig 3



WM20N22128H3

Fig 4



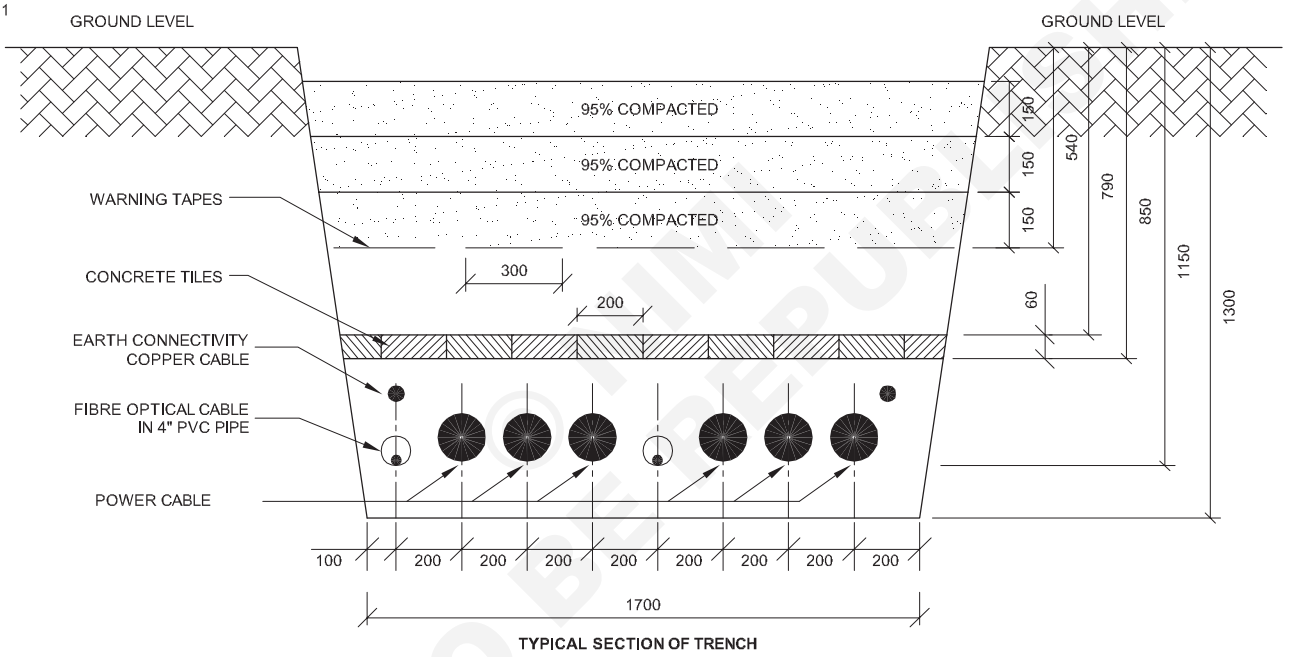
WM20N22128H4

TASK 2: **Perform cables laying in trench**

1 Propare the cable trench as required size as shown if Fig 1

Size of cable trench is depending on number of cables laying size of each cable trench could be done in the Presence of civil engineer

Fig 1



TYPICAL SECTION OF TRENCH

WM20N22128J1

2 The trench is covered with a 10cm thick layer of fine sand. This sand bed protects the cable from the moisture from the ground

3 When multiple cables are to be laid in the same trench, a horizontal and vertical spacing of aouut 30cm

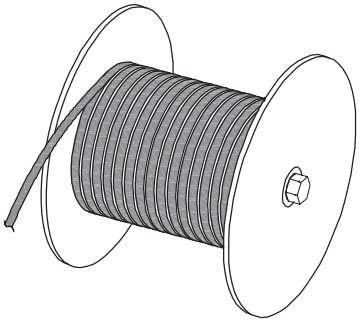
Spacing between the cables ensure fault occurring on one cable does not damage the adjacent cable and reduce the effect of mutual heating

4 At the bending point, the cable trench must be followed adequate size as per cable manufacturer recommendation.

5 Cable trench should be sufficient to allow the cables to installed within specified cable pulling dimensions and without damaging the cable sheaths.

6 Cable laying of cable pulling by cable drum driving mechanism is necessary as shown in Fig 2

Fig 2



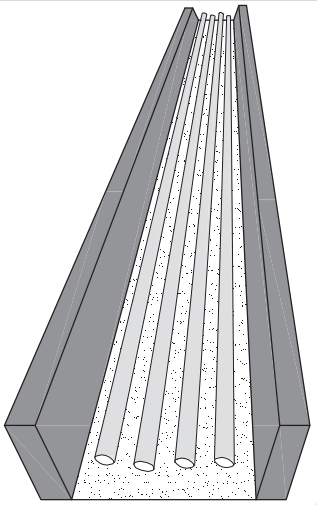
WM20N22128J2

7 After laying of cables dressing is necessary as shown in Fig 3

8 After cable dressing the trench is covered with 10 cm of fine sand

9 Finally the trench is covered with trench cover plates to protect against mechanical injuries.

Fig 3



WM20N22128J3

Demonstrate various cable glands. practice cable entry on a switch cabinet wall

Objectives: At the end of this exercise you shall be able to
- **identify different cable glands**
- **prepare cable entry on a switch cabinet wall.**

Requirements

Tools/Instruments

- Side cutter 200mm - 1 No.
- Combination plier 200 mm - 1 No.

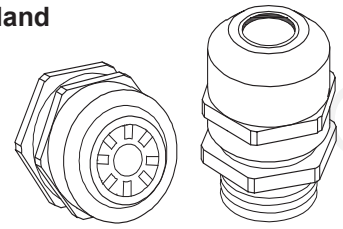
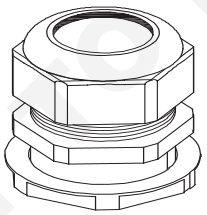
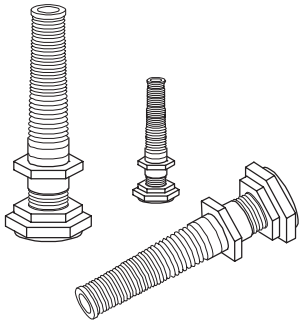
Materials

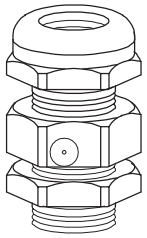
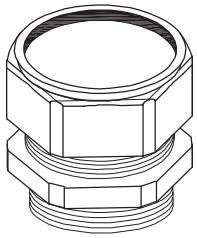
- EMC Gland - 1 No.
- Armoured cable gland - 1 No.
- Spiral flexible cable gland - 1 No.
- Breathable cable gland - 1 No.
- Cable entry plates - 1 No.

PROCEDURE

TASK1: **Identify the various cable glands**

Instructor may arrange the various glands on the table and also explain uses and application of glands

Sl.NO	Sketch of gland	Name of the gland
1	**EMC gland**  EMC GLAND	
2	**Armoured cable gland**  ARMOURED CABLE GLAND	
3	**Spiral flexible cable gland**  SPIRAL FLEXIBLE CABLE GLAND	

4	**Breathable cable gland**  BREATHABLE CABLE GLAND	
5	**Stainless steel cable gland**  STAINLESS STEEL CABLE GLAND	

— — — — — — — — —

Task 2 : **Prepare cable entry on a switch cabinet wall**

1 Mark hole on the wall for requirred size for all cable

How many cables are requiret to the panel and identitfy the cables size, drill hole as you required size in require shape

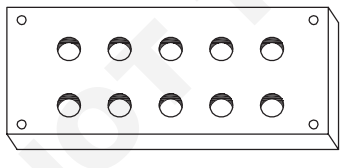
2 Take metal or plastic plates of wall entry. This plate is bigger than the hole maked on wall (3cm on all side. to hold the screws.

In case you chose stainless steel plate of 14 guage.

3 Mark driling holes for various diametre.

4 Drill the hole as marked placed for various diameter as shown in Fig 1.

Fig 1

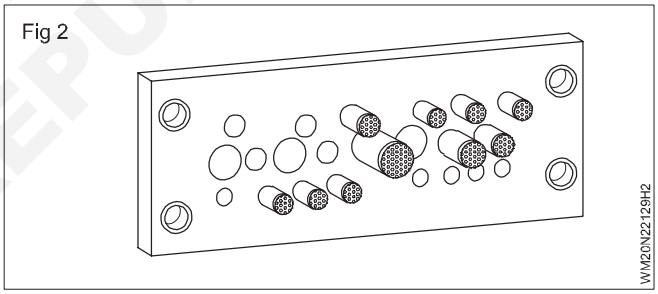


5 Fix the various gromments in the holes of drilled plate to avoid insulation damage of cables.

6 Run all the cables one by one in cable entry plate through gromments.

7 Finally fix the cable entry plate on the wall as shown in Fig 2.

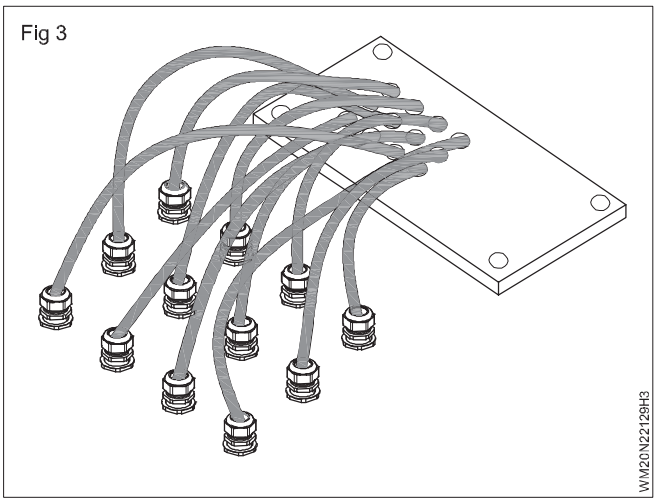
Fig 2



Now a days fully ready made cable entry plates are available in the market

8 For trainee reference complete view of switch cabinet wall of shown in Fig 3.

Fig 3



— — — — — — — — —

Practice passing of cables through cable entry plate for standard cables without connetors, up to IP68 rated protection

Objectives: At the end of this exercise you shall be able to
- **choose required cable entry plates**
- **demonstrate the process at cable installation through cable entry plate.**

Requirements

Tools/Instruments

• Combination plier 200mm	- 1 No.
• Electrician knife 150mm	- 1 No.
• Drill machine &various drill bits	- 1 No.
• Half round file	- 1 No.
• Screw driver 200mm	- 1 No.
• DE spanner set	- 1 No.

Materials

• Various cables	- as reqd.
• Cable entry plate	- 1 No.
• Various size of grommets	- default on no of cables

PROCEDURE

Task 1: **Demonstrate passing of cables through cable entry plates**

1 Prepare cable entry plate. (Repeat 1 to 7 steps of exercise no 2.2.129 Task 2).

2 Collect various cables (different diametre).

3 Collect various grommels for various cables in cable entry plate.

4 Insert the cable into the suitable cable entry plate.

5 Attach the strain relief with a cable tie while inserts

6 Check the tightness of the inserted cables and observed for dust and water protection.

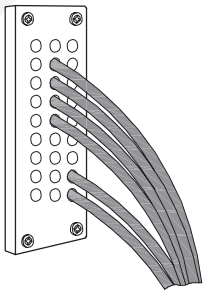
7 In the same way insert all the cables one by one on suitable cable entry inserted the cable entry plate as shown in Fig 2.

8 Show it you instructor and take important suggestions.

9 IP68 rated protection is shown Fig 1.

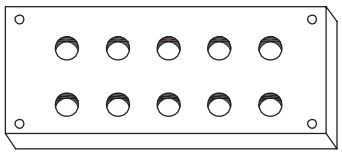
IP68 = Ingress protection against dust and water

Fig 1



WM20N22130H1

Fig 2



WM20N22130H2

Practice split cable entry for multiple pre-terminated cables, up to IP65 rated protection

Objectives: At the end of this exercise you shall be able to
- **identify split sealing grommets**
- **demonstrate split cable entry in to cable entry plate.**

Requirements

Tools/Instruments

- Screw driver 200mm - 1 No.
- Combination plier 200mm - 1 No.
- Portable drilling machine with required drill bits - 1 No.

Materials

- Various split grommets - as reqd.
- Split cable entry plate - 1 No.
- Various pre terminated cables - default on no of cables

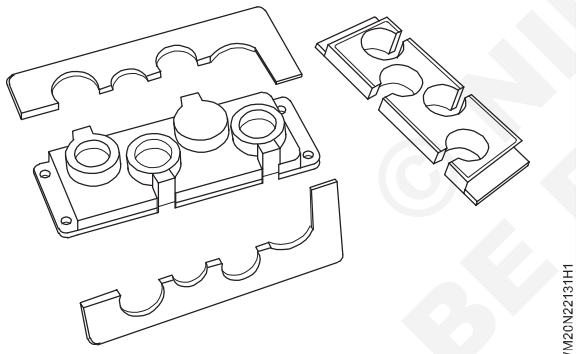
PROCEDURE

TASK 1: **Practice split cable entry for multiple pre-terminated cables, up to IP 65 rated protection**

1 Collect all the required materials from the instructor or store room.

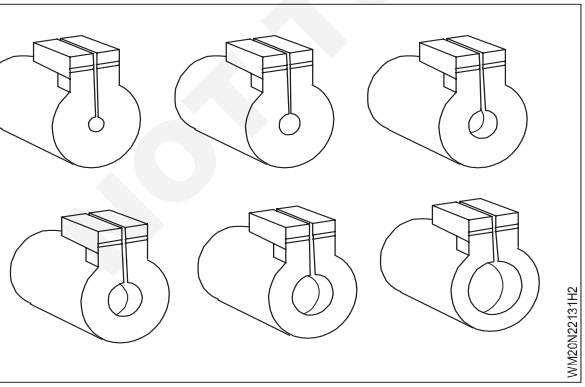
2 Repair cable entry plate for multiple pre-terminated cables as shown in Fig 1.

Fig 1



3 Fix various split grommets on cable entry plate. various grommets as shown in Fig 2.

Fig 2

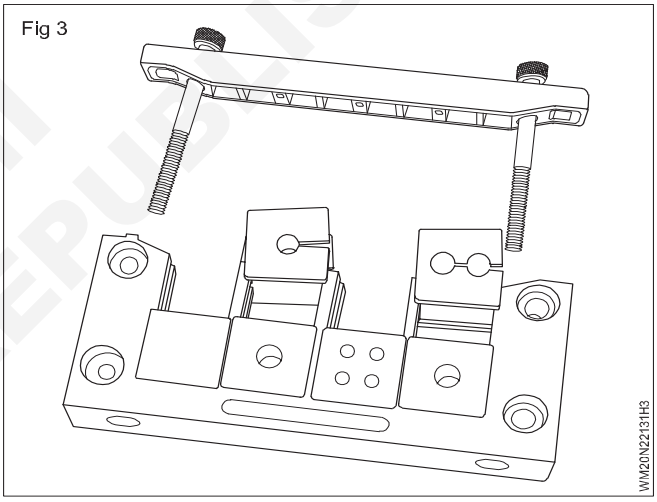


4 Insert pre-terminated cable into the suitable split grommet on the cable entry plate.

5 Insert all remaining various pre-terminated cables into suitable split grommets on cable entry plate.

6 Assemble the multiple pre terminated cable entry plate all sides with screw (Fig 3).

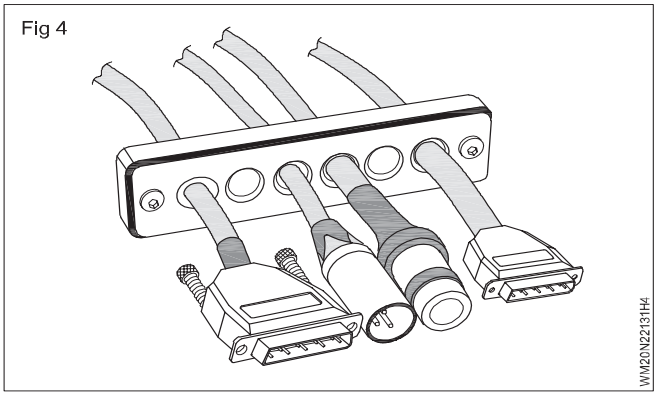
Fig 3



7 Check the mechanical strength by hand pulling, pushing.

8 For trainee reference complete view is shown in Fig 4.

Fig 4



Now a day's cable entry plate for multiple pre-terminated cables are available in electrical hard ware shops.

Demonstrate bonding and grounding of race ways, cable assembly and panels

Objectives: At the end of this exercise you shall be able to
- **explain necessity of bonding**
- **explain necessity of grounding**
- **demonstrate the process of grounding.**

Requirements

Tools/Instruments

- Combination plier 200mm - 1 No.
- Di spanner kit - 1 No.
- Hard Gloves - 1 No.
- Hammer 500 grams - 1 No.

Equipment/Machines

- Complete welding equipment - 1 No.
- Professional welder - 1 No.

Materials

- Earthling conductor suitable size - as reqd.
- MS plate as required size
- MS l angular plate as required

PROCEDURE

TASK 1: **demonstration of bonding of race ways , panels**

1 Locate the bonding points.

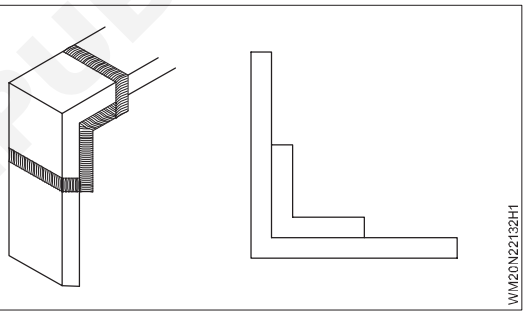
Where the connections exposed to the atmosphere in highly corrosive and wet locations avoid joints.

2 Identify where the permanent boding switching bondings necessary.

Switching boding means to disconnect the jumper for maintenance purposes.

3 Direct bonding made by welding or brazing by a professional welder and use ‘L’. plates at corners as shown in Fig 1.

Fig 1



4 At removable places use jumpers with suitable clamp or bolted connection.

5 Finally connect all the race ways to the earth rods in the earth pit.

Demonstrate use of earth rods. test underground cables for faults and remove the fault.

Objectives: At the end of this exercise you shall be able to
- **locate open circuit faults in the cable**
- **locate short circuit faults in the cable**
- **locate the leakage fault in the cable and rectify the fault.**

Requirements

Tools/Instruments

- Combination plier 200 mm - 1 No.
- Connector Screw driver 100 mm - 1 No.
- Screw driver 200 mm with blade of 4 mm width - 1 No.
- D.E electrician's knife 100 mm - 1 No.
- Megger 500V - 1 No.
- Earth rod - 1 No.

Equipments/Machine

- Wheatstone bridge - 1 No.

Materials

- Connecting Probe for Megger - 1 set
- Connecting Probe for Wheatstone bridge - 1 set
- Connecting Cables (flexible, uniform, cross sectional area) - as reqd.

PROCEDURE

TASK 1: **Demonstrate use of earth rods**

1 Earth rods can be used in areas with high corrosion.

2 Earth rods can be used where an especially long life of electrical installation.

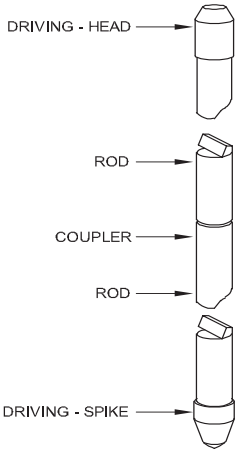
3 These are used in installations with high fault currents.

4 These solid copper bars are not suitable for deep driving into the ground.

Construction of earth rod:

They are made using an electroplating process where a layer of copper is deposited on a steel core as shown Fig 1

Fig 1



TASK 2: **Locate open circuit faults in underground cable**

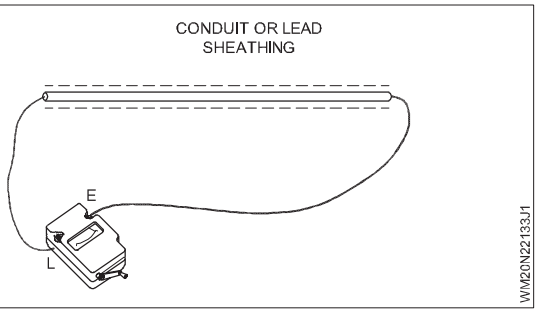
This test is made to check whether the cable insulation is in open condition and to identify the exact location of the open circuit.

1 Switch 'OFF' the mains. Remove the fuse and the neutral links in the main switch and keep them in safe custody.

2 Select 500 V Megger and connect one terminal of the Megger, say L, to the one end of cable as shown in Fig 1.

3 Connect the other terminal of the Megger say 'E' to the other end of the cable.

Fig 1



4 Rotate the megger at 160 r.p.m.

5 Observe the megger reading. If the megger shows infinity, there is open circuit in the cable.

Open circuit may be due to open in the cable.

If the megger shows '0' reading, it indicates no open in the cable.

6 Connect the 'E' terminal near the middle of the cable and repeat the above procedure for open circuit.

If it shows '0' reading, there is no open in between 'L' and the middle of the cable.

7 Repeat the above procedure, connecting the 'E' terminal to beyond the middle point of the cable at varied distances.

When the megger shows infinity in a particular place, that is the point of open.

8 Locate the faulty portion and make fresh straight joint to the UG cable.

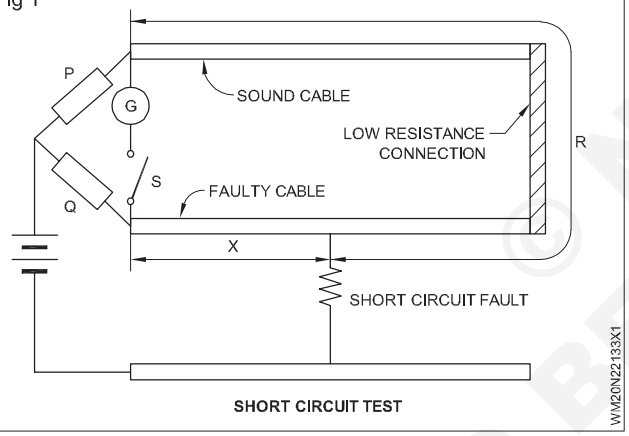
TASK 3: **Locate the short circuit fault in U.G cable**

This test is made to locate the short circuit in the cable by Murray loop test.

1 Switch 'OFF' the main switch. Remove the fuse of the main switch and keep it in safe custody.

2 Select a Wheatstone bridge and connect one end of the cable to the meeting point of P and Galvanometer and another cable end to the meeting point of Q and Galvanometer as shown in Fig 1.

Fig 1



SHORT CIRCUIT TEST

3 Measure the length of each cable.

4 Connect the other two ends of both the cables by means of low resistance wire.

5 Take the battery terminal (negative) wire and place it at any point of the cable and observe the deflection in the Galvano meter.

The area of the cable where the Galvanometer shows '0' reading is the exact location of the short circuit. It can be calculated with the formula given below.

$$(i.e)\ \frac{x}{p}=\frac{Q}{R}\ \text{or}\ \frac{X}{R+X}=\frac{Q}{P+Q}$$

where X is the length of the fault from the test end.

L is length of each cable.

6 Locate the fault while measuring the length of the cable and clear the short circuit in the UG cable.

TASK 4: **Locate the ground fault in U.G cable**

This test is also done to locate ground fault in the cable by Murray Loop test.

1 Connect the cables as shown in the Fig 1 and repeat the steps explained in the short circuit test (task 2).

The area of the cable where the Galvanometer shows '0' reading is the exact location of the ground fault.

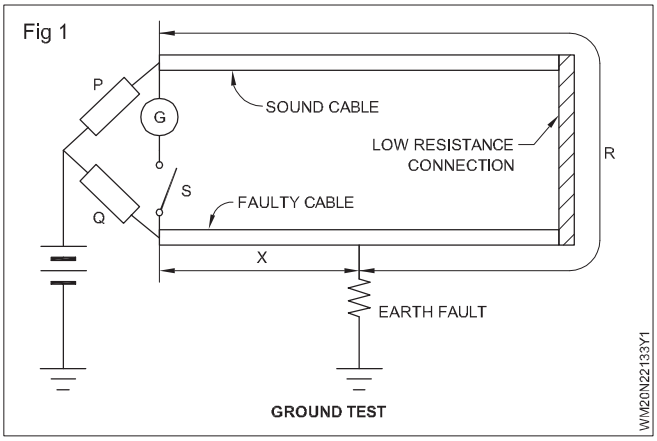
2 Calculate and locate the place of the ground fault as given below.

$$X=\frac{Q}{P+Q}\times 2L$$

Where 'X' is the length of the fault from the test end.

3 Locate the place where the ground fault is by measuring the length from the test end and repair the fault.

Fig 1



GROUND TEST

Group different wattage lamps in series for specified voltage

Objectives: At the end of this exercise you shall be able to
- **read and interpret the data stamped on a given lamp**
- **measure the voltage drop across the lamp when unequal wattage lamps are connected in series to the supply**
- **state the reasons for the behaviour/condition of glow of unequal wattage lamps in series.**

Requirements

Tools/Instruments

- Multimeter - 1 No.
- Voltmeter MC 0-15V - 3 Nos.
- Ammeter MC 0-500 mA - 1 No.

Equipment/Machines

- DC variable source 0-24 volts, 5 amps with output current & voltage indicator - 1 No.

Materials

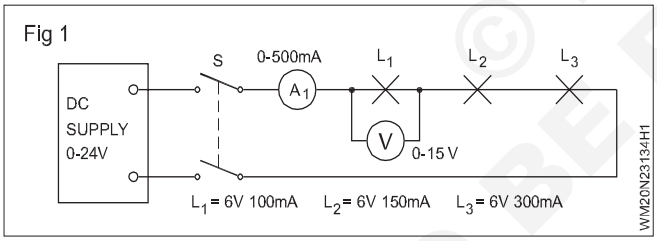
- Bulbs screw cap - 6V 100 mA - 10 Nos.
- Bulbs screw cap - 6V 150 mA - 6 Nos.
- Bulbs screw cap - 6V 300 mA - 4 Nos.
- Bulb-holders - 20 Nos.
- Connecting leads - as reqd.
- Knife switch DPST 16A - 1 No.

PROCEDURE

TASK 1 : **Connect 3 lamps of 6 volts in series across 18 volts supply (unequal wattage) and test it**

1 Connect the three lamps with ammeter A in series to the variable voltage DC supply source Fig 1.

Fig 1



Keep the output of DC source at minimum, say 0 volts.

2 Connect a MC voltmeter (0-15 V) across L1 (i.e low current rating/low wattage bulb). Close the switch S.

3 Gradually increase the supply voltage from 0 volts, observing ammeter, voltmeter and lamp L1.

4 Increase the voltage upto 18 volts. Record your observations.

_____

_____

_____

5 Does the lamp L1 fuse? If yes, give your reasons, stating the observation made just before fusing.

_____

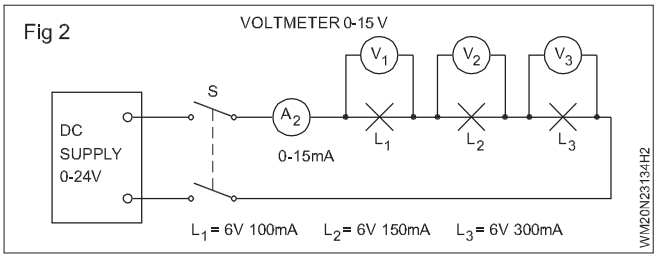
_____

_____

6 Open the switch S and reset the supply voltage to OV. Replace the bulb L1.

7 Form the circuit Fig 2 with 3 voltmeters 0-15 volts connected across each lamp.

Fig 2



8 Close the switch S and increase the supply voltage until the current reaches 100 mA., (i.e. rated current of low wattage bulb in the series circuit).

9 Read the voltages V1, V2 & V3 and record in Table 1.

Table 1

Supply Voltage	V1	V2	V3

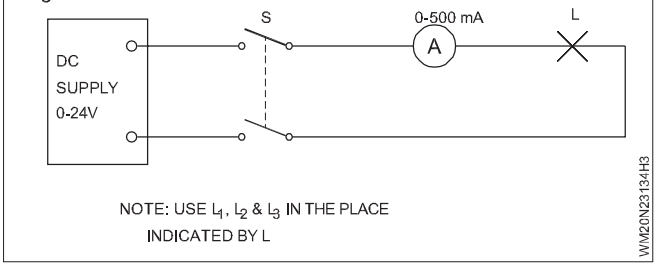
10 Give your reasons for the unequal distribution of supply voltage.

11 Connect each lamp L1, L2 & L3 independently in the circuit Fig 2 and record the value of current and voltage when the supply voltage is 6 V in Table 2

Table 2

Lamp in circuit	Supply voltage	V	I	V/I
L1 6 V 100 mA	6 V			
L2 6 V 150 mA	6 V			
L3 6 V 300 mA	6 V			

Fig 3



NOTE: USE L_1, L_2 & L_3 IN THE PLACE INDICATED BY L

Conclusion

The voltage across each of the lamps connected in series varied because of

_____

_____

_____

The stamped value of voltage and current on the lamp means that the specified _____ when applied will cause a _____ to flow.

Resistance of lamp varies because of different _____ of lamp.

Practice on low voltage track system, mains voltage track system and LED battery powered lighting

Objectives: At the end of this exercise you shall be able to
- **explain low voltage track system**
- **explain mains voltage track system**
- **identify suitable battery for LED lights.**

Requirements

Tools/Instruments

- Combination plier - 1 No.
- Screw driver - 1 No.
- Drill machine with suitable bits - 1 No.
- Pencil for making - 1 No.

Equipment/Machines

- Libattery 3.2 V 2AH - 5 Nos.

Materials

- Low voltage track 12v - as reqd.
- low voltage track connectors - 2 Nos.
- LED lights for voltage track - 3 Nos.
- LED lights 12v 20ma - 2 Nos.
- Low voltage track end caps - as reqd.
- Srews and wooden pieces - as reqd.

PROCEDURE

TASK 1 : **Installation of low voltage track system**

1 Collect low voltage track (Fig 1) and all its accessories

2 Read and interprit installation guide lines of low voltage track from the manufactures manual

3 Mark the location where you want to install low voltage track with pencil and mark holes as per low voltage track system with pencil

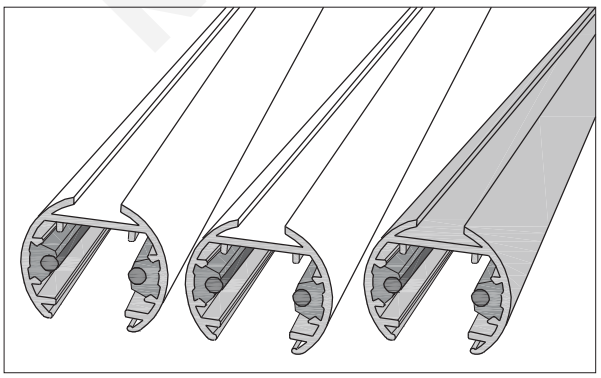
4 Make drill holes as per markings and fix wooden pieces for screws

5 Install low voltage track as your required length and the joints making very easy by connecting the connectors to ends of low voltage observe Fig: 2 for different joints of track

6 Fix the LED light in the low voltage track and switch on the supply

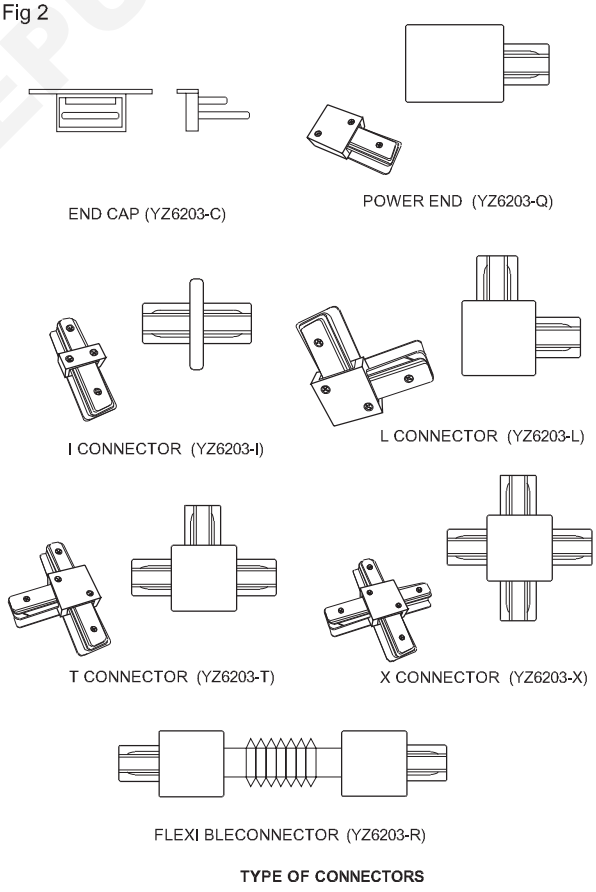
7 For trainee reference complete installation view as shown in Fig .3

Fig 1



WM20N23135H1

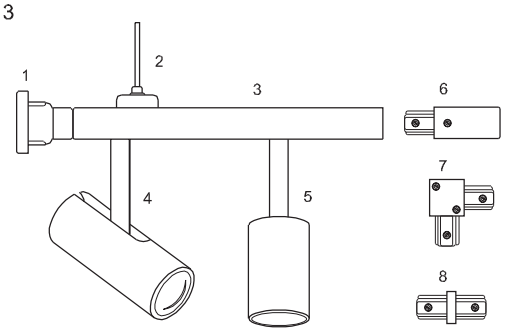
Fig 2



TYPE OF CONNECTORS

WM20N23135H2

Fig 3



1. END CAP
2. SUSPENSION KIT (OPTIONAL)
3.TRACK
4. SPOTLIGHT
5.PENDANT
6.FEED IN
7.L CONNECTOR
8. STRAIGHT CONNECTOR

WM20N23135H3

TASK 2 : **Installation of mains voltage track system**

Main voltage track system is also tracks line low voltage track system built variation is main voltage track is designed to 240v or 440 or both 240v and 440v means (6leads housed in the mains voltage track system as shown in fig 1)

1 Collect mains voltage track system and all its accessories.

2 Observe the track and how many wires are houses in the track (like two wires four wires or six wires).

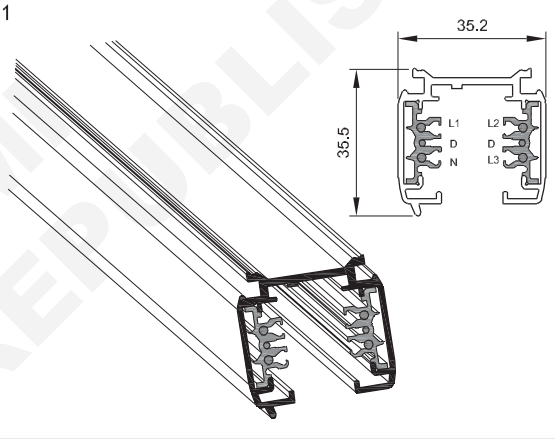
3 The maximum load of this system for single phase is 16A (3500 VA).

4 The maximum load of this system for three phase is 16A (10500 VA).

5 For trainee reference 6 wires mains voltage track system as show in Fig 1.

6 For installation follow the steps 2 to 7 from task 1.

Fig 1



WM20N23135J1

TASK 3: **Installation of LED battery powered lighting**

1 Collect 12v 20ma LED's two numbers.

2 Collect 3.2 V, 2Ah batteries.

3 Calculate the required voltage for parallel connection of two LED's of 12v 20ma.

Calculation

Required voltage for LED's =12v.

Number of batteries requirement for 12v

$$\frac{12}{3.2} = 3.75$$

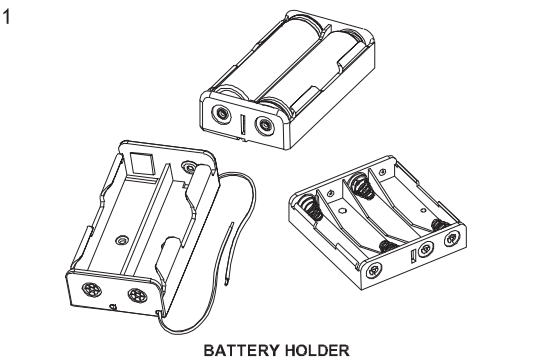
∴ 3.75 rounded to 4 numbers.

4 We connect 4 batteries in series by using battery box a shown in Fig 1.

5 Connect the LED's "+" terminal to battery "+" terminal and LED's "-" terminal to battery "-" terminal through a switch.

6 Switch on and observe the LED's.

Fig 1



BATTERY HOLDER

WM20N23135X1

Prepare a decorative lamp circuit to produce rotating/running light effect

Objectives: At the end of this exercise you shall be able to
- **select lamps/sequential control for light decoration**
- **design lighting layout for running light**
- **design layout for rotating light**
- **connect the motor for 3-point running light (sequential control motor)**
- **connect lamp circuits in the electronic sequential controller.**

Requirements

Tools/Instruments

- Multimeter - 1 No.

Equipment/Machines

- Single phase motor FHP with reduction gear - 1 No.
- 240V operation output load 5 to 10 A with speed and intensity control - 2 Nos.

Materials

- Cams - 3 Nos.
- Brushes - 3 Nos.
- Connection leads flexible - as reqd.
- Cam drive arrangement with shaft - 1 No.
- Lamps 240V, 15W, BC - 54 Nos.
- Batten Lamp holder 6A, 250 V - 54 Nos.
- DPST knife switch 16A 250V - 2 Nos.
- Electronic sequential controller - 1 No.

PROCEDURE

TASK 1 : **Prepare a rotating light effect**

1 Connect the lamps, switches and the flasher motor. (Fig 1).

2 Keep the D.P.S.T switches S1 & S2 Open.

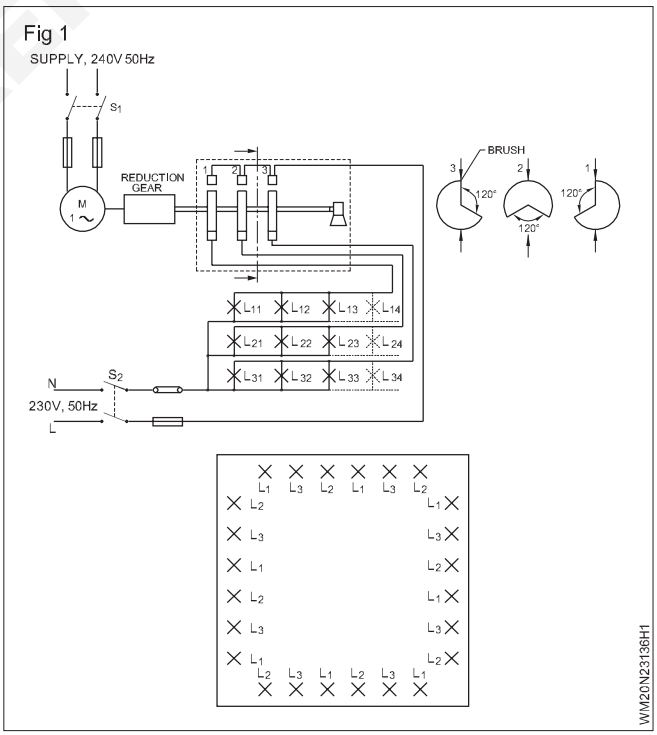
3 Close the D.P.S.T switch S1 and start the flasher motor (sequential light controller.

4 Close the D.P.S.T Switch S2 and observe the make and break contacts 1,2,3 and “On” “off” operations of the 3 lamp banks.

Do not touch live wires

6 Open the D.P.S.T. switch S_1 and S_2

Fig 1



TASK 2 : **Prepare a running light effect**

1 Prepare the lighting design as shown in Fig 2.

2 Close the D.P.S.T. switch S1 and observe the lighting.

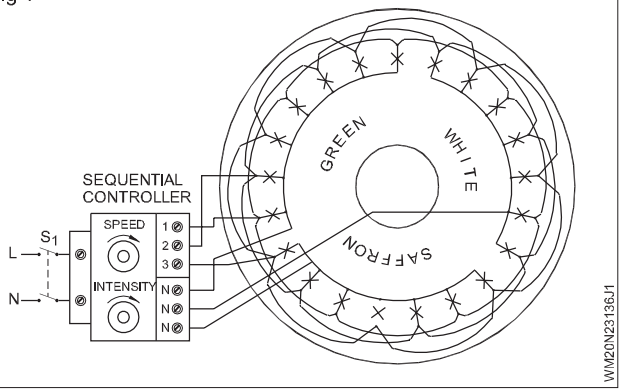
3 Increase the speed of operation by operating the speed control.

4 Adjust the intensity of light-adjusting the knob on the electric sequential controller.

5 Reduce the speed and intensity of the lighting system.

6 Open the D.P.S.T. switch S_1.

Fig 1



Install different display spot lights

Objectives: At the end of this exercise you shall be able to
- **explain how to install different display spot lights.**

Requirements

Tools/Instruments

- Combination plier 150mm - 1 No.
- Screw driver 150mm - 1 No.

Equipment/Machines

- Power drilling machine with 12mm suitable drill bits - 1set.

Materials

- Pencil - 1 No.
- Measuring tape - 1 No.
- Spirit level - 1 No.
- Spot lights with accessories - 1 No.

PROCEDURE

TASK 1: **install different display spot lights**

1 Use a pair of compasses to draw a circle in pencil on the ceiling where you will position your light.

2 After checking for pipes or cables with a detector drill a small through hole just inside the circle.

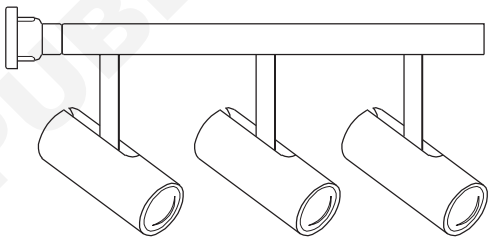
3 Use a key hole saw to cut around the marked circle.

4 Make sure you're wearing safety goggles and a mask when you do this.

5 After you've removed the disc of plaster board from the ceiling you should find that your lights slot into place on spring clips that grip the plaster board around them (Fig 1).

6 Fix spot light on the hole show it to your instructor and get approval.

Fig 1



Install different LED downlights

Objectives: At the end of this exercise you shall be able to
- **explain how to install LED down lights.**

Requirements

Tools/Instruments

- Combination plier 150mm - 1 No.
- Screw driver 150mm - 1 No.

Equipment/Machines

- Power drilling machine win suitable drill bits - 1set.

Materials

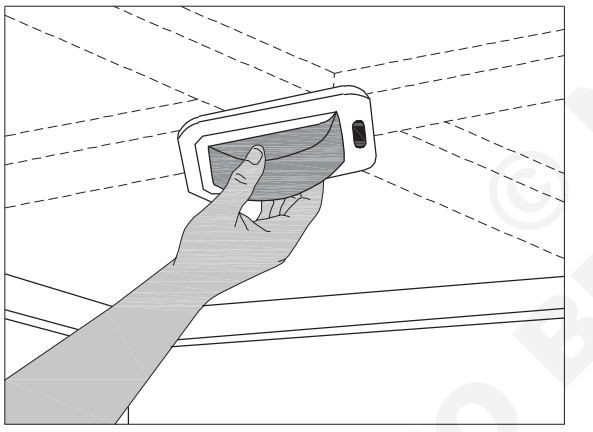
- Pencil - 1 No.
- Measuring tape - 1 No.
- Spirit level - 1 No.
- LED down lights with accessories - 1 No.

PROCEDURE

TASK 1: **Positioning the lights**

1 Use a stud finder to locate the joists in your ceiling (Fig 1).

Fig 1



POSITIONING THE LIGHT

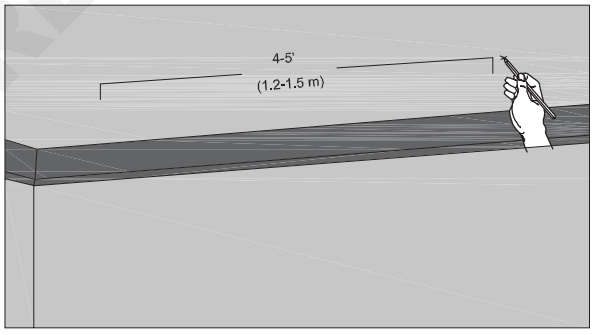
WM20N23137J1

2 Check behind the ceiling with a pipe and wire detector to make sure its clear.

3 Mark the location where you want your downlight with a pencil.

4 Space additional lights so they are 4-5 ft. apart (Fig 2).

Fig 2



WM20N23137J2

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TASK 2 :**Cutting the holes**

1 Choose a downlight that's short enough to fit in your ceiling (Fig 1)

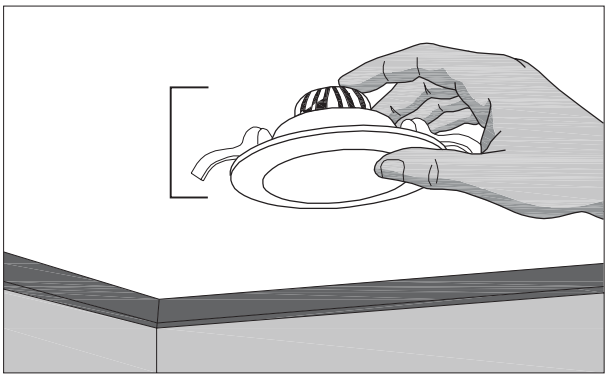
2 Measure the rear diameter of the light to know the size of cut out (Fig 2)

3 Put a hole saw on your drill that is the same size as the cut out.

4 Use a hole saw to cut through your ceiling (Fig 3)

5 Remove the piece of ceiling you cut from the hole saw.

Fig 1



CUTTING LIGHT

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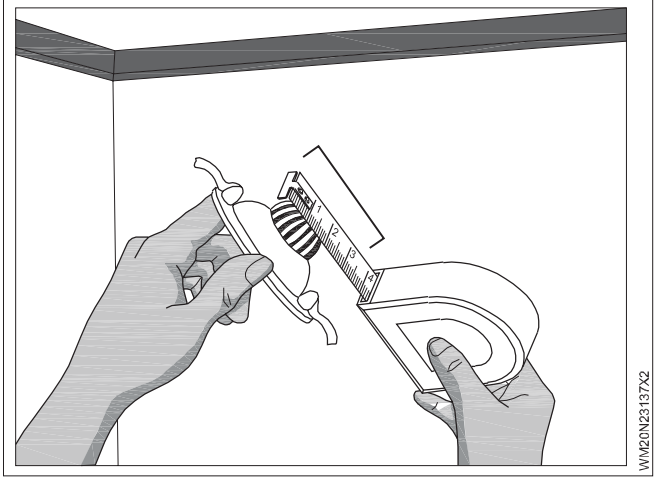
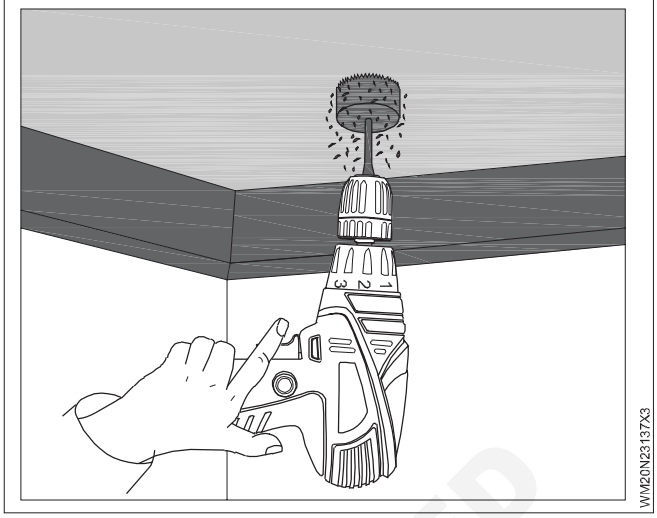
Fig 2



WM20N23137X2

Fig 3



WM20N23137X3

TASK 3 : **Installing the downlights**

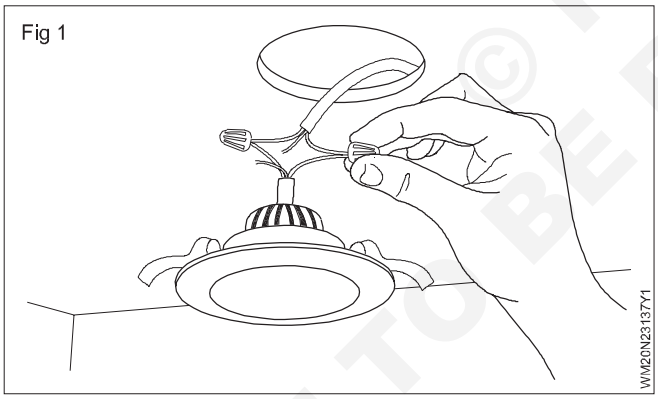
1 Switch off the power

2 Run wires through your walls to the spot you are installing the light.

3 Strip the ends of the wires in your wall and on the downlight.

4 Splice the matching wires with wire cafs (Fig 1)

Fig 1

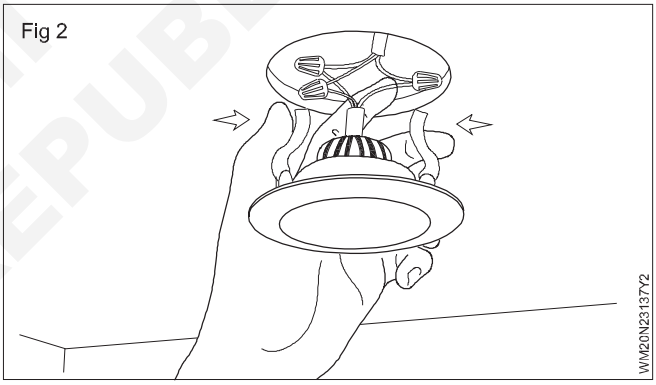


WM20N23137Y1

5 Hold the spring clips against the sides of the light (Fig 2)

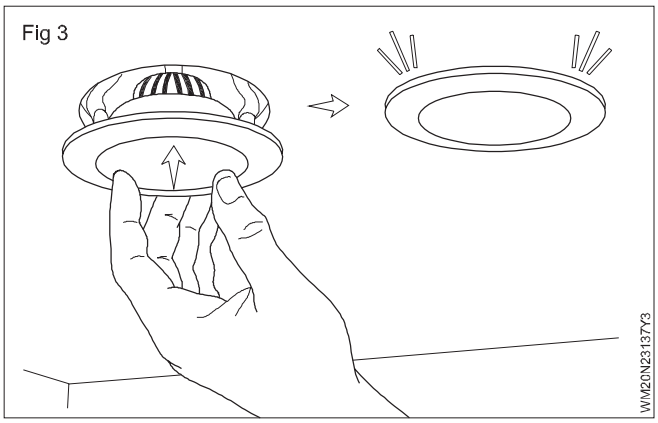
6 Push the light into the hole until you hear the clips snap into place (Fig 3)

Fig 2



WM20N23137Y2

Fig 3



WM20N23137Y3

Demonstration kitchen under cabinet lighting shelf lighting,closet lighting and cove lighting

Objectives: At the end of this exercise you shall be able to

- **visit a luxiours big house and identify kitchen under cabinet lighting shelf lighting closet lighting and cove lighting**

Requirements

Tools/Instruments

- Combination plier 150mm - 1 No.
- Screw driver 150mm - 1 No.

Equipment/Machines

- Power drilling machine with 12mm suitable drill bits - 1set.

Materials

- Pencil - 1 No.
- Measuring tape - 1 No.
- Spirit level - 1 No.
- Spot lights with accessories - 1 No.

PROCEDURE

TASK 1: **identify kitchen under cabinet lighting shelf lighting closet lighting and cove lighting**

Instructor may take the trainees to a nearest luxiours big house and explain kitchen under cabinet lighting, shelf lighting closet lighting and cove lighting

1 The following figures are given for trainee's reference

i Kitchen under cabinet lighting (Fig 1 &2)

Fig 1

Fig 2

ii Shelf lighting (Fig 3)

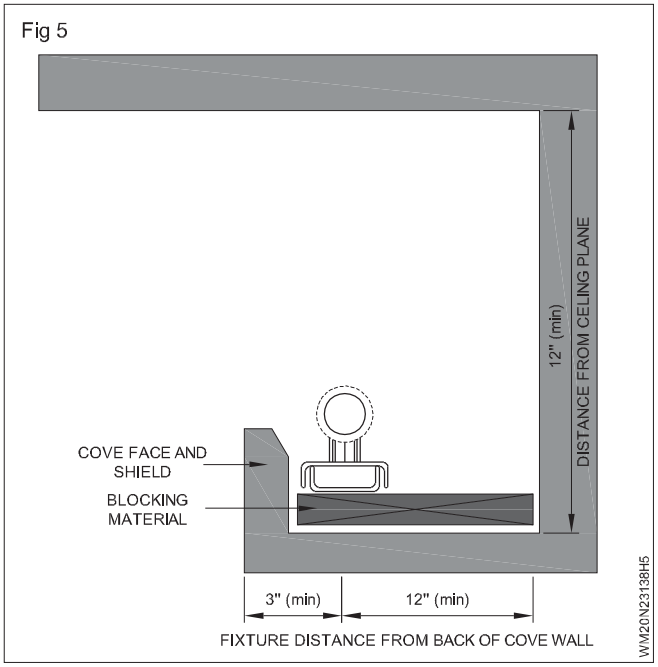
Fig 3

iii Closet lighting (Fig 4)

Fig 4

iv) Cove lighting (Fig 5)

Fig 5



2 Observe types of lights used in above four cases note down in your notebook.

Practice installation of various lamps eg. fluorescent tube, HP mercury vapour, LP mercury vapour, HP Sodium vapour, LP Sodium vapour, Metal halide, LED lights, pendant lighting

Objectives: At the end of this exercise you shall be able to

- **connect a flourescent tube with accessories, install and test it**
- **assemble the instant start fluorescent lamp with an instant start ballast**
- **assemble the rapid start fluoresceent lamp fitting with accessories**
- **connect a H.P. M.V lamp with acccessories, install and test it**
- **connect a H.P.S.V lamp with accessories install and test it**
- **connect a L.P.S.V lamp with accessories install and test it**
- **connect a metal halide lamp with accessories install and test it.**

Requirements

Tools/Instruments

- Insulated combination plier - 150 mm - 1 No.
- Insulated screwdriver - 200 mm x 4mm - 1 No.
- Insulated connector screw driver - 100 mm - 1 No.
- Long round nose plier - 150 mm - 1 No.
- D.B. Electrician's knife 100 mm - 1 No.
- Test lamp 100 W, 250 V - 1 No.
- DC power supply /9V/500mA battery - 1 No

Materials

- Tube light fitting 1200 mm - single patti - 1 No.
- Choke 40w, 250v - 1 No.
- Tube light starter - 40W,250V - 1 No.
- Tube light holder plain - 2 Nos.
- Starter holder - 2 Nos.
- MV lamp holder suitable for 240W, 250 V lamp (Goliath screw type) - 2 Nos.
  single patti - 1 No.
- MV lamp choke - 240 Watts, 250 v - 1 No.
- Capacitor 4 MFD / 380 U - 1 No.
- L.P.M.V lamp 40 W, 250 V - 1 No.
- MV lamp 240W, 250V - 1 No.
- General purpose PCB for IC circuit - 1 No
- IC 555 with IC base - 1 No
- IC CD 4017 with IC base - 1 No
- Resistors
  10 KW 1/4 W - 1 No
  330W 1/4 W - 8 Nos
- Preset 100 K (Variable resistor) - 1 No
- Capacitor 100mF/15V - 1 No
- 10 nF (0.001 mF) - 1 No
- LED's - 8 Nos
- Switch - 1 No
- Connecting wires - as reqd.
- Solder, flux - as reqd.

PROCEDURE

TASK 1: **Assembling of a fluorescent lamp (LPMV lamp) with its accessories**

1 Check the choke for its short and open with a test lamp as shown in Fig 1, and record the results.

Indicate the result by marking a tick (✓) here.

Testing of choke

Possible result

State of lamp glow	Condition of choke
a Normal glow	Internal short circuit
b Dim	Good working condition
c No glow even after checking the leads and connection	Open circuit in the choke

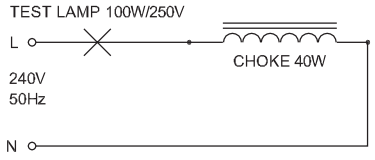
2 Check the starter with a series test lamp as shown in Fig 2. Observe the flickering of the lamp which indicates good condition of the starter.

3 Assemble the following fluorescent tube accessories in the fitting base. Refer to the sketch. (Fig 3)

1) Holders for tube 2) Starter-holder 3) Choke.

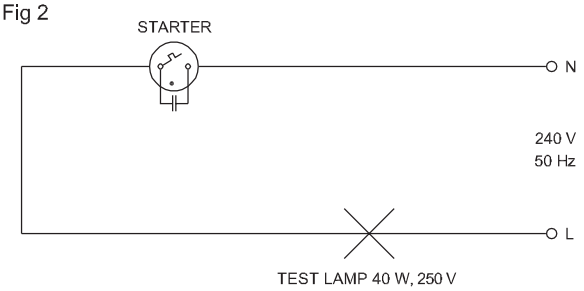
4 Connect the accessories as shown in Fig 4 (for a single tube light). Also install the tested starter.

Fig 1



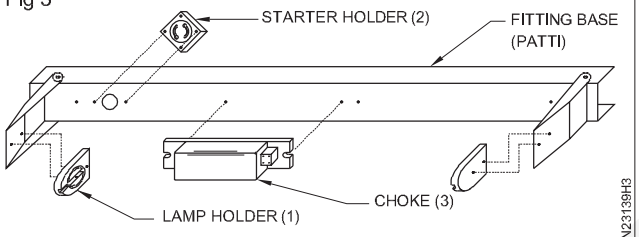
TEST CIRCUIT

Fig 2



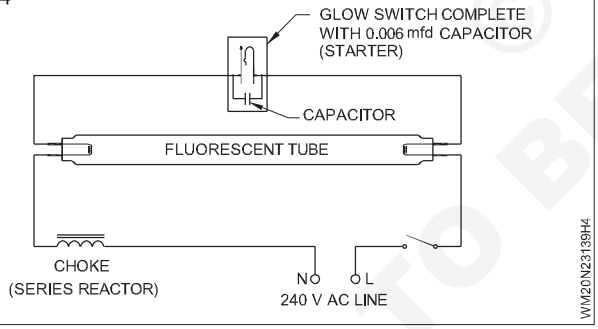
TESTING OF STARTER

Fig 3



ASSEMBLY OF ACCESSORIES

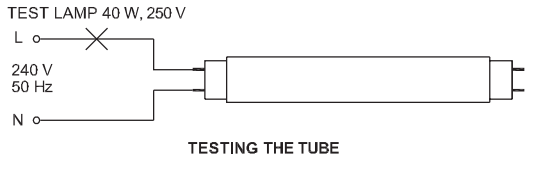
Fig 4



5 Test the filament on both sides of the fluorescent tube for its continuity as shown in Fig 5. Discard the fluorescent tube with open or fused filament in either side.

6 Fix the bulb in the holder.

Fig 5



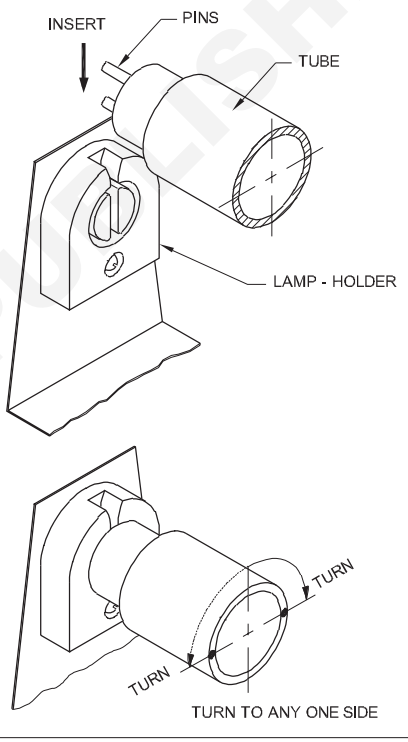
TESTING THE TUBE

Firstly, you have to make sure that the slot in the inner parts of the holder is turned to the proper position.

7 Then insert both the ends (pins) into the holder of the fittings on either side of the tube.

One end is shown in Fig 6. Push the socket pins all the way into the fittings until you feel that you can turn the tube in the sockets.

Fig 6



TURN TO ANY ONE SIDE

8 Turn the tube at both ends in any one direction by a quarter turn. Stop when you feel that the pins have `snapped' into position.

Be careful not to bend the pins at either end of the tube.

9 Test the tube light assembly for its working.

— — — — — —

TASK 2 : **Installation of tube light fitting**

1 Follow the recommended method and procedure depending on the type of wiring.

The fixing of the tube to the wall, ceiling or tubular post should be strong enough to support the weight of the fitting.

The installed fitting must be below the level of the ceiling fan to avoid the flickering effect of the shadow.

2 Connect the tube light fitting to the ceiling rose.

Check the supply at the ceiling rose. Switch off the supply before making any connection.

3 Fix the fluorescent tube in the fitting.

Use a stable ladder and a helper to hold the ladder while you are working on the ladder.

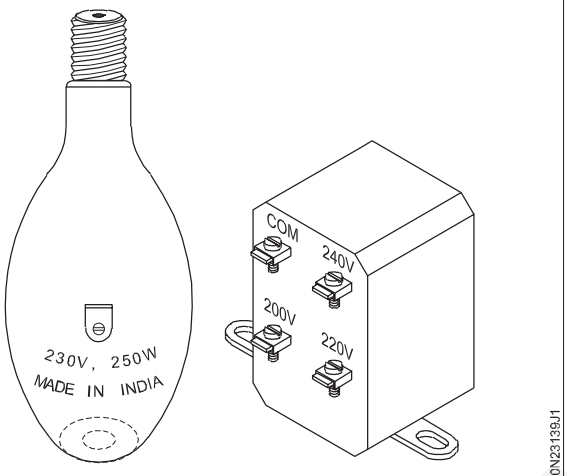
4 Switch `ON' the supply and observe the glow of the tube. If the tube is not glowing, check for proper housing of starter and tube.

— — — — — —

TASK 3 : **Install and test the H.P.M.V (High Pressure Mercury Vapour) lamp with accessories**

1 Read the specification of the mercury vapour lamp and the choke from the markings. (Fig 1)

Fig 1



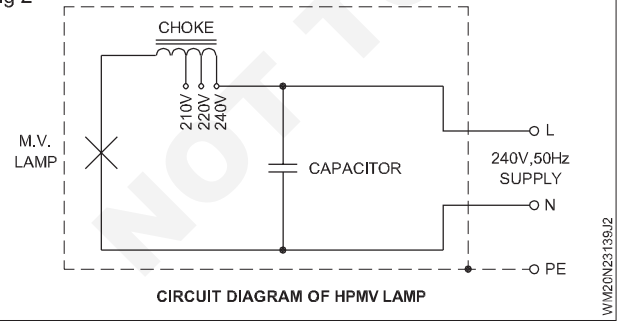
2 Connect the H.P.M.V. lamp in series with the 60W 240V bulb and test in 240V AC supply. Check whether the series test lamp glows.

3 Test the choke for its working condition.

4 Assemble the accessories (choke, holder and capacitor) in the fitting, following the manufacturer's instructions.

5 Connect the accessories as per circuit diagram, Fig 2 (Pictorial diagram Fig 3) using the recommended type of termination.

Fig 2

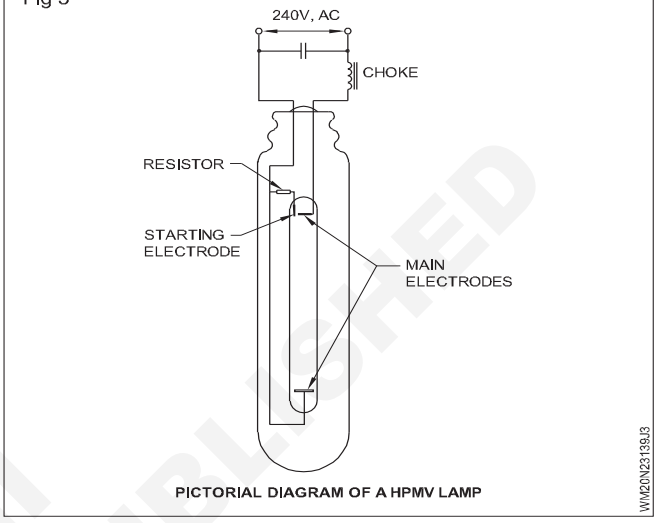


Choose the tapping of the choke suitable to the rated supply system voltage.

6 Fix the bulb in the holder and test the working of the lamp with the supply voltage.

Ensure the fitting is properly earthed at the earthing terminal provided, before testing.

Fig 3



7 A modern M.V. lamp with a built-in resistor needs no external accessories to be connected as discussed above. It can be connected as we do an incandescent lamp.

Installation of the M V lamp fitting

8 Assemble, connect and test the M.V. lamp fitting on a table, for its working. Then remove the cover and bulb.

Mount at the location

9 Observe the recommended method and procedure specified by the manufacturer in the installation leaflet.

Do not alter the specifications recommended by the manufacturer because it should be strong enough to support the weight of the fitting.

10 Connect the M.V. lamp fitting to the supply. The method depends on the system of wiring, location of fitting etc.

Ensure that the supply line is dead (not live), before making the connections.

11 Fix the bulb in the holder securely and refit the cover.

12 Switch on the supply and wait until the high pressure mercury vapour lamp glows with its full brightness. then switch off the supply.

TASK 4 : **Install and test H.P.S.V. (High Pressure Sodium Vapour) and LPS lamp with accessories**

1 Read the specification from the markings on the leak transformer, choke and bulb.

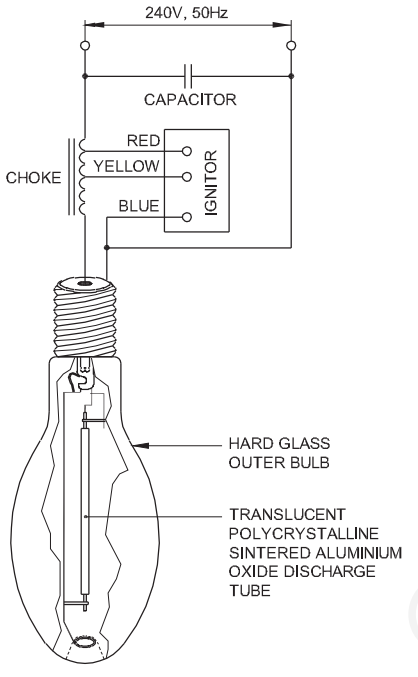
2 Check the transformer and choke with a test lamp for shorts and open.

3 Assemble the accessories (choke, leak transformer and lamp-holder) in the fitting.

Follow strictly the manufacturer's instructions.

4 Give connections as per diagram shown in Fig 1

Fig 1



HIGH PRESSURE SODIUM VAPOUR LAMP

Use the recommended type of termination only.

5 Choose the appropriate voltage tapping suitable to the supply voltage. (Fig 1)

6 Fix the bulb in the holder.

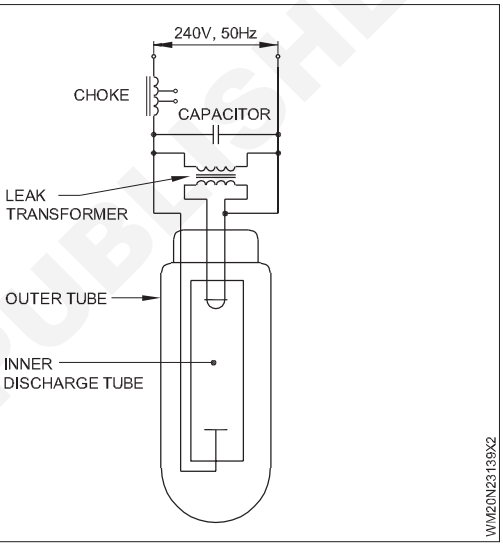
Ensure the fitting is properly earthed.

7 Test the working of the assembled fitting by connecting it to the mains.

8 Note the time taken for the bulb to give full illumination.

9 Repeat the above steps for a high pressure sodium vapour lamp. Connect as per the diagram shown in Fig 2.

Fig 2



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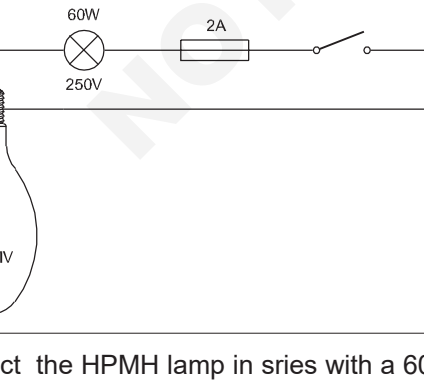
TASK 5 : **Testing of High prssure metal Halide**

1 Read the specifications of the given Halide lamp as Fig 1 collect the required accessories.

Fig 1



2 Connect the HPMH lamp in sries with a 60W. 250V incandescent amp as shown in fig. 16 and test with 240V AC supply. Check whether the series test lamp glows. If the test lamp flows it means that HPMV lamp in good codition.

3 Connect as the circuit diagram and test with 240V supply.

4 Measure the current and test with 240V supply.

Measure the current and voltage. Calculate the power and verify with the rated values.

Voltage :_____Volt

Current : _____Amp

Power : _____Watt

— — — — — —

TASK 6: **Installation of LED lights**

1 Refer the circuit diagram. List the component and quantity required.

2 Check and confirm good condition of given component.

3 Assemble the circuit as shown in the figure 1 on the general purpose PCB.

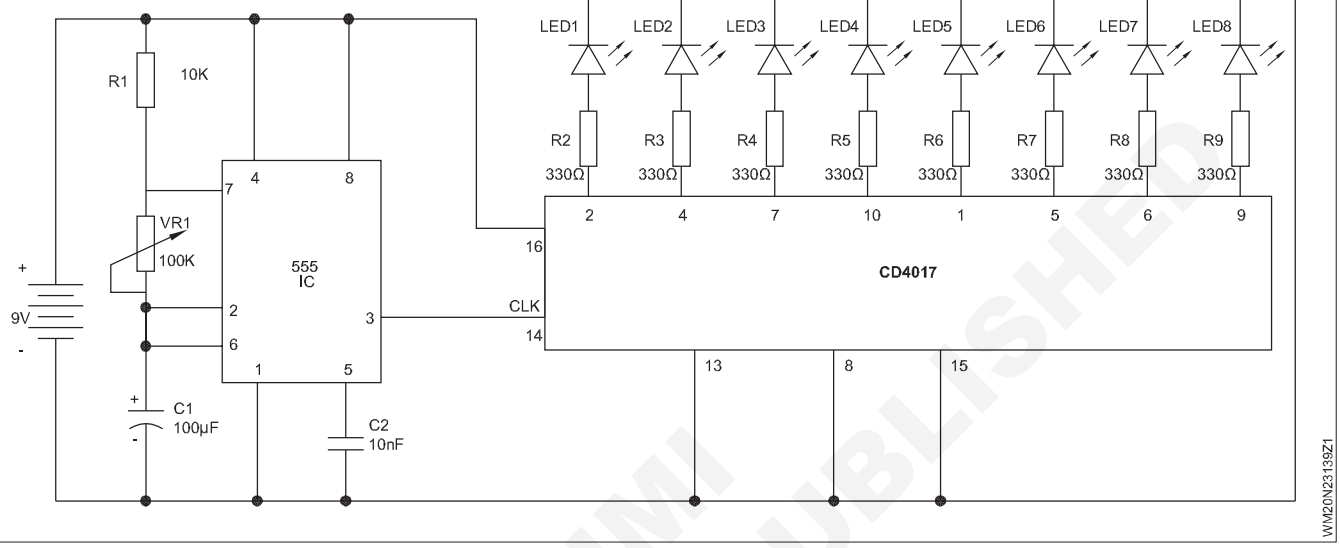
4 Get the assembled circuit checked by your instructor

5 Connect the power supply and observe the working of the dancing LED circuit.

6 Get the work of the circuit checked by your instructor.

7 Observe that the LEDs will glow one after other and on time is to be varied , vary the 100K potentiometer. The LED's may be fixed in the photos.

Fig 1



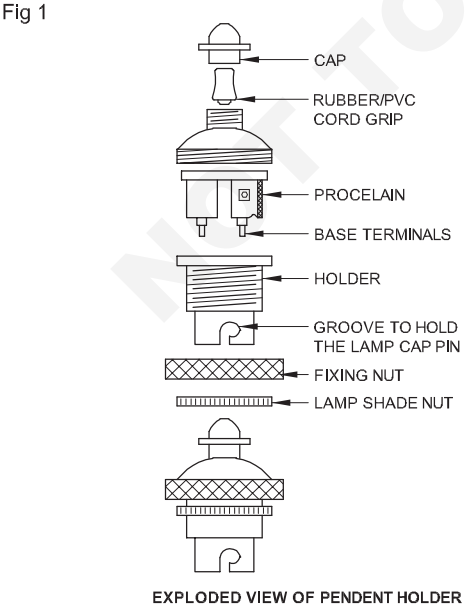
Working Principle

IC 4017 is a IC of CMOS family and has got wide range of applications. It internally consists of 10 stage decade/ divider.

In this 555 IC astable multivibrator which gives continuous pulse at pin 3 and it is applied to clock input pin 14 of CD 4017 which is used decade counter, its output become logic high and low sequentially (one after other) which seems to be dancing LED.

TASK 7 : **Pendant lighting image is given below for trainees refrence**

Fig 1



EXPLODED VIEW OF PENDENT HOLDER

Assemble program and practice on DMX controller for operation of par lights

Objectives: At the end of this exercise you shall be able to
- **connect install and practice DMX controller with PAR lights.**

Requirements

Tools/Instruments

- combination plier 150mm - 1 No.
- screw driver 150mm - 1 No.
- Connector 100mm - 1 No.

Equipment/Machines

- DMX 512 controller with accessories - 1set.

Materials

- LED PAR ligts - as reqd.
- Connecting wires - as reqd.

PROCEDURE

TASK 1: **setup a DMX 512 controller and LED par lights (Fig 1 & 2)**

1 Turn on DMX controller

2 Turn off blackout mode on the controller

3 Set the controller to 16 channel mode

4 Connect the DMX controller to the first light

5 Set the light to 4 channel mode and DMX address 1

6 Connect the second light to the first

7 Set the light to 4 channel mode and DMX address as required

Fig 1

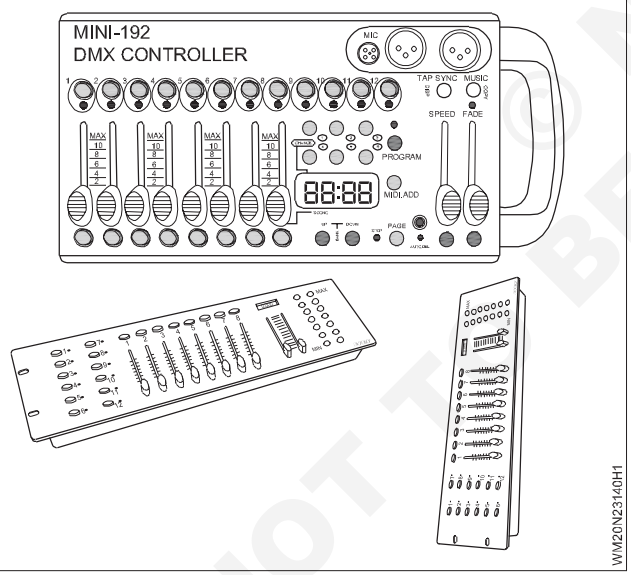
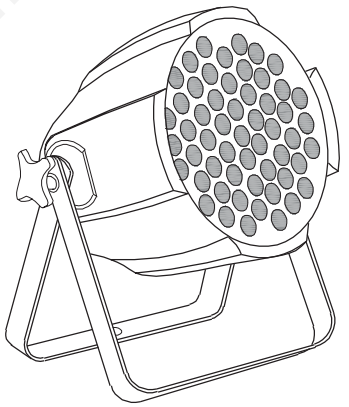


Fig 2



Visual demonstration of LED video wall panel installation hardware & software setup

Objectives: At the end of this exercise you shall be able to
- **install the wall mount**
- **attach the base and mounting the unit on your furniture**
- **connect the antenna/set-top box and the power.**

Requirements

Tools/Instruments

- LCD/LED TV with accessories - 1 set.
- Trainees tool kit - 1 set.
- Power drilling machine with 12mm suitable drill bits - 1 set.
- Pencil - 1 No.
- Measuring tape - 1 No.
- Sprit level - 1 No.

PROCEDURE

TASK 3 : **Installation of LED video wall panel**

1 Refer the instruction manual for the installation procedure by the manufacturer.

Follow the measurements correctly, make sure to use the screws and wall mount accessories properly.

2 Carefully attach the wall mount bracket at the rear side of the LED video wall panel.

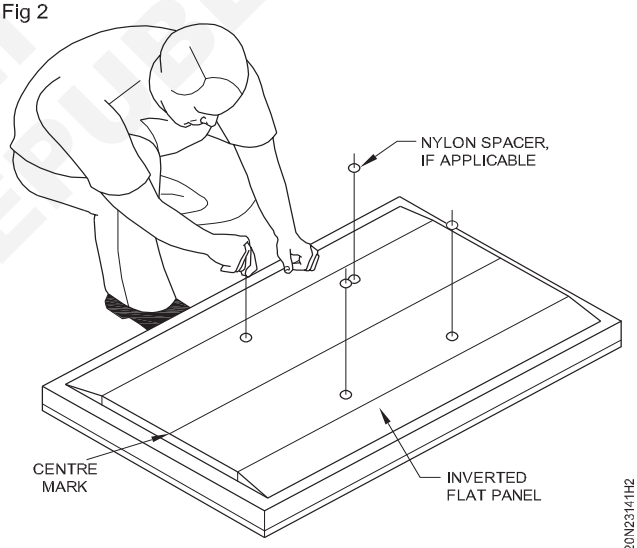
3 Measure and mark the desired viewing height on the wall.

Arrange an assistant to help you in this task of installing the LED vedio wall panel.

4 Continue to follow the installation of wall mounting panel steps as shown in Fig 1 to 12.

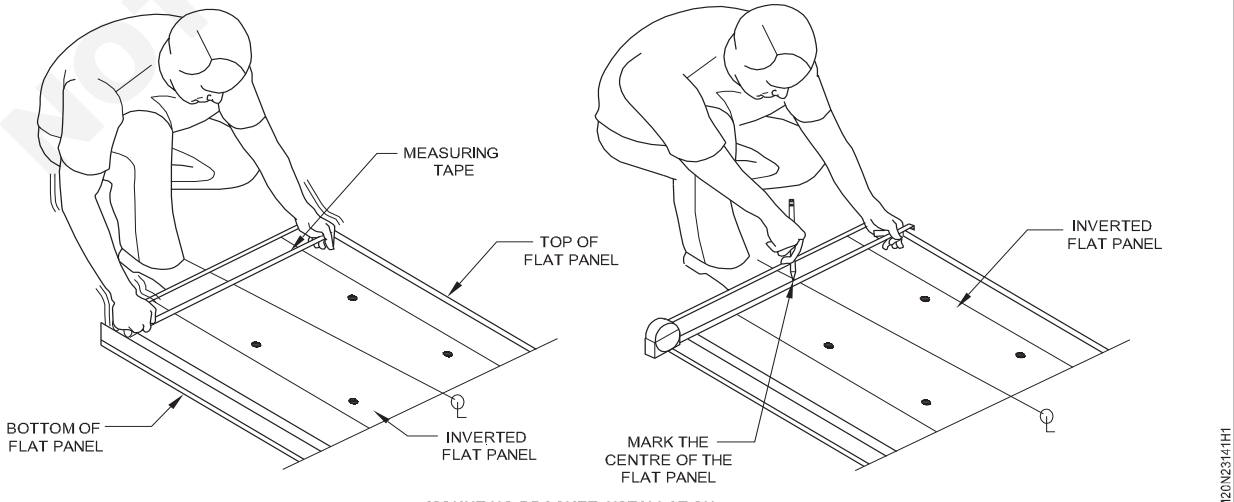
5 Get the work checked by the instructor.

Fig 2



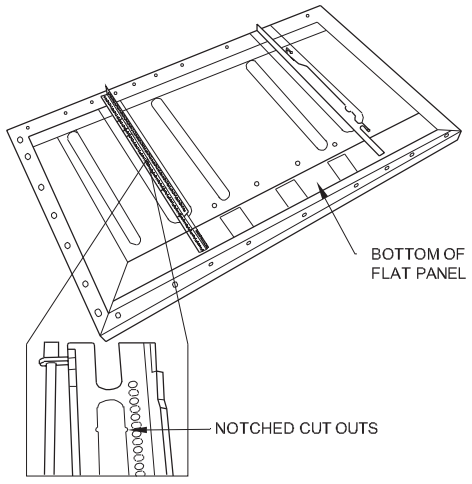
MOUNTING BRACKET INSTALLATION

Fig 1



MOUNTING BRACKET INSTALLATION

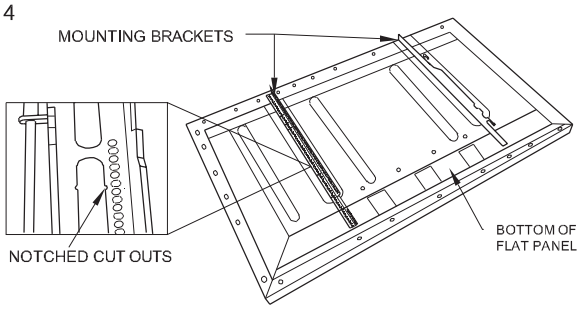
Fig 3



MOUNTING BRACKET INSTALLATION

WM20N23141H3

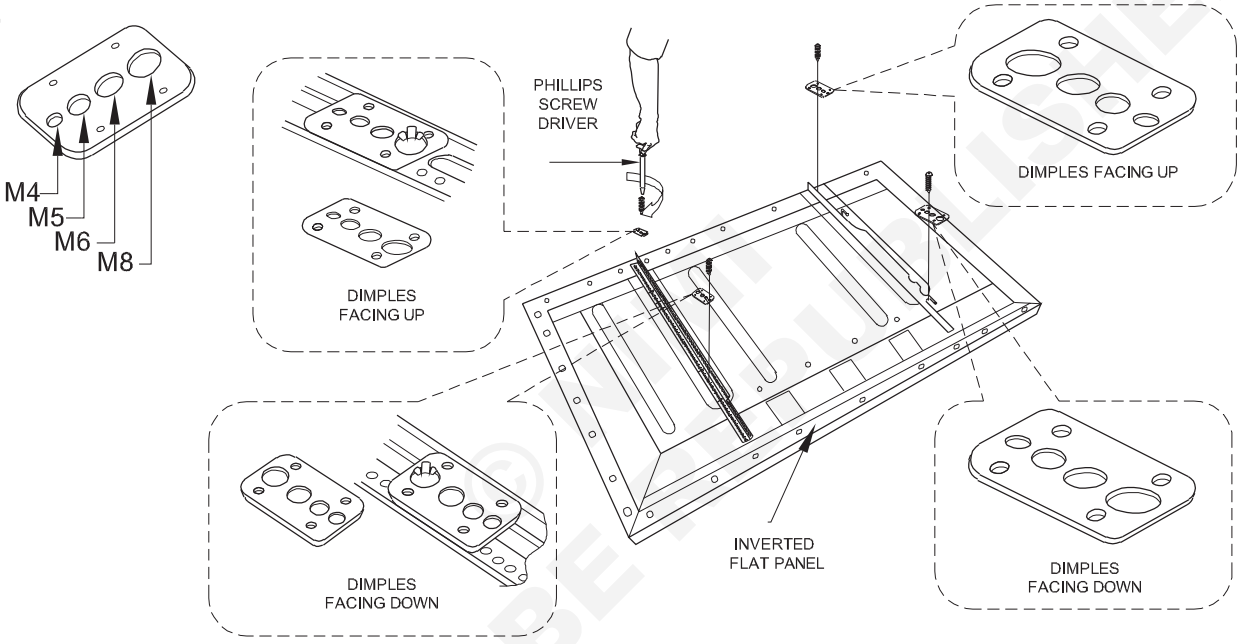
Fig 4



MOUNTING BRACKET INSTALLATION

WM20N23141H4

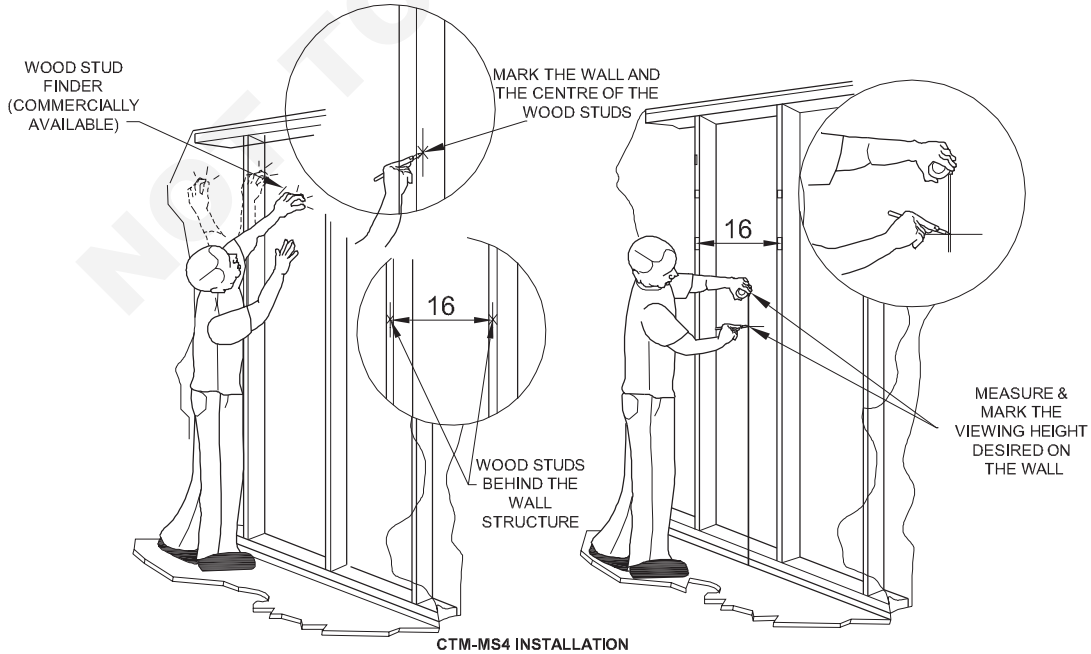
Fig 5



MOUNTING BRACKET INSTALLATION

WM20N23141H5

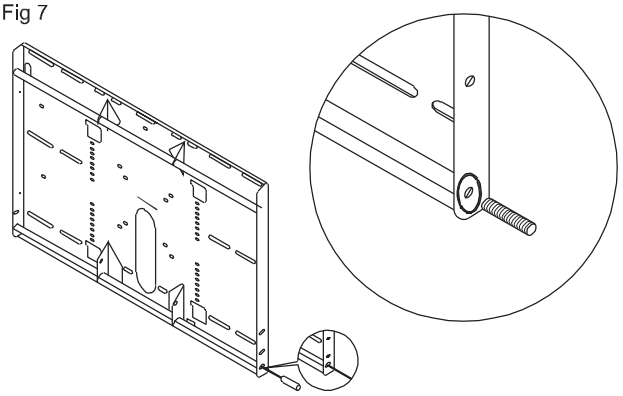
Fig 6



CTM-MS4 INSTALLATION

WM20N23141H6

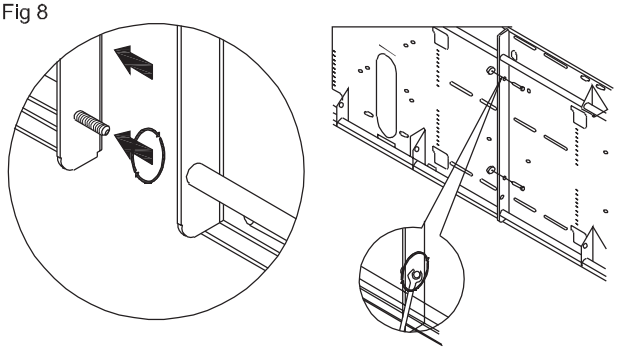
Fig 7



CTM-MS4 INSTALLATION

WM20N23141H7

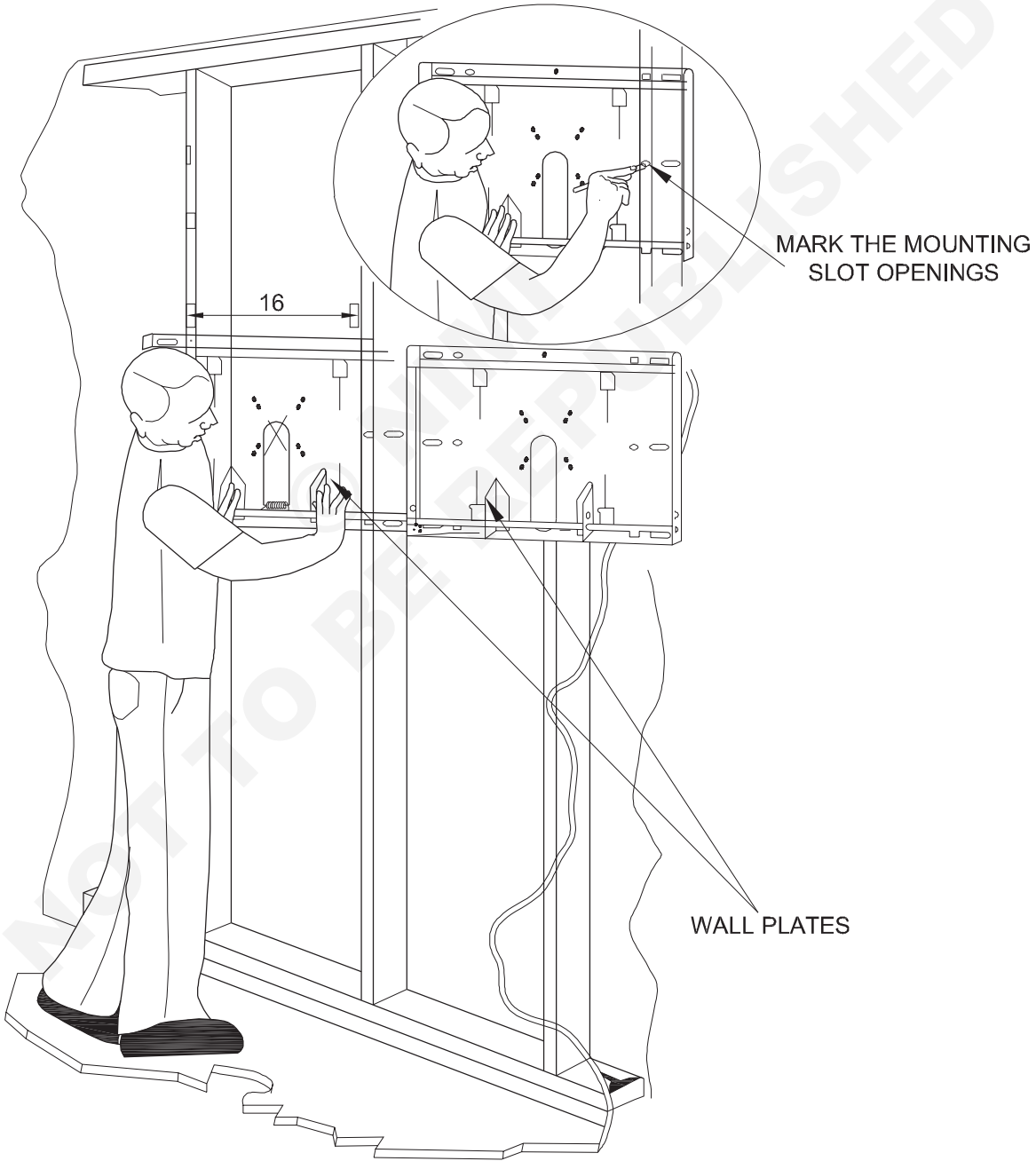
Fig 8



CTM-MS4 INSTALLATION

WM20N23141H8

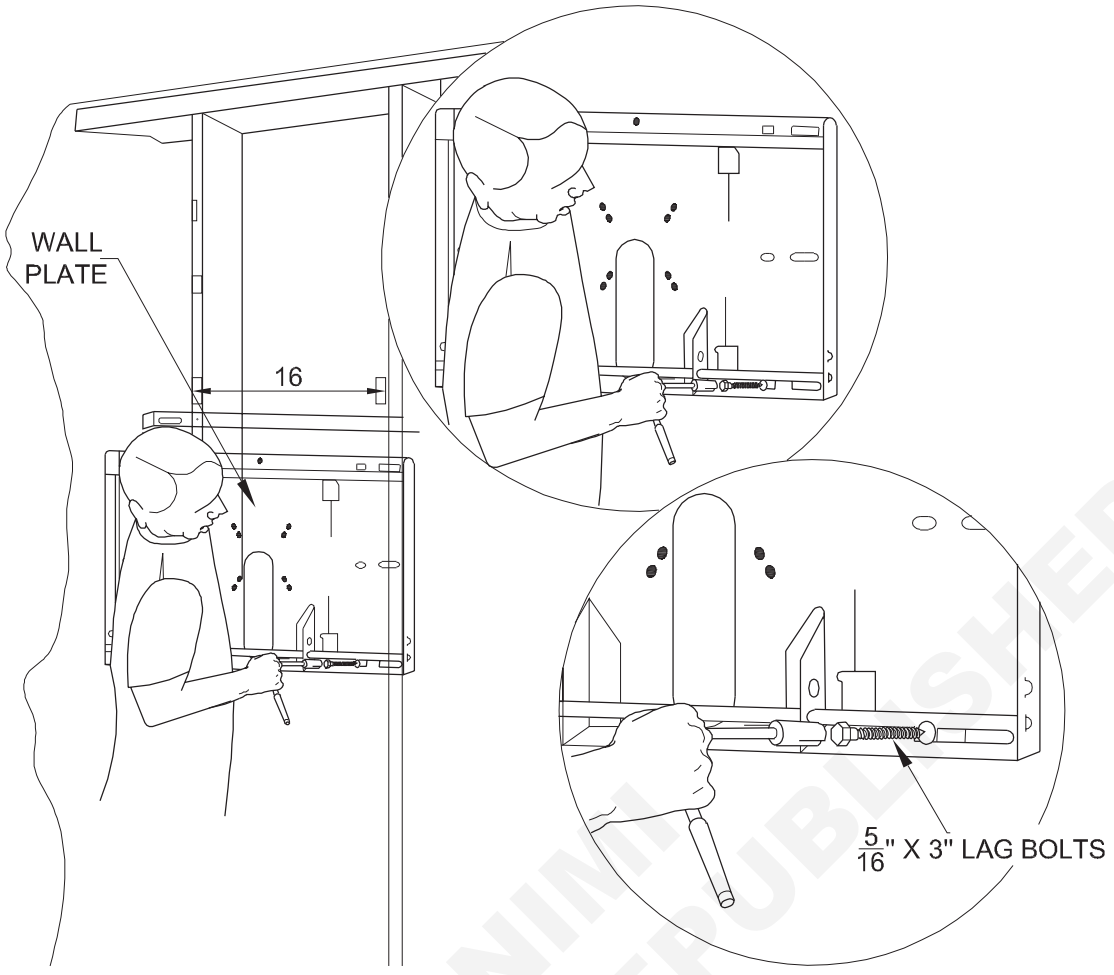
Fig 9



CTM-MS4 INSTALLATION

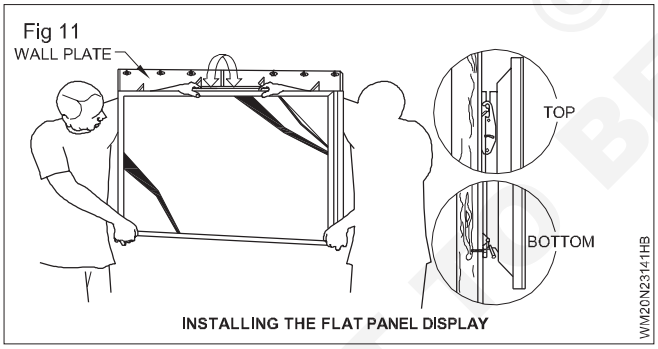
WM20N23141H9

Fig 10



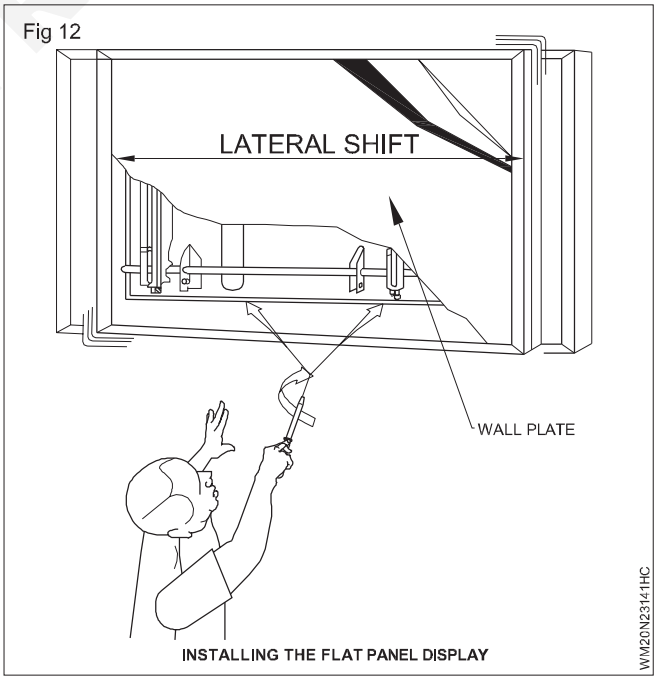
WOOD INSTALLATION

Fig 11



INSTALLING THE FLAT PANEL DISPLAY

Fig 12



INSTALLING THE FLAT PANEL DISPLAY

Determine the value of resistance by colour code and identify the types

Objectives: At the end of this exercise you shall be able to
- **identify the types of resistors by referring to the pictorial representation**
- **identify the colour bands, and decode the resistance value**
- **calculate the tolerance value by the colour band**
- **measure the actual value with an ohmmeter verify with calculated value.**

Requirements

Tools/Instruments

- Multimeter/Ohmmeter - 1 No.

Materials

- Various types of resistors (assorted values) including potentiometers of carbon track and wire-wound type. - as reqd.

PROCEDURE

TASK 1: **Identify the type of resistor from pictorial representation**

1 Identify the resistor's type by referring Fig 1 and write the type in Table 1.

2 Sketch the I.S. symbol for the identified resistor in Table 1.

Fig 1

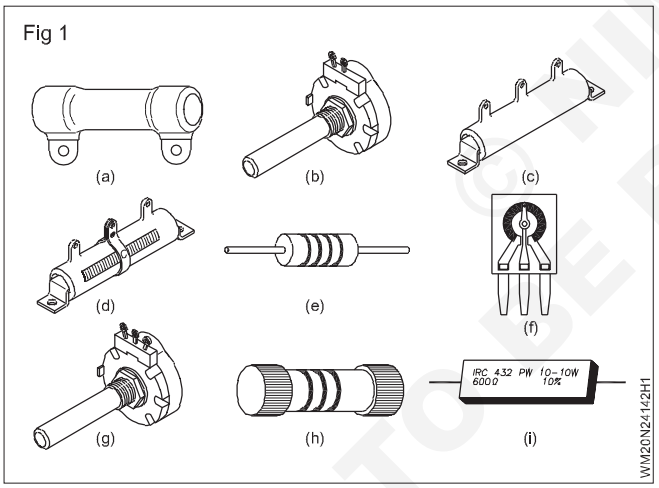


Table 1

Sl. No.	Sketch reference	Type of resistor	Symbol
1	A		
2	B		
3	C		
4	D		
5	E		
6	F		
7	G		
8	H		
9	I		

TASK 2 : **Identify the colour band and decode the resistance value**

1 Identify the value of resistors shown in Fig 1 from the colour bands and enter Table 2.

2 Identify the first two colour bands of the resistors given by the instructor (in sequence commencing from the 1st colour band closer to one end of the resistor - Refer Fig 2.

3 Write the 1st number and 2nd number in Table 2.

4 Identify the colour of the 3rd band and write the multiplier value in the respective column in Table 2.

5 Compute the value of the resistor and record in Table 2.

6 Identify the 4th band colour and fill up the tolerance in Table 2.

7 Determine the resistance value and the tolerance for the another given resistors and record in your note book by repeating the above steps 1 to 6.

8 Measure the value of the resistors by using a multimeter/ohmmeter and enter the values in your note book by following the procedure given below.

Fig 1

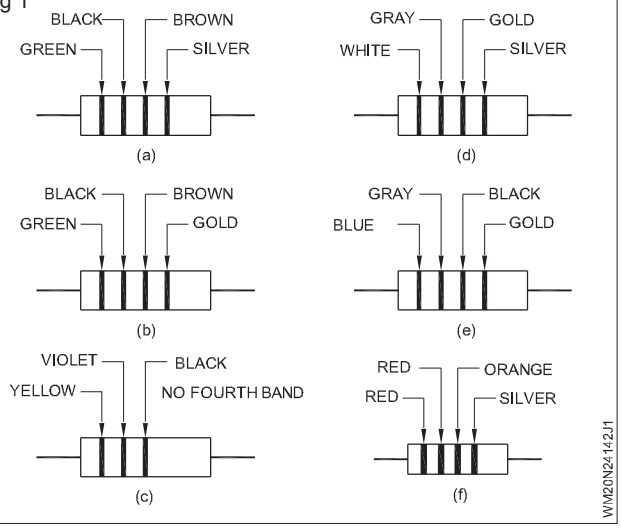
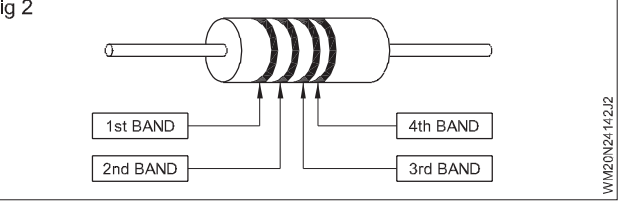


Fig 2



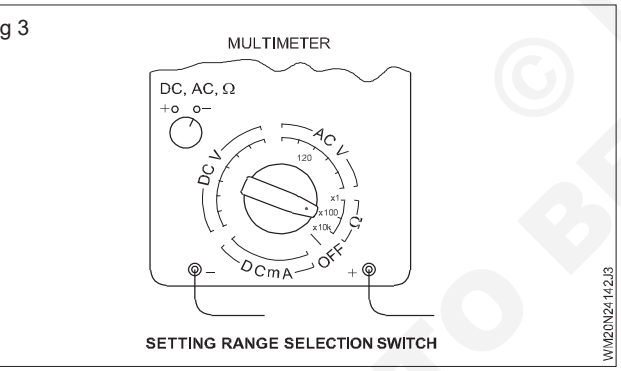
a Connect the probes (Measure resistance by multimeter)

i Connect the red probe to the POSITIVE terminal

ii Connect the black probe to the COMMON terminal

b Set the multimeter/ohmmeter (Fig 3)

Fig 3



i Set the range selector switch to one of the ohm range.

c Conduct zero ohm adjustment in analog multimeter

i Short-circuit the two probes at the selected range.

ii Turn the ohm adjustment knob until the pointer is set at zero ohm. (zero adjustment)

d Connect the resistor to be measured.

i Keep your finger tips off from the probes.

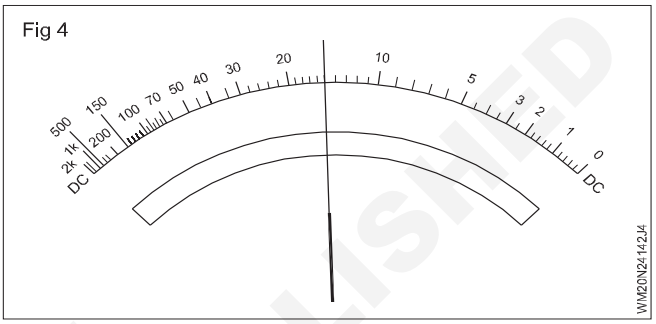
ii Maintain firm contact with the resistor lead wires.

e Read the meter

i Use a range which deflects the pointer to middle of the scale (Fig 4)

ii Read the meter in the Ohm scale right above the pointer. (In this case 15 as shown in Fig 4)

Fig 4



iii Resistance = (Ohm scale reading) x (Magnification at selected range of the resistance range).

iv In Fig 4, the resistance range x 100 is selected, if so the value of the resistance is 15 x 100 = 1500 ohms = 1.5 (K Ohm)

9 Enter the marked value of resistance and tolerance (by the colour band over the resistor) in Table 2.

10 Calculate the minimum and maximum values of actual resistance for each resistor considering the tolerance marked over it. Record the values in Table 2.

11 Determine the acceptability (OK or not OK) by comparing the measured value with the minimum and maximum of the indicated value.

Note : Each range selection zero adjustment is to be ensured for correct value of resistance.

Table 2

Sl.No.	Theortically calculated values									Practically measured value	Tolerance
	Colour				1st No.	2nd No.	3rd No.	Mulitiplier	Resistance value		Tolerence limit (±) in percentage
	1st Band	2nd Band	3rd Band	4th Band							
A											
B											
C											
D											
E											
F											

Determine V-I characteristics of semi conductor diode

Objectives: At the end of this exercise you shall be able to

- **refer data book and**
  - **identify the diode is Ge, Si etc**
  - **verify operating voltage and current rating**
  - **list the application of the diode**
- **identify the terminals of a diode and test the diode for its condition**
- **plot the forward characteristics, determine the forward resistance of the diode and the barrier potential**
- **plot the reverse characteristics of the diode and determine the minority carrier current.**

Requirements

Tools/Instruments

- Multimeter (Digital) - 1 No.
- Voltmeter MC 0-1 V - 1 No.
- Milliammeter MC 0-25 mA - 1 No.
- Voltmeter MC 0-30 V - 1 No.
- Micro ammeter MC 0-100 Micro Amp - 1 No.
- Semi conductor diode data book - 1 No.

Equipment/Machines

- DC regulated power supply 0- 30 V, 1 A - 1 No.

Materials

- Assorted types of diodes including IN 4001 or IN 4007 - as reqd.
- 570 Ω, 5W potentiometer - 1 No.
- SPST switch 6A 250V - 1 No.
- Bread board 150 x 150 mm - 1 No.
- Suitable connecting wires for bread board - as reqd.
- Patch cords with clips - 2 sets
- 100Ω 1/4 W resistor - 1 No.
- 10 Ω 1/4 W resistor - 1 No..

PROCEDURE

TASK 1: **Determine the forward V-I characteristic of the diode**

1 Construct the circuit in the bread board as in Fig 1.

2 Set initially V_B = 0 and switch ON the power supply.

3 Set V_B = 5V, set the potentiometer to minimum position.

4 Close the switch S and adjust potentiometer to increase the voltage across the diode in steps of 0.1 V as per the Table.1

5 Record the corresponding values of current read by the ammeter in the Table.1.

6 Check the value of voltage across the diode at which the current starts increasing and remain constant at later.

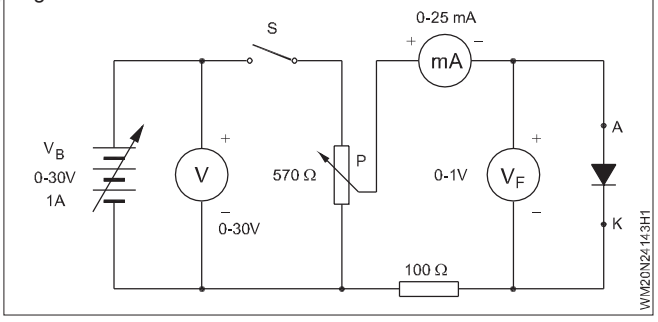
7 Switch OFF the supply

8 Plot the graph with V_F on X axis and I_F on Y - axis.

9 Determine the forward resistance.

$$R_F = \frac{V_F}{I_F} \text{ ohms}$$

Fig 1



From the graph determine the knee point voltage at which large quantity of current starts flowing. Enter the value below.

Knee point voltage .... volts If the knee point voltage is around 0.3 V or 0.7V the diode is germanium or silicon respectively.

Note : Increase the voltage beyond 2.0V as indicated in case diode is not reached in saturation current.

Table 1

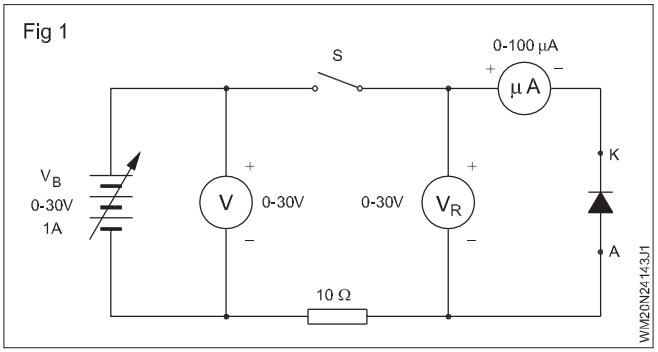
V_F Volt	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0
I_FmA	0											

— — — — — —

TASK 2 : **Determine the reverse V-I characteristic of a diode**

1 Construct the circuit in a bread board as in Fig 1 (Reverse the Diode terminals with respect to previous task)

Fig 1



2 Switch on the power supply and close the switch S.

3 Increase the voltage gradually across the diode by operating the power supply as per Table 2 and note down the corresponding current read by the ammeter in Table 2.

4 Switch OFF the power supply.

5 Plot the graph on the same graph sheet (Task 3) with V_R on x-axis and I_R on Y-axis.

6 Determine the minority carrier current from the graph.

If the reverse voltage becomes equal to the PIV of the diode then the diode starts conducting and not to increase the voltage beyond PIV of the diode.

7 Repeat the experiment for different type of diodes.

Table 2

V_R Volts	0	5	10	15	20	30
I_R in Micro camps						

Wireman - CFL/LED lamps & DC regulated power supply

Identify the circuit components and their terminals, diode, transistor, capacitor, regulator

Objectives: At the end of this exercise you shall be able to
- **identify the diode is Ge, Si etc**
- **verify operating voltage and current rating**
- **identify the terminals of a diode and test the diode for its condition**
- **identify the terminals of transistor**
- **identify the terminals of capacitor**
- **identify the terminals of regulator.**

Requirements

Tools/Instruments

- Multimeter (Digital) - 1 No
- Voltmeter MC 0 -1 V - 1 No
- Milliammeter MC 0 - 25 mA - 1 No
- Voltmeter MC 0 - 30 V - 1 No
- Micro ammeter MC 0 - 100 micro Amp - 1 No
- Semi conductor diode data book - 1 No

Equipment/Machines

- DC regulated power supply 0 - 30 V,1 A - 1 No

Materials

- Assorted types of diodes including IN 4001 or IN 4007 - as reqd.
- 570 Ω, 5w potentiometer - 1 No.
- SPST switch 6A 250V - 1 No.
- Bread board 150 x 150 mm - 1 No.
- Suitable connecting wires for bread board - as reqd.
- Patch cords with clips - 2 sets.
- 100 Ω 1/4W resistor - 1 No.
- 10 Ω 1/4W resistor - 1 No.
- Transistors - 1 each.
- Capacitors (diff type) - 1 each

PROCEDURE

TASK 1: **Identify the terminal leads of a given diode**

1 Set the multimeter in ohms range (W x 1).connect its leads to a M.C voltmeter (0.3V), to find out the polarity of multimeter output voltage.

In digital multimeter the marked polarity and polarity of output voltage are the same.

2 Check the deflection of the voltmeter, if it indicates the voltage, mark the terminal of the multimeter corresponding to the voltmeter polarity.

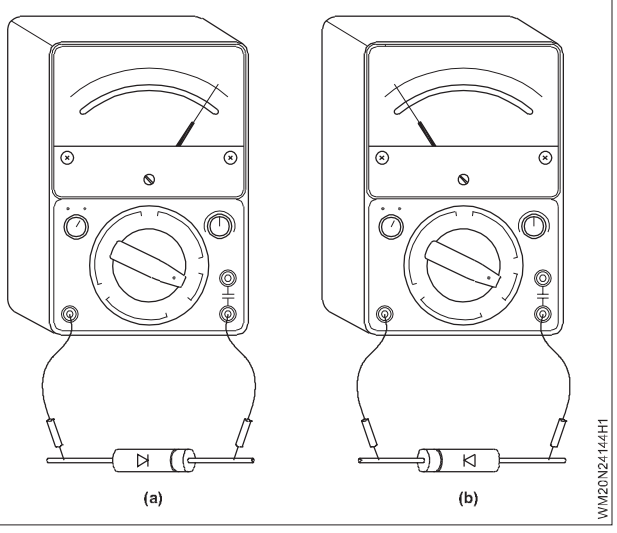
3 Mark the terminal of the multimeter opposite to voltmeter polarity.If the voltmeter kicks back then.

4 Connect the +ve marked terminal for the multimeter to one terminal of the diode and other to the - ve and observe the reading.

a) If the meter reads low resistance then the lead of the diode connected to +ve marked terminal of the meter is the ANODE and the other is cathode. (Fig 1 (a)

b) If the meter does not deflect as in Fig 1 (b) then the lead of the diode connected to +ve marked terminal for the multimeter is the cathode and the other is anode.

Fig 1



If the meter reads low resistance for both polarities the diode is short.

If the meter reads high resistance for both polarities the diode is open.

TASK 2 : **Identification of terminals of a transistor**

1 Identify which terminal of the ohmmeter being used is connected to the +ve terminal of the internal battery of the meter. Set the meter range to RX100W.

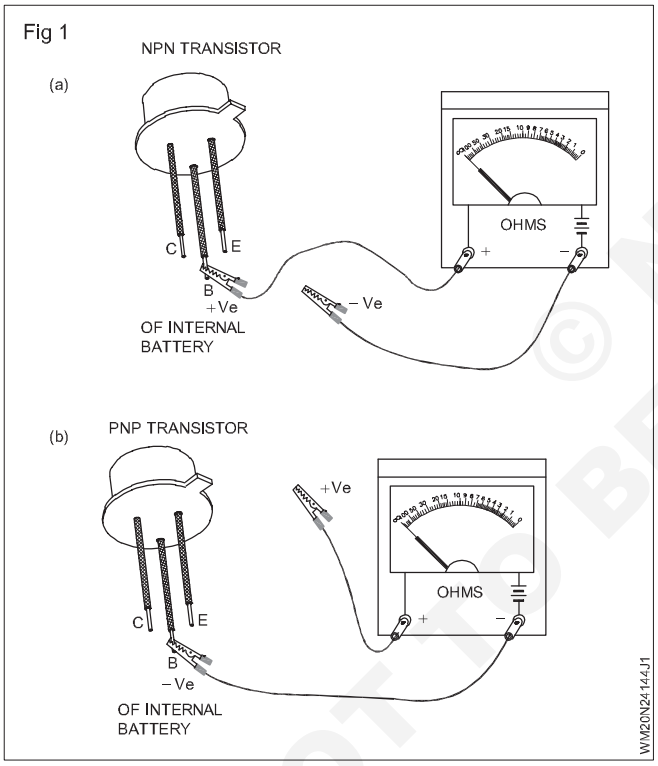
Ohmmeters in very low or very high ohms range can produce excessive current/voltage and may damage low power transistors while testing.

2 Connect one of the prob to the base of the transistor as shown in Fig 1a and 1b.

3 Clip the other meter prob to the emitter. Check if the base-emitter junction diode of transistor shows low resistance (few tens of ohms) or very high resistance (few tens of kiloohms). Record your observation in Table 1.

4 Reverse the polarity of the probs connected across the base-emitter and check if the base-emitter junction diode of transistor shows low resistance or very high resistance. Record your observation in Table 1.

Fig 1



5 From the recorded observations in steps 3 and 4, and referring to the table given below, conclude and record, the condition of the base-emitter junction diode of the transistor as GOOD, open or shorted in Table 1.

If the resistance of the junction measured in both directions is high, in addition to the condition of the junction given in table, an other possibility is, your identified base pin may be wrong. You may be measuring resistance across emitter-collector. In case of doubt, recheck the identified pins of the transistor and repeat steps 2,3 and 4.

6 Repeat steps 2,3,4, and 5 and check the condition of the base-collector junction diode of the transistor.

7 Measure the resistance across the emitter-collector and record the observation as V-HIGH (> 1MW) or LOW (<500W).

In a good transistor the resistance between the emitter and collector will be very high. A low resistance indicates that the transistor is leaky.

8 Clip the meter across the emitter-collector with correct polarity as in Fig 2. Touch the base-collector with moist finger as in Fig 2 and check if the resistance shown by the meter decreases indicating that the transistor is turning ON. Record your observation as YES or NO in Table 1.

9 From the observations recorded at steps 5,6,7 and 8, give your conclusion on the overall condition of the transistor under test. Refer Table 1.

10 Repeat the steps 1 to 9 for atleast five more transistors of different types.

11 Report and get your work checked by your instructor.

Fig 2

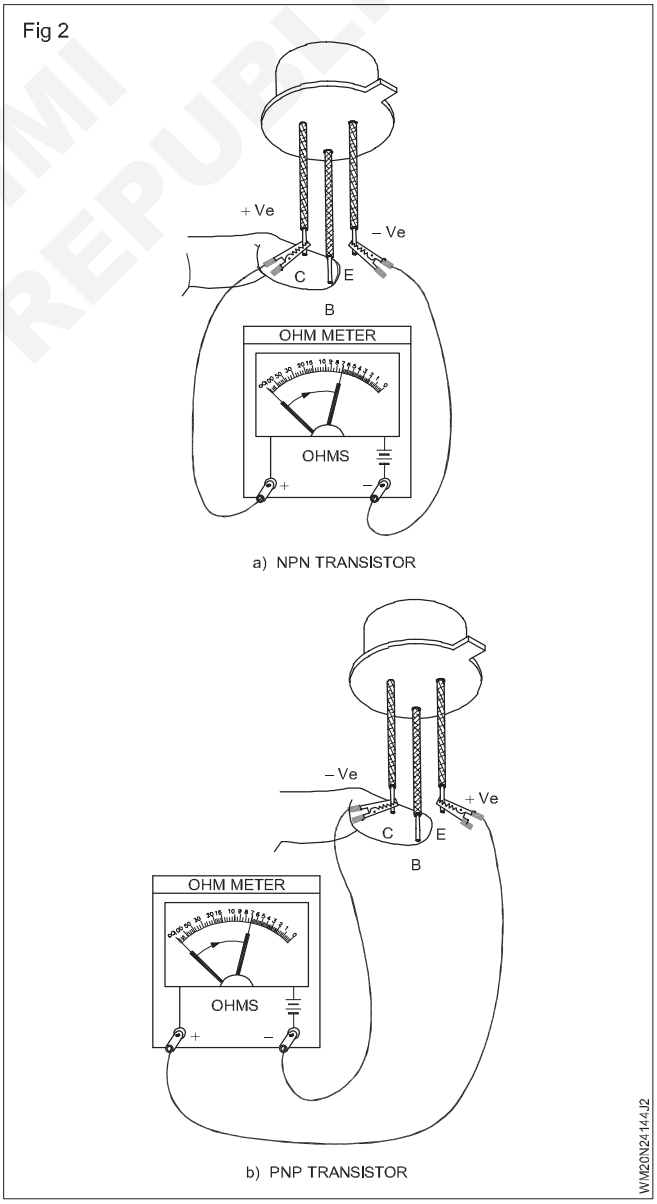


Table 1

Resistance of P - N junction with meter prods in one direction	Resistance of P - N junction with meter in reversed direction	Condition of P - N Junction
Low	Very High	Good
low	Low	Shorted
Very High	Very High	Open (See Note above)

TASK 3 : **Identify the capacitor terminals (Fig 1)**

1 Polarity marked on the polarity capacitor.

2 The negative polarity of a capacitor marked with (-) sign

3 The positive lead of a polarity capacitor is large in length

4 Identify the capacitor and their type and enter their details in table 2.

5 Identify the value of a capacitor, capacitance, voltage rating and polarity and note it down on table 2.

Fig 1

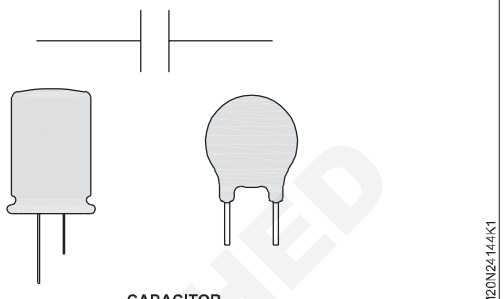


Table 2

Sl.No	Type of capacitor	Value of capacitor	Voltage rating of capacitor	Polarity & Non - polarity capacitor

TASK 4 : **Identify the terminals of a regulator (Figs 1 & 2)**

The three terminals voltage regulator is designated with the terminals input, common and output.

1 Hold the regulator in such a way that the heat sink is should be leaning the over your hand

2 Extreme left terminal is the input

3 Extremely right terminal is the output

4 Middle terminal is a common terminal

5 Apply input voltage as given in table1

6 Note down the output voltage and enter in table1

Fig 1

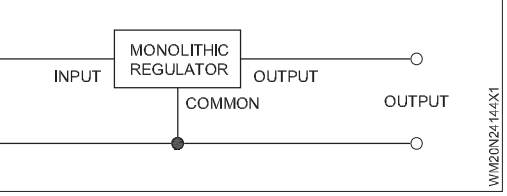


Fig 2

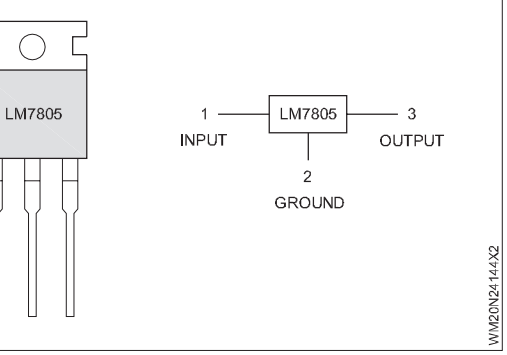


Table 1

Sl.No.	Input voltage	Output voltage	
1	10V		
2	15V		
3	20V		
4	25V		
5	30V		
6	35V		
7	40V		

Construct half-wave, full wave and bridge rectifiers

Objectives: At the end of this exercise you shall be able to
- **construct a half-wave rectifier and test**
- **construct and test a full-wave rectifiers using two diodes**
- **construct and test bridge type, full wave rectifiers using four diodes.**

Requirements

Tools/Instruments

- Trainees kit - 1 No.
- Voltmeter MC 0-30V - 1 No.
- Multimeter (Digital) - 1 No.
- Soldering iron 60w / 250v - 1 No.

Equipment/Machines

- DC regulated power supply 0 - 30 V,1 A - 1 No

Materials/Components

- Lug board General purpose 5 points - 1 No.
- Diode IN4007 - 4 Nos.
- Resistor 470W (Ohm) - 1 No.
- Step-down transformer,(centertaped) 240V/12.0.12, 500mA - 1 No.
- Multi strand wire, red, blue 23/0.2 of 650V grade - as reqd.
- Base board (Laminated board 30x15x3mm) - 1 No.
- Mains cord 3 core cable 23/0.2 of 650V grade - 1 No.
- Nuts, bolts and washers - as reqd.
- 3 Pin plug 6A 250 V - 1 No.
- Resin core solder 60/40 - as reqd.

PROCEDURE

TASK 1: **Construct half-wave rectifier and test it**

1 Test the continuity of the primary and secondary windings of the given transformer. Record the specifications of the given transformer.

2 Follow the order of steps given below by referring Fig 1.

- Mount the tested transformer as shown in Fig 1 on BASE BOARD using suitable size nuts, washers and bolts. Get it checked by your instructor.
- Mount the rectifier diode on lug board by soldering
- Solder the wire connection and the three core power cord. (Fig 1)

3 Connect AC mains to the board and switch ON mains. Measure and record the mains voltage and transformer secondary voltage $V_{S(rms)}$ (AC input to rectifier) in the Table 1.

4 Calculate and record the calculated DC voltage across load RL using the formula,

$V_{dc} = 0.45\ V_{S(rms)}$

where, $V_{S(rms)}$ is the AC input to the rectifier.

5 Measure and record the rectified DC voltage V_{dc} across load R_L using multimeter.

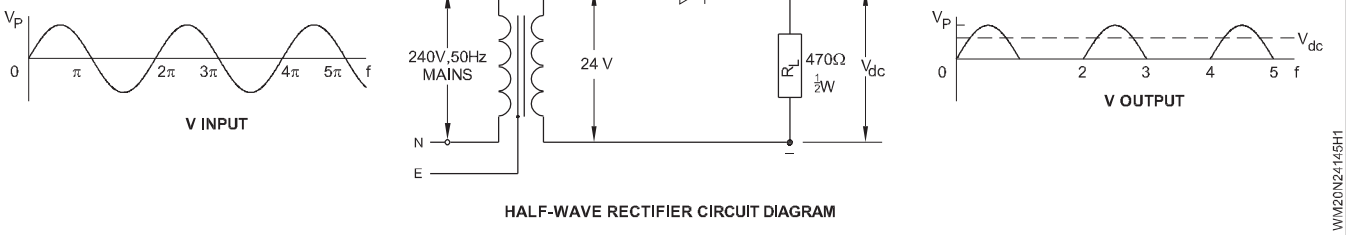
6 Record the difference in the calculated and measured values.

7 Get it checked by your instructor.

Transformer specifications

Rated primary voltage	
Rated secondary voltage	
Secondary current or VA rating of transformer	
Type of transformer step-up/ step down	
No. of windings in secondary	

Fig 1



HALF-WAVE RECTIFIER CIRCUIT DIAGRAM

Table 1

Readings of single diode half wave rectifier

Vs(rms) (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

TASK 2: **Construct fullwave rectifier with centre tap transformer**

1 Check to confirm good condition of the given components. Record specifications of the transformer.

2 Construct a full wave rectifier circuit as shown in the schematic and layout diagram at Fig 1.

3 Switch ON the circuit. Measure the AC input voltage Vs(rms) to the rectifier across the center-tap and any one end of the transformer and record it in Table 2.

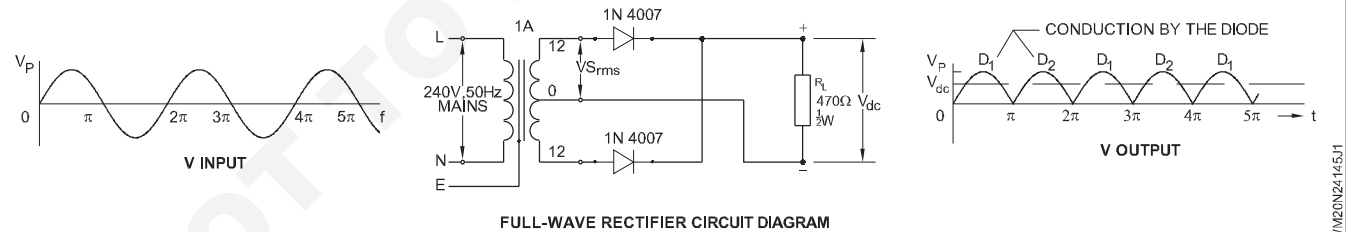
4 Calculate the expected DC voltage Vdc across load RL using the formula given below;

In full wave rectifier, Vdc = 0.9 Vs(RMS) where, Vs(rms) is the voltage across the centre-tap and any one end terminal of secondary. Record the value in Table 2.

5 Measure the rectified output Vdc across load RL and record it Table 2.

6 Calculate and record the difference in the calculated and measured Vdc values. Get it checked by your instructor.

Fig 1



FULL-WAVE RECTIFIER CIRCUIT DIAGRAM

Table 2

Readings of two-diode full-wave rectifier

Vs(rms) (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

TASK 3: **Construct bridge rectifier**

1 Modify the two diode full wave rectifier wired in Task 2 to construct a bridge rectifier, referring to the schematic and layout diagrams (Fig 1).

2 Switch On the circuit. Measure and record the AC input $V_{s(rms)}$ to the rectifier in Table 3.

3 Calculate the expected output DC voltage Vdc across load RL using the formula, In a bridge rectifier.

V_{dc} = 0.9 $V_{s(rms)}$ where, $V_{s(rms)}$ is the AC input to the rectifier (refer Fig 1). Record the value in Table 3.

4 Measure the DC output V_{dc} across the load R_L and record it in Table 3.

5 Record the difference in the calculated and measured values in Table 3.

6 Report and get it checked by your instructor.

Fig 1

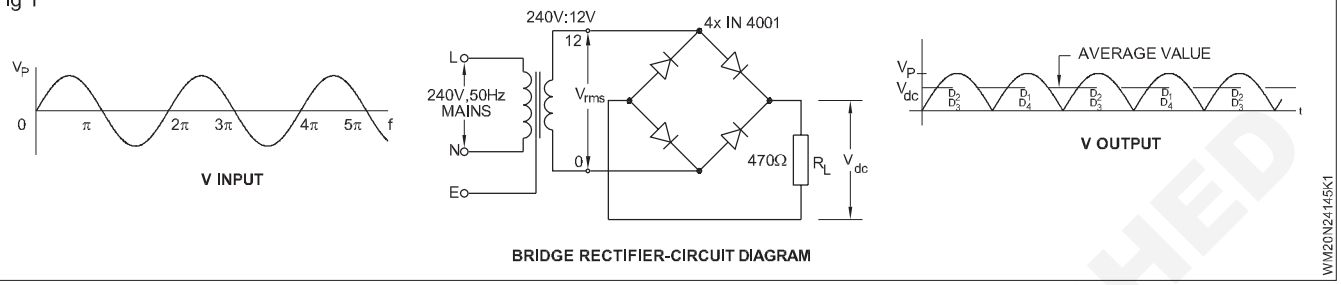


Table 3

Readings of bridge rectifier

Vs(rms) (1)	Calculated V_{dc} volts (2)	Measured V_{dc} volts (3)	Difference of (2) & (3) (4)	Peak value of V_s (5)	Frequency of V_s (6)

Wireman - CFL/LED lamps & DC regulated power supply

Practice soldering on basic electrical and electronic circuits

Objectives: At the end of this exercise you shall be able to
- **identify the different components of soldering**
- **solder the various types of electrical circuits**
- **solder the electronic components on PCB.**

Requirements

Tools/Instruments

• Side cutter (150mm)	- 1 No.
• Stand for soldering iron	- 1 No.
• Soldering iron -35wats	- 1 No.
• Sand paper	- 1 No.
• Electrician knife -100mm	- 1 No.

Materials/Components

• Soldering flux	- 1 No
• Lead	- as reqd.
• PCB board	- 1 Nos
• Electroniccomponents (resistors, capacitors, diodes, transistors...etc.	- 1 Nos

PROCEDURE

1 Clean the soldering bit with sand paper

2 Clean the components for soldering

3 Place the component on the PCB

4 Heat the soldering iron

5 Apply flux on soldering area

6 Melt lead

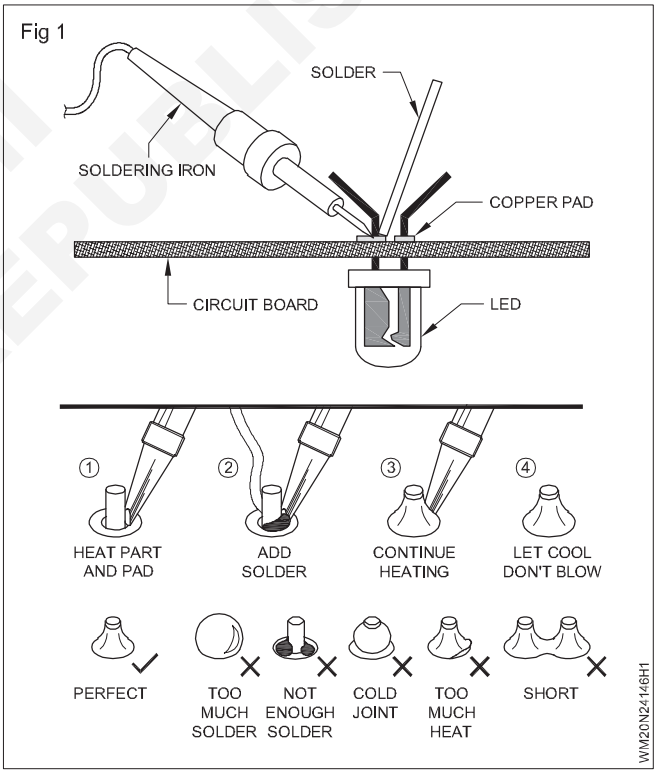
7 Make solder by applying melting lead at a suitable temperature

8 Apply little bit pressure after few seconds

9 Observe the Basic eletrical component is perfectly soldered or not

10 For trainees reference observe the given figures.

Fig 1



Troubleshoot defects in simple power supplies

Objectives: At the end of this exercise you shall be able to
- **carry out step-by-step troubleshooting of a power supply having bridge rectifier and capacitor filter**
- **carry out a short cut method of troubleshooting of the power supply through problem tree and service flow diagram.**

Requirements

Tools/Instruments

- Trainees kit - 1 No.

Materials/Components

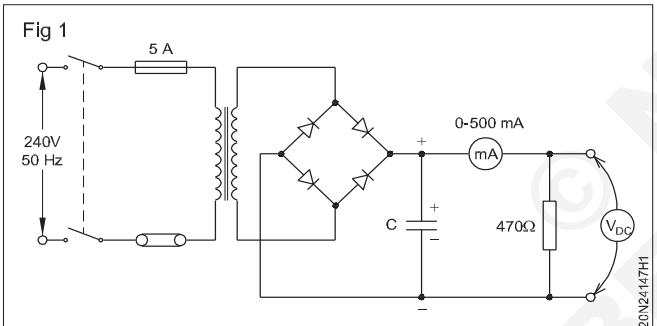
- Bridge rectifier power supply circuit with filter - 1 No.
- Spare components - as reqd.

PROCEDURE

TASK 1 : **Troubleshoot defects in bridge rectifier power supply**

1 In the given power supply board, refer Fig 1. Check for any one of the physical defects listed below; Record the observed defect(s) in Table 1. Service the defect(s).

Fig 1



POWER SUPPLY HAVING BRIDGE RECTIFIER AND FILTER CAPACITOR

– Loose/open wire connections.

– Loose/open component lead connections.

– Dry solder points.

– Shorting of terminals due to solder spray or bad skinning/bending of wire ends or component leads.

2 Trace the circuit wiring and check the correctness of the following.

– Polarity of diodes

– Polarity of polarized capacitors.

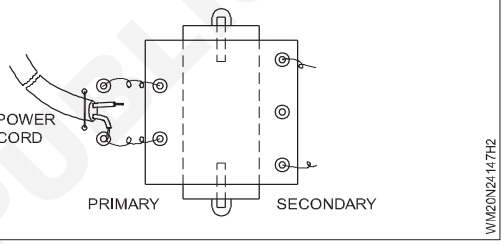
Correct the polarities if found defective and record the defect observed and polarity corrected in Table 1.

3 Open one of the wire ends of the power cord connected to the power supply. (Fig 2)

This will disconnect the transformer primary from the power cord.

4 Using a continuity tester, check the power cord for any one of the following defects and record the defect observed if any;

Fig 2



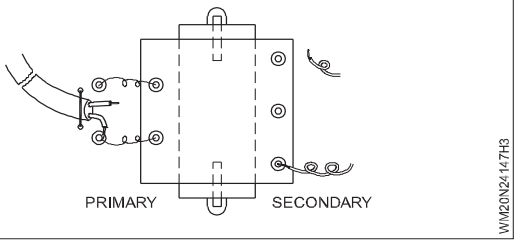
– Open or shorted wires in the plug.

– Open or shorted wires in the 2-core cable.

5 Check the continuity of transformer primary winding. If found open or short the coils record defect.

6 Remove the wires soldered at the secondary winding terminals of the transformer (Fig 3).Check the continuity of the secondary windings. Record your observation.

Fig 3

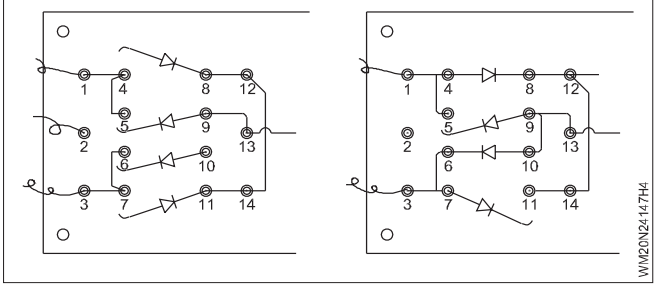


7 Open one lead of each diode (Fig 4). Check the condition of the diodes. Record your observation in Table 1.

8 Open one of the leads of the capacitor. Check the condition of the filter capacitor by carrying out the capacitor action test. Record your observation in Table 1.

9 Check the condition of the bleeder/load resistor. Record your observations in Table 1.

Fig 4



10 Get the defects recorded in steps above, checked by your instructor. Get his approval to replace the components found defective.

11 Collect and test the new components to replace the identified defective components.

12 Replace the defective components with the new components and solder back all connections opened while testing.

13 Connect serviced power supply to AC mains and switch ON mains supply. Check and record the output condition in Table 2 under the heading final condition after servicing.

If there is no output from the PSU even after carrying out the laid procedure of servicing, consult your instructor.

The output may have problems other than the one for which it is serviced. Record the problem as it is observed.

14 Get the work checked by your instructor.

Final condition of power supply after servicing

a Output voltage level

b Ripple voltage Vr(p-p) in output DC

Table 1

Sl.No.	Name of the defective component	Nature of defect observed	Specification the component to be replaced	Equivalents, if any, for the components to be replaced	Specification of the component to be replaced
Sample	Solderred point	Dry solder	.....	.....	De-soldered

— — — — — —

TASK 2 : **Troubleshoot defects in power supply using shortcut/logical approach method**

1 Switch 'ON' the given defective power supply unit and record the identified defect in record sheet.

2 Refer the problem tree corresponding to the identified defect.

3 Refer the service flow sequence (SFS-1) or (SFS-2) depending on the identified defect of power supply. Follow the logical sequence to service the defective power supply.

4 Record the identified component defects and remedial measure taken in Table 2 of record sheet.

Refer the problem tree corresponding to the SFS for finding the possible causes of the defects.

Whenever any component is found defective, record its type, cause of defect and other details in the Table 2 of record sheet.

Whenever any component is replaced, record the specification of the replaced component in Table 2 of the record sheet.

Once the servicing as per SFS is complete, record the final condition of the power supply in Table 2 as done in step 13 of Task 1.

5 Get your work checked by your instructor.

6 Final condition of power supply after servicing.

a Output voltage level :

b Ripple voltage Vr(p-p) in output DC :

7 Refer service flow chart 1 & 2 and follow the sequence of approach.

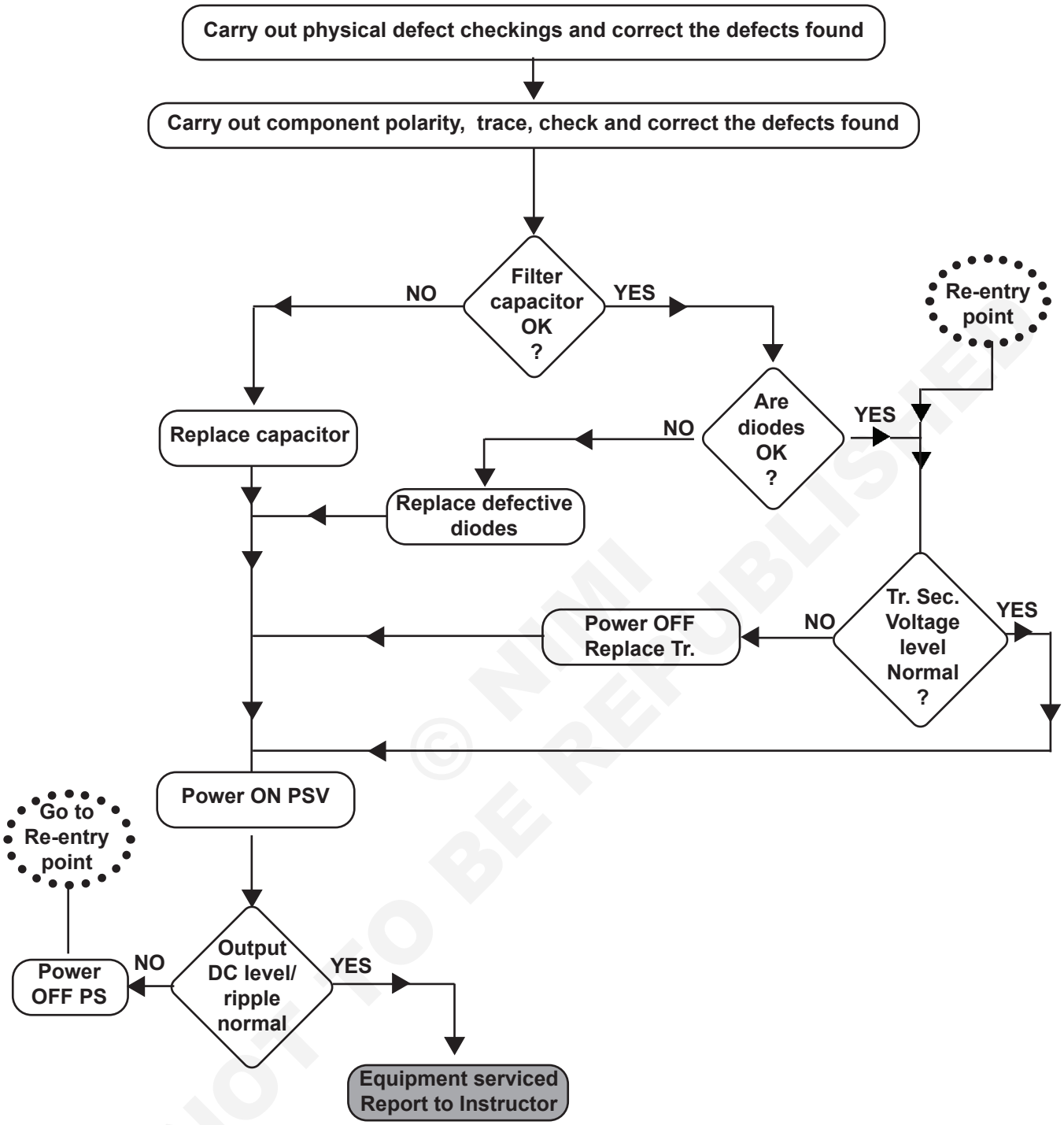
8 Interpret the problem Tree-Chart 1 & 2 (PTC-1 & PTC -2) and locate the exact fault / repair.

TABLE 2

Sl.No.	Name of the defective component	Nature of defect observed	Specification the component to be replaced	Equivalents, if any, for the components to be replaced	Specification of the component to be replaced

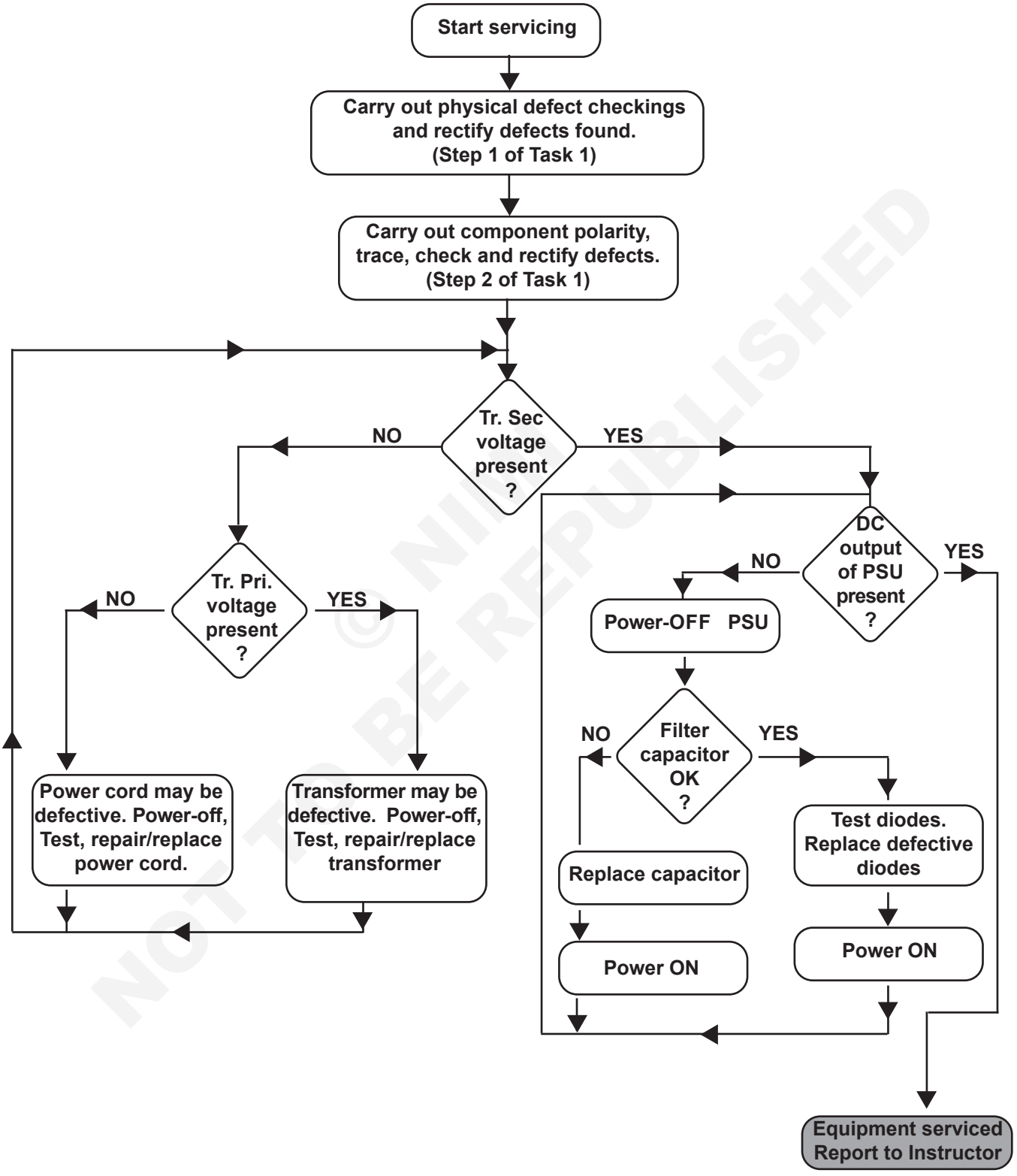
— — — — — —

NATURE OF DEFECT : **Low output DC**



Service Flow Sequence (SFS-2)

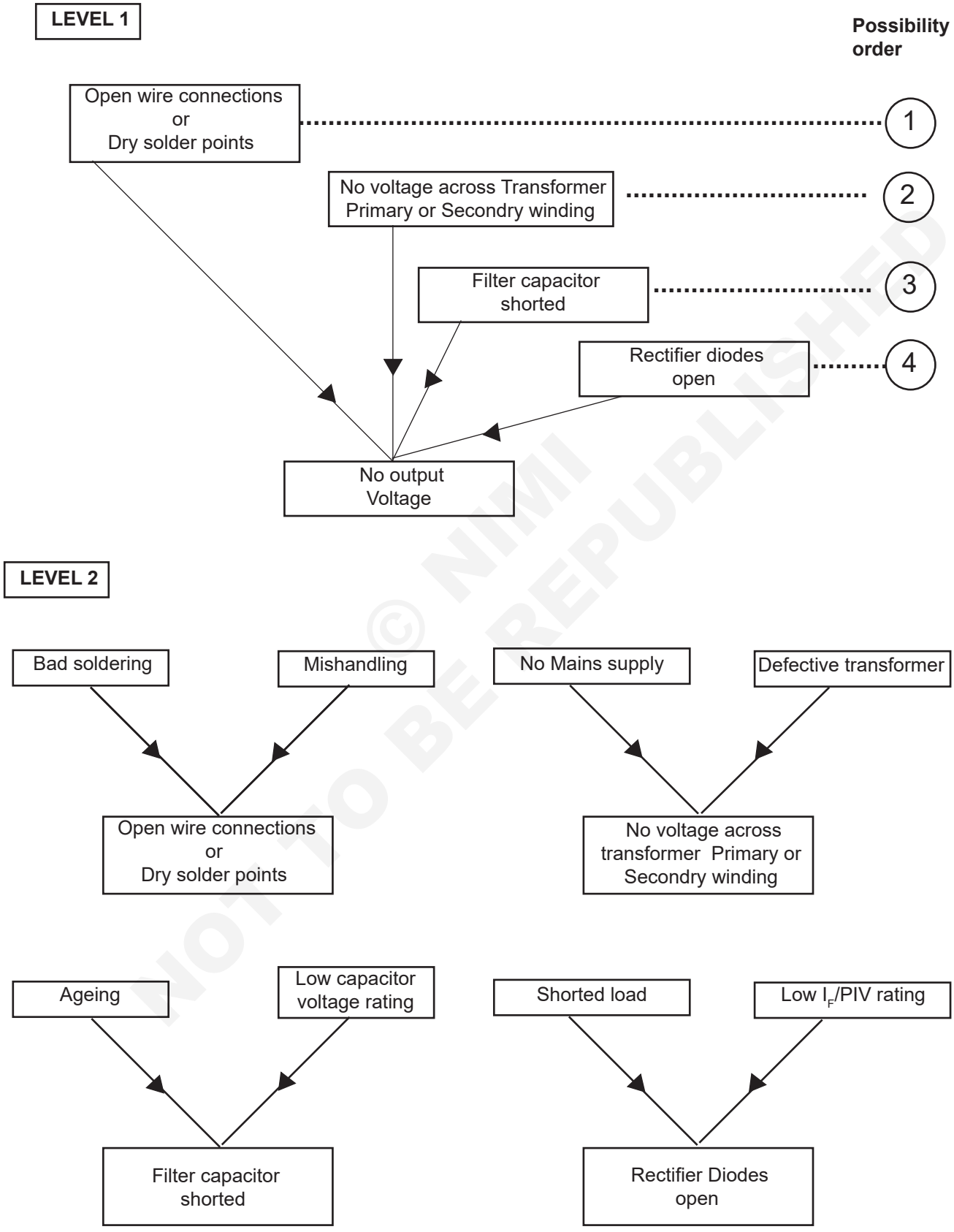
NATURE OF DEFECT : **Defective power supply with NO OUTPUT VOLTAGE**



Problem Tree Chart -1 (PTC-1)

NATURE OF DEFECT : **No Output voltage**

TYPE OF SYSTEM : **Bridge rectifier with capacitor filter**

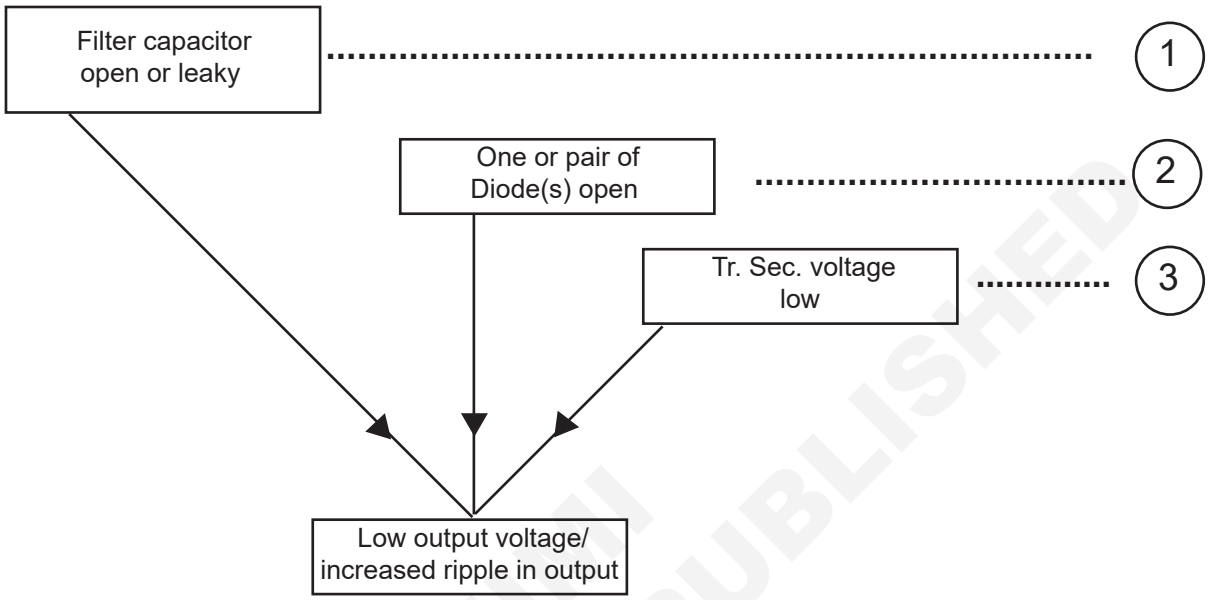


Problem Tree Chart -2 (PTC-2)

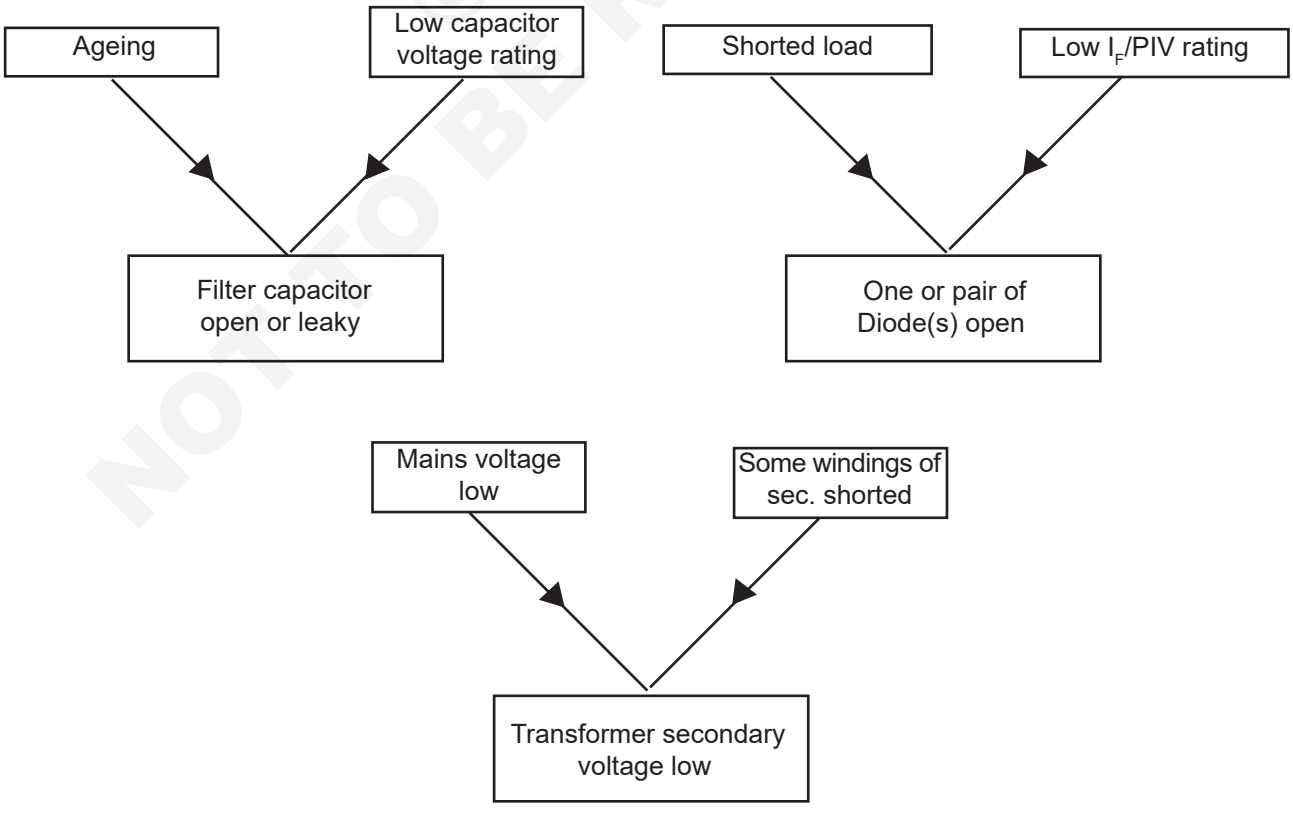
NATURE OF DEFECT : **Low Output DC/Increased ripple**

TYPE OF SYSTEM : **Bridge rectifier with capacitor filter**

LEVEL 1



LEVEL 2



Identify different components and circuits of CFL & LED lamps

Objectives: At the end of this exercise you shall be able to
- **identify the components of the CFL lamps**
- **explain the function of various components in CFL lamp**
- **state the function of each component in LED lamp**
- **explain the function of various components in LED lamp.**

Requirements

Tools/Instruments

- Multimeter Digital - 1 No.
- Wire stripper 150mm - 1 No.
- Combination plier 200mm - 1 No.
- Screw driver 150mm - 1 No.
- Tester 0- 500V - 1 No.

Materials/Components

- Different wattage CFL lamps - as reqd.
- Different wattage of LED lamps - as reqd.

PROCEDURE

TASK 1 : **Identify the parts of a CFL lamps (Fig 1)**

1 Lamp cover 2 Glass tube

3 Phosphor coating 4 Electrodes

5 Ballast 6 Lamp base

1 Lamp cover : Compact flurosent bulbs have a cover over the glass tube and give the required shape of bulb

2 Glass tube: Glass tube through which light is traveling which produces the gases and mercury

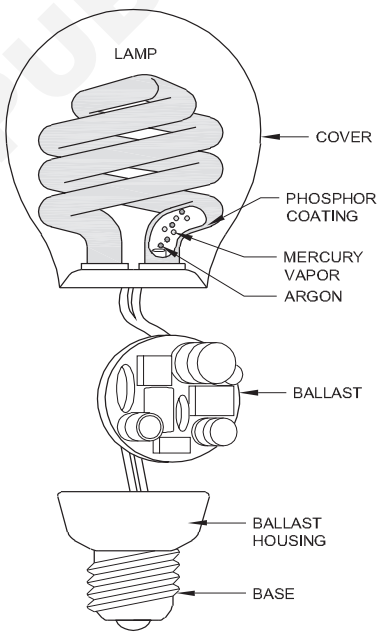
3 Phosphor coating : Inside the glass tube visible light energy is produced with mercury and other gasees

4 Electrodes: Current is flowing between the electrodes inside the tube

5 Ballast: Regulates the voltage into the lamp

6 Lamp base: It is holding the ballast and other parts and it is used to hold the lamp in the holder to connect.

Fig 1



PARTS OF CFL LAMP

Table 1

Sl.No	CFL lamp Wattage	CFL lamp voltage	Parts you observed in lamp	Components in CFL lamp ballast	Remarks

— — — — — —

TASK 2 : **Identify the main components of an LED lamp**

1 LED (light emmiting diode): It is a source of light it will illuminate the light by the movement of electrons by passing a current in semi conductor

2 Driver : Regulated voltages is flowing through the LED, output can be propotional to current; if slight variation voltage changes in light output, because the led driver is a very key component.

3 Solid state lighting : It is used in LED's solid state lights are not required head elements as a filements LED light is formed semiconductors junction.

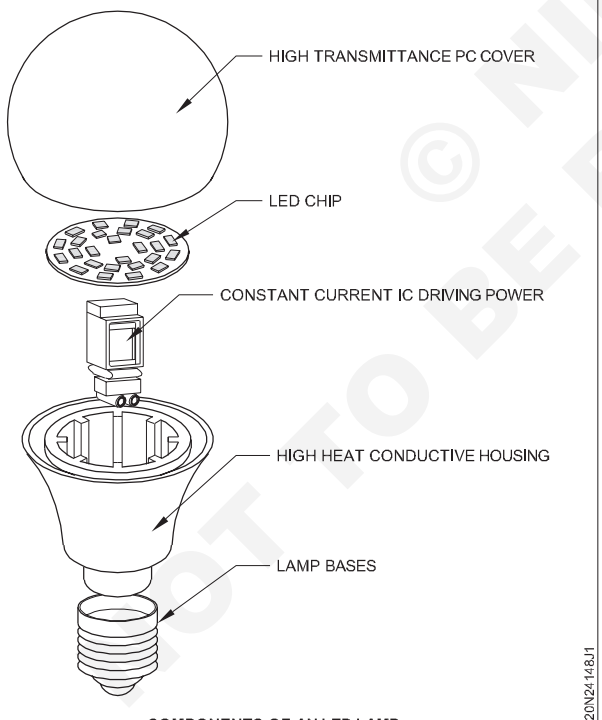
4 Heat sink and the optic lens: It is a key component in LED.LED's do not generate much external heat but generate internal. If heat is generated in side of the LED life of the bulb is decreases and also effects the quality of light.

5 Lamp base: holds all parts of lamp and it is used to hold the lamp in holder to connect.

Table 2

Sl.No	LED lamp watt	LED lamp voltage	Parts you observed in lamp	Components observed in LED lamp	Remarks

Fig 1



COMPONENTS OF AN LED LAMP

Wireman - CFL/LED lamps & DC regulated power supply

Check faulty section/ component of LED & CFL practice for repairing

Objectives: At the end of this exercise you shall be able to
- **identify the fault components in CFL lamps**
- **replace the fault components and repair CFL lamp**
- **identify the fault components in LED lamps**
- **replace the fault components and repair LED lamps.**

Requirements

Tools/Instruments

- Multimeter - 1 No.
- Wire stripper - 1 No.
- Combination plier - 1 No.
- Screw driver - 1 No.
- Tester - 1 No.
- Soldering iron - 1 No.

Materials/Components

- Faulty components - as reqd.
- Different wattage CFL & LED lamps - 1 No each.
- Spare components - as reqd.
- Flux and lead - as reqd.

PROCEDURE

TASK 1 : **Check CFL lamp**

1 Before opening the CFL lamp ensure that the supply is switched off

2 Open the cap securely

3 Check each component with a multi - meter

4 Note down the result in table 1

5 Replace the component which are not working.

Table 1

Sl.No	Name of the component	Rating of the component	Fault observed	Replaced component	Fault rectified		Working or Not
					Yes	No	

— — — — — —

TASK 2: **Check LED lamp**

1 Before opening the LED lamp ensure that the supply is switched off

2 Open the lamp securely

3 Check each component with a multi - meter

4 Note down the fault in table - 2

5 Replace the components which are not working.

Table 2

Sl.No	Name of the component	Rating of the component	Fault observed	Replaced component	Fault rectified		Working or Not
					Yes	No	

— — — — — —

Construct a solar lantern using solar PV panel (15 W) charge controller (6V-5A) output control circuit for variable illumination, rechargeable battery (6V,7Ah) and DC LED lamp (5W)

Objectives: At the end of this exercise you shall be able to

- **assemble, test, install and maintain solar lantern and rechargeable battery ((6V, 7Ah and DC LED lamp (5W).**

Requirements

Tools and Equipments

- Solar PV panel (15W) - 1No.
- Charge controller (6V, 5A) - 1No.
- Output control circuit for variable illumination - 1No.
- Rechargeable battery (6V, 7Ah) - 1No.
- DC LED lamp (5W) - 1No.
- Lantern assembly kit - 1No.
- Solar PV module,75W - 1No.
- LED lamp 12V DC,5W - 1No.
- Dusk to dawn charge controller 12V, 10A - 1No.
- Solar battery,12V, 100Ah - 1No.

PROCEDURE

TASK 1: **Assemble, test, install and maintain solar lantern (Fig 1)**

1 Fix the LED bulb to the holder.

2 Fix the LED bulb – holder assembly to the Top cover of the Lantern

3 Connect the wires one end to the Bulb holder and other end to the output of “Output control circuit for variable illumination’

4 The Rechargeable battery and Output control circuit to the corresponding terminal points on Charge controller

5 Fix the Rechargeable battery in the Bottom piece of the Lantern.

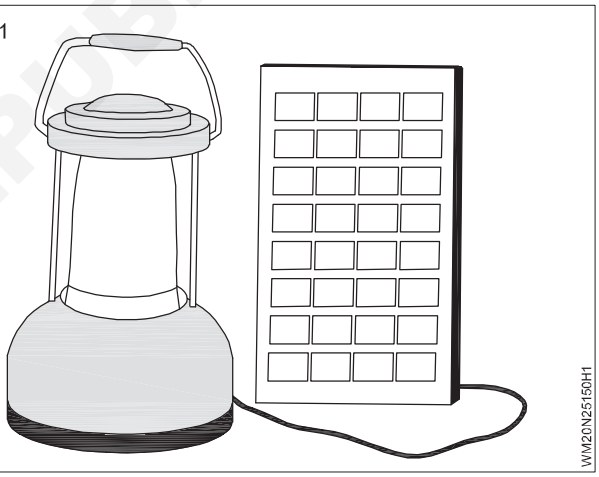
6 Fix the Charge controller and the output control circuit board

7 Complete the assembly

8 Place the solar panel in sunlight and test the kit

9 Record the observations

Fig 1



10 After completion the exercise write down the observation.

Observations:

TASK 2: **Test a dusk to dawn charge controller using other essential components**

Note

The SPV Module receives solar energy and converts it into electrical energy.

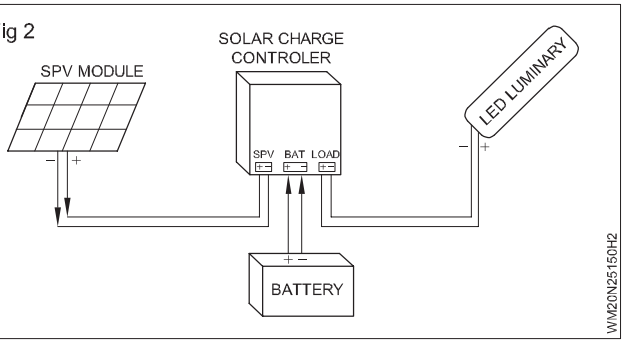
Converted electrical energy is stored in the battery through solar charge controller

When the light intensity reduced to about 10 lx during sun set, charge controller will turn ON the LED Light

Battery provides the energy to luminary and discharges as time passes

When sun rises again next morning the charge controller will turn off the LED Light

Fig 2



During night if battery voltage reduces below its critical value the charge controller will turn off the LED light to protect battery from deep discharge.

1 Connect the Solar battery 12V/100Ah to the battery input terminals of the Dusk to Dawn charge controller 12V/10A

2 Connect LED lamp 12V DC/5W to the output terminals of the Dusk to Dawn charge controller

3 Connect the Solar PV module,75W to the solar input terminals of the Charge controller

4 Place the solar panel in sunlight

5 Check the indication in charge controller showing the battery charging going ON

6 After the charging is complete the indication shows intermittent

7 Observe at sunset when it becomes dark the LED automatically lights ON

8 Alternatively, during daylight if testing is required then the positive input terminal from Panel to charge controller can be disconnected to see the LED automatically lights ON.

Observations:

Construct a solar day- lighting using manual charge controller(12V 10A), solar battery (12V 100 Ah), solar panel (75W) and 4 X LED light (12V DC 5W)

Objectives: At the end of this exercise you shall be able to
- **install and test manual day lighting solar system.**

Requirements

Tools and Equipments

- Manual charge controller (12V, 10A) - 1No.
- Solar battery (12V, 100Ah) - 1No.
- Solar panel (75 W) - 1No.
- 4X LED light (12V DC, 5W) - 1No.
- Sockets, switches, wires as necessary - 1No.

PROCEDURE

1 Wire the load circuit using conduit pipes, Sockets, switches, wires etc in parallel connection. Take care of polarities

2 Keep the switches in OFF positions

3 Connect the LED bulbs

4 Verify the charge controller is in OFF position

5 Connect the load wires positive and negative to the corresponding output ports on charge controller

6 Connect the fully charged Solar battery (12V, 100Ah) to the battery input terminals of charge controller

7 Connect the Solar panel (75 W) to the solar input-terminals of charge controller

8 Place the solar panel in sunlight

9 Check charging 'LED' is ON

10 Switch ON the charge controller

11 Verify output LED is ON

12 Switch ON LED bulbs one by one and test the Day lighting circuit

13 After completing the exercise write down observation.

Observations:

— — — — — —

Construct a solar street light using dust to dawn charge controller (12V,10 A), solar battery (12V 100 Ah), solar panel (75W) and 4X LED light (12V DC, 5W)

Objectives: At the end of this exercise you shall be able to
- **construct foundation for pole of street light**
- **install and test solar streetlight.**

Requirements

Tools and Equipments

- Civil construction work related tools: crowbar, spade etc - 1No.
- Marking pen and nail - 1No.
- Thread - 1No.
- Measuring tape - 1No.
- Ruler - 1No.
- Tool kit - 1No.
- Safety gadgets - 1No.
- Solar PV module - 1No.
- LED lamps - 1No.
- Light pole - 1No.
- Control box (charge controller, battery) - 1No.

Materials

- Gravels, sand, cement as per requirement - 1No.
- Pole - 1No.
- Marking - 1No.
- Digging - 1No.
- Bar bending - 1No.
- Filling concrete mix - 1No.
- Curing concrete - 1No.

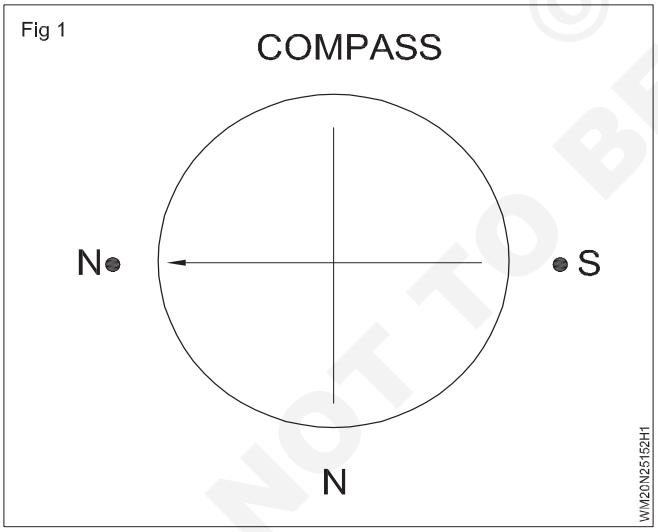
PROCEDURE

TASK 1 : **Marking of street light poles**

1 Use compass and mark true north and south poles

2 Draw line connecting north and south poles points Fig 1

Fig 1



3 Place the pole mount aligned to the connecting lines

Making foundation on ground

- Mark the base
- Remove the pole mount
- Dig pit (Crater) as per drawing (Example: if Base is 1ft x 1 ft then the crater should be 1ft x 1 ft x 1.5ft as shown)
- Use the wooden stencil of base of the pillar mount
- Fix the bar bended TMT rods with thread on top end on to the stencil
- Keep the assembly in the carter with the stencil on ground level Fig 2
- Fill in concrete mortar in the pit and allow to harden doing proper curing
- Remove the stencil & fasten the bolts; keep ready for next task Fig 3

Fig 2

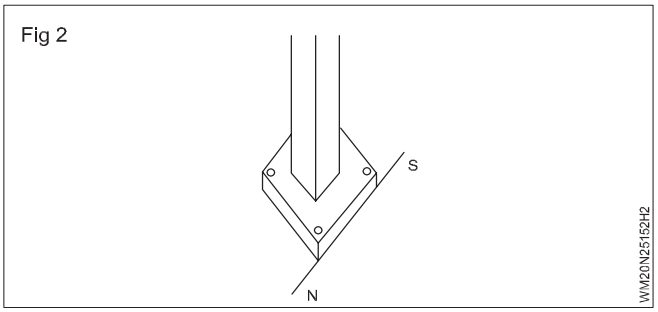
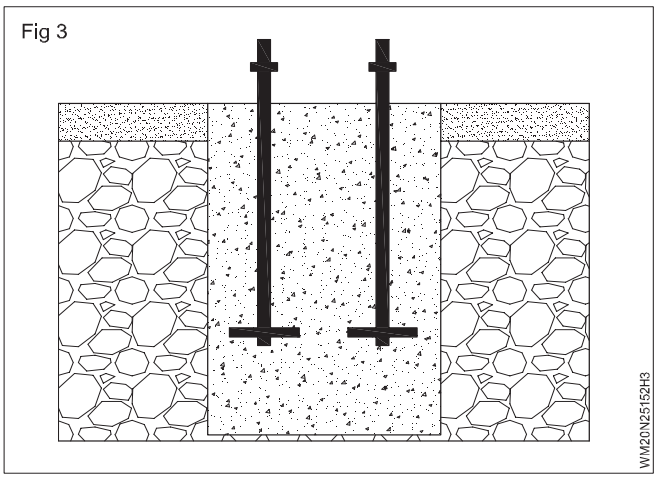


Fig 3



TASK 2 : **Assembly of Street light pole**

1 Assemble the Control box with charge controller and battery inside.

2 Do the wiring from battery to the controller, wires for the lamp and solar panel and bring outside the box

3 Insert the wires through the middle hole in the pole and draw it internally till top hole of the pole

4 Assemble the lamp holder with LED light and fit to the Holding arm.

5 Complete the wiring to the LED lights

6 Fix the Solar panel on to the mounting frame and fit the assembly to the Pole top

7 Complete the assembly and check for dusk to dawn functioning of charge controller

8 Remove any error if so

9 Erect the pole and fit on to the mounting screw on the base made in Task 1

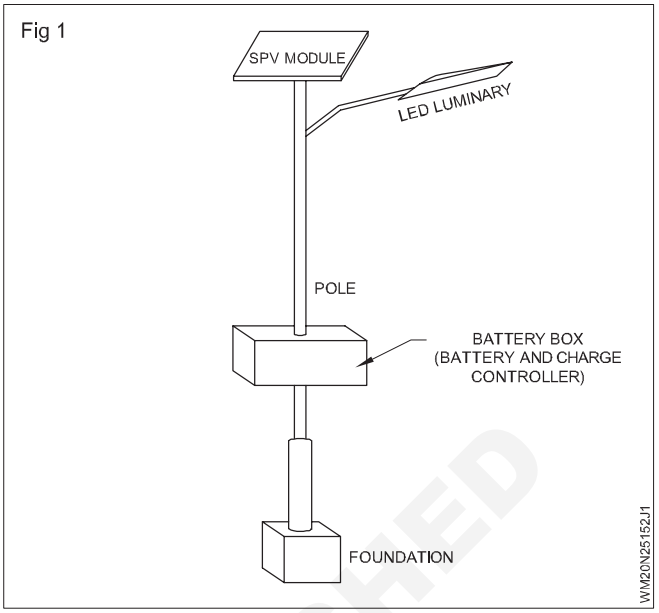
Parts of Typical Solar Street Light (Fig 1)

Luminary Integrated solar LED Street light

Electric connection of the solar street light system

10 Verify the solar panel orientation as shown in the figure above

Fig 1



11 Charging continues in the day time and stops once battery is fully charged

12 In the evening after sunset the LED lamp lights ON

13 Testing we can do by removing one of the panel wire from charge controller and then connecting back

— — — — — —

Construct a Solar water pump using a D.C pump (24 V) solar panel (250 W) charge controller (24V,10A)

Objectives: At the end of this exercise you shall be able to
- **install and test solar DC water pump.**

Requirements

Tools and Equipments

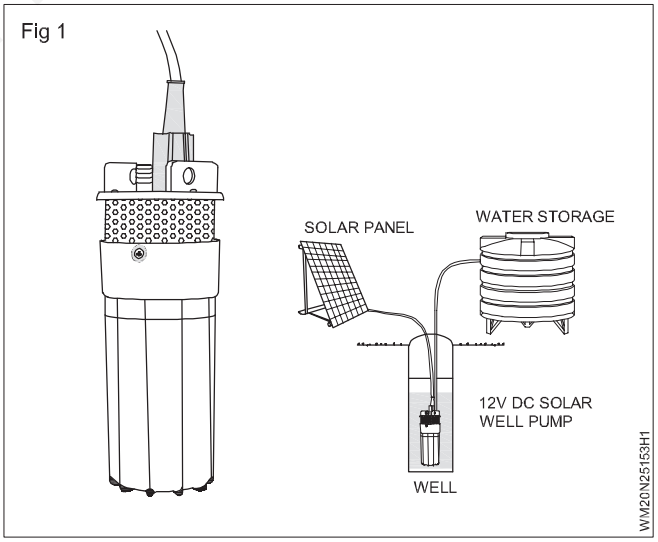
- Manualcharge controller (24 V, 20A) - 1No.
- Solar battery (2 X 12V, 100Ah) - 1No.
- Solar panel (250 W) - 1No.
- DC water pump (24V DC, 10A) - 1No.
- Bucket of Water - as reqd.
- Inlet and outlet tubes - 1No.
- Sockets, switches, wires - as reqd.

PROCEDURE

Note: If DC 12 V water pump is available, use Charge controller 12 V 10 A, solar battery 12 V, 100 AHr and Solar panel 75 W

- Wire the load circuit using conduit pipes, Sockets, switches, wires etc. Take care of polarities.
- Keep the switches in OFF positions
- Connect the DC water pump
- Connect water tubes to inlet and outlet mouths of water pump
- Immerse other end of inlet tube inside the bucket of water
- Keep the other end of outlet tube near top of bucket so that the water may fall inside bucket
- Verify the charge controller is in OFF position
- Connect the load wires positive and negative to the corresponding output ports on charge controller
- Connect the fully charged Solar battery bank (2 X 12V, 100Ah connected in series) to the battery input terminals of charge controller
- Connect the Solar panel (75 W) to the solar input terminals of charge controller
- Place the solar panel in sunlight
- Check charging 'LED' is ON
- Switch ON the charge controller
- Verify output LED is ON
- Switch ON the water pump and wait for water to get pumped and flow in the bucket
- If water is not pumped but still pump is ON switch OFF immediately and check for the problem if any. The inlet tube may not immersed in water, or inlet tube may have air block/bubbles inside or the solar panel may be in shade or not giving enough current. Do not 'Dry run' the pump because it may spoil the motor in it.
- Write down the observations.

Fig 1



Observations

Connect a solar panel (10W), solar charge controller (12V, 10A), solar battery (12V, 100 Ah) and a normal inverter and convert to a solar inverter

Objectives: At the end of this exercise you shall be able to
- **connect a normal inverter to function as a solar inverter by adding a solar panel and charge controller.**

Requirements

Tools and Equipments

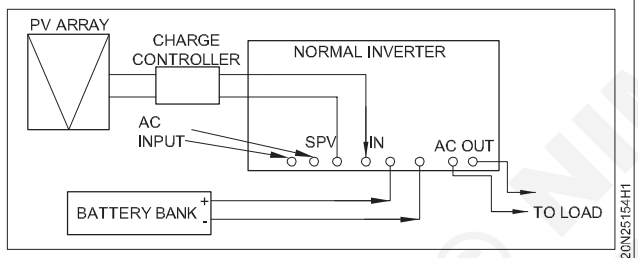
• 12V DC/230V AC normal inverter	- 1No.	• Load bank	- 1No.
• Solar panels 75 W x 2	- 1No.	• 12V 100 AHr battery	- 1No.
• Charge controller	- 1No.	• Clamp meter	- 1No.

PROCEDURE

- Study the inverter wiring diagram and connect the components of the solar inverter.

Normal to Solar Inverter wiring (Fig 1)

Fig 1



Wiring Sequence

- Wire the charge controller
- Connect charge controller to battery
- Connect battery to inverter
- Connect panel to charge controller
- Connect loads

In all the above steps wire or connect means only physical connection. But not energizing.

- Keep all MCB in OFF position and fuses removed for safety.
- Follow the testing sequence of the inverter in and test the solar in verter in a similar way for normal load, full load and overload conditions
- Record the observations.

Observations:

Prepare bill of material for a 1 kW solar PV installation

Objectives: At the end of this exercise you shall be able to
- **select components for 1 kW SPV after sizing**
- **draw SLD for 1 kW SPV system.**

Requirements

Tools and Equipments

- Inputs regarding sizing of PV plants (from Trade Theory book as well as websites)
- Inputs from market about component specifications
- Input from market about cost of components

Note:

Knowledge of matching the specifications of components.

Knowledge of SLD.

Inputs from market about component specifications.

Input from market about cost of components.

Knowledge of matching the specifications of components.

PROCEDURE

TASK 1: **Discuss different probabilities of combinations of making 1 KW solar PV installation**

1 Study related theory and also from web about the technical details.

2 Discuss among trainees and instructors, the technical feasibilities.

3 Prepare at least three variants which deliver 1000 W AC power output.

4 Consider cost variation also.

5 Record your observations.

6 Prepare SLDs for each case.

Observations

Sl.No	Bills of Materials	Quantity

— — — — — —

TASK 2: **Prepare a bill of materials for the given SLD**

1 Study the SLD.

2 Review the sample component profiles.

3 Collect similar specifications from market.

4 Discuss and prepare a bill of materials for purchase.

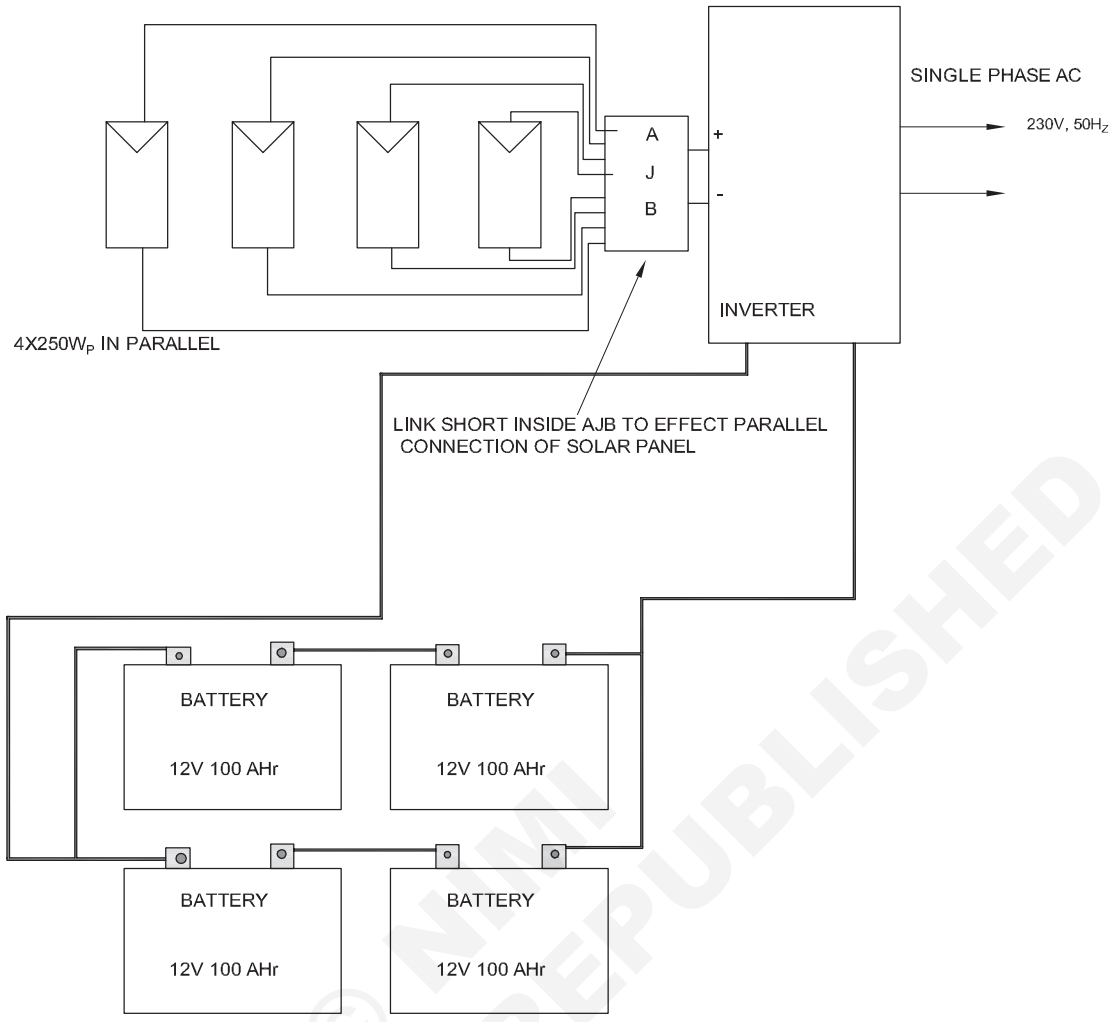
SLD

SLD for 1 kW using parallel combination of solar panels (Fig 1)

Bill of materials

Sl.No	Bill of Materials	Quantity

Fig 1



TASK 3: **Prepare bill of materials for 1 kW SPV off grid plant**

1 Similar to task 2 above consider serial connection of solar panels.

2 Draw a SLD for 1 kW SPV off grid plant with serial connection of solar panels.

3 Consider changes required in ratings of other components.

4 Prepare bill of materials.

5 Bill of materials:

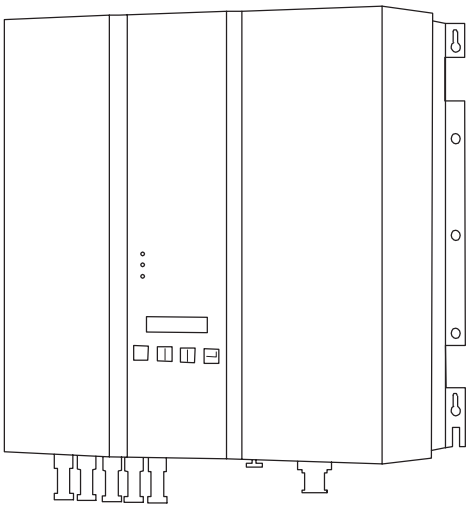
Sample product profiles

1 For academic interest only; not recommended commercially.

2 Similar products from different manufacturers are available in market.

Transformer-based string inverter (Fig 2)

Fig 2



Demonstrate automatic manufacturing of solar panel through audio visual aids

Objectives: At the end of this exercise you shall be able to
- **make a solar panel.**

Note:

- **Visit to solar panel manufacturing industry.**
- **Obtain in-plant training through MoU from institute with the industry.**
- **Audio-video sessions of making solar panels.**

PROCEDURE

TASK 1: **Learn the skills of making solar panel in automatic manufacturing**

1 Learn the processes in automatic manufacturing of solar panels.

2 Prepare a project report.

Observations

Sl.No	List of observation

— — — — — —

Demonstrate installation of solar street light

Objectives: At the end of this exercise you shall be able to
- **construct foundation for pole of street light**
- **install and test solar streetlight.**

Requirements

Tools and Equipments

- Civil construction work related tools: crowbar, spade etc - 1No.
- Marking pen and nail - 1No.
- Thread - 1No.
- Measuring tape - 1No.
- Ruler - 1No.
- Tool kit - 1No.
- Safety gadgets - 1No.
- Solar PV module - 1No.
- LED lamps - 1No.
- Light pole - 1No.
- Control box (charge controller, battery) - 1No.

Materials

- Gravels, sand, cement - as reqd.
- Pole - 1No.
- Marking - 1No.
- Digging - 1No.
- Bar bending - 1No.
- Filling concrete mix - 1No.
- Curing concrete - 1No.

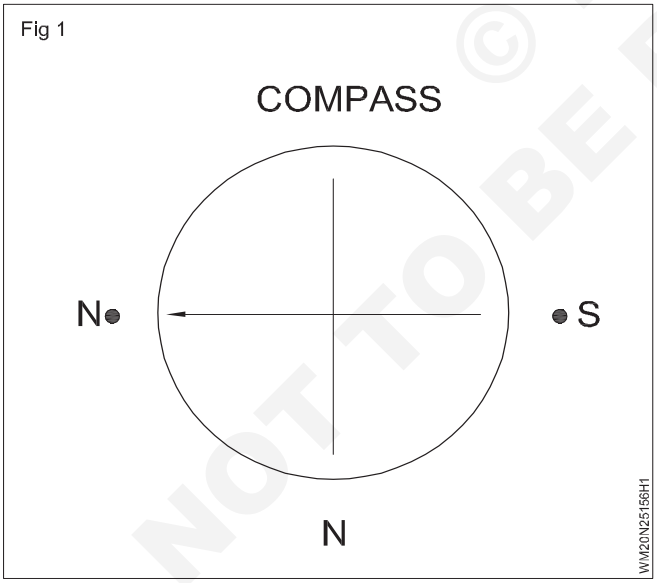
PROCEDURE

TASK 1 : **Marking of street light poles**

1 Use compass and mark true north and south poles

2 Draw line connecting north and south poles points (Fig 1).

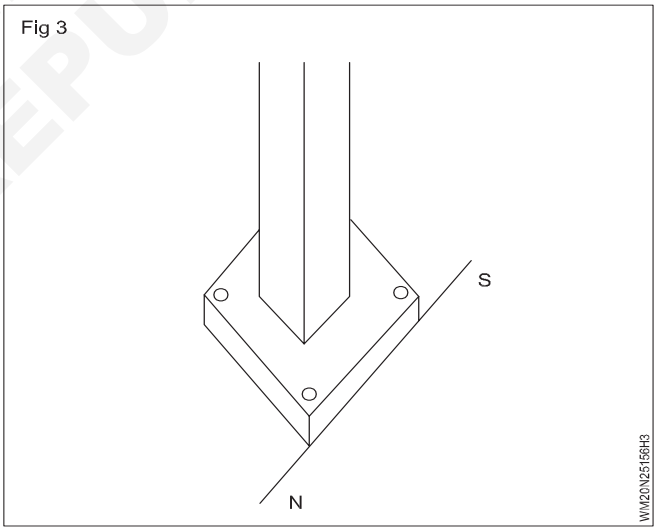
Fig 1



3 Place the pole mount aligned to the connecting lines (Figs 2 & 3)

Fig 2

Fig 3



Making foundation on ground

- Mark the base
- Remove the pole mount
- Dig pit (Crater) as per drawing (Example: if Base is 1ft x 1 ft then the crater should be 1ft x 1 ft x 1.5ft as shown)
- Use the wooden stencil of base of the pillar mount (Fig 4)
- Fix the bar bended TMT rods with thread on top end on to the stencil
- Keep the assembly in the carter with the stencil on ground level

Fig 4

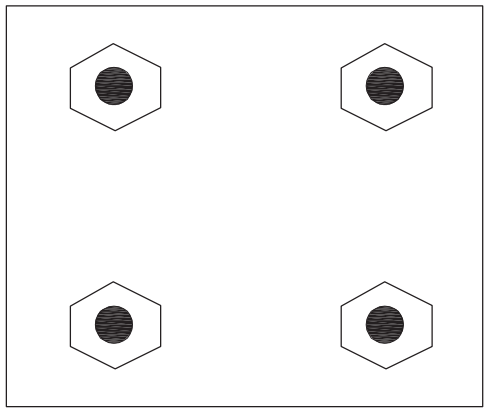


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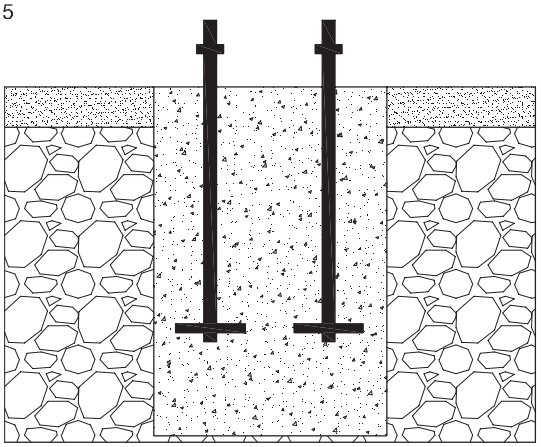
Fig 5



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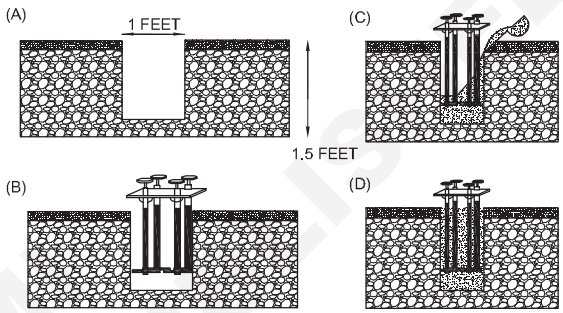
- Fill in concrete mortar in the pit and allow to harden doing proper curing
- Remove the stencil & fasten the bolts; keep ready for next task (Figs 5 & 6)

Fig 6



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TASK 2 : **Assembly of Street light pole**

1 Assemble the Control box with charge controller and battery inside. (Figs 1 & 2)

Fig 1

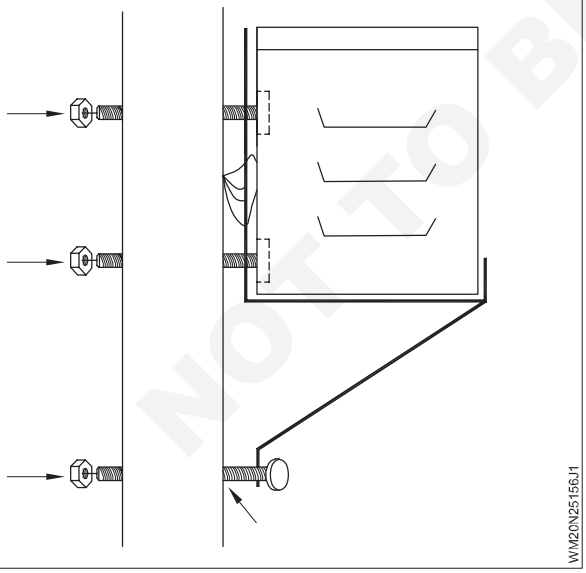

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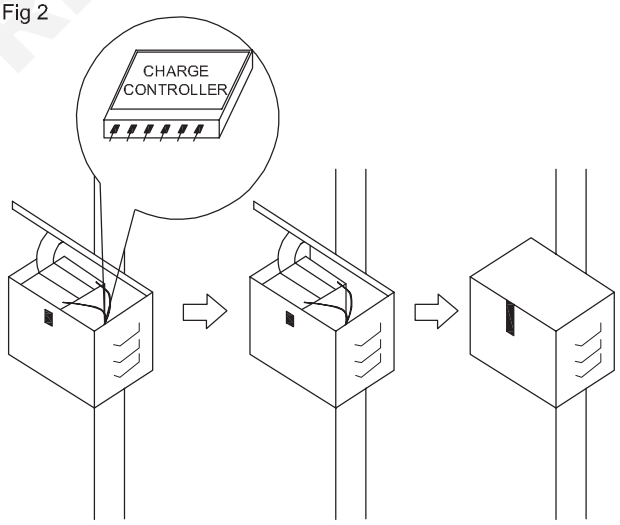
Fig 2



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2 Do the wiring from battery to the controller, wires for the lamp and solar panel and bring outside the box

3 Insert the wires through the middle hole in the pole and draw it internally till top hole of the pole

4 Assemble the lamp holder with LED light and fit to the Holding arm. (Figs 3 & 4)

Fig 3

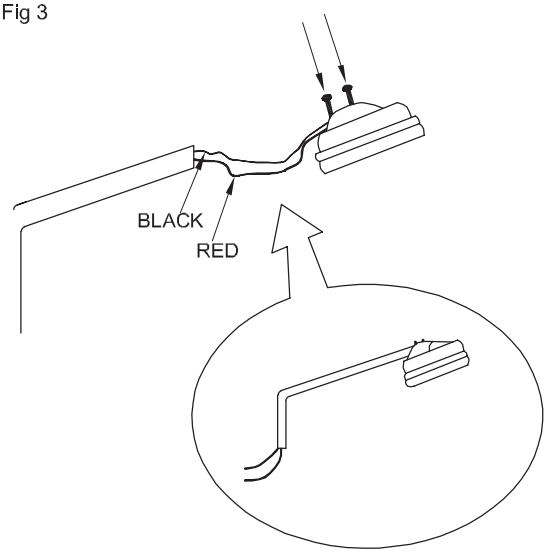
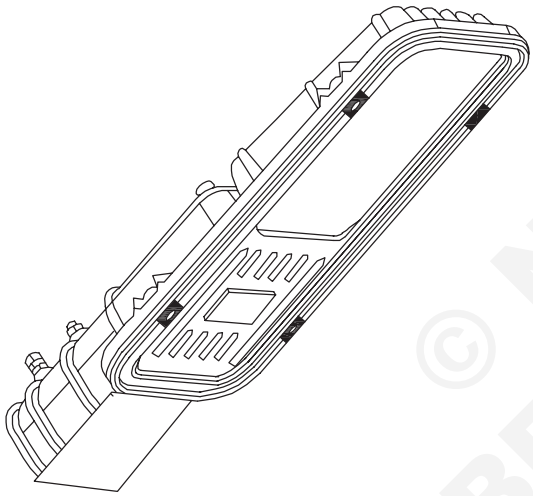
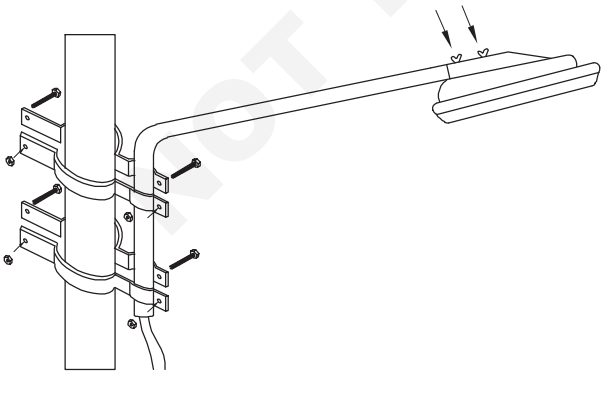


Fig 4



5 Complete the wiring to the LED lights (Fig 5)

Fig 5



6 Fix the Solar panel on to the mounting frame and fit the assembly to the Pole top (Figs 6 & 7).

7 Complete the assembly and check for dusk to dawn functioning of charge controller

Fig 6

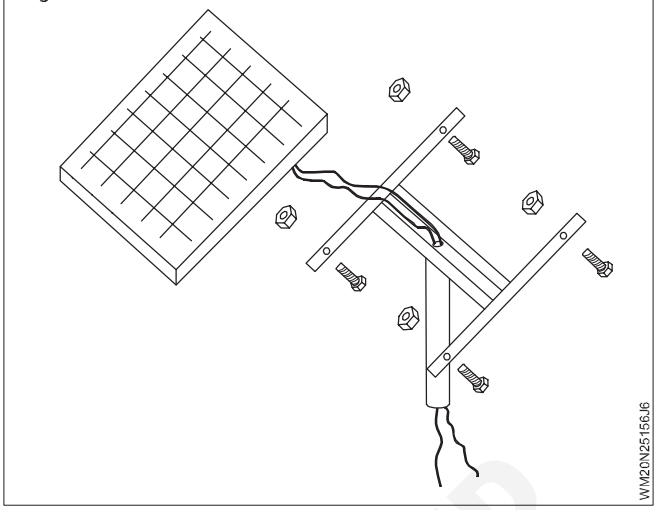
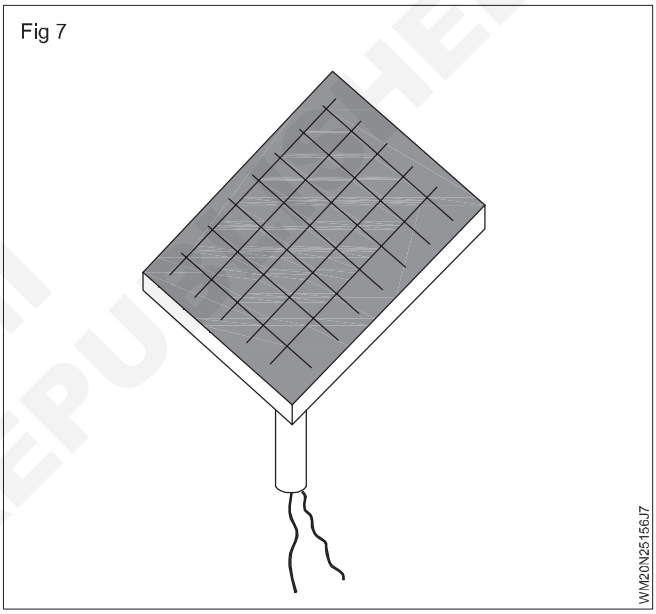


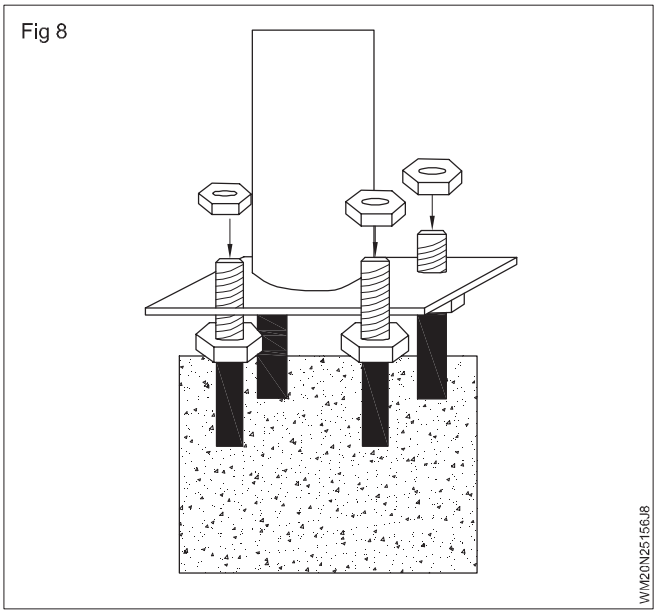
Fig 7



8 Remove any error if so

9 Erect the pole and fit on to the mounting screw on the base made in Task 1 (Fig 8)

Fig 8



Parts of Typical Solar Street Light (Fig 9 &10)

Fig 9

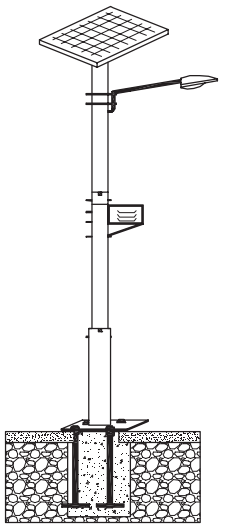


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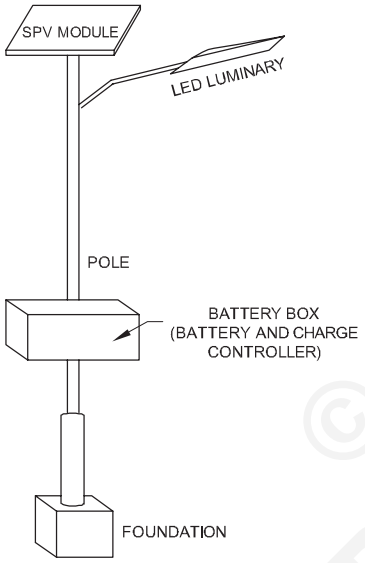
Fig 10



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Luminary Integrated solar LED Street light (Fig 11)

Electric connection of the solar street light system (Fig 12)

10 Verify the solar panel orientation as shown in the figure above

11 Charging continues in the day time and stops once battery is fully charged

12 In the evening after sunset the LED lamp lights ON

13 Testing we can do by removing one of the panel wire from charge controller and then connecting back.

Fig 11

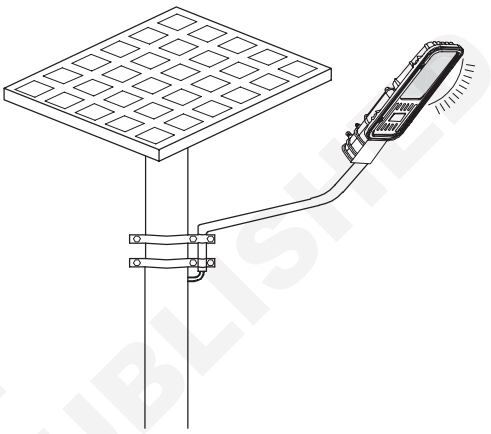

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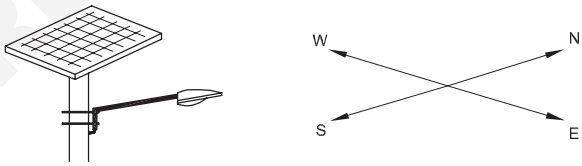
Fig 12



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Demonstrate solar fertilizer sprayer

Objectives: At the end of this exercise you shall be able to
- **construct and test a solar fertilizer sprayer.**

Requirements

Tools and Equipments

- Rechargeable Battery (6 Volt, Lithium battery) operated miniature motorized (DC) water sprayer (Pump and hose with nozzle end) - 1No.
- Container for liquid (Fertilizer or pesticide) - 1No.
- Solar panel 10 W - 1No.
- Charge controller 6 V/5A - 1No.
- Shoulder back holding brackets or jackets - 1No.

PROCEDURE

TASK 1 : **Make a solar fertilizer sprayer**

1 Wire the charge controller.

2 Connect the battery terminals to ports on charge controller.

3 Connect the DC Motor-pump to the output of charge controller.

4 Connect the Solar panel 10 W through switch to the input of Charge controller.

5 Keep the switch in OFF position.

6 Construct the sprayer using the solar panel on exposed back side and jacket or holding bracket on the other side. Battery positioned behind panel.

7 Pour liquid (diluted fertilizer or pesticide as the case may be) in the container.

8 Hold the combined set on shoulder back.

9 Switch On the circuit.

10 Press the nozzle and test pump starting.

11 Demonstrate spraying.

Refer the picture below

Solar Fertilizer/Pesticide sprayer (Fig 1)

Circuit diagram for a solar DC product (Fig 2)

Fig 1

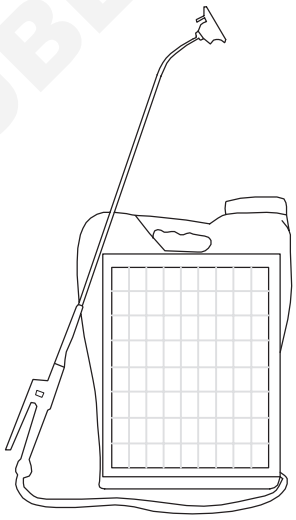

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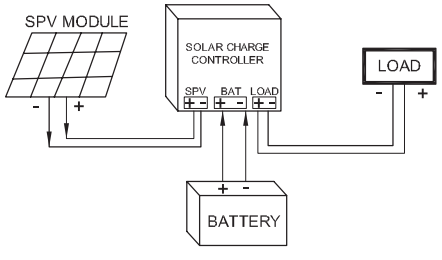
Fig 2



WM20N25156X2

Demonstrate solar water pump

Objectives: At the end of this exercise you shall be able to
- **construct and test solar water pump.**

Requirements

Tools and Equipments

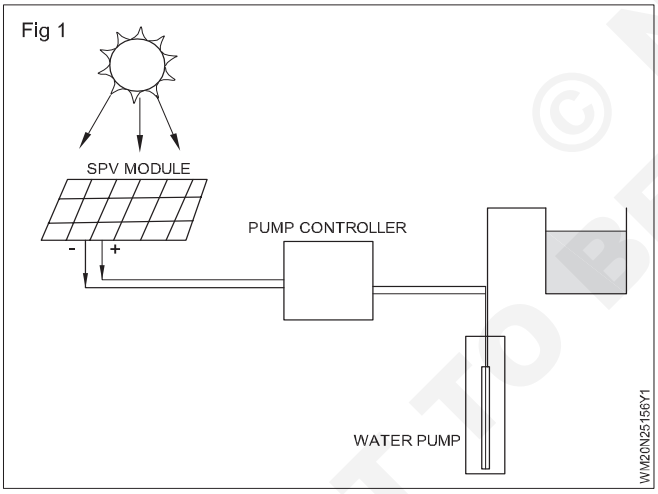
- D.C. Motor Pump Set with Brushes or Brush Less D.C.(B.L.D.C.) to pump 50 liters of water per watt peak of PV array, from a Total Dynamic Head of 20 metres (Suction head, if applicable, up to a maximum of 7 metres) and with the shut off head being at least 25 metres. (AC motor pump and suitable pump controller also another choice) - 1No.
- Suitable pump controller - 1No.
- Solar PV panels, as recommended for the pump purchased from market - 1No.
- Connecting cables and control switches - 1No.
- Tools (Electrical, civil and plumbing requirements - 1No.

Note: As the project is costlier, it is recommended that the institute shall make MoU with local solar PV contractors for involving the Solar technician trainees into on job training while the contractors are in field work as per their work orders.

PROCEDURE

Block Diagram (Fig 1)

Fig 1



Make a solar water pump

1 Select and prepare the location:

The Solar Pump system uses the sun light as the sourceof energy. So the place of installation of the solar pumpsystem shall be;

- Free from shadows caused by the trees for Solar array.
- Free from shadows caused by the buildings or anyerected structures for array.
- Free from natural water channels.
- Plane area.
- Near to the Bore well or the Pump.

If the place does not satisfy the above requirements, thenit is necessary to prepare the suitable place.

2 Civil work

Civil work includes the preparation of proper foundation for mounting structure. the number of SPV modules aremore and all must be mounted on the same structure.So, the foundation must be strong enough to hold theweight of the SPV module and withstand wind. The civilwork includes;

- Prepare the Pit for mounting structure andelectrical ground point.
- Prepare the cement concrete.
- Erect the Structure.

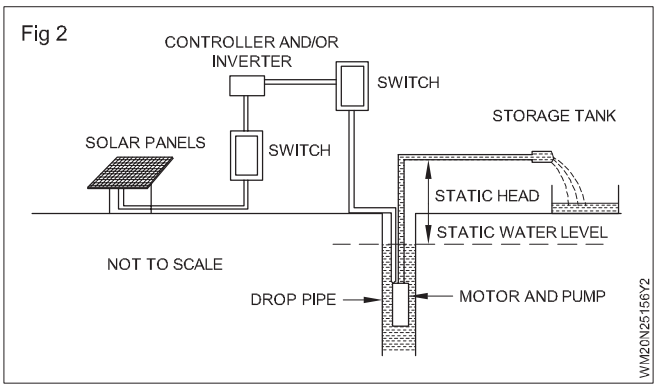
(Refer earlier exercises on Solar PV foundation, mounting of panels, panel wiring etc).

3 Electrical connection

The electrical connection is the process of connectingall the devices electrically together. The typical electricalcircuit diagram of Solar pump system is as shown in Fig 2.

Circuit diagram of solar pump system (Fig 2)

Fig 2



Demonstrate solar traffic light

Objectives: At the end of this exercise you shall be able to
- **construct and test solar traffic lights.**

Requirements

Tools and Equipments

- Manual charge controller rated (12V, 10 A) - 1No.
- Solar battery (12V, 100 Ah) - 1No.
- Solar panel (75 W) - 1No.
- Traffic lights (12 V DC) - 1No.
- Sequence control electronic circuit for traffic lights (Consult Electronic Mechanic tarde) (Check DC supply requirements to match with Charge controller output) - 1No.

PROCEDURE

TASK 1 : **Construct a Solar traffic light**

1 Wire the charge controller.

2 Connect the battery terminals to ports on charge controller.

3 Connect the Sequence control electronic circuit for traffic lights to the output of charge controller.

4 Connect the traffic lights to output of Sequence control electronic circuit.

5 Connect the Solar panel 75 W through switch to the input of Charge controller.

6 Keep the switch in OFF position.

7 Test the connections.

8 Switch On the circuit.

9 Demonstrate traffic light control for different timings.

Block Diagram (Fig 1)

Project work / Industrial visit:

1 Solar -wind Hybrid plant (500 W + 500 W).

2 Report on skills required in the Solar PV installation.

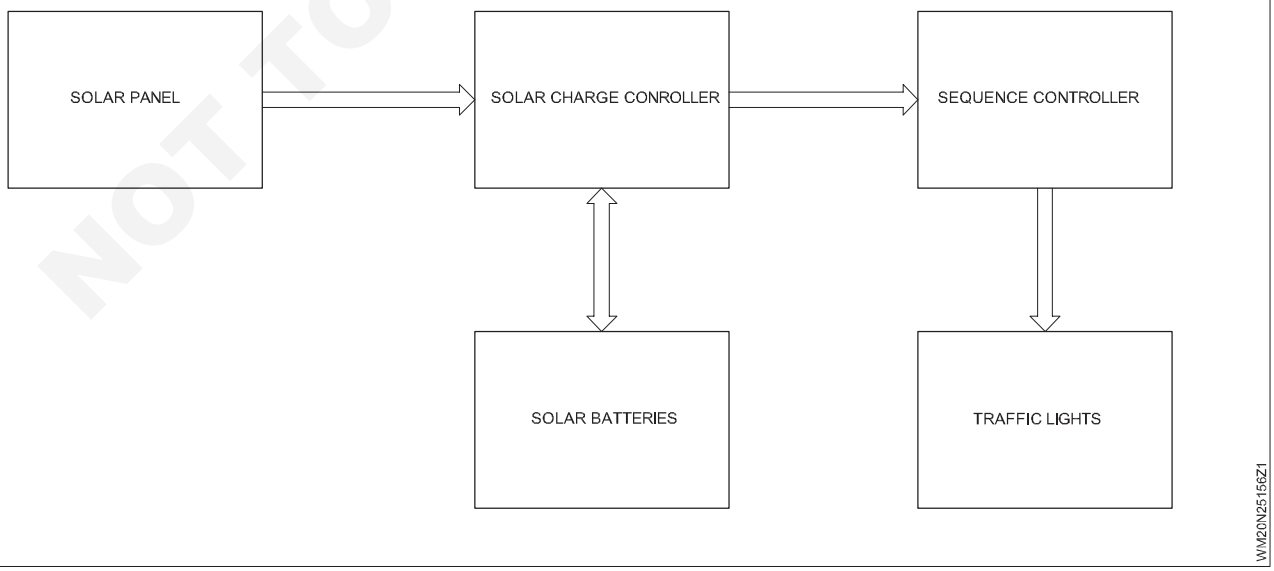
3 Report on existing National and state level energy policy.

4 Report for setting up a small business in the solar industry.

5 Report on recent development s in Renewable Energy Industry.

6 Report on employment opportunities in Renewable Energy Industry globally.

Fig 1



Demonstrate synchornization between solar panel and AC grid supply using visual aids

Objectives: At the end of this exercise you shall be able to
- **perform solar PV plant integration with grid.**

Requirements
Tools and Equipments • Connected solar PV system - 1No.

PROCEDURE

TASK 1 : **Connect solar PV plant with grid**

1 Visit solar PV plant integrates with grid.

2 Study the features.

3 Collect information.

4 Record your observations

5 Design a miniature model of PV plant integrated with grid.

Observation

Sl.No	List of observation

Identify different parts of various underground cables

Objectives: At the end of this exercise you shall be able to
- **identify the voltage grade of the cable**
- **skin the UG cable**
- **dress the UG cable.**

Requirements

Tools/Instruments

- Insulated combination piler 200 mm - 1 No.
- DE Electrician's knife 100 mm - 1 No.
- Hacksaw adjustable 300 mm with blade - 1 No.
- Handvice 50 mm jaw - 1 No.

Materials

- UG cable multicore CU/Al. 30 cm - 1 piece
- Binding wire 16 SWG - as reqd.

PROCEDURE

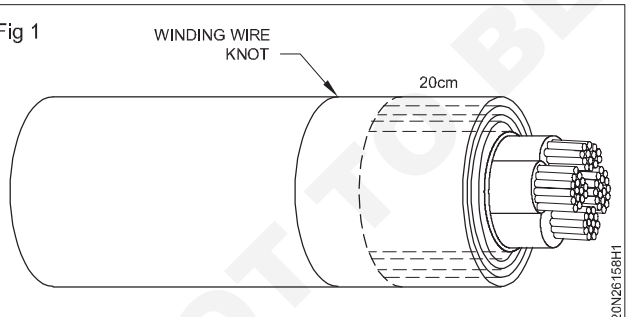
Paper insulated 3, 31/2 core cable may taken. This instructor has to demonstrate the steps for skinning and dressing of cables in this exetcise.

1 Collect the UG cable piece and examine it for physical damage.

2 Bind the winding wire at 20 cm (20 cm at one side) of the UG cable.

3 Mark 18 cm at one end near the binding wire knot from the end where skinning is to be done, as shown in Fig 1.

Fig 1



UG CABLE $3\frac{1}{2}$ CORE

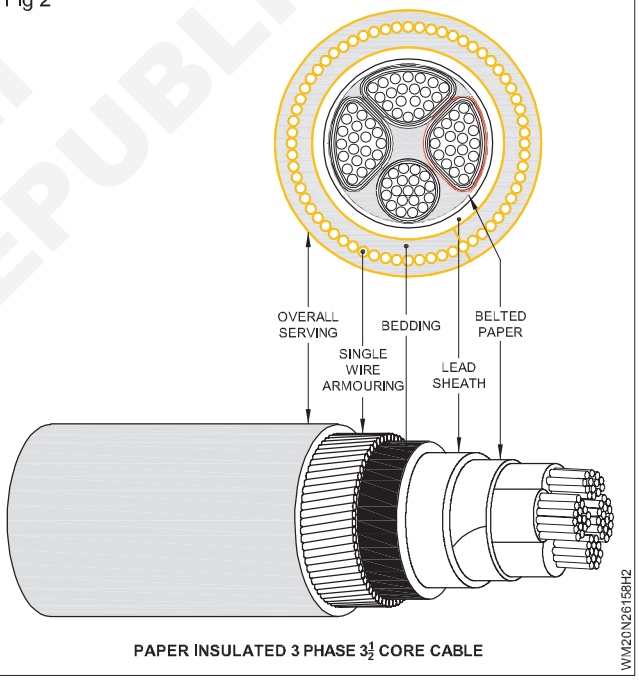
4 Cut the overall serving using the knife and remove the overall serving.

5 Mark 3 cm from the cutting edge and cut the single wire armouring using hacksaw.

6 Mark 3 cm from cutting edge and cut the bending using knife/hacksaw.

7 Repeat steps 2-6 to skin all other layers till it is visible as shown in Fig 2.

Fig 2



PAPER INSULATED 3 PHASE $3\frac{1}{2}$ CORE CABLE

Carefully examine the skinned portion for any damage/excess cutting.

8 Dress the protruding parts of the cable using a knife for a better finish.

9 Write the parts of underground cables in your notebook.

10 Get your work approved by your instructor.

Practice preparation of cables for termination and joining

Objectives: At the end of this exercise you shall be able to
- **cut the cable according to requirement**
- **prepare the cable as per require measurement.**

Requirements

Tools/Instruments

- Insulated combination plier 200 mm - 1 No.
- Screwdriver 200 mm - 1 No.
- D.E. Spanner 6mm to 25 mm - 1 set
- DE Electrician's knife 100 cm - 1 No.
- Triangular file smooth 200 mm - 1 No.
- Hacksaw adjustable 300 mm with 32 TPI blade
- Hand vice 50 mm - 1 No.

Materials

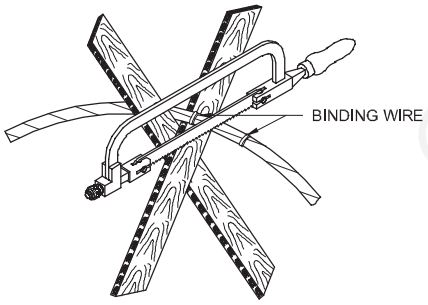
- UG cable multi-core copper/ aluminium - as reqd.
- Binding wire 16 SWG - 200 g

PROCEDURE

TASK 1 : **Preparation of cable for termination**

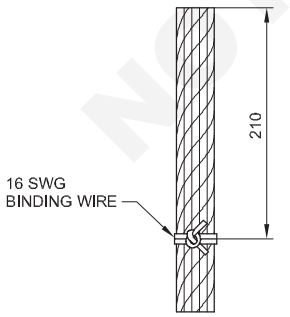
1 Cut the given cable into two pieces as in Fig 1.

Fig 1



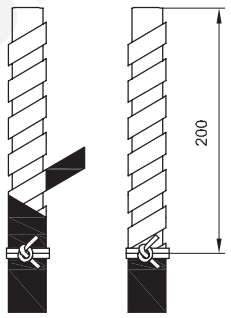
2 Bind 16 SWG GI binding wire on the serving (PILC cable) of the cables at a distance of 210 mm from one end as shown in Fig 2 to avoid loosening of the serving and damaging of the armour.

Fig 2



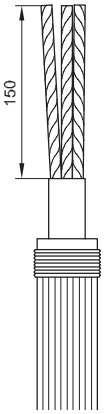
3 Remove the armour and serving of the cables to a length of 200 mm from the end of each cable as shown in Fig 3.

Fig 3



4 Remove the lead sheath to a length of 150 mm from the end of each cable as shown in Fig 4 and also remove the impregnated paper.

Fig 4



Avoid nicks or cuts on the core. Do not remove the paper insulation of individual cables.

5 Remove the paper insulation from both the cables to a length of 15 mm from the end.

Some prefer staggering of the joint position to have maximum efficiency of the joint. In such cases, the cable insulation should be removed accordingly.

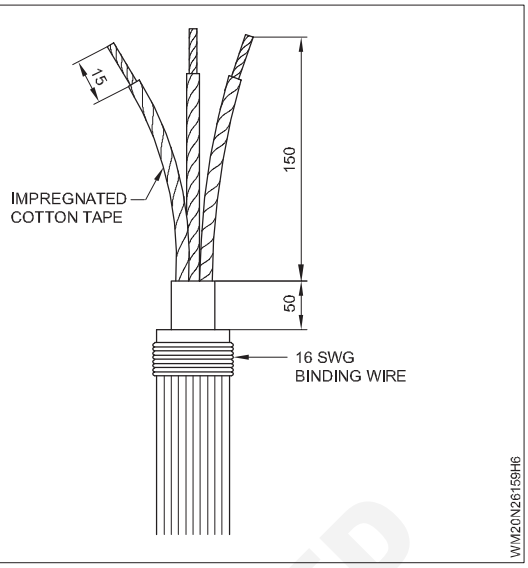
6 Twist the bare conductors tightly and tin the conductors. (Fig 5)

Wrap the end of the paper insulation near the bare conductor with lightly wetted cotton tape or asbestos tape to protect against excess heat.

7 Wrap the portion of the paper insulated cable with impregnated cotton tape to protect it from moisture and hot solder. (Fig 5)

Provide colour coding marks on cables at this stage.

Fig 5



8 Clean the split copper sleeves and the brass glands thoroughly and tin them.

9 Clean the joint box and keep the bottom cover on the floor.

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Demonstrate termination kits and practice on terminations of LT/HT cables

Objectives: At the end of this exercise you shall be able to

- **crimp the lugs on U.G cables by using crimping tool (manual (or) Automatic)**
- **terminate crimped cables with busbar**
- **terminate the loop connection for other circuit**
- **fix the mould and cast epoxy termination**
- **test the termination of UG cable with trifurcating box.**

Requirements

Tools/Instruments

- Trainees tool kit - 1 Kit.
- Crimping tool (manual (or) Automatic with dies - 1 No.
- Combination plier 150 mm - 1 No.
- Wire stripper 200 mm - 1 No.
- Ring spanner set - 1 Set.
  Screw driver 200mm - 1 No.
- DE Spanner set of six (6mm to 25 mm) - 1 Set.
- Electrician's knife 100mm - 1 No.
- Hacksaw frame 300 mm with blade of 32 TPI - 1 No.
- Triangular file smooth 150mm - 1 No.
- Ball peen hammer 250 grams - 1 No.
- Tong 200mm - 1 No.
- Hand vice 40mm - 1 No.
- Crimping tool - 1 No.
- Wire brush - 1 No.

Materials

- 3 1/2 core U.G Al. cable -25mm2 - 1 Mt.
- Aluminium lugs 25mm2 - 6 Nos.
- Antioxide agent (Penetrox) - 100g.
- Cotton waste - 100g.
- Aluminium lugs 16 sq.mm - 2 Nos.
- UG cable,multicore copper 3 x 95sqmm - 2M.
- Pre fabricated trifucating kit consisting of Cable jointing compound (Resin) - 1 Kit
- Cable jointing compound (hardener) - 400g
- Plastic trifurcating body (pair) - 1 set
- Polymeric cylinder - 1 No.
- Polymeric bushings - 3 Nos.
- Earth connection conductor - 1 set
- Sealing tape for cable entry - 1 roll
- Cleaning solvent - 1 bottle
- Binding wire - 5M.
- PVC tape non-adhesive - 1 roll
- PVC tape adhesive - 1 roll
- Crimping type copper / Al. lugs 95sqmm - 3 Nos.
- GPFC lug sealings - 2 pkts
- Instruction manual - 1 No.

PROCEDURE

Task 1 : **Demonstration on termination kit and practice on termination of LT cable**

Read and interpret the instructional manual of termination kit and refer the Figure 1.

1 Select the appropriate lugs to be crimped suitable to the core size of the U.G cable.

Ensure the lugs and cable core are the same materials.

2 Remove (strip) the outer insulation, armour and bedding of the cable to the required length using knife.

Length of the stripping off depends on the space available / position of busbar in the busbar chamber.

3 Spread in the cores of the cable and remove the core insulation to a length which depends on the barrel length of the lugs.

4 Scratch the core of the cable thoroughly by using wire brush before crimping.

Aluminium oxidise very quickly and forms a hard non- conductive coating that develops on the surface

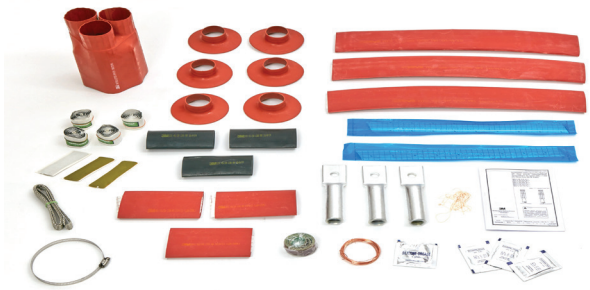
5 Apply anti oxidizing agent (penetrox) to the bare core of the cable to prevent the formation of surface oxides.

6 Insert the correct size of dies into the crimping tool and place the lugs between the dies.

Align the dies between knurls an barrel.

7 Place the lugs on the non - moving top die.

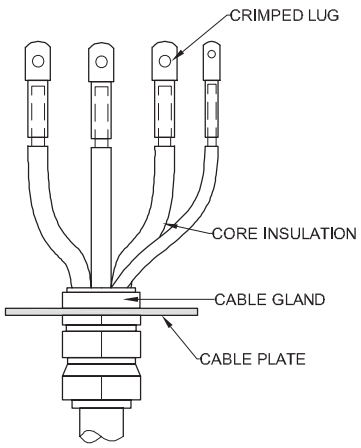
Fig 1



Allow the ram die to move and crimp the always crimp the lug from the tongue end to the conductor end refer the catalog for the correct number of crimps.

8 Start the crimping cycle and hold the lug along with cable steadily until the entire cycle is completed, release the ram.

Fig 2



9 Repeat the same process until all crimp location on the barrel have been completed.

10 Crimp the lugs on the remaining cores of the cable by following the above steps.

11 Get it approved by the instructor.

— — — — — —

TASK 2 : **Practice on termination of H.T cable**

1 Read and interpret the instructional manual of termination kit.

2 Cut and prepare 2 x 95sqmm PILC cable for the dimensions given in Table-1 by referring Fig.1.

Table-1

Sl. No	Cable size	L	L1	L2	L3	L4	LC
1	3 x upto 95	30	20	40	10	175	530
2	3 x 120 to 185	30	20	50	10	190	560
3	3 x 225 to 300	30	20	60	10	220	590
4	3 x 400 to 500	30	20	65	10	230	620

L —> length of outer sheath inside the bottom cylinder

L1 —> length of Armour

L2 —> length of lead sheath

L3 —> length of inner sheath

L4 —> clearance between centre to centre

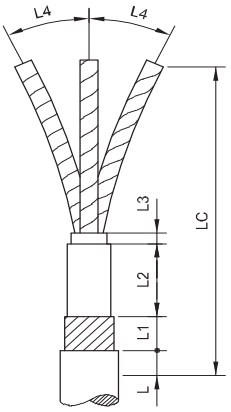
Lc —> length of centre core

3 Wrap 3 layers of PVC non-adhesive tape provided with kit over paper belting.

4 Wrap 2 layers of PVC non-adhesive over cores to avoid the damage of the cores while inserting various polymeric components into the position.

Ensure that, lugs are crimped on the conductors at this stage

Fig 1



5 Clean the lead sheath and armour with the wire brush

It is necessary to clean the lead sheath and armour with the solvent provided in the kit.

6 Connect lead sheath and armour with flexible copper binding wire (provided with kit).

7 Fix the earthing link over lead sheath, refer Fig.2.

8 Insert pre-fabricated cable entry cylinder through the cores over the outer sheath of the cable refer Fig 3.

9 Place the cylinder to rest on the outer sheath of the cable by lowering it down, refer Fig 4.

10 Seal the gap between outer sheath and cylinder body and also the point of earthing conductor outlet, with the sealant and PVC adhesive tape (provided with the kit). Refer Fig 4.

Fig 2

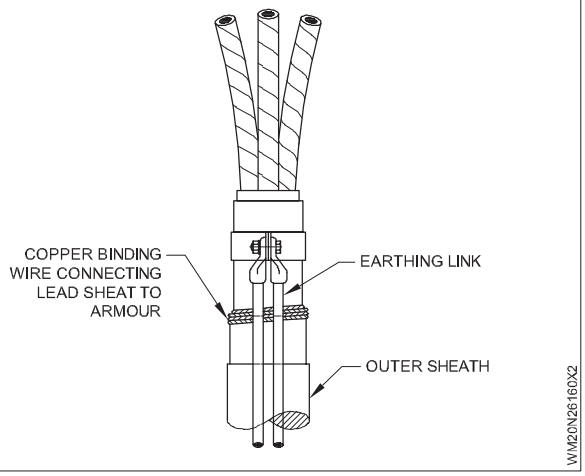


Fig 3

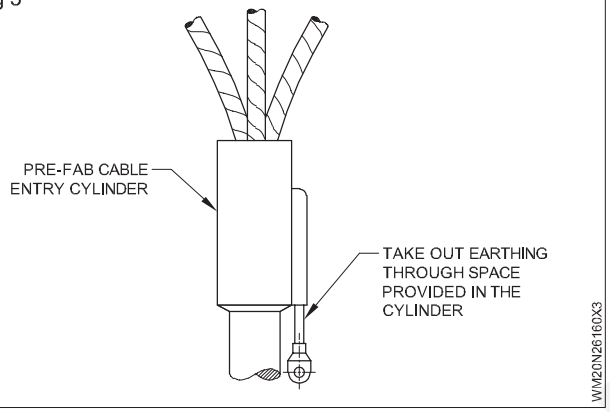
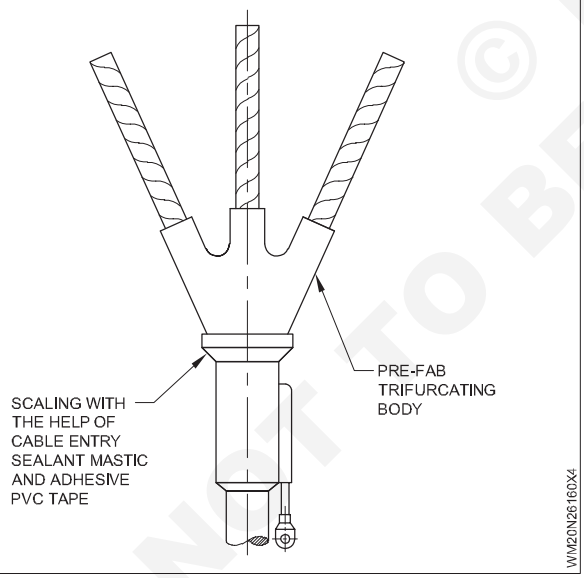


Fig 4

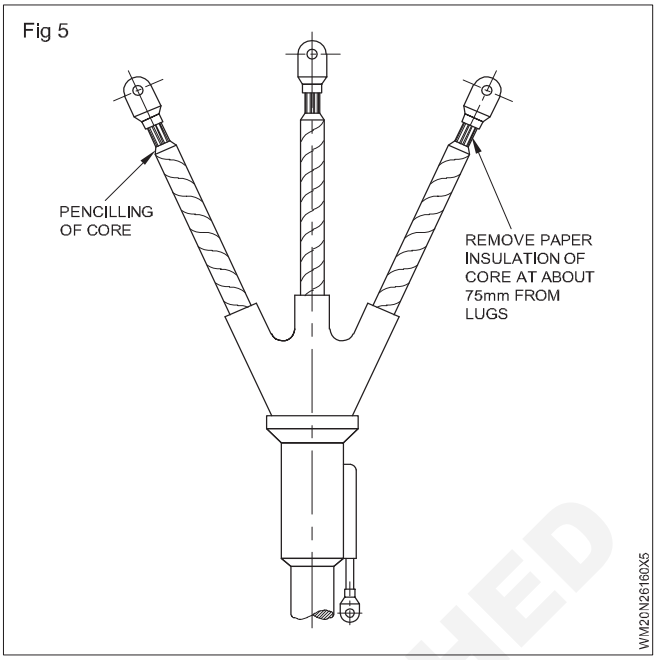


11 Insert the pre-fabricated trifurcating body on the cores of cables and fix it on the pre-fabricated cable entry cylinder. Ref Fig 4.

To avoid any kind of leakage at the joining points, seal it with the help of sealant and adhesive PVC tape.

12 Skin the insulation, fix the lugs on the conductor ends and crimp as per the normal practice. Ref. Fig 5.

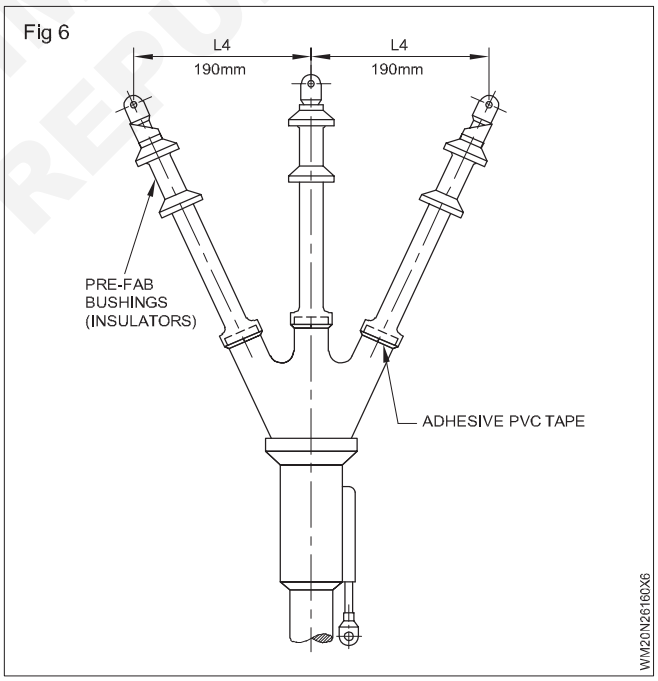
Fig 5



Ensure that after crimping the lugs, the insulations of the conductor is removed about 75 mm in length from the lug end. Ref. Fig.5.

13 Insert the bushings (Insulators) and fix it on the trifurcating body. Ref Fig 6.

Fig 6



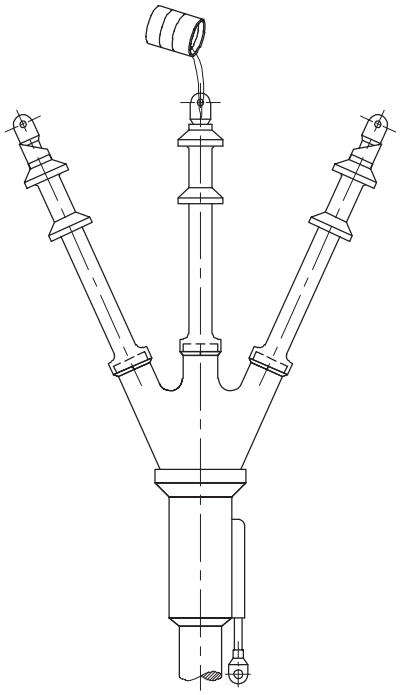
14 Seal the joint by applying 3 layers of adhesive PVC tapes, so that compound does not leak. Refer Fig 6.

15 Stir the cable jointing compound to make it homogeneous (resin and hardener).

Allow air bubbles entrapped while mixing the compound.

16 Pour mixed compound through the centre bushing till all the three bushings are filled with the compound upto the top level refer Fig.7.

Fig 7



WM20N26160X7

If any leakages, seal them properly.

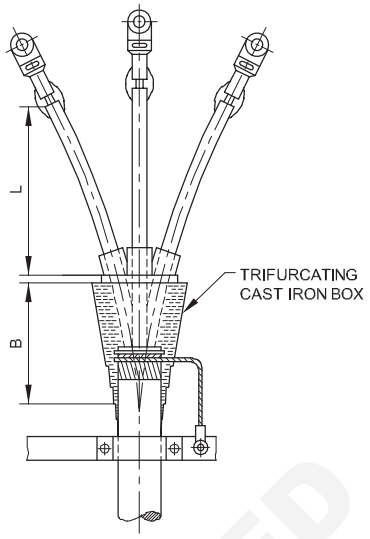
Top up with the compound, if any shrinkage occurs.

17 Apply General purpose fast curing compound (GPFC) provided with the kit, after the mould is hardened, to prevent entry of any moisture during rain.

Trifurcating of 1.1kV grade, PVC cable for dry and non-corrosive atmosphere by means of brass glands (or) by simple dressing, is shown in Fig 8.

18 Refer Fig 9 for complete view.

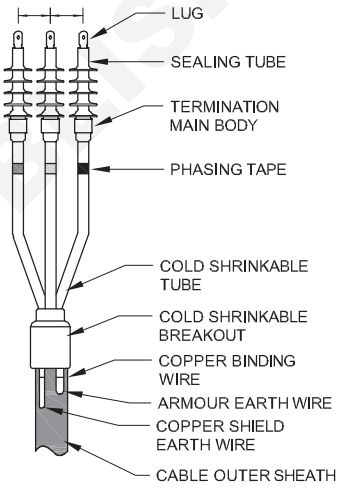
Fig 8



TERMINATION FOR PVC CABLE

WM20N26160X8

Fig 9



WM20N26160X9

Practice discharging procedure of underground cables

Objectives: At the end of this exercise you shall be able to
- **Explain discharging procedure of low voltage underground cables.**

Requirements

Tools/Instruments		Materials	
• Earthing device	- 1 No.	• 4 core UG cable	- as reqd.
		• Manufacturers user manual	- as reqd.

PROCEDURE

Discharging a low voltage underground cable is a procedure used to ensure the safety of personnel and equipment during maintenance, repair or replacement activities. Here's a general procedure for dicharging a low voltage underground cable:

1 Obtain a copy of the cable manufacturer's recommendations for discharging the cable, if available.

2 Isolate the cable from the power source by opening the relevant switches or isolators.

3 Check that the cable is de - energized using a voltage detector or a multimeter.

4 Connect a suitable earthing device to the cable to discharge any residual charge. The earthing device should be rated for the voltage and current of the cable being discharged.

5 Attach the earthing device to the cable by clamping it onto the cable or using a suitable connector.

6 Wait for the cable to discharge fully, which may take several minutes, depending on the length and capacitance of the cable.

7 Once the cable is fully discharged, remove the earthing device and re -check the cable to ensure it is de -energized.

8 Carry out the required maintenance, repair or replacement activities on the cable.

9 Once the work is complete, remove the earthing device and reconnect the cable to the power source.

Make straight joint of different types of under ground cable

Objectives: At the end of this exercise you shall be able to
- **cut the cable to the suitable length**
- **prepare the cable and dress the cable ends for straight joint**
- **make the joints by soldering**
- **fix the cast iron protective shell around the joints**
- **fill the cast iron box with molten bituminous compound**
- **test the cable joint for proper performance.**

Requirements

Tools/Instruments

- Insulated combination plier 200mm - 1 No.
- Screw driver 200mm - 1 No.
- D.E. Spanner 6mm to 25mm - 1 Set.
- D.B. knife 100mm - 1 No.
- Melting pot with 1 set of ladle - 1 No.
- Blow lamp 1/2 litre capacity - 1 No.
- Triangular file smooth 200mm - 1 No.
- Hacksaw frame adjustable 300mm with 32TPI blade - 1 No.
- Ball peen hammer 250gm - 1 No.
- Hand vice 50mm - 1 No.
- Megger 500V - 1 No.

Materials

- UG cable multi-core Copper 3 x 25sqmm PILC cable - 2 M.
- GI binding wire No.16SWG - 200g.
- Sand paper '00' grade - 1 No.
- Kerosene - 2 litres
- Cotton tape 25mm and 10mm - 1 each
- Bituminous compound - 100g.
- Jute/Asbestos thread - 50g.
- Impregnated cotton tape - 1No.
- Porcelain barrier (spacers) - 3 Nos.
- Split copper sleeve of suitable size - 1No.
- Match box - 1 No.
- CI cable joint straight type box with accessories - 1 kit
- Lead liner sleeves for 1.1KV, 3 x 25 sq.mm PILC cable - as reqd.
- Bricks - 4 Nos.
- Solder 60/40 - 1/2kg
- Soldering flux - 10g.
- Cotton cloth - 100g.
- Brass Glands - 2 Nos.

PROCEDURE

TASK 1: **Preparation of cable for termination**

Refer exercise no 2.6.159

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TASK 2: **Make straight joint**

1 Insert the tinned portion of the cable ends into split sleeves taking into consideration of the colour code of the cables.

2 Turn the split position of the sleeves in upward position to facilitate for pouring of the solder.

3 Apply soldering flux to the split sleeves and the bare portion of the conductor.

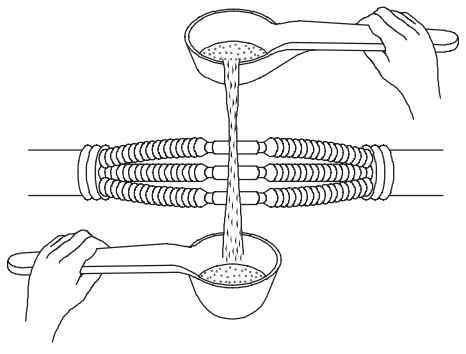
4 Heat the solder to the molten stage using blow lamp.

Keep the ladles are dry and then start scooping the molten solder alternatively in the ladles till the ladles are sufficiently hot.

5 Keep one of the empty ladles underneath the split sleeve which has to be soldered.

6 Pour the molten solder on the sleeve such that the solder enters into the joint through the split as shown in Fig 1.

Fig 1



A THROUGH-TYPE JOINT ON PAPER INSULATED CABLES USING POT AND LADLE

WM20N26162H6

After the joint is sufficiently heated, Increase the pouring time to allow the solder to solidify inside the joint.

7 Stop pouring the solder when the sleeve is filled up and the colour of the solder is bright.

8 Repeat this procedure to other joints one after another.

Do not shake or disturb the position of the cables during the soldering process as it will result in dry joints.

9 Wrap with 2 layers of impregnated PVC tape over the joints after the joint is cooled.

10 Place the spacers and insulate covers of cable, ensuring the minimum distance away from the joints.

11 Bind the spacer with cord (thread) binding to hold them in position.

12 Clean the bare lead sleeve and armour by abrading with emery paper.

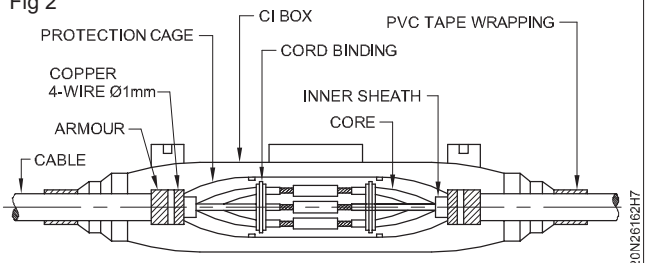
13 Plumb the lead sleeves (or) wiping glands to the lead sheath of the cable to prevent the moisture entering into the joints as in Fig.2.

14 Fill the lead sleeve with molten bitumen compound (or) insulating compound as desired.

15 Fix the cast iron protective shell (box) around the joint.

16 Preheat the joint box before filling the preheated sealing compound.

Fig 2



STRAIGHT THROUGH JOINTS FOR CABLES 3.3kV AND 6.6kV GRADE

17 Close the top and bottom parts of the joint box together.

18 Position the brass glands properly in the cover of the joint box.

19 Pour molten bitumen sealing compound through the cover inlet (compound filling plug) as shown in Fig.3.

20 Stop pouring the compound when the compound raises upto the mouth.

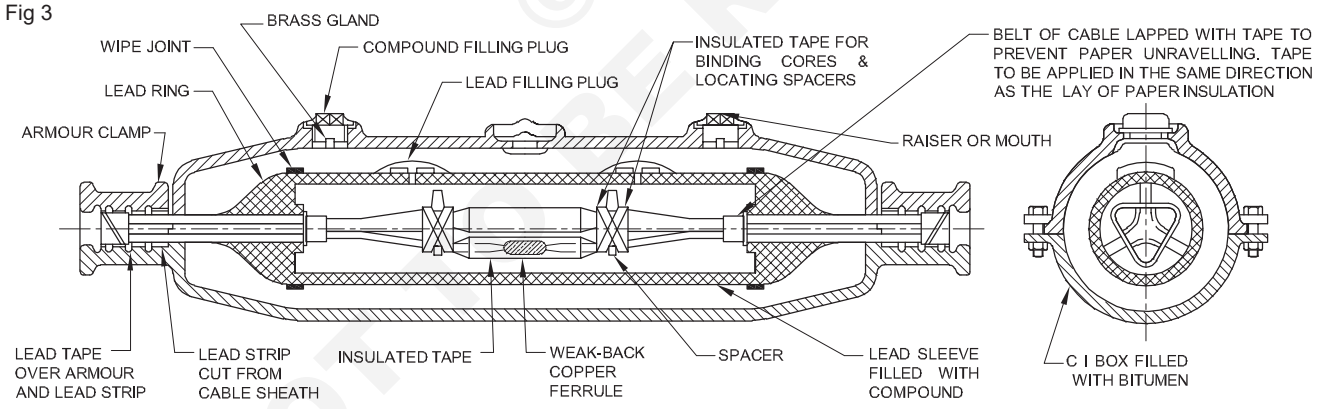
21 Allow sufficient time for cooling and top up with the molten compound, if required.

22 Fix the cover inlet of the joint box after the joint is sufficiently cooled.

23 Test the cable joint with megger to confirm the continuity, correct phasing and insulation resistance and record them.

The trainees can be taken to the place or site where the cable joint are done by the local electricity board personnels.

Fig 3



TYPICAL H.V STRAIGHT JOINT BOX (FOR 3-CORE PAPER-INSULATED, LEAD-SHEATHED & ARMOURED CABLES)

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TASK 3: **Aluminium cable joint**

1 Follow the procedure as explained in Tasks 1 and 2 except that the solder to be used is Alca 'P' and the flux is Eyre '7'.

Demonstrate jointing of XLPE cables using Audio - Visual aids

Objectives: At the end of this exercise you shall be able to
- **make straight through joint on XLPE cable.**

Requirements

Tools/Instruments

• Wire stripper 200mm	- 1 No.
• DE knife 100mm	- 1 No.
• Comination plier 150mm	- 1 No.
• Blow clamp 0.5 point	- 1 No.
• Crimping tool 150mm	- 1 No.
• Cable jointing kit	- 1 No.
• Computer projector with all necessary accessories	- 1 No.

Materials

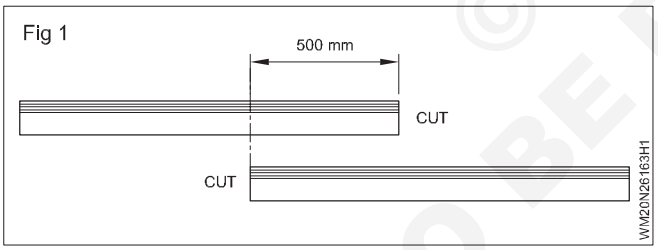
• XLPE cable 35 sq.mm, 11kV, 1m	- 2 Nos.
• Metal connector	- 1 No.
• Fill oil can	- as reqd,
• Mastic tape	- as reqd.
• Heat shrink tube	- as reqd.
• Grease	- as reqd.
• Wirebrush	- 1 No.
• Cleaning cloth	- as reqd.
• Block stress control tube	- 1 No.
• Compression links	- as reqd.
• PVC tape rolls	- 5 Nos.

PROCEDURE

1 Place the two pieces of cables by overlapping by 500mm minimum

2 Mark centre line and cut using side cutting pliers as per the diagram (Fig 1).

Fig 1

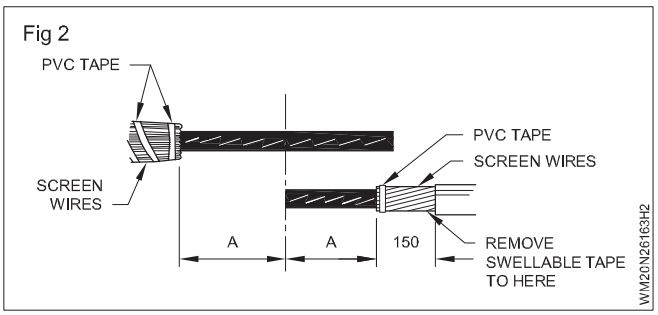


3 Clean cable surfaces and cover with plastic wrap about 1.5 meter each side of the centre line

4 Remove outer sheath using wire stripper and also inner sheath to a distance 'A' from the centre line of the left hand side (LHS) of the cable (Fig 2).

5 Remove the outer and inner sheath 'A' + 150mm from the centre line of the right hand side (RHS) of the cable (Fig 2)

Fig 2



6 Bend back the long screen wiresof the LH cable and secure with a spiral wrap of the PVC tape.

Do not tape the bend down because it can be straightened easily

7 Remove water swellable tape on the RHS cable mark

8 Cut the screen wires at a distance 'A' from the centre line using side cutting pliers

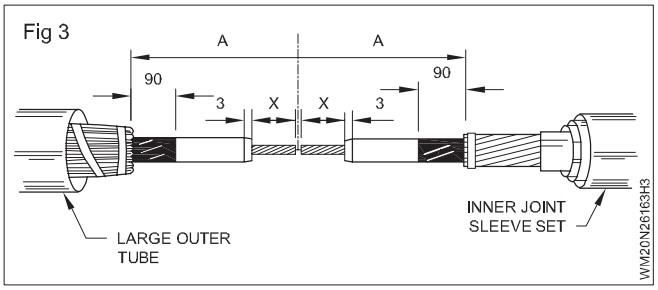
9 Remove water swellable tape over the ends of the wires

10 Place the large enter heat shrink tube over the LH cable

11 Cover the parked tubes with plastic wrap

12 Cut cables at the centre line (Fig 3)

Fig 3



13 Remove semi-conductive screen and remove the insulation from conductors for a distance 'x' equal to half the connector length + 5mm

14 Cut A 3mm (Max.) bevel on the insulation ends

15 Remove the light firm burns of jointing conductor by wire brush

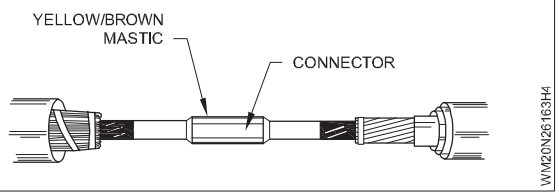
16 Join the conductors with the connector and die

17 Remove any burns and thoroughly clean excess of grease from connector and cable insulation using cleaning pads

Do not reuse pads and the insulation

18 Stretch it to half its original width by using yellow/ brown Mastic tape (Fig 4)

Fig 4



19 Fill the gaps between the connector and cable insulation and continue

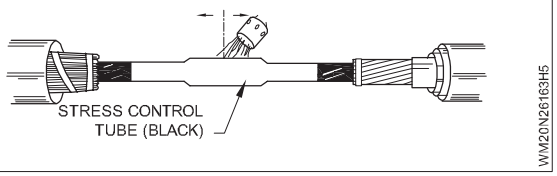
20 Over the connector and overlapping the cable insulation at each end by 5 mm

Do not touch the mastic applied and do not use too much mastic

21 Check that all surfaces are clean and that no dirt or moisture inside of the tubes

22 Place the black stress control tube over the joint (Fig 5).

Fig 5



Starting at the centre shrink, the tube towards one end then towards the other end until fully shrink

23 Apply heat evently through out the process

24 Wipe of excess adhesive, which will flow the ends after completed the joints

25 Instructor may arrange to watch the joining of XLPE cable for trainees through internet.

Power — Exercise 2.6.164

Wireman - Cable joints

Demonstrate Various tests on under ground cables

For this Exercise refer Excercise No: 2.2.133

Demonstrate different charger specifications

Objectives: At the end of this exercise you shall be able to
- **explain different charger specification electric vehicle.**

Requirements			
Materials			
• A4 Sheet	- 1 No.	• Eraser	- 1 No.
• Pencil	- 1 No.	• Different chargers	- as reqd.

PROCEDURE

TASK 1: **Demonstration of different charger specifications**

1 Table below showcases the mapping of different charger specification in India.

The Ministry of power has issued the revised consolidated guidelines and standards for charging infrastructure for E-Vehicle on 14th January 2022. The objective is to enable a faster adoption of E-vehicle in India by ensuring safe, reliable accessable and affordable E-vehicle charging infrastructure and eco-system.

S.No.	Charging Station	Voltage (V)	Power (kW)	Type of Vehicle	Type of compatible charger
1	Level 1 (AC)	240	<=3.5 kW	4w ,3w,2w	Type 1, Bharat AC-001
2	Level 1 (DC)	>=48	<=15 kW	4w,3w,2w	Bharat DC-001
3	Level 2 (AC)	380-400	<=22 kW	4w,3w,2w	Type 1, Type 2, GB/T , Bharat AC-001
4	Level 3 (AC)	200-1000	22 to 4.3 kW	4w	Type 2
5	Level 3 (DC)	200-1000	Up to 400 kW	4w	Type 2, CHAdeMO, CCS1,CCS2

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Perform installation of EV charging station for public places

Objectives: At the end of this exercise you shall be able to
- **explain installation of EV charging station for public places.**

Requirements

Tools/Instruments

- Electrician tool kit - 1 No.
- EV charging station unit for public - 1 No.

Materials

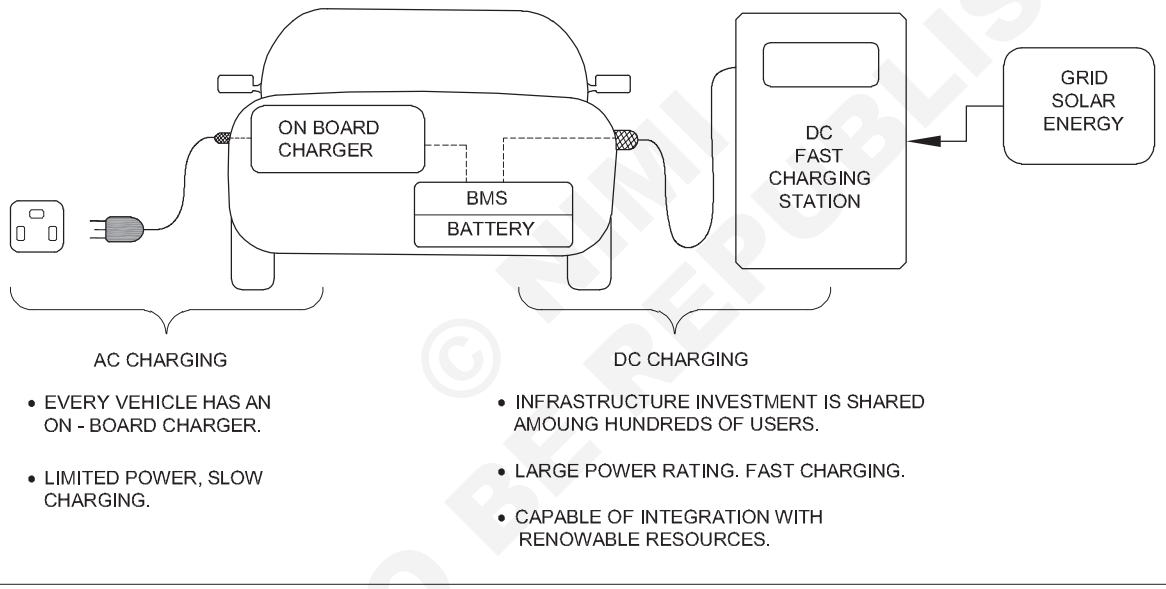
- Insulation tester - 1 No.
- Charging probes - as reqd.
- 6 square mm PVC copper insulated cable - as reqd.

PROCEDURE

1 Instructor may take the trainees to a nearest EV charging station.

2 Before entering EV charging station the trainer may explain all components of EV station. (Fig 1)

Fig 1



3 Components of EV station,

a Three pin plug socket

b ON board charger

c Battery Management System (BMS)

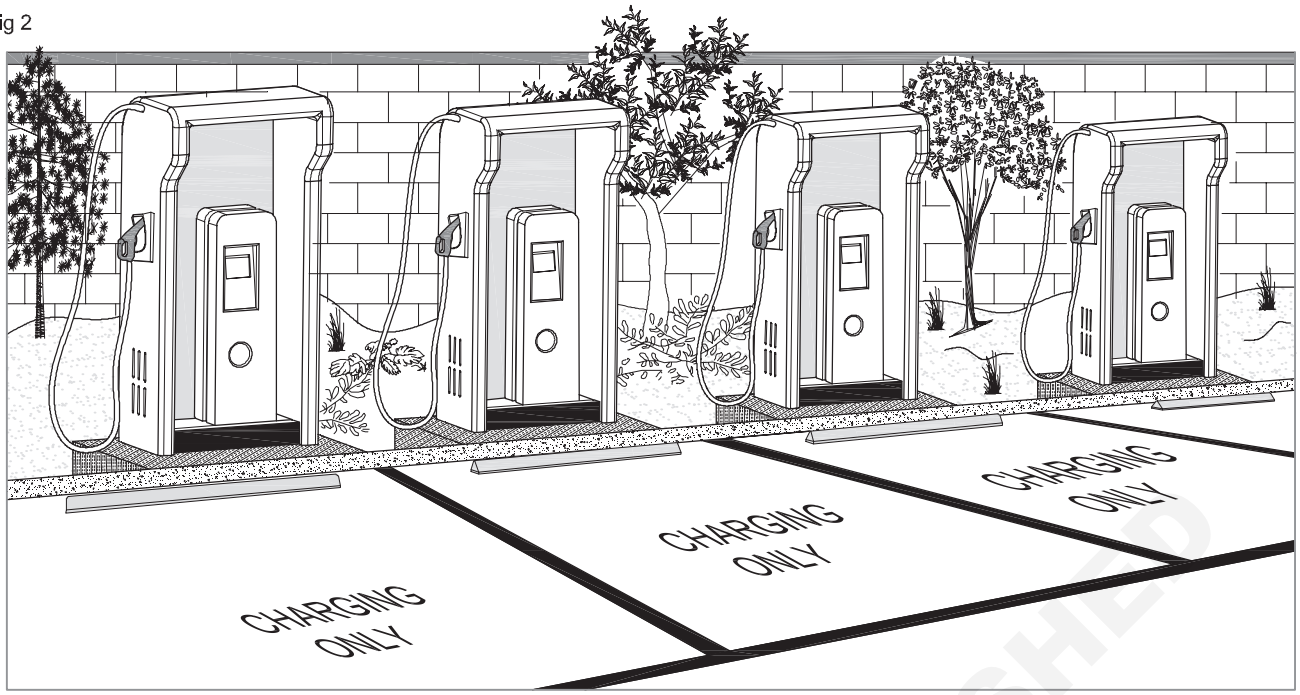
d DC fast charging station

4 Trace the various components of EV charging station by is specification.

5 Note down the block diagram of EV charging unit.

6 Get approvel from the component authority then connect any E-vehicle (2-Wheeler or 4-Wheeler) to the charging unit and note down the voltage and current readings. (Fig 2)

Fig 2



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Perform installation of home EV charging stations

Objectives: At the end of this exercise you shall be able to
- **explain installation o home EV charging station.**

Requirements

Tools/Instruments

- Electrician tool kit - 1 No.
- EV charging unit for home - 1 No.
- Multimeter Digital - 1 No.

Materials

- Insulation tester - 1 No.
- Charging probes - as reqd.
- 4 square mm PVC copper insulated cable - as reqd.

PROCEDURE

1 Collect EV charging unit from the store.

2 Identify the suitable space for EV charging unit.

3 Fix charging unit on the wall.

4 Select suitable PVC cable (4 mm2).

5 Connect 230V supply to the EV charging unit.

6 Before giving supply to the charging unit measure supply voltage using multimeter.

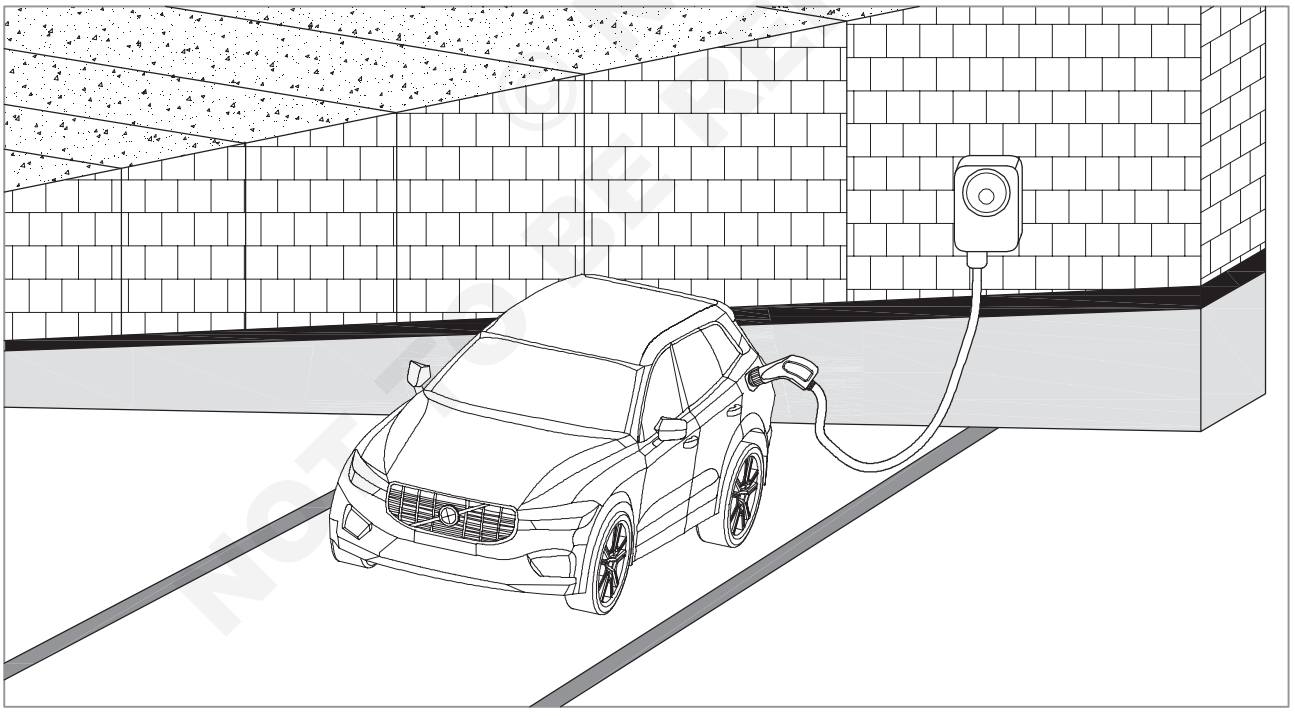
7 Connect EV charging unit to the four wheeler as shown in Fig 1.

8 Get approval from your instructor.

9 Avoid loose connection.

10 Show the control panel working to your instructor and get it approved.

Fig 1



WIM20N27167H1

Service and repair of bell / buzzer

Objectives: At the end of this exercise you shall be able to
- **test, identify the fault and repair the calling bell**
- **test identify the fault and repair the buzzer.**

Requirements

Tools / Instruments

• Trainee's kit	- 1 No.
• Wire stripper 150 mm	- 1 No.
• D.B. Electrician Knife 100mm	- 1 No.
• Mini Screwdriver set	- 1 Set
• Insulated nose plier 150mm	- 1 No.
• Multimeter Digital	- 1 No.
• Megger 500V	- 1 No.
• Nylon mallet 125 gm	- 1 No.

Equipment / Machines

• Power bell-12V/24V	- 1 No.
• Buzzer-12V/24V	- 1 No.

Materials

• Connecting wires	- as reqd.
• Insulation tape 20mm P.V.C	- 1 Roll
• Spare components	- as reqd.

PROCEDURE

TASK 1: **Test, identify the fault and rectify the Power bell (Fig 1)**

If the bell is not working it means the fault may be in any part of bell circuit from push button to the bell.

Assume, the fault is in push button, bell assembly circuit wiring

i Fault in push button

1 Remove the fixing screw and pull out the push button

2 Disconnect the wires by loosening the terminal.

3 Bring the two bare wire ends together.

if bell rings, the fault is in push button. Remove the buttons and replace it.

4 Install new push button, by connecting the two wires to terminal screws of new push button.

5 Test it for its good working condition and fix the push button

ii Fault in bell / assembly

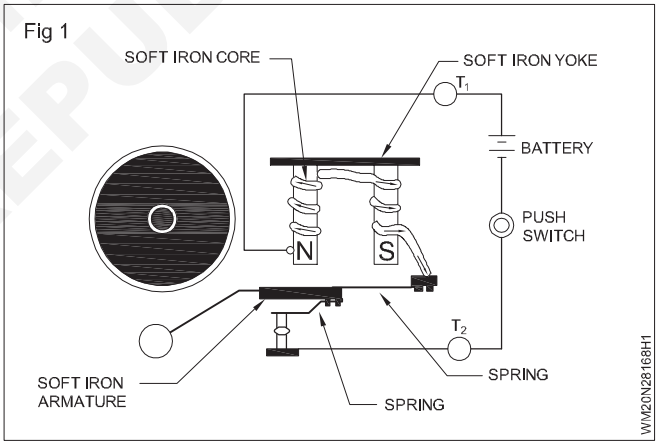
1 Connect and test the bell for its working.

If bell does not ring, the fault may be in bell assembly wiring. We assume the fault is in bell.

2 Remove snap-on cover of bell by lifting the cover slightly upward then pull out and remove the cover.

Look for the number of wires, 2 or 3 or more which depends on number of tones in ring bell. But standard bell or buzzer has two wires only.

Fig 1



3 Disconnect the wires by loosening terminal screws.

4 Connect them to 12V.

If bell sounds (or) bulb gives light when the bell button is pushed, it means, the bell is in good working condition.

5 Replace and install a new one and test it.

Important parts of an electric bell are :

1 Electromagnet

2 Armature

3 Spring

4 Armature rod

5 Hammer

6 Gong

TASK 2 : **Test, identify the faults and repair the buzzer**

1 Connect the components of buzzer as in Fig.1

2 Press the key switch.

It gives off a loud noise (buzz) - if it does not make noise/ sound it means, fault may be in circuit or battery or solenoid coil.

If fault in cell/battery

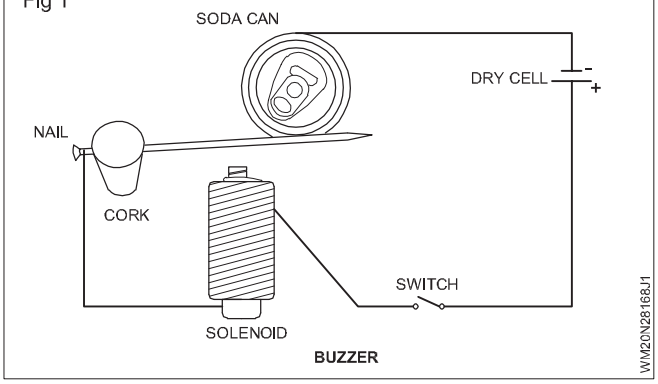
3 Check the circuit by testing with other cell, if it gives peep sound replace with new cell of same range and test it.

If fault is in solenoid

4 Connect the buzzer with new cell and switch 'ON' the circuit.

If it does not give sound it indicates, the fault is with switch (or) connections.

Fig 1



5 Trace the circuit for loose connection, and rectify it.

If the switch contacts are found carbonized, clean it (or) replace it.

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Service and repair of electric iron, electric kettle, cooking range and geyser

Objectives: At the end of this exercise you shall be able to

- **connect and test the given automatic iron for its working**
- **dismantle the automatic iron and reassemble it**
- **trace and identify (or) locate the faults in an automatic iron**
- **replace the faulty parts with good one**
- **test the electric kettle element and identify the defect**
- **replace the old element with a new one**
- **assemble the kettle and test for its working**
- **dismantle the suspected parts of the cooking range**
- **test the continuity of heating element**
- **replace the burn out heating element and worn out selector switch**
- **reassemble, connect and test the cooking range**
- **test the line cord for continuity**
- **dismantle a geyser**
- **trace identify and locate faults in a geyser**
- **replace faulty parts with good ones**
- **assemble the geyser and test for its working.**

Requirements

Tools / Instruments

- Screwdriver 150mm - 1 No.
- Spanner set 6 to 22mm (6 Nos) - 1 Set
- Megger 500 V - 1 No.
- Multimeter - 1 No.
- Electircian tool kit - 1 Set
- Cutting plier 150mm - 1 No.
- Tester 500 V - 1 No.
- Nose piler 150 mm - 1 No.

Equipment / Machines

- Automatic electric iron box 750W, 250 V - 1 No.
- kettle (sauce pan type) 500W/ 250V - 1 No.
- Electric cooking range1500W/250 V - 1 No.
- Geyser 1500W 250V 25 liters - 1 No.
- Megger 500 V - 1 No.

Materials

- Kettle Element 500W/250V - 1 No.
- Asbestos sheet and fibre washers - as reqd.
- Test lamp 100W/240V - 1 No.
- Element suitable for available Cooking range 1500W, 250V - 1 No.
- Geyser heating element 1500W, 240V - 1 No.
- Geyser thermostat - 1 No.
- 3- core flexible cord (48/0.2 with 15A, 3 pin plug) - 1 No.
- Insulating material such as asbestos and mica sheets Suitable for electric Iron - as reqd.

PROCEDURE

TASK 1: **Service and repair of electric iron**

1 Conduct a visual examination of the power cord and plug, after interpreting the name plate details

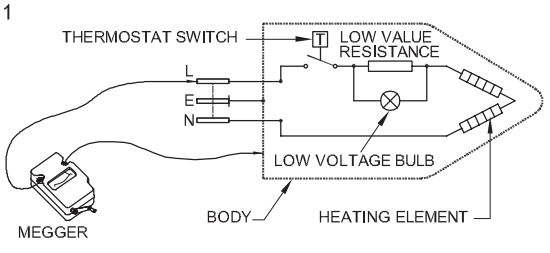
2 Conduct preliminary test for

- short circuit, continuity & insulation
- earth fault
- defective element circuit

3 Replace the cord, if necessary

4 Check for the insulation resistance between line terminal of the iron and the body of the iron (Fig 1) and record in Table 1.

Fig 1



MEASUREMENT OF INSULATION RESISTANCE BETWEEN THE BODY AND THE TERMINALS

Table 1

Terminals	Value in Mega ohms
L & Body	
N & Body	
E & Body	
Plug pin L & Body	
Plug pin N & Body	
Plug pin E & Body	

Disconnect the indicator bulb if any before the short, open and IR test.

Always disconnect the iron from supply while testing with insulation tester / Megger.

5 Check for insulation resistance between the neutral terminal and earth.

6 Connect the electric iron to the mains and check for its working

7 Check the presence of dangerous voltage existing between the body and earth of the supply with a neon tester or voltmeter.

In case of earth fault

8 Disconnect the electric iron from the supply, dismantle it. Visually inspect and test with a multi-meter/megger for any contact of live wire with the body

- insulation failure
- broken parts
- damaged thermostat/actuating leaf porcelain
- switch actuator.
- Check for continuity of thermostat and heating element.

9 Rectify the fault by replacing the defective part (element, thermostat etc.) Fig 2 (A & B).

In case of open in element circuit

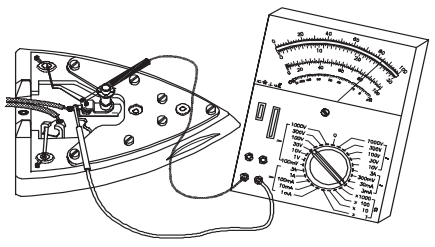
10 Remove the cover to check the thermostat, indicator bulb circuit and element

- Connect the series test lamp to the element circuit shorting the contacts of the thermostat indicated by 1 in Fig 3. If the test lamp glows the thermostat is defective.
- Connect the terminals of the indicating bulb by a piece of insulating wire, shown by 2 in Fig 3. If the test lamp glows the trouble is in this section.
- Short the terminals of the element shown by 3 in Fig 3. If the lamp glows the element is open. Replace the element.

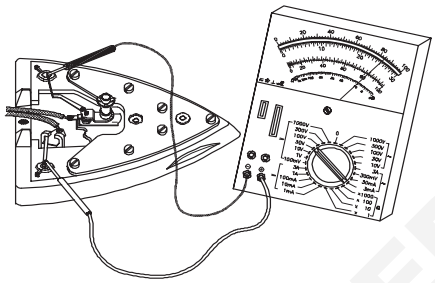
Failure of temperature setting controller

11 Check the adjusting knob for proper fixing and actuation of shaft. (Fig 4)

Fig 2



(A) TESTING THE THERMOSTAT FOR CONTINUITY



(B) TESTING THE HEATING ELEMENT FOR CONTINUITY

ELN26102H2

Fig 3

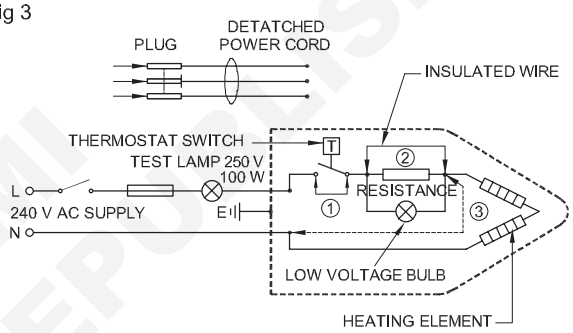


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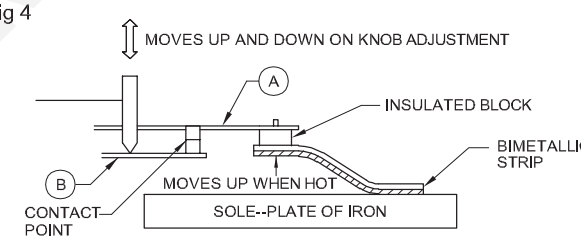
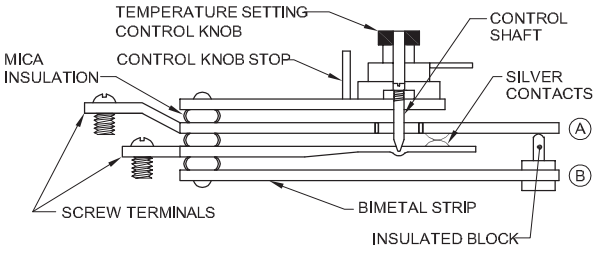
Fig 4



a) A SIMPLIFIED SKETCH OF ADJUSTABLE THERMOSTST



WM20N28169H4

b) OPEN FRAME BIMETALLIC ADJUSTABLE THERMOSTAT

12 Open the contacts of the thermostat and inspect them visually.

13 Clean the pitted or burnt out contacts.

14 Check for the actuating mechanism. (Heat the thermostat by a suitable external heating device.)

15 Assemble the iron and test for good working.

TASK 2 : **Service and repair of a Kettle**

1 Record the name-plate details of the appliance.

Name-plate Details

2 Disconnect the power cord and check the power cord for continuity of the cable, soundness of the terminal connection and insulation resistance between the line, neutral and earth terminals.

If found defective, either repair or replace the power cord.

3 Check the continuity of the kettle heating element either by using a test lamp or a Megger without opening the kettle.

If there is no continuity, the element is assumed to be open and it has to be replaced

4 Check the insulation resistance between the appliance socket terminals and the body of the kettle.

If the insulation resistance is less than one Megohm, the kettle element needs to be replaced.

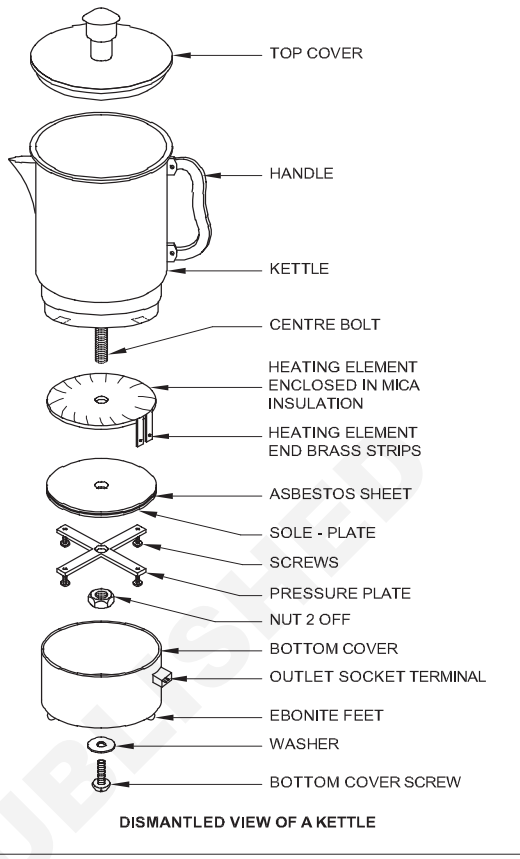
5 Read the assembly diagram in the instruction book of the kettle and dismantle the parts in the sequence recommended by the manufacturer.

6 In the absence of the manufacturer's recommended sequence diagram of the assembly, the following parts may be removed observing the correct procedure as shown in the exploded Fig 1.

- Bottom cover
- Pressure plate
- Sole-plate with asbestos insulation
- Element

7 Obtain a suitable element of the right shape, wattage and voltage and necessary mica and asbestos sheets of the same type and quality.

Fig 1



DISMANTLED VIEW OF A KETTLE

8 Check the element for its continuity and ohmic value.

9 Replace the new element in position.

10 Assemble the parts in proper order and connect the appliance.

Take care to fit the asbestos sheet and the sole plate at the sole plate housing in the correct order.

11 Measure the insulation resistance between the body of the appliance and its terminals before and after connecting the power cord.

Switch 'ON' the kettle only after filling water in it.

12 Test the appliance with supply for its working.

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TASK 3 : **Service and repair of a cooking range**

1 Note the name plate details of the electric cooking range.

2 Disconnect the power supply from the appliance.

3 Study the connection diagram, given by the manufacturer or trace the connections of the cooking range (Fig 1).

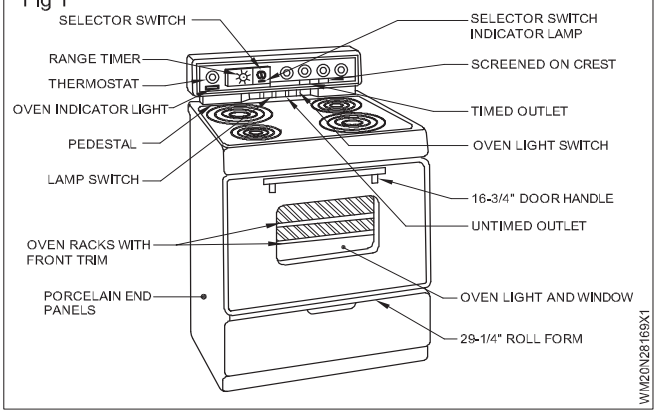
4 Check the continuity of the surface unit element one by one.

5 Replace the burnt out surface unit element as shown in Fig 2.

Before replace the coil check the correct shape, wattage and voltage of the element. Do not attempt to open parts whcih are not notified as defective.

6 Assemble and connect the electric cooking range.

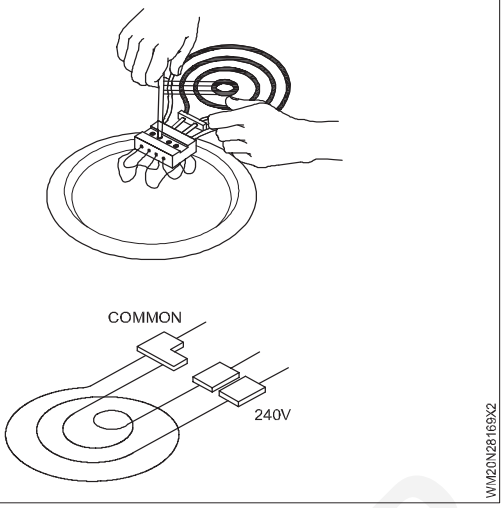
Fig 1



7 Measure the insulation value between the terminal to body of the appliance at various positions of all the switches.

Insulation resistance value should be more than one Megohm.

Fig 2



8 Check the appliance with the supply for its working condition.

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TASK 4 : **Replace the wornout selector switch of cooking range**

1 Open the cover of the defective switch, trace the connections and note down the position and column of cables.

2 Open the connections of the switch from the terminals.

3 Check the continuity of input and output of the selector switch.

4 Confirm the condition of the contacts. If found wornout, then remove the switch from the appliance. (as shown in Fig 1).

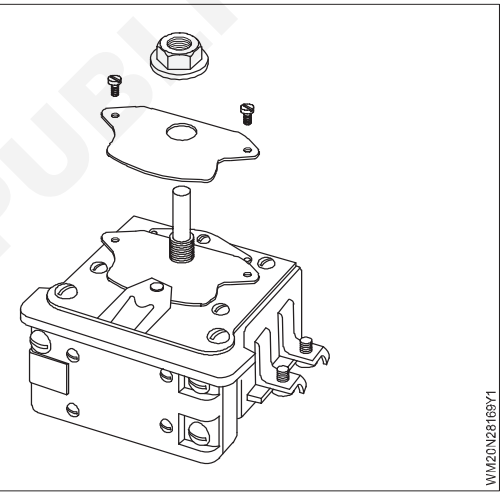
Take care to fix the screws, washers at the complete housing of the selector switch.

5 Replace the new selector switch in position.

6 Connect the cables as per made in step 1.

7 Measure the insulation resistance between line terminals and the body of the cooking range at various positions of all the switches. Measured insulation resistance should be above one megohms.

Fig 1



8 Test the assembled switch with the supply for its working.

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TASK 5 : **Service and repair of a geyser**

1 Record the details of the appliances in Table 2

2 Open the inspection cover for Power terrminals connection and thermostat installation in the geyser after removing the power plug. (Fig 1)

Check and ensure that the switch is off before removing the power plug.

3 Connect a visual examination of the i) power cord ii) plug pin termination and iii) termination at appliance.

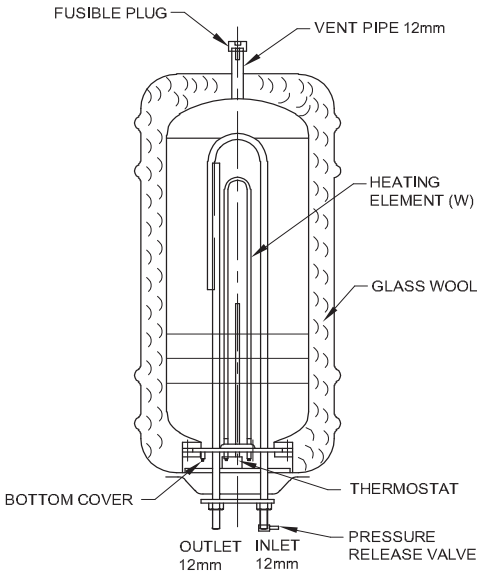
4 Check for proper tightness and good Power contact at terminations. Replace the plug pin if found pitted.

5 Conduct the insulation test on the cord - between the leads, lead and earth. Enter in Table 1

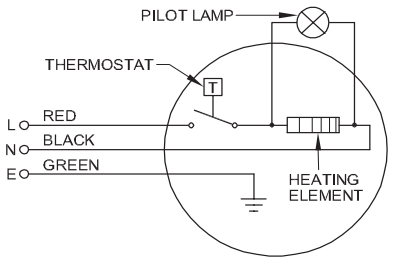
6 Measure the insulation resistance between the element and the earth/body and record in Table 1. The minimum value of the insulation resistance should be one megohm. If it is less than one megohm, send the geyser for repair and rectification.

7 Connect the geyser to the supply and switch on the appliance, keeping the inspection/bottom cover of the Power connections open.

Fig 1



(a) GEYSER



(b) SCHEMATIC DIAGRAM OF A GEYSER

WM20N28169Z1

The geyser should be switched on only with water in the container.

8 Observe that the heating process is cut off by the actuation of the thermostat. (The time depends on the capcity of the geyser and the thermostat setting).

9 Switch off the supply. Remove the plug. Measure the insulation resistance value between the terminals and the body of the heater/thermostat while it is hot and record the value in Table 1

10 Replace the thermostat if unit in the insulation value is less than one megohm.

11 Refit the inspection cover. If the insulation value is normal (i.e. above one megohm) apply grease over the screw before fitting.

Complaints

Listen to the complaints of the customer/user and note them. Proceed as stated below for the specific nature of fault complaint.

Nature of fault

1 No hot water : Check for the undermentioned causes in the given sequence.

a No power

b Defective thermostat

c Thermostat out of calibration

d Defective heater element

i No power

Check the fuse of the circuit, and replace the fuse, if blown.

Check the availability of power at the socket outlet using a test lamp

Open the inspection cover and check the cord for its continuity. Replace the cord, if necessary.

Switch off the supply and remove the plug before opening the cover.

ii Defective thermostat : Check the thermostat for continuity between its terminals at diferent settings. Replace the defective thermostat with a good one. No continuity between the terminals indicates defectiveness.

iii Thermostat cut off calibration : Adjust the thermostat for a higher setting. If the thermostat is found to be good, switch ON supply. Observe the fuse.

iv Defective element : Check the element for its continuity and insulation value between the terminal and the body (sheating of the element).

Replace the defective heating elementwith an identical good one . Switch on the supply and observe.

2 Water too hot

Check for the undermentioned causes.

a Thermostat set too high

b Defective thermostat

i Check the setting of the thermostat and adjust it to a lower value. Switch on the geyser. Wait for the thermostat to cut off the supply, or for about 20 minutes. Open the inlet. Collect the water at the outlet and measure the hot water temperature.

ii If the water temperature is much higher than the set value of the thermostat, replace the thermostat with a good one. If the temperature of the hot water is close to the range setting of thermostat it indicates a defective setting as the only cause.

3 Water not hot enough

Check for the undermentioned causes.

a Thermostat set too low

b incorrect heater element

c Excessive lime in tank

i check the thermostat setting and adjust it to a higher value. If the geyser produces hot water with the resetting, then the earlier setting was wrong.

ii Check and test the wattage of the heating element. If it shows a lower value, replace it with a higher wattage element.

iii Remove the heating element, inspect the element and the inner side of the copper vessel for deposit of excess lime coating. In case the heating element is of correct wattage, and the thermostat is properly set remove the lime coating.

Drain the water from the container of the geyser before removing the element.

Table 2

Name of the appliance :		Serial No :	
Voltage :		Current :	
Supply :		Wattage :	
Capacity :		Make :	
Cord Insulation	Between lines ..... Megohm	Between line/body ..... Megohm	Date of servicing
Element insulation	Between terminal and body / thermostat		Recommended Repair Replacement if any
	Cold		
	Hot		

— — — — — —

Service and repair of induction heater

Objectives: At the end of this exercise you shall be able to
- **dismantle the induction heater and identify or locate the faults**
- **replace the faulty parts with good ones**
- **assemble the induction heater and test for its working.**

Requirements

Tools / Instruments

• Electrcian Tool Kit	- 1 Set
• Screw driver 250 mm	- 1 No.
• Connector screw driver 150mm	- 1 No.
• Electrician Knife 150 mm	- 1 No.
• Metal brush	- 1 No.
• Soldering iron 60W, 230V	- 1 No.
• Tile cutter	- 1 No.
• Multimeter Digital	- 1 No.

Equipment / Machines

• Induction heater 1 kW, 250V	- 1 No.

Materials

• Cotton waste	- as reqd.
• Thinner	- as reqd.
• Resin core solder	- as reqd.

PROCEDURE

TASK 1: **Service and repair of induction heater**

1 Note the name plate details of the induction heater and record them in the Table.

Name Plate Details	
SL No. _____	Power _____ KW
Make _____	1ϕ / 3ϕ
Voltage _____V	
Current _____A	

2 Disconnect the power supply from the induction heater.

3 Check the power cord for continuity of the cable

If found defective, replace the power cord

4 Open the induction heater.

5 Do a thorough cleaning of PCB and other parts.

6 Remove the main board for visual inspection and trouble shooting.

7 Check whether PCB is covered by varnish.

8 Apply thinner and rub with metal brush and scrap with a knife and expose the dry solder points. (Fig 1)

9 Retouch all the points with fresh solder.

10 Check whether any capacitor cracked in the PCB (Fig 2). If so remove it from the PCB with the help of tile cutter (Fig 4) .

11 Check the electrolytic capacitors on the board and replace with a new one if they are found at the brim.

12 Press the switches on the control board and if they show resistance, it may be due to improper contact.

13 Replace all the Press-to-on button switches.

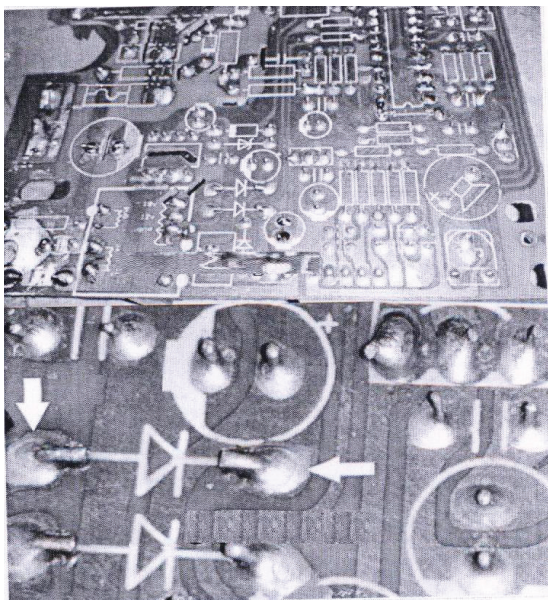
If buttons are slightly longer than the one on the board, nip the extra length with tile cutter tool

14 Defective switche is shown below (Fig 5)

15 After completing the work put the PCB and other parts back into the cabinet, (Fig 3). Fig 6 shows the cook top of induction heater.

16 Test the appliances with supply for its working.

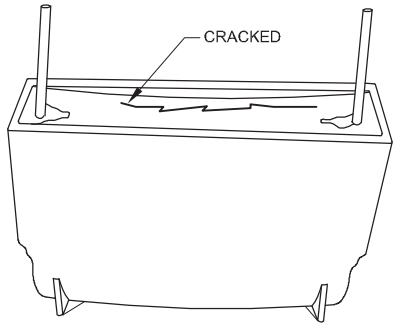
Fig 1



DRY SOLDERS

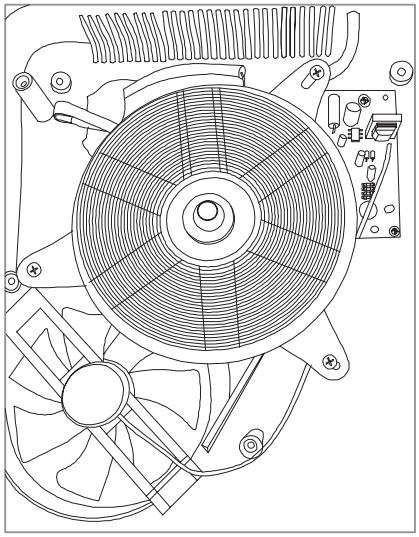
ELN26103H1

Fig 2



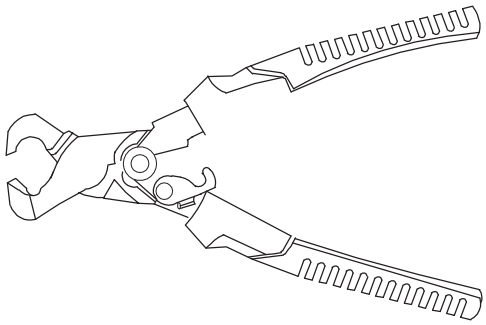
WM20N28170H2

Fig 3



WM20N28170H3

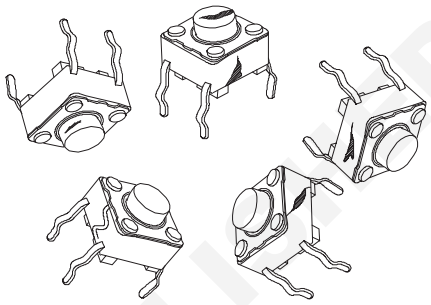
Fig 4



TILE CUTTER

WM20N28170H4

Fig 5



DEFECTIVE SWITCH

WM20N28170H5

Service and repair of mixer, grinder and food processor

Objectives: At the end of this exercise you shall be able to
- **read and interpret the data of given mixer, grinder and food processor**
- **identify the problem by visual inspection and test**
- **replace faulty parts with good one**
- **lubricate reassemble and test for its working.**

Requirements

Tools / Instruments

- Test lamp 100 W, 240 V - 1 No.
- Electrician tool kit - 1 Set
- D.E. spanner set of six 6 mm to 22 mm - 1 Set
- Plastic spanner for opening the jar screw - 1 No.
- Box spanner set of 6mm to 22 mm - 1 No.
- Multimeter - 1 No.
- Megger 500 V - 1 No.
- Philips screwdriver 4 mm blade dia - 1 No.
- Pulley puller 3leg 200 mm - 1 No.

Equipment / Machines

- Mixer 250 V 50 Hz. 400 watts - 1 No.
- Grinder 250 V 50 Hz 0.25 HP - 1 No.
- Food processor 1000 Watts 250V, 50HZ - 1 No.

Materials

- Grease/lubricating oil - as reqd.
- Kerosene - as reqd.
- Cleaning brush - 1 No.
- Sandpaper smooth - as reqd.
- Soldering lead, 40:60, soldering flux - as reqd.
- Service manual (if available) - 1 No.

PROCEDURE

TASK 1: **Service a mixer**

1 Note down the name-plate details in the maintenance cards. (Table 1)

2 Enter the details of the complaint from the customer in the maintenance card.

3 Switch on the mixer and check for its functioning.

4 Isolate the mixer from the supply.

5 Open the bottom cover and conduct visual inspection for :

- damages in the supply cord and loose terminal connections
- good condition of switches
- proper mounting of the motor.

Check whether the nyon/rubber coupling of the jar and motor are properly seated, if not replace.

Sometimes the retaining spring and washer might have got spoiled and need to be replaced.

Enter the mixer details in the maintenace card (Table 1)

6 Conduct an insulation test of the motor and record in the maintenance card (Table 2). The schematic diagram of a mixer circuit is given in Fig 1.

Table 1
Maintenance Card

Name of the customer _____ Address _____

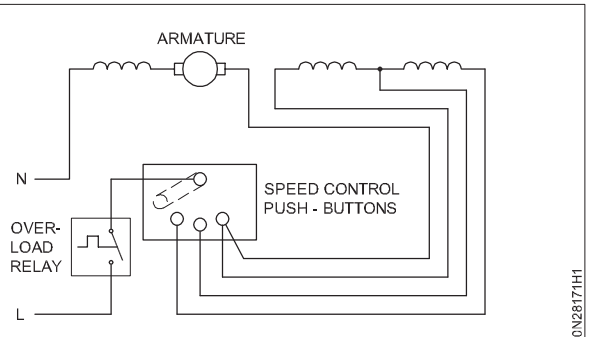
Name of the appliance _____ Serial No _____

Wattage _____ Current _____ Voltage _____

Supply _____ Make _____

Date of servicing	Consumer's complaint	Defects noticed by visual inspection	Details of repair and replacement

Fig 1



SCHEMATIC DIAGRAM OF A TYPICAL PORTABLE 3 - SPEED FOOD MIXER

The insulation resistance value should not be less than one megohm.

7 Improve the insulation value by heating or varnishing, if the insulation value is less than one megohm and enter the test results in the maintenance card. (Table 2)

8 If the motor is opened for varnishing, clean thoroughly the stator and armature and bush bearings. (Fig 2)

9 Conduct the insulation test after varnishing and enter the results in the maintenance card (Table 2).

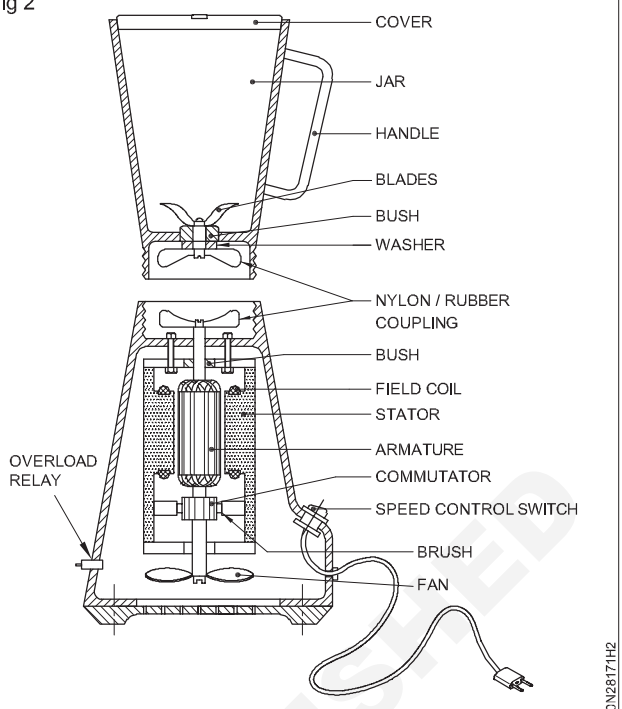
Remember that the nuts at the blades and the centre shaft holding nut are to be loosened by clockwise movement and tightened by anti-clockwise movement in most of the mixers.

10 Lubricate the bearing as recommended by the manufacturer before assembly.

Most of the bearings need no lubrication. If required,a drop of light oil like 3-in-1 oil could be used.

11 Clean the commutator surface. A black carbon deposit could be removed by CTC. Seat the bushes properly over the commutator. Check for adequate length of brushes to exert spring pressure.

Fig 2



PARTS OF A FOOD MIXER

If the brush length is shorter by 1/3 of its original length it is better to replace with the brushes of the same grade and size. The new brush has to be bedded on the commutator properly.

12 Assemble the motor and tighten the terminal screws.

13 Assemble the blade with the jar and nylon coupling at the bottom.

14 Connect the motor to the supply and start the mixer.

15 Observe the working of the mixer for smooth running.

Table 2

Date of servicing	Insulation resistance before varnishing/heating		Insulation resistance after varnishing/heating		Details for repair and replacment
	Between terminal and body	Between Armature and field	Between terminal and body	Between Armature and field	

TASK 2 : **Repairing of mixer**

1 Listen to the complaints of the customer/user and enter in the maintenance card (Table 1).

Common complaints are listed in the troubleshooting chart along with reasons for the possible cause and the corrective action to be taken.

2 Inspect visually the following parts for trouble.

- Power cord and plug
- Terminal connections at the switch (back cover to)
- Couplings
- Freeness of the shaft
- Burnt smell or discolouring of windings.

— — — — — —

TASK 3 : **Service a grinder**

1 Switch on the grinder and check for its functioning.

2 Isolate the grinder from the supply.

3 Open the inspection cover. Note down the name-plate details in Table 3.

Table 3

Name of appliance	r.p.m
Serial No.	Volt
Capacity H.P	Current
Phase	Frequency

4 Conduct visual inspection:

- for supply cord
- for good condition of switches
- for proper mounting of motor and drive alignment (Fig 1)

5 Conduct an insulation test of the motor and record in Table 4. If the insulation value is above 1 megohm, switch on the grinder and observe its function.

6 If the insulation resistance is less than 0.5 megohm, improve the insulation value by heating or varnishing, provided the motor is opened for varnishing.

7 Clean thoroughly the motor and the bearing of the grinder.

8 Lubricate the bearing as recommended by the manufacturer before assembly.

9 Assemble the motor and tighten the terminal screws, pulley screws, flywheel nuts, motor fixing bolts etc. (After adjusting belt tension)

10 Connect the motor to the supply and start the grinder. Observe the working of the motor and the grinder for smooth running.

Fig 1

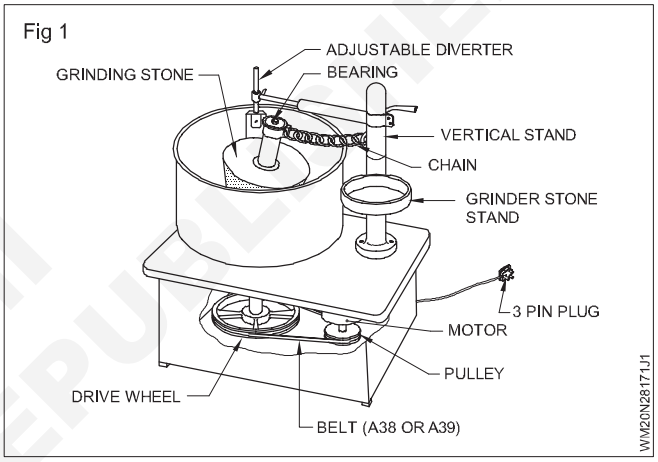


Table 4

Insulation resistance	**Between terminals and body**	**Between winding**
Date of servicing		
Recommended repair		
Replacement if any		

— — — — — —

TASK 4 : **Repairing of grinder**

1 Listen to the complaints of the customer/user complaints may be:

i Grinder not working

ii fails to start, but runs in either direction, when started manually

iii starts but heats rapidly

iv reduction in speed - motor gets too hot

v grinder is noisy

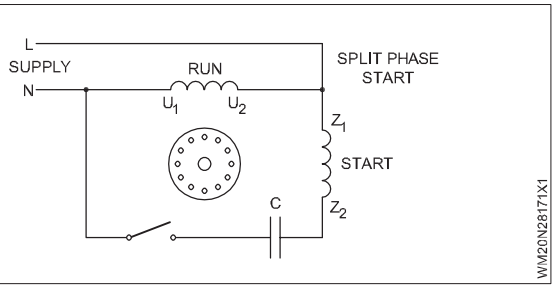
vi grinder gives shock.

Grinder not working

i Check whether there is open connection in line. Rectify the fault if observed.

ii Check for any open circuit in motor winding (starting and running winding). Send it for repairs, if open circuited. (Fig 1)

Fig 1



iii Check tightness of the belt. Adjust the belt for proper tension as recommended by the manufaturer.

iv Check whether it is due to tight bearings. Test by turning the shaft by hand. If lubrication does not help, the bearing must be replaced.

v Fails to start, but runs in either direction when started manually.

vi Check the contact of the centrifugal switch. If the contact of the centrifugal switch is not closed, repair it or replace it.

vii Check the capacitor. Replace it if defective.

Starts but heats rapidly

viii Check the cetrifugal switch. If it is not opening, rectify or replace.

Reduction in speed - motor gets too hot

ix Check the winding for its short circuiting and grounding (earthing).

x Check the bearing to know whether it is sticky. repair or replace, if found defective

Grinder is noisy

xi Check for worn out bearings - replace the bearings and inspect the shaft for scoring.

xii Check the end play, add additional end for preventing wahers, if the play is too much.

xiii Check the loose parts (that is loose hold-down bolts, loose fan, pulleys etc). Tighten them.

xiv Check whether there is misalignment. Align the pulleys correctly. (Fig 1 in Task 3)

xv Check the belt. Replace if it is worn out. (Fig 1 in Task 3)

xvi Check the shaft of the motor. Replace or send the motor for repair, if found bent.

Grinder gives shock

xvii Open the inspection cover and check for any line contact with the metallic body. Also ensure earthing is proper.

xviii Rectify the accidental contact, if any, and insulate them properly.

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TASK 5 : **Servicing of a food processor**

1 Note down the name-plate details in the maintenance card. (Table 5)

2 Enter the details of the complaint from the customer in the maintenance card.

3 Switch on the food processor and check for its functioning.

4 Isolate the food processor from the supply.

5 Open the bottom cover, and conduct visual inspection for:

– damages in the supply cord and loose terminal connections

– Condition of switches

– Motor condition and note down in table 4.

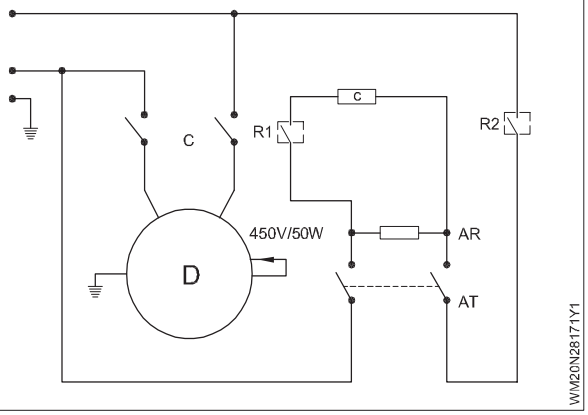
Table 5

Name of the customer		Address
Name of the appliance		Serial No
Wattage	Current	Voltage
Supply		Make

Date of servicing	Consumer's complaint	Defects noticed by visual inspection	Details of repair and replacement

6 Conduct an insulation test of the motor and record in the maintenance card (Table 6). The schematic diagram of a mixer circuit is given in Fig 1.

Fig 1



The insulation resistance value should not be less than one megohm.

7 Improve the insulation value by heating or varnishing, if the insulation value is less than one megohm and enter the test results in the maintenance card. (Table 6)

8 If the motor is opened for varnishing, clean thoroughly the stator and armature and bush bearings.

9 Conduct the insulation test after varnishing and enter the results in the maintenance card (Table 5).

Remember that the nuts at the blades and the centre shaft holding nut are to be loosened by clockwise movement and tightened by anti-clockwise movement in most of the mixers.

10 Lubricate the bearing as recommended by the manufacturer before assembly.

Most of the bearings need no lubrication. If required,a drop of light oil like 3-in-1 oil could be used.

11 Clean the commutator surface. A black carbon deposit could be removed by CTC. Seat the bushes properly over the commutator. Check for adequate length of brushes to exert spring pressure.

If the brush length is shorter by 1/3 of its original length it is better to replace with the brushes of the same grade and size. The new brush has to be bedded on the commutator properly.

12 Assemble the motor and tighten the terminal screws.

13 Assemble the blade with the jar and nylon coupling at the bottom.

14 Connect the motor to the supply and start the food processor.

15 Observe the working of the food processor for smooth running.

Table 6

Date of servicing	Insulation resistance before varnishing/heating		Insulation resistance after varnishing/heating		Details for repair and replacment
	Between terminal and body	Between Armature and field	Between terminal and body	Between Armature and field	

— — — — — —

TASK 6 : **Repairing of food processor**

1 Listen to the complaints of the customer/user and enter in the maintenance card.

Common complaints are listed in the troubleshooting chart along with reasons for the possible cause and the corrective action to be taken.

2 Inspect visually the following parts for trouble.

- Power cord and plug
- Terminal connections at the switch (back cover to)
- Couplings
- Freeness of the shaft
- Burnt smell or discolouring of windings.

3 Conduct the continuity and insulation tests and enter the values in Table. Ascertain the area of problem by analysing the customer's complaint, visual inspection and test results. (Refer to the maintenance card.)

4 Troubleshoot the food processor following the hints given in the troubleshooting chart.

5 Assemble the food processor conduct the continuity and insulation test. Enter the values in the maintenance cards.

6 Connect the food processor to the supply, and test run after satisfactory values of the test are obtained.

Trouble shooting chart

Problem	Possible cause	Corrective action
Food processor does not run	a) Overload trip might have tripped.	a) Reset the overload relay and advice the customer not to overload the food processor in future.
	b) No power at the outlet.	b) If the food processor is running in your shop but not running at the customer's house ask the customer to get the socket repaired.
	c) Defective power cord or plug.	c) Test, repair or replace the power cord/plug.
	d) Locked shaft.	d) Unplug the supply and try to rotate the shaft by hand. Clean the bearings; lubricate the bearings as advised by the manufacturer. If the shaft is still tight, recondition or replace the bearings. The shaft might have got bent. Replace the shaft or armature assembly.
	e) Worn out brushes.	e) Replace the brushes and loose springs
	f) Open circuited.	f) Check the field and armature windings. If found defective get it rewound or replace.
Blows fuse when switched on	a) Shorted power cord.	a) Replace the cord.
	b) Locked shaft.	b) As in 'd' above.
	c) Defective armature or field coils.	c) Test the windings for short. If short is found, re-wind or replace.
	d) Poor insulation resistance.	d) Check, test and repair.
	e) Low capacity fuse.	e) Check the capacity of the fuse against the mixer rating. Replace if required.
Slow speed with weak power.	a) Wrong materials or too much quantity loaded for processing.	a) Verify from the customer about the load and advise accordingly.
	b) Jammed rotor.	b) Rotate by hand. If found tight, clean the bearing / bush and lubricate it. If it is found still tight, change the bearings or check for bent shaft.
	c) Tight blade assembly.	c) Check the spring, washer and assembly. Repair or replace if required.
	d) Worn out brushes or loose spring.	d) Check, repair or replace if required.
	e) Bent shaft.	e) Check, repair or replace if required.
	f) Partially shorted or grounded winding or poor insulation resistance.	f) Check, test and repair/rewind if required.

Food processor runs but becomes hot.	a) Overloading of food processor.	a) Bring down the load in the mixer or advise the customer to go for a higher capacity mixer.
	b) Time rating of food processor is exceeded.	b) Check the duration the mixer is switched on by the customer and compare with the mixer rating. Advise accordingly.
	c) Bent shaft and rotor is rubbing the stator.	c) Check, repair or replace if required.
	d) Improper coupling.	d) Check, repair or replace if required.
	e) Shorted winding.	e) Check, test and rewind if required.
Food processor-makes noise	a) Dry bearing.	a) Check and lubricate.
	b) Loose mounting screws.	b) Check and tighten the loose screws.
	c) Rotor rubbing against stator.	c) Check the alignment and shaft for bend. Repair or replace the shaft if required.
	d) Bent fan blades.	d) Check and straighten the blades. If not possible replace the fan blades.
	e) Broken or missing gasket.	e) Replace.
Motor runs on one speed only.	a) Check the speed selector switch connections and function of switch.	a) Repair or replace the switch.
	b) Partially burnt out field winding	b) Test with multimeter. Repair or rewind.
Bad sparking at motor brushes.	a) Struck or worn out or loose brushes.	a) Check, reshape the brushes, replace the springs or reposition the brushes for proper tension.
	b) Pittings or uneven commutator surface.	b) Use sand paper or turn the commutator on a lathe.
Food processor produces shock.	a) Water leaking and coming in contact with live terminals. (Double insulated mixers with plastic body and two pin plug No earth connection).	a) Check the drain hole in the coupler head assembly for blockage. Check the jar examine for leakage due to loose shaft or worn out bearing, ebonite washer breakage. Repair or replace.
	b) Vent hole in the mixer body clogged.	b) Clean the vent hole.
	c) Damaged power cord.	c) Check and replace if required.
	d) Absence of earth connection.	d) Check the earth connection in the food processor motor, power cord and at socket. Repair and re-do the earth connection if required.
	e) Live parts coming in contact with metal body.	e) Check with a Megger and take corrective action if required.
Smoke coming	a) Improper seating between coupling.	a) Check whether male and female parts of the coupling are properly seated. If not include additional washers in the detachable blade assembly to make proper seating between couplings.
	b) Worn out coupling.	b) Check and change the coupling if required.
	c) Misaligned coupling.	c) Check the motor assembly and re-align if required.

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Service and repair of fan, blower, cooler etc

Objectives: At the end of this exercise you shall be able to
- **read and interpret the data of given fan, blower and cooler**
- **identify the problem in the fan, blower and cooler**
- **dismantle the fan, blower and cooler**
- **replace faulty parts with good ones.**

Requirements

Tools / Instruments

- Test lamp 100 W, 240 V - 1 No.
- Electrician tool kit - 1 Set
- D.E. spanner set of six 6 mm to 22 mm - 1 Set
- Plastic spanner for opening the jar screw - 1 No.
- Box spanner set of 6mm to 22 mm - 1 No.
- Multimeter Digital - 1 No.
- Megger 500 V - 1 No.
- Philips screwdriver 4 mm blade dia - 1 No.
- Pulley puller 3leg 200 mm - 1 No.

Equipment / Machines

- AC ceiling Fan 60 W, 250 V - 1 No.
- Blower 250 V 50 Hz. 900 watts - 1 No.
- Air cooler 250 V 50 Hz 165 watts - 1 No.

Materials

- Grease/lubricating oil - as reqd.
- Kerosene - as reqd.
- Cleaning brush - 1 No.
- Sandpaper smooth - as reqd.
- Soldering lead, 40:60, soldering flux - as reqd.
- Service manual (if available) - 1 No.

PROCEDURE

TASK 1: **Servicing on AC ceiling fan**

1 Switch `ON' the fan and check for its smooth functioning at different settings of the regulator.

2 Isolate the fan circuit from supply by
- removing the circuit cut-out or
- switching off the mains and removing the fuse units.

3 Conduct visual inspection
- for good condition of switch
- for proper mounting of regulator and firm fitting of knob.

4 Open the switch cover. Remove any external deposits, using a hair brush.

5 Check firmness of termination. Open the regulator and clean the inside with a brush. Check and adjust the contacts, terminations. (Fig 1)

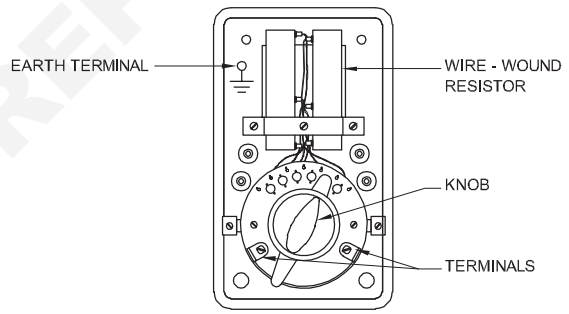
6 Measure the insulation resistance between the outgoing terminal of the regulator and earth. (Fig 2) Record its value in Table 1.

7 Make arrangements to reach to the ceiling fan through stable means of elevation. (ladder, table etc. The safety of a person is of utmost importance. Fig 3)

8 Note down the visual marking made on the fan, if any, and the name-plate details for filling up the entries in Table 1.

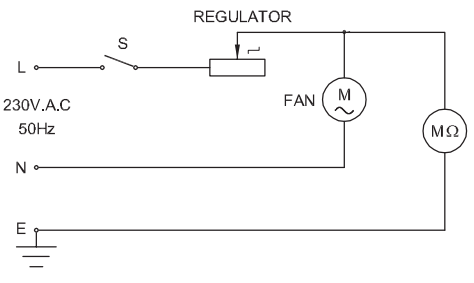
9 Remove the fan blades in succession and refit the screws and spring washers in their place, in the body of the fan.

Fig 1



INSIDE VIEW OF A REGULATOR

Fig 2



10 Slide the top and bottom canopies for inspection and cleaning. (Fig 4)

11 Inspect the supporting hook, grommet, shackle, supporting system, split pin etc.

12 Inspect the cotter pin, check-nut, connections to the capacitor, fan leads, connector. (Fig 5) Clean the external dust, dirt with a brush.

Fig 3

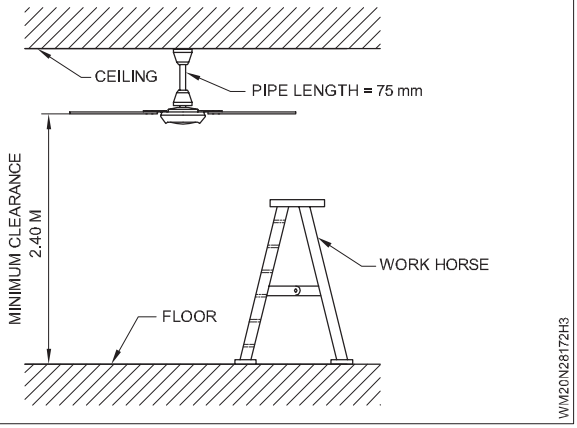


Fig 4

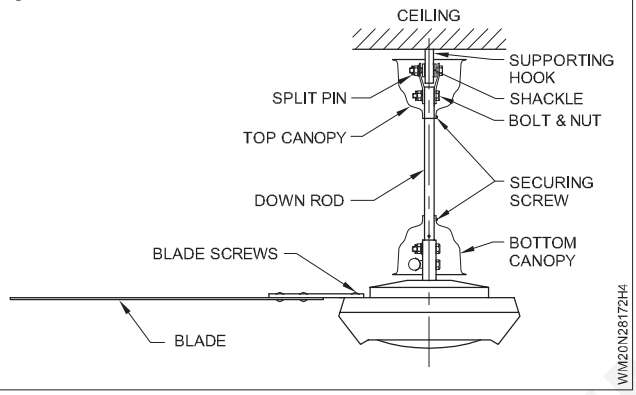
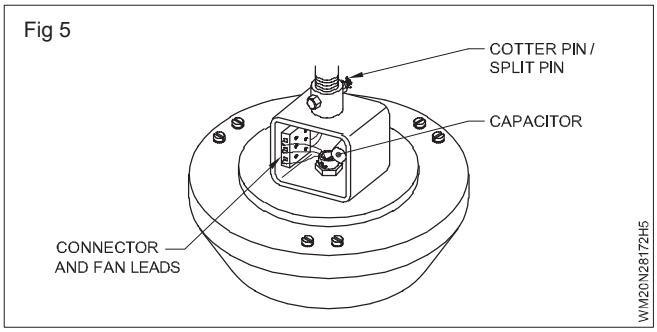


Fig 5



13 Clean the fan body first with a dry cloth and then with a wet cloth.

On inspection after sliding the canopy, if any excess of moisture or water is found, bring the fan down with the rod for testing its insulation resistance.

14 Dry the fan body by external heating with 500W or 1000W bulb or in an oven, if insulation is weak due to dampness.

15 Clean the blades thoroughly and mount them back. Apply grease/oil on the screws at the time of fixing the blade.

16 Test the fan for its smooth functioning, after resuming supply to the fan circuit.

17 Record your observations about the points listed in Table 2.

Table 1

Name of appliance	
Serial No.	Voltage
Sweep	Make
Supply	Current
Watts	Special marking
Insulation resistance between terminal & body	Megohms
Date of servicing Recommended repair/ replacement made, if any	

Table 2

Sl.No.	**Points to be observed**	**Condition**	
		Normal	**Abnormal**
1	Speed		
2	Noise		
3	Heat (after 10 min. run)		
4	Wobbling		
5	Function of regulator in all positions		

TASK 2: **Repairing of ceiling fan**

Listen to the user's complaints. Complaints may be

– fan is not running

– fan is noisy

– fan wobbles excessively

– motor runs hot.

Fan is not running.

1 Check the concerned branch circuit fuse and ensure the availability of supply in the fan circuit.

2 Check for the supply in the outgoing lead from the regulator to the fan.

If any fault is noticed in the switch and/or regulator, rectify or replace it and ensure free rotation of the fan by rotating it manually.

3 Check the supply at the fan terminals (either at the fan terminals or at the ceiling rose).

4 Give temporary connection for further testing, if there is no supply at the ceiling rose.

5 Check the connection of the capacitor for loose connection after switching off the supply if the fan is still not running.

6 Switch ON the supply.

7 Replace the capacitor with an identical good capacitor, if the fan is not running.

8 Lower the fan if even after replacing the capacitor the fan is not running. Test winding and take the necessary repair work if needed.

Fan is noisy

1 Collect the history and nature of the noise of the fan from the user.

2 Run the fan and observe the noise.

3 Identify whether the noise is due to one or a combination of the following. (The parts are shown in Fig 1).

a Slack canopy - touching the rotating body.

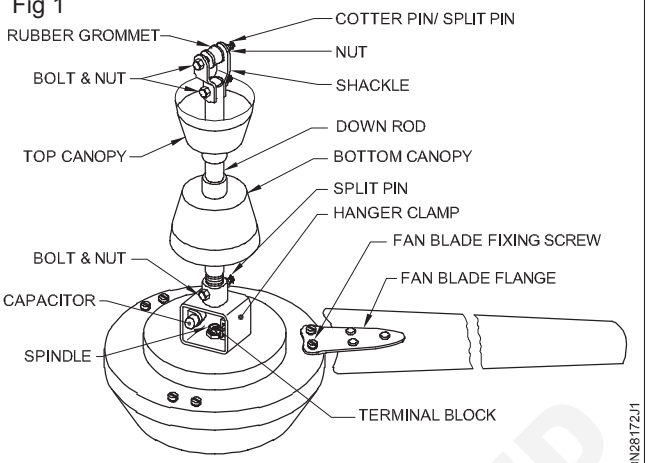
b Worn out/partly out shackle.

c Loose element of the blade.

d Loose or missing screws.

e Capacitor housing slack.

Fig 1



PARTS OF A CEILING FAN

f Broken or worn out split pin at the top and bottom.

g Lack of lubrication, or dirt in bearing.

h Worn out bearing/bush.

i Blade distortion/breakage.

j Alignment of blades.

Fan wobbles excessively.

1 Check to be sure that the screws which attach the fan blade flanges to the motor hub are tight.

2 Check to be sure that the fan blade flanges seat firmly and uniformly to the surface of the motor hub.

If the flanges are seated incorrectly, loosen the flange screws and re-tighten.

3 Tighten the hanger bracket screws to the junction box, secure the hook.

4 Interchange the adjacent (side by side) pair of blades.

If the fan blades are out of balance, it can re-distribute the weight and result in smoother operation.

Motor runs hot

1 Check for partial short circuit in winding. If defective, send it for rewinding.

2 Check for tight bearing, if it is defective, replace it with good bearing.

— — — — —

TASK 3: **Servicing on air blower**

1 Note down the name plate details in the maintenance cards (Table 1)

2 Enter the details of the complaint from the customer in the maintenance card.

3 Switch 'ON' the Blower and check for its smoth functioning.

4 Isolate the Blower from the supply.

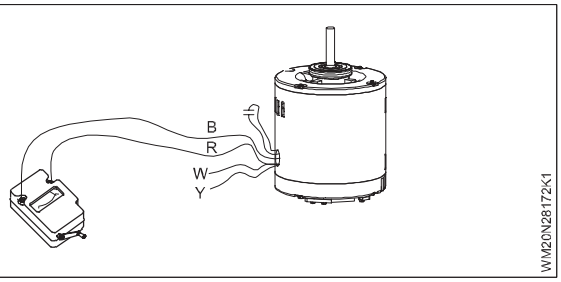
5 Open the Blower cover and conduct visual inspection for

- Damage in the supply cord, Blower or three parts and loose terminal connections.

- Good condition of switches and fan blades
- Proper mounting of the motor.

6 Conduct an insulation test after motor and record in the maintenance card Table 2 and Fig 1).

Fig 1



7 Improve the insulation value by apply varnishing, if the insulation is less than 1 mega ohs, and the test results in the main card

8 If the motor is opened for varnishing, clean thoroughly the stator and armature and bush bearings.

9 Conduct the insulation test after varnishing and enter the results in the maintenance card (Table 2)

10 Nuts and bolts should be tightened.

11 Lubricate the bearings, shaft and fan blade.as recommended by the manufacturer.

12 Inspect the blower wheel to make sure it is clean and free of damage, if it is dirty, clean it using a soft brush or cloth.

13 Check the blower belt for any signs of wear or damage, replace the belt if needed.

14 Assemble the motor and tighten the terninal screws.

15 After servicing the blower observe the working of the blower for smoth by connecting to the supply.

Table 1

Maintenance card

Name of the customer _____ Address _____

Name of the Appliance _____ Serial No _____

Wattage _____ Current _____ Voltage _____

Supply _____ Make _____

Date of servicing	Consumer's complaint	Defects noticed by visual inspection	Date of repair and replacement

Table 2

Date of servicing	Insulation resistance before varnishing/heating		Insulation resistance after varnishing/heating		Details for repair and replacment
	Between terminal and body	Between Armature and field	Between terminal and body	Between Armature and field	

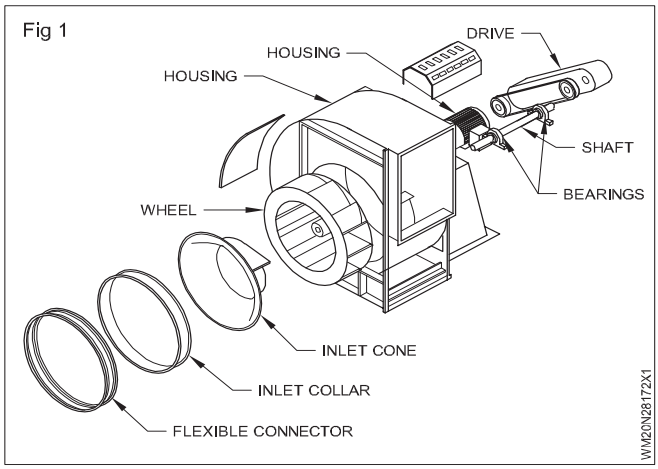
TASK 4: **Repairing of air blower**

1 Listen to the complaints of the customer / user complaints may be.

i Blower not working, fails to start.

ii Starts but heat rapidly

Fig 1



Blower not working, fails to start:

- Check whether there is open connection, rectify the fault.
- Check tightness of the belt, Adjust the belt for proper tension as recommended by the manufacturer.
- Check the belt, it such as a broken belt, replace with a new one.

Start but heat rapidly

1 Check the blower speed switch. If it is not working rectify or replace.

2 Once the issue has been diagnosed, obtain any replacement parts that are needed.

3 Reassemble the blower, test the blower to ensure it is operative properly.

Service on Cooler:

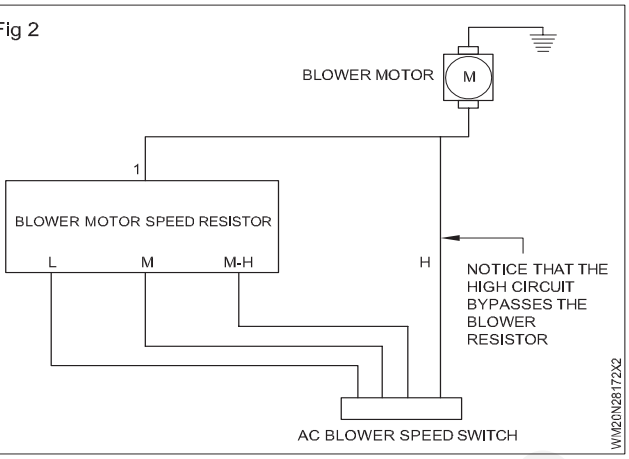
1 Note down the name plate details in the maintenance cards (Table 1)

2 Enter the details of the complaint from the customer in the maintenance card.

3 Turn off the air cooler and unplug it from the power source to avoid any electrical accidents.

4 Remove the water tank from the cooler and drain any remaining water.

Fig 2



5 Remove the front panel of the air cooler to access the interior.

6 Use a soft – bristled brush (or) a vacuum cleaner to remove any dust or debris that may have accumulated on the fan blades, cooling pads and other interior parts. (Fig 1)

Step 1: Clean the cooling pads by soaking them in a bucket of water mixed with mild detergent. Rinse the pads thoroughly with the clean water and let them dry completely before putting them back into the air cooler.

Step 2: Check the fan motor and lubricate if it necessary. Use a small amount of oil and apply it to the motor's bearing.

Step 3: Clean the water pump and ensure that it is free from any debris that may clog the pump.

Step 4: Check the water level sensor and make sure it is clean and functioning properly.

Step 5: Reassemble the air cooler by putting back the front and the water tank.

Step 6: Plug in the air cooler and turn it on to check if it is working correctly.

Step 7: Once you have ensured that the air cooler is functioning correctly, you can return it to the designated location.

Remember to follow all safety precautions and guidelines while performing this procedure, always wear appropriate personal protective equipment (PPE) such as gloves and eye protection when working with electrical equipment.

Table 1
Maintenance card

Name of the customer _____			Address _____
Name of the Appliance _____			Serial No _____
Wattage _____	Current _____		Voltage _____
Supply _____			Make _____
Date of servicing	**Consumer's complaint**	**Defects noticed by visual inspection**	**Date of repair and replacement**

TASK 4: **Repairing Air cooler**

Step 1: Turn off the air cooler and unplug it from the power source to avoid any electrical accidents.

Step 2: Check the air cooler for any visible damage (or) wear and tear. Identify the problem that needs to be repaired by using the circuit diagram shown in Fig 1.

Step 3: If there is a problem with the motor, check the motor winding for continuity. The motor needs to replaced. If there is a continuity, check the capacitor and replace if it necessary.

Step 4: If there is a problem with the fan blade, check it for any visible cracks bends. If it is damaged, replace it with a new one.

Step 5: If there is a problem with the water pump, check the pump for any visible damage (or) clogging. If it is clogged, clean it with a brush and water. If it is damaged, replace it with a new one.

Step 6: If there is a problem with the water level sensor, check the sensor for any visible damage or wear and tear. If it is damaged, replace it with a new one.

Step 7: If there is a problem with the cooling pads, check them for any visible damage or wear and tear. If they are damaged, replace them with new ones.

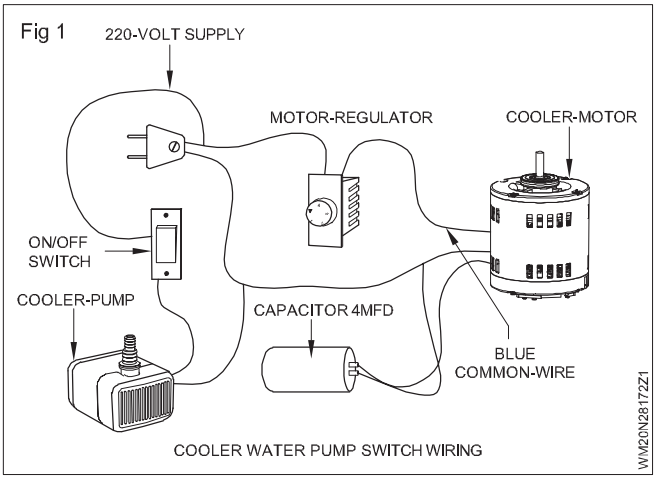
Step 8: If there is a problem with the control panel or switches check them for any visible damage or wear and tear. If they are damaged, replace them with new ones.

Step 9: After identifying the problem and repairing or repairing or replacing the necessary pants, reassemble the air cooler.

Step 10: Plug in the air cooler and turn it on to check if it is working correctly.

Step 11: Once you have ensured that the air cooler is functioning correctly, you can return it to the designated location.

Fig 1



COOLER WATER PUMP SWITCH WIRING

Service and repair of semi automatic washing machine, demonstrate components of fully automatic top and front load washing machine using visual aids

Objectives: At the end of this exercise you shall be able to
- **record the name plate details of the wahing machine**
- **listen to the complaint of the customer and identify the type of fault**
- **rectify the fault in the washing machine**
- **service the washing machine through general checks and visual inspection**
- **conduct insulation resistance test on a wahing machine**
- **record the details of maintenance in the service card.**

Requirements

Tools / Instruments

- Megger 500 V - 1 No.
- Test lamp 60W,240V - 1 No.
- Combination plier 150 mm - 1 No.
- D.E spanner set 6 of 22mm set of 8 - 1 Set
- Philips screw driver 150 mm - 1 Set
- Grease gun 1.2 litre cap - 1 No.
- Oil cane 1/2 litre cap - 1 No.
- Gear pulley puller 3 leg 150 mm - 1 No.
- Multimeter - 1 No.

Equipment / Machines

- Washing machine semi automatic type 240V, 50Hz - 1 No.
- Washing machine fully automatic type 240V, 50Hz - 1 No.

Materials

- Washing machine spares - as reqd.
- Oil/grease - as reqd.
- Water proofing kit - as reqd.
- Teflon tape/m seal - 1 No.

PROCEDURE

TASK 1: **Repairing of washing machine**

1 Record the details of the washing machine (Fig 1) in Table 1.

2 Listen to the complaints of the customer/user. The complaints may be anyone listed in the left side column of the table 2 The causes and remedies are given in the right side column of the table 2.

Table 1

Name-plate details

Manufacturer

Sl.No. _____ Phase _____

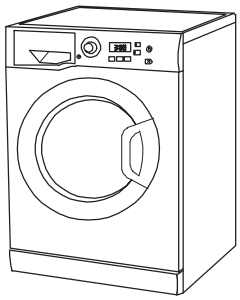
Capacity _____ R.P.M _____

H.P/K.W _____ Voltage ____ Hz

Max.weight of clothes/ _____ Current _____

drum capacity _____

Fig 1



WASHING MACHINE

WM20N28173H1

Table 2

Troubleshooting chart for washing machine

Sl.No.	Complaints	Causes and remedies
1	Machine not Swiching “ON”	I Check for open connection and rectify the same II Check the incoming supply III Check the fuse on the machine IV Check the motor windings and repair of minor repairs can be carried out, if needed send it for repairs/rewinding for internal open circuit. V Check the speed governing starting switch, repair or replace with a new switch.
2	Water not filling up in the washing drum	I The inlet pipe is chocked. Open the inlet valve, clean it and reconnect it using water proofing teflon tape II Check incoming water supply and replace the same.
3	Water does not drain out of the wash drum	I Check the outgoing valve, clean and reconnect it with proper water proofing II Check the outgoing pipe for any kinks - repair or replace the same.
4	Machine does not switch ‘OFF’ after	I Check the timer working. The timing mechanism at pre-deter mined times set on the timer have been closed or clogged - if possible, repair it.Otherwise replace the timer with a new one. II The timer may be okay but the switch may be stuck -replace the switch.
5	Machine becomes ‘ON only for a very short duration and then switches off	I The timer setting may be incorrect;set the timer properly. II The speed governor switch may be faulty; dismantle the motor and repair the same, If possible, or replace the starting speed governor swivel mechanism. III The running winding impedance could have increased due to open circuit and insulation failure. Check the running winding impedance and rewind the motor, if necessary.
6	The machine is noisy	I Check the balancing of the drum and correct the same if found off balance. II The motor shaft pulley/drum driver pulley may be loose,tighten the same. III The belt of the machine drive might have loosened thus giving play. IV Check the bearings of the motor, replace the worn out or grease the same using the recommended grease. V Check all rubber bushings that are used in the machine for absorbing mechanical vibration, and replace, if found spoilt or missing.
7	The machine gives shock	I Isolate the machine from the spply and carry out megger test II If there is an insulation failure found in the plug, isolate the motor and check the winding with body. III If winding insulation failure is detected, send the motor for rewinding. IV If insulation failure is detected, trace the complete wiring of the machine and locate the faulty or leaky insulation area. V Replace the complete wire that is found faulty VI Check for any water leakage/seepage into the Power wiring area and carry out water proofing for all such areas where leakage of water is detected. VII Check the machine body if it has been earthed and the earth brought to the plug. Check if the socket board earthing is present; then correct the same by providing proper earthing

8	When power is swiched 'ON' motor	I Check if the motor shaft is rotating; the pulley to the hum is heard but the wash agitator does motor shaft may be loose, tighten the same. II Check the belt tension. If the belt has become loose tighten the same by the tension adjustor or replace the belt with a new one. III Check if the agitator of the machine is sufficiently loose,i.e. the bearing if free and not tight; carry out lubrication of the bearing if necessary.
9	When the machine control switch is switched 'ON' the fuse blows	I Isolate the machine from the supply, isolate the motor terminals and check if there is an insulation failure/short circuit in the motor or in the wiring of the machine. II If short circuit/insulation failure in the motor, rewind the motor. III If short circuit/insulation failure is present in the rest of the machine, trace the same and remove the short circuit.

— — — — —

TASK 2: **Servicing of washing machine**

1 Read the instruction manual of the washing machine.

2 Connect the machine to the supply and switch on the machine in steps as indicated by the operating/ instruction manual.

3 Check the water flow at the inlet to the machine. If found incorrect clean the inlet and reconnect the water supply using proper waterproofing method. If leakage is present at the connecting point between the machine and the water pipe, use teflon tape between the couplings to prevent leakage.

4 Check the water flow at the outlet and check whether all the water is drained out of the wash drum. If it does not, disconnect the machine from the supply then level the machine on the floor and let the water is drained out.

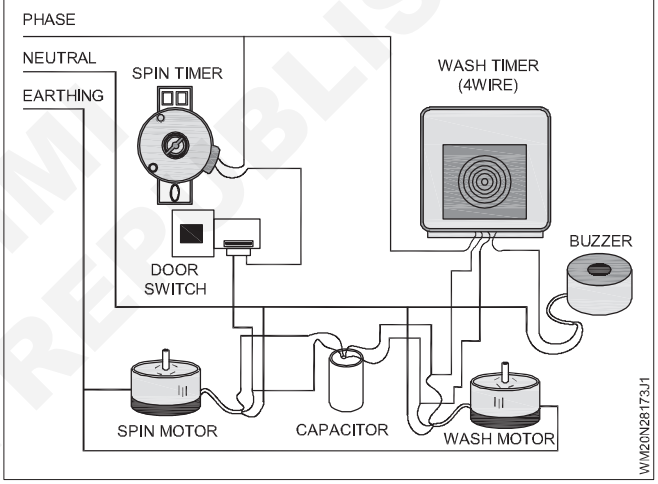
5 Isolate the machine from the supply. Open the inspection cover of the machine and carry out visual inspection of :

- the supply cord and its terminations i.e. between plug and machine terminals
- condition of the motor pulley-belt and drive alignment
- all internal connections between the control panel and the machine motors, timer and switches, shown in Fig 1.

6 Lubricate the bearings of the motor with a suitable grease as recommended by the manufacturer with the help of the grease pump.

7 and especially where maximum vibration of the machines is felt, use a dot of grease or oil in the threads.

Fig 1



8 Conduct an insulation test of the motor and record it in Table 3, using a 500V Megger. Insulation resistance should be around 1 megohm; if found less then check the wiring and internal accessories and all Powerly live parts for moisture and weak insulation. Remove the moisture and prevent any water leakage near the Power parts suitably. Reconduct the insulation test.

9 Close the inspection hatch/cover and connect the machine to the supply and load the machine with the number of clothes recommended by the manufacturer for the smooth running of the washig machine.

Table 3

Insulation resistance between terminal & body windings	
Date of servicing	
Recommended repair	
Replacement of parts	

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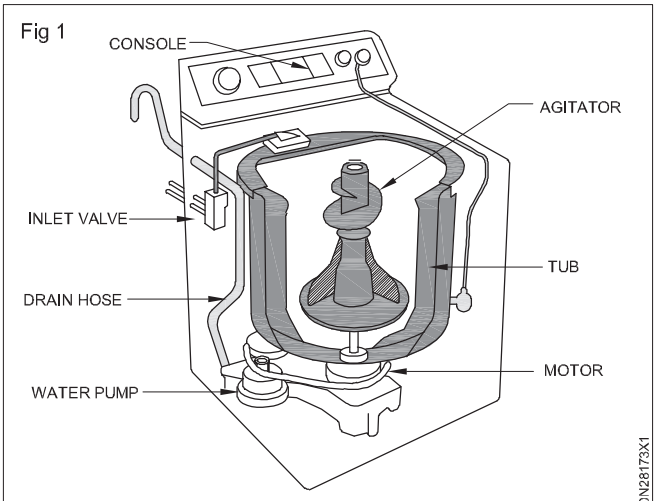
Components of fully automatic top load and front load washing machine

1 Fully automatic top load washing machine components (Fig 1):

Fig 1

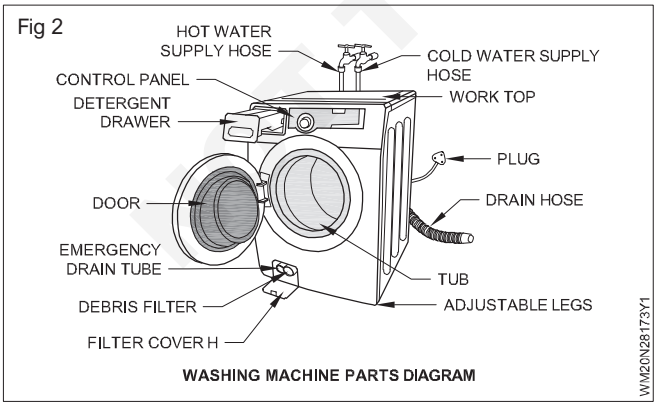


TOP LOAD WASHING MACHINE

- **Control panel :** This where you set the wash program, water level and other settings.
- **Tub:** this where the clothes are placed for washing. The tub rotates to agitate the clothes and remove dirt and stains.
- **Agitator:** This is spindle in the center of the tub that rotates to agitate the clothes and remove dirt and stains.
- **Drain pump:** This pumps out the dirty water from the machine during the rinse and spin cycle.
- **Motor:** This powers the agitator and spin cycle.
- **Lid switch :** This prevents the machine from starting if the lid is open.

2 Fully automatic front load washing machine components (Fig 2):

Fig 2



WASHING MACHINE PARTS DIAGRAM

- **Control panel :** Similar to top load machines, this is where you set thw wash program, water level, and other settings.
- **Drum :** This is where the clothes are placed for washing. The drum rotates on a horizontal axis to lift the clothes up and down in the water, creating friction to remove dirt and stains.
- **Door :** This is where you load and unload the clothes. It has a seal to prevent water from leaking out.
- **Drain pump :** Similar to top load machines, this pumps out the dirty water from the machine during the rinse ans spin cycle.
- **Motor :** This powers the drum and spin cycle.
- **Water pump :** This pumps water into the machine during the wash cycle.
- **Heating element :** Some machines have a heating element to heat the water for a more effective wash.

Both types of machines also have sensors and timers to control the various functions and ensure that the machine operates safely and efficiently.

Visual aids refer to any type of visual element used to enhance communication or presentation. Examples of visual aids include charts, graphs, diagrams, photographs, videos, animations and other images that help illustrats or explain a topic. These visual aids are often used in conjunction with written or spoken content to make it more engaging and easier to understand for the audience. In the context of demonstrating the components of a washing machine, visual aids might include images, diagrams or videos that show the various parts of the machine and how they work together.

Procedure to demonstrate components of fully automatic top load washing machine

1 Begin by locating and identfying the various components of the washing machine, including the control panel, tub, agitator, drain pump, motor and lid switch.

2 Show how to load clothes into the machine by opening the lid and placing the clothes into the tub. Make sure to not overload the machine.

3 Demonstrate how to set the wash program, water level and other settings using the control panel.

4 Turn on the machine by closing the lid and pressing the start button.

5 As the machne runs through the wash cycle, explain how the agitator rotates to create turbulance in the water and clean the clothes.

6 Show how the drain pump removes the dirty water from the machine during the rinse ans spin cycle.

7 As the spin cycle begins, demonstrate hoe the motor spins the tub to remove excess water from the clothes.

8 Finally, open the lid and show the clean, freshly washed clothes.

Procedure to demonstrate components of fully automatic top load washing machine

1 Begin by locating and identfying the various components of the washing machine, including the control panel, drum, door, drain pump, mtor, water pump and heating element (if applicable)

2 Show how to load clothes into the machine by opening the door and placing the clothes into the drum. Make sure to not overload the machine.

3 Demonstrate how to set the wash program, water level and other settings using the control panel.

4 Turn on the machine by closing the door and pressing the start button.

5 As the machine runs through the wash cycle, explain how the drum rotates on a horizontal axis to lift the clothes up and down in the water, creating friction to remove dirt and stains.

6 Show how the water pump adds water to the machine during the wash cycle.

7 Explain how the drain pump removes the dirty water from the machine during the rinse and spin cycle.

8 Finally, open the door and show the clean, freshly washed clothes.

9 Finally, Open the door and show the clean, freshly washed clothes.

Instructor should arrange visual aids for demonstrate components of fully automatic top load and front load washing machine.

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Service and repair of refrigerator

Objectives: At the end of this exercise you shall be able to
- **identify the electrical parts /components of refrigerator**
- **identify the mechanical components of refrigerator.**

Requirements

Tools / Instruments

- Screw driver 150mm - 1 No.
- Screw driver 10mm tip 200mm length - 1 No.
- Cutting plier 200 mm length (insulated) - 1 No.
- Philips screw driver set - 1 No.
- Ohm meter - 1 No.
- Line tester 0-500V - 1 No.
- Combination insulated handle plier - 1 No.
- Series test lamp - 1 No.
- Multimeter Digital - 1 No.

Materials

- Current coil relay - 1 No.
- OLP (Over load protection relay) - 1 No.
- FHP compressor - 1 No.
- 2m 1 sq.mm lead wire - 1 No.
- 2m wire with crocodile clip - as reqd.
- Test board fitted with voltmeter & ammeter - 1 No.
- Thermostat - 1 No.
- Capacitor - 1 No.
- Cotton waste/ cloth - as reqd.
- Loose wire - as reqd.

PROCEDURE

TASK 1: **Identify the Electrical parts (Figs 1 to 6)**

1 Disconnect the connection & identify the electrical components

2 Keep it on work bench.

3 Clean the motor and spare part.

4 Identify the components.

Fig 1

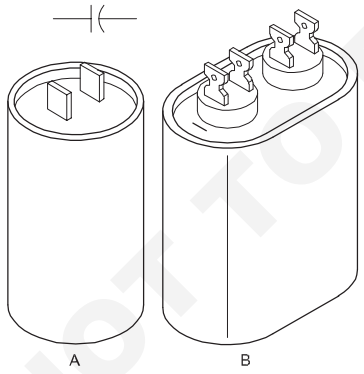

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Fig 2

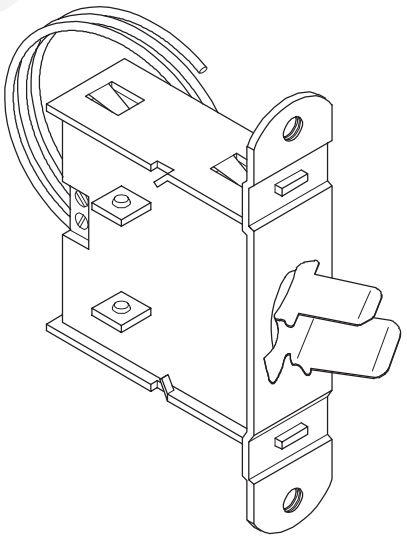

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Fig 3

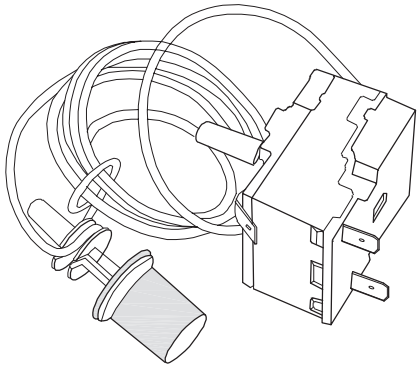

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Fig 4

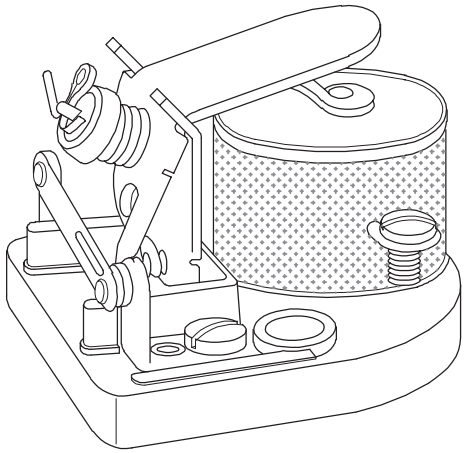

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Fig 5

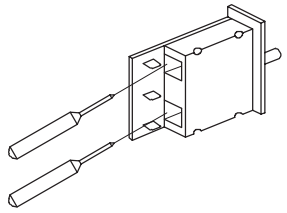

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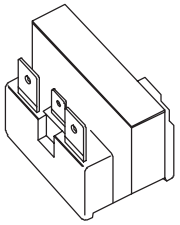
Fig 7



MRN1654H7

Table 1

Figure No	Name of the part
1	
2	
3	
4	
5	
6	
7	

— — — — —

TASK 2: **Identify the Mechanical parts (Figs 1 to 5)**

Fig 1

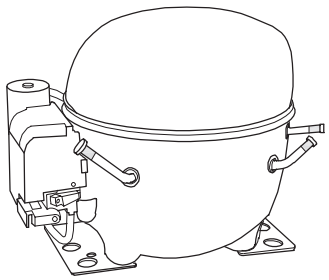


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Fig 2

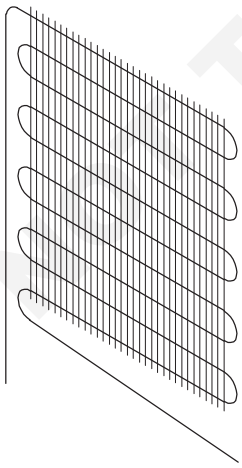

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Fig 3

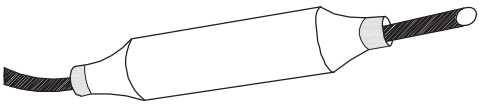

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Fig 4

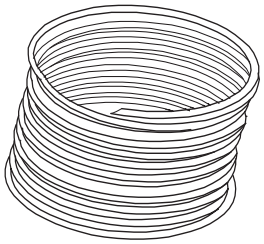

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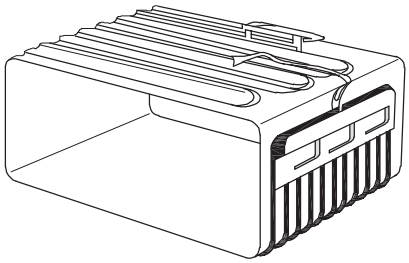
Fig 5



WM20N28174J5

Table 2

Figure No	Name of the part
1	
2	
3	
4	
5	

TASK 3: **Test the current coil relay**

1 Check continuity between the 4 & 5 with help of ohmmeter. (Fig 1)

2 If the continuity is OK between 1 and 2. Coil continuity of current coil relay is OK. Normal condition 4 & 5 continuing will be there.

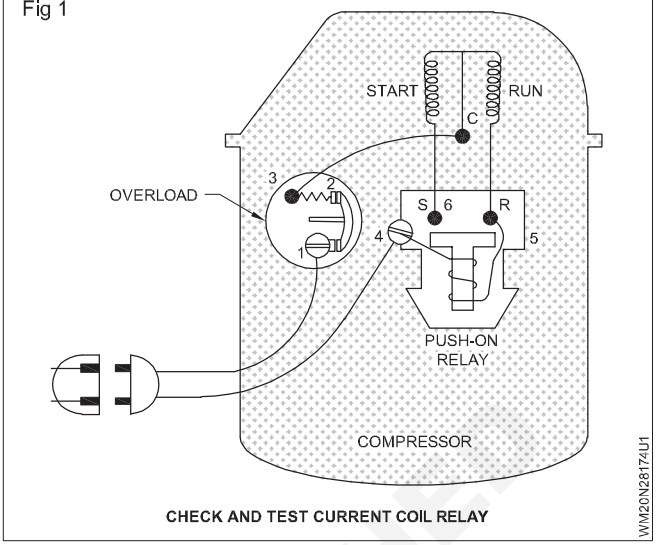
3 Check continuity between 5 & 6. Normal condition (when not in use) 5 & 6 open. If there is no continuity between 5 & 6 relay is OK (assumed winding wire removed from 5 & 6)

4 Keep the relay up side down. Check continuity between 5 & 6. If the continuity is there. Relay is OK.

5 Bring to its original position.Check continuity between 2 & 3. If there is no continuity. Relay found OK.

6 Check plunger movement and observe sound. Keep the relay upside down. Plunger moves up and you can hear the sound. Bring to normal position. Plunger comes down. You can hear sound. If there is no sound, relay is defective. Relay plunger operating is not OK.

Fig 1



CHECK AND TEST CURRENT COIL RELAY

— — — — —

TASK 4: **Check and the overload protector**

Refer TASK 3: Figure

1 Check continuity between 1 & 3

2 If the continuity OK between 4 & 5,continuity of bimetal contacts OK.

3 If there is no continuity Overload is defective

4 Check any rust formation in disc.If rust formation is there, not advisable to use. (Fig 1)

— — — — —

TASK 4: **Identification of compressor winding**

Terminal pins with Ohmmeter of fraction horse power pneumatic compression.

Before carrying out the exercise remember the following

– Running winding resistance always less than starting winding

– Starting winding resistance always higher than running winding

– Resistance of run and starting winding sum of starting winding resistance and running winding resistance

1 Set the ohmmeter as per the (Fig 1)

2 Measure the resistance between A and C (20 Ohms)

3 Record in the record sheet table no.1

4 Measure the resistance between A & B (40 ohms)

5 Record in the record sheet table

6 Measure the resistance between C & B (60 ohms)

7 Record in the record sheet

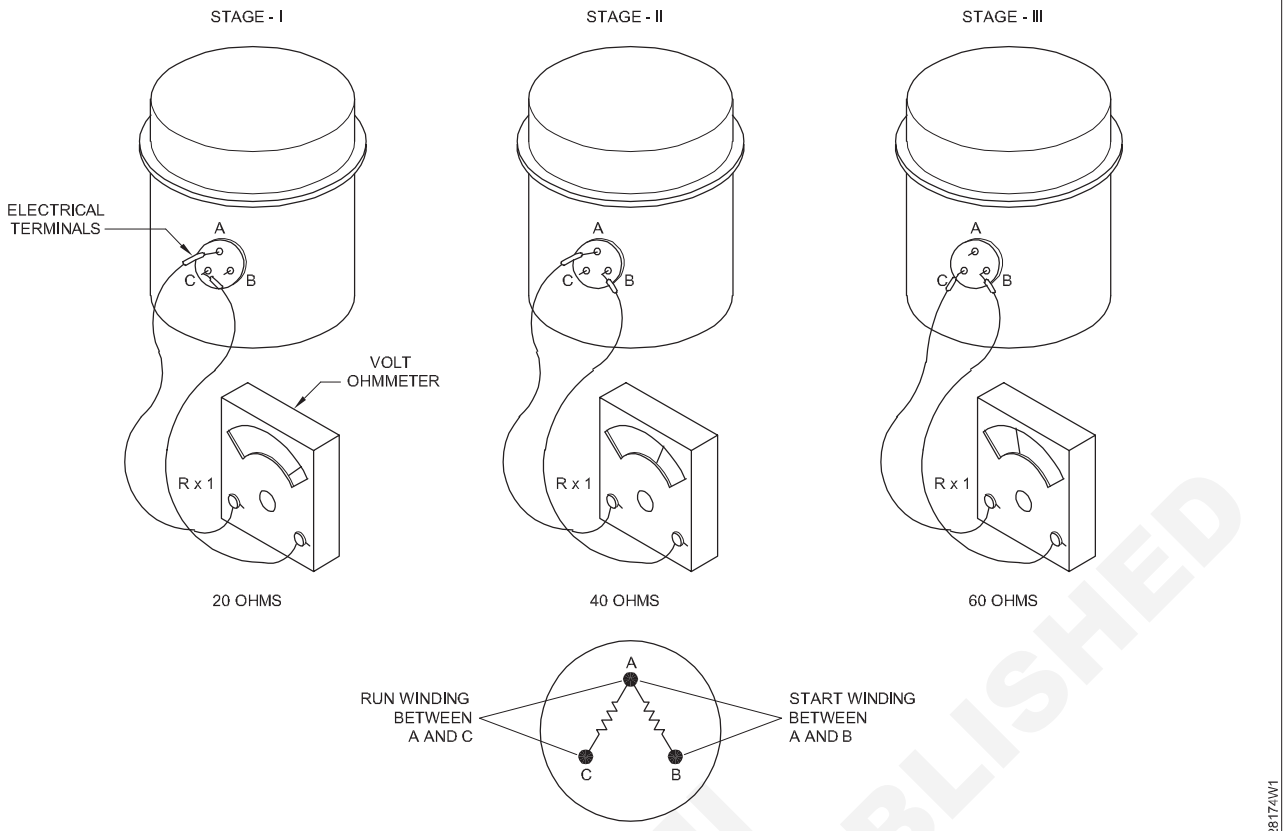
8 Identified ‘A’ terminal pin become common terminal

9 Identified ‘B’ terminal pin become starting winding

10 Identified ‘C’ terminal pin run winding

Resistance value slightly vary from manufacturer to manufacturer. Instructor must have compressor manufacturer specification.

Fig 1



SINGLE PHASE FRACTIONAL HORSE POWER COMPRESSOR

TASK 5: **Check short circuit in compressor**

1 Select ohmmeter scale (R x 10000) (Fig 1)

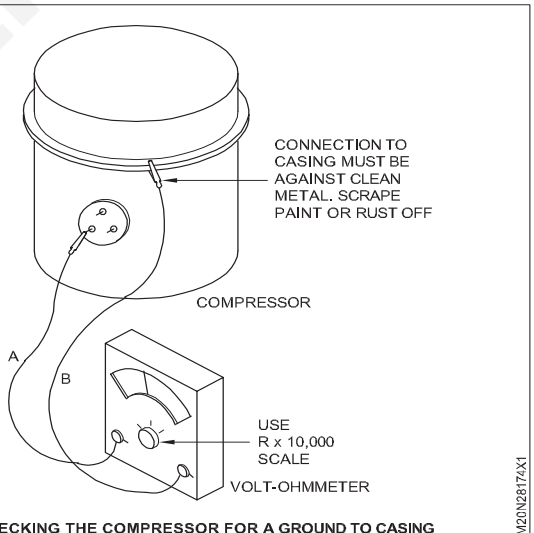
2 Place 'A' probe to compressor terminal

3 Place 'B' probe to metal casing of compressor

4 Check continuity. If continuity is there compressor grounded. (Fig 1)

5 If there is no continuity compressor not grounded.

Fig 1



CHECKING THE COMPRESSOR FOR A GROUND TO CASING

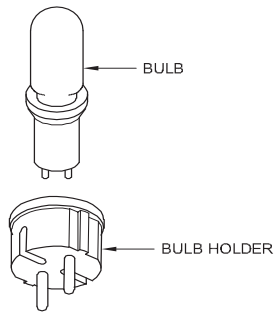
TASK 6: **Check the condition of a door switch**

1 Switch 'ON' the refrigerator

2 Open the refrigerator door and check the condition of cabinet bulb. It should glow.

3 If it is not, check the bulb. (Fig 1)

Fig 1



BULB AND BULB HOLDER

WM20N28174Y1

4 If the bulb is fused, replace the bulb on refrigerator and check.

5 Still the bulb not glows then switch off the refrigerator and remove the door switch and disconnect the wires.

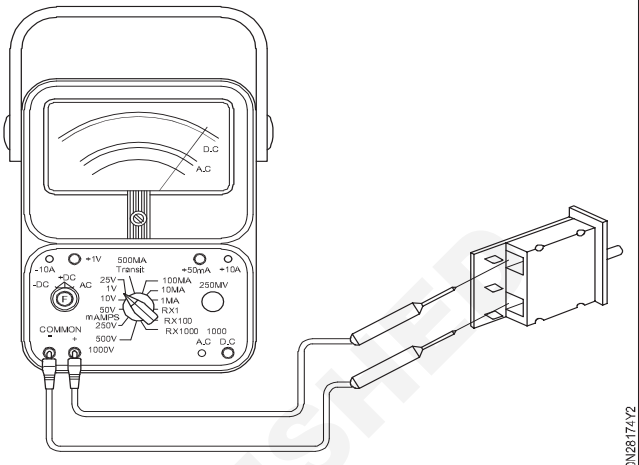
Note : Mark all connections which are being disconnected.

6 Check the continuity in switch by multimeter or by test lamp is ON and OFF position. (Fig 2)

7 Check bulb holder wires.

8 If switch found defective, replace it and connect wires.

Fig 2



CHECK DOOR SWITCH

WM20N28174Y2

— — — — —

TASK 7: **Check the condition of a thermostat**

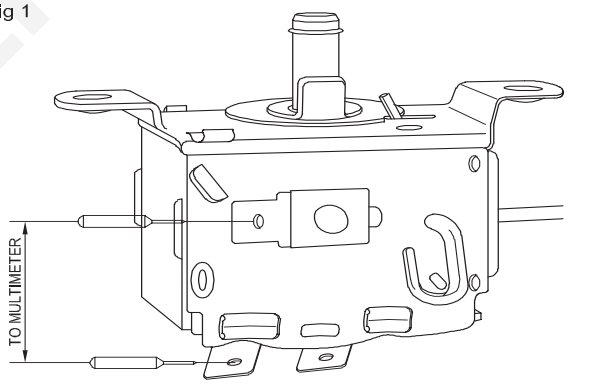
1 Switch ON the Refrigerator.

2 If it is not run check thermostat.

3 Remove the thermostat and its wires.

4 Test thermostat continuity in 'OFF and ON' position by multimeter or test lamp. (Fig 1)

Fig 1



TYPICAL THERMOSTAT

WM20N28174Z1

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TASK 8: **Check capacitor**

Caution: do not place fingers across the terminals of a capacitor. It may be charged and gives a shock. Short it with a insulated wire before handling.

1 Remove the capacitor for test.

2 Connect the capacitor in capacitor test circuit. (Fig 1A)

3 Check the fuse (D) in the circuit as shown.

4 Switch ON the circuit plug (E)

5 Press the charging switch (B) for one or two seconds. (Fig 1B)

6 Put off the circuit plug (E).

7 With the switch open at (B) touch the shorting switch (C). If the capacitor is good, the switch will spark. (Fig 1C)

8 If it does not spark in the first time, try it two or three times before replacing the capacitor to the unit.

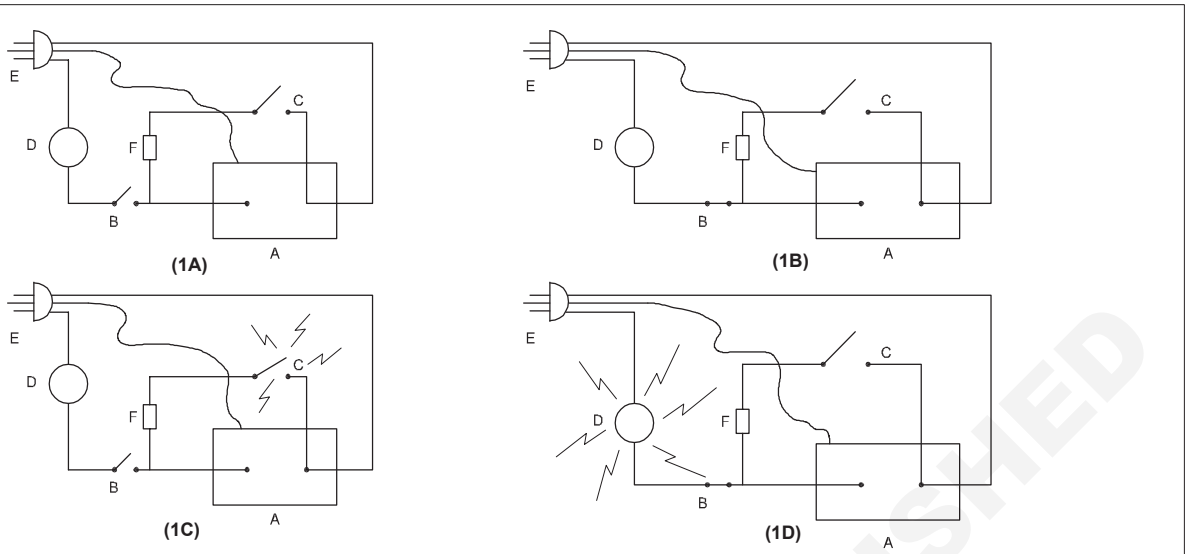
Note : If the capacitor is good it will spark as in (Fig 1C).

If the capacitor is shorted or grounded the fuse (D) will blow as in view. (Fig 1D).

If the capacitor does not take a charge, it will not spark. This indicates an open circuit. (Fig 1A). The capacitor is connected to the terminals of the tester.

Caution: The capacitor should be put in a protective case while testing it because a shorted capacitor may explode when put in a circuit.

Fig 1



A - CAPACITOR BEING TESTED
B - CHARGING SWITCH
C - SHORTING SWITCH
D - FUSE OR CIRCUIT BREAKER
E - ATTACHMENT PLUG TO 220V CIRCUIT
F - RESISTOR

2A - SWITCHES OPEN
2B - CHARGING SWITCH CLOSED
2C - GOOD CAPACITOR
2D - SHORTED CAPACITOR

ONE METHOD OF TESTING A CAPACITOR

WM20N28174ZH1

Demonstrate, installation and repair of pump set and submersible pump

Objectives: At the end of this exercise you shall be able to
- **install pumpset and submersible pump**
- **repair of pumpset submersible pump**
- **prepare the maintenance schedule.**

Requirements

Tools / Instruments

- DE spanner set 6mm to 22mm - 1 No.
- screw driver 150 and 200 mm - 1 No.
- Insulated combination pliers 200mm - 1 No.
- Ballpeen hammer 500 8m - 1 No.
- Pipevice adjustable 50mm - 1 No.

Equipment / Machines

- Pumpset coupled with motor - 1 No.
- Submersible pump - 1 No.
- Megger 500 V - 1 No.

Materials

- PVC insulated cable 3/20 or Screw driver 7/20 copper - 1 No.
- Teflon tape 5m roll - 1 No.
- Rubber or pvc bushings - 1 No.
- Lubrication oil - 1 No.

PROCEDURE

TASK 1: **Install and repair of pumpset**

The instructor may arrange the list of components and required tools, equipment's and material to demonstrate installation of pump set and submersible pump

1 Identify the location for pump set and submersible pump installation. Ensure that the location is free from flooding and has a stable base to support the pump set.

2 Clear the area of any debris rocks or dirt that may interfere with the installation.

Pump set

3 Assemble the pump set by connecting the motor to the pump using appropriate coupling.

4 Fix the pump set on the base plate or foundation with the help of bolts and nuts.

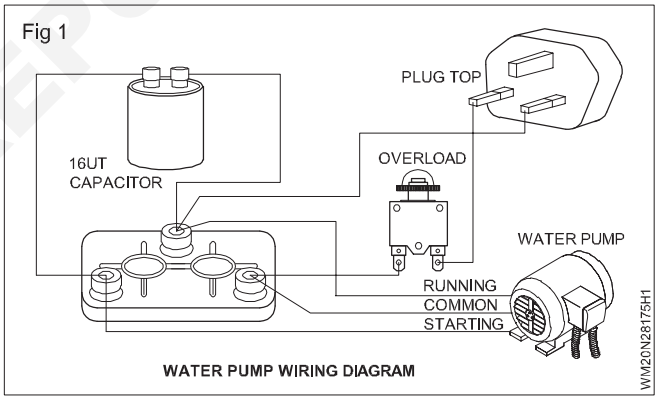
5 Connect the pvc suction pipe to the inlet of the pump using appropriate fittings and teflon tape.

6 Tighten the fittings with a pipe wrench to ensure no water leakage.

7 Connect the electric cables and wires from the electric control panel to the pumpset as show in fig 1

8 Secure the connections with insulation tape and ensure no loose connections.

Fig 1



WATER PUMP WIRING DIAGRAM

9 Fill the pump set with water switch on the power supply to start the pumpset.

10 observe the flow of water through the discharge pipe and ensure it is consistant and free from any blockages.

11 Test the pump set for any leaks vibrations or abnormal noises.

12 Adjust the motor speed and discharge flow rate as required.

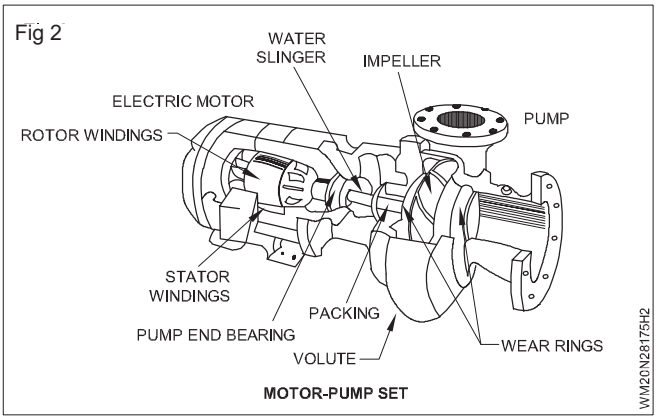
13 Once the pump set is functioning correctly the installation is complete.

Repair of motor pump set

1 Switch off the main supply MCB and remove the fuses if any

2 Read the name plate details of the pump set (Fig 2)

Fig 2



MOTOR-PUMP SET

3 Check the fuse cable and starter for its rating and their function.

4 Check the supply cable take remedial action (if required)

5 Check the tightness of pump set, fan cover and enclosure.

Replace rusted fastener if any required

6 Check ventilation dust and cooling fan. replace any block in cooling system if needed.

7 Check the motor for open short and insulation resistance tests. Take corrective steps if needed.

8 Check the earth continuity ohmic value and tightness replace the earth conductor if required.

9 Check the pressure gauge if any for its proper function.

10 Check the leakage water from any parts of the motor pump set repair if required.

11 Check the air lock releasing valve vent replace if required

12 Check the foot valve by opening and pouring the water in the air lock releasing pipe

The water level in the air lock releasing pipe should not decrease. If the water level is slowly decreasing if indicate that the foot valve may be defective get if rectified.

13 Check the condition of centrifugal switch and capacitor.

Repair or replace it if required.

14 Check the discharge water pressure and record it

15 Prepare the schedule for periodical maintenance for the motor pump set and follow the schedule regularly.

— — — — —

Task 2 : **Install and repair of submersible pump motor**

Submersible pump

1 Lower the submersible pump into the bore well or water source using appropriate lifting equipments

2 Connect the submersible pump to the discharge pipe using appropriate fittings

3 Tighten the fittings with a pipe wrench to ensure no water leakage.

4 Connect the electrical cables and wires from the electrical control panel to the submersible pump according to the wiring diagram.

5 Secure the connections with electric tape and ensure no loose connections. (Fig 1)

6 Fill the pump set with water and switch on the power supply to start the submersible pump

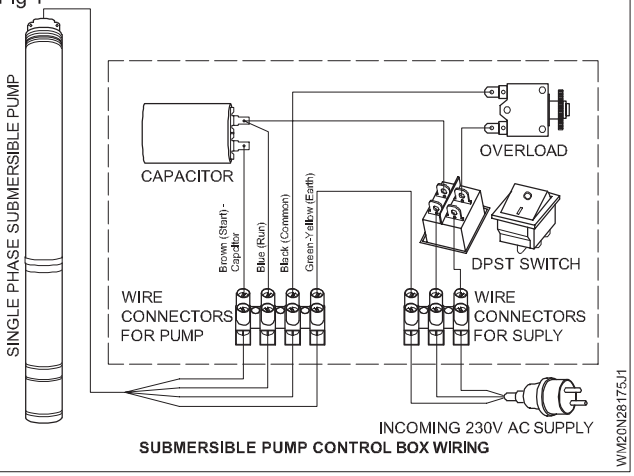
7 Observe the flow of water thoroughly the discharge pipe ensure it is consistent and free from any blockages.

8 Test the submersible pump for any leaks, vibrations or abnormal noises.

9 Adjust the motor speed and discharge flow rate as required

10 Once the submersible pump functioning correctly the installation is complete.

Fig 1



SUBMERSIBLE PUMP CONTROL BOX WIRING

Repair of submersible pump:

1 Switch off the power supply to the submersible pump motor.

2 Disconnect the electrical cable/ from the control panel and motor terminals.

3 Drain the pump remove it from the well or water source.

4 Inspect the motor casing visually for any signs of damage or corrosion.

5 Disassemble the motor casing using appropriate tools and techniques.

6 Remove the pump impeller and diffuser from the motor shaft.

7 Remove the motor stator and rotor from the motor housing.

8 Remove the bearings capacitors and wires from the motor assembly.

9 Inspect the bearings capacitors for any sign of wear damage or corrosim replace with new one if its required

10 Check the motor for open short and insulation resistance tests take corrective steps if needed.

11 Check the pressure gauge if any for its proper function.

12 Assemble the motor casing and components

13 Tighten two bolts and screws to the recommended torque specifications

14 Reconnect the electric cables and wires to the control box and motor terminals.

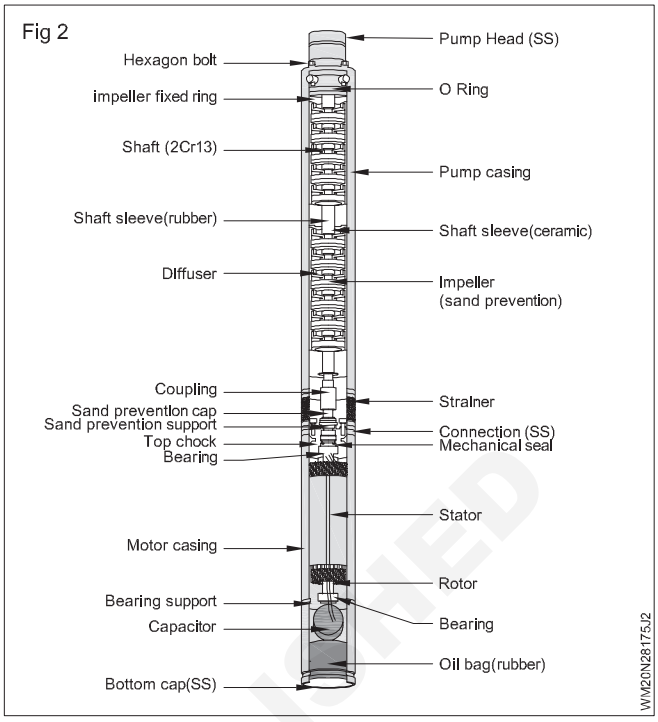
15 Use Teflon tape to seal the pipe connections.

16 Lower the pump in to the well or water source

17 Switch on the power supply to start the motor.

18 Observe the flow of water through the discharge pipe and ensure it is consistent and free from any blockages.

Fig 2



19 Test the motor for any leaks vibrations or abnormal noises

20 Adjust the motor speed and discharge flow rate as required

21 Regularly check the motor and pump for any leaks blockages or wear and tear.

22 Clean the motor and pump periodically to prevent the sediment or debris buildup

23 Lubricate the bearings with grease

24 Conduct regular electrical safety checks and inspections to ensure safe operations.

— — — — —

Acquaint with electrical and carryout repair of electrical circuit of window and split AC

Objectives: At the end of this exercise you shall be able to
- **identify mechanical and electrical parts of window A/C.**

Requirements

Tools / Instruments

• Trainee's tool kit	- 1 No.
• Test board	- 1 No.
• Test lamp with 200 watts	- 1 No.
• Multimeter/ohmmeter Digital	- 1 No.
• Line tester 0-500V	- 1 No.
• Knife 100mm	- 1 No.

Materials

• Complete system of window A/C	- 1 No.
• Capacitors	- 1 No.
• Relay	- 1 No.
• OLP (2 & 3 terminal)	- 1 No.
• Insulation tape	- 1 Roll.
• Terminal Clips	- 1 box
• Two pin plug	- 1 No.

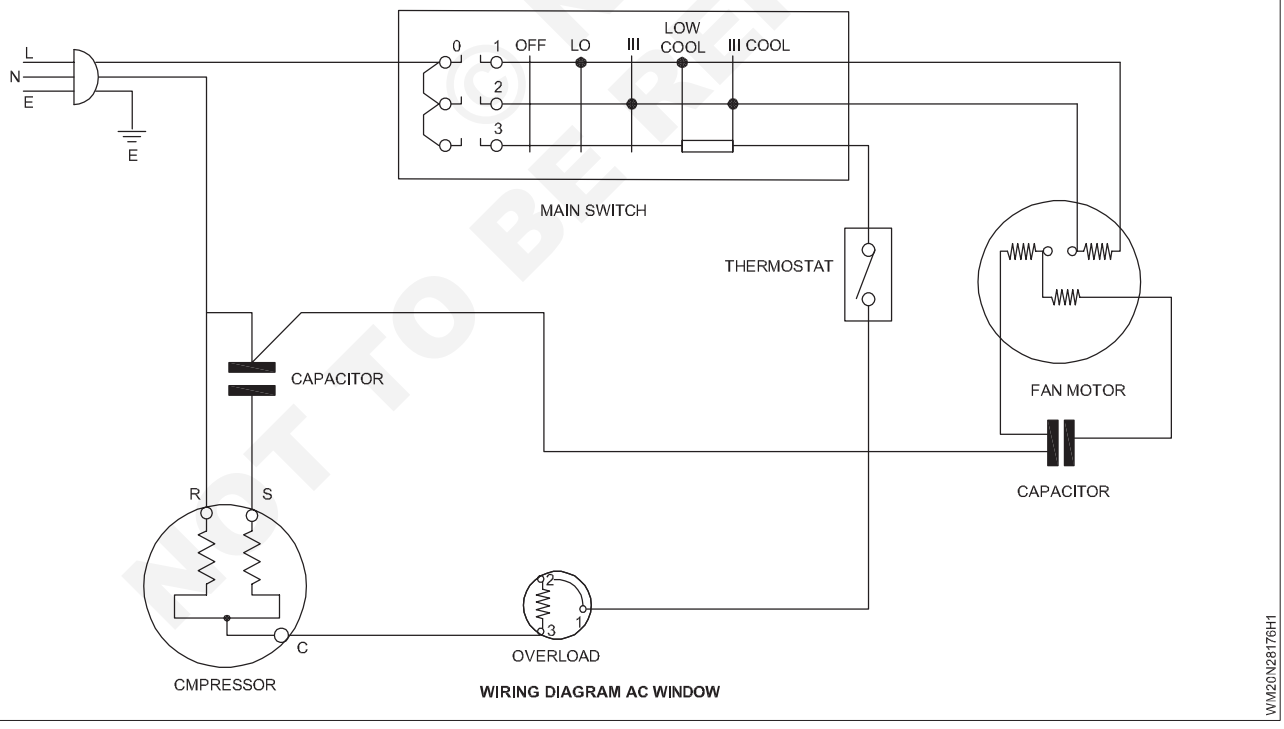
PROCEDURE

TASK 1: **Identify mechanical parts of window A/C**

1 Identify the labelled components (Fig 1)

2 Record the name of components and the functions in the table 1 of record sheet.

Fig 1



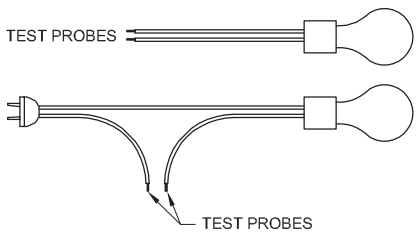
TASK 2: **Identify electrical parts & test compressor winding by test lamp**

1 Remove the terminal cover from the compressor.

2 Remove the terminal wire clips from the compressor and label it.

3 Take a test lamp with 200 watts bulb. (Fig 1)

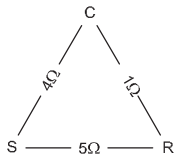
Fig 1



4 Plug the test lamp to test board and hold the probes carefully and switch ON.

5 Touch a probe with 'C' and other with 'R'. The bulb will be glowing bright. The continuity of running winding is good. (Fig 2)

Fig 2



6 Then remove the probe from R and touch it to 'S' terminal. Bulb glow dull. The starting winding continuity is good.

7 Remove the probe from 'C' and touch into 'R' terminal then the bulb glow very bright. The running and starting winding is good in continuity, otherwise the winding may be open.

— — — — —

TASK 3: **Test compressor winding using ohmmeter/multimeter**

1 Take multimeter and set knob to resistance W.

2 Touch one probe to 'C' and other probe to 'R'. Note the reading shown in multimeter.

3 Remove the probe from the 'R' and touch to 'S' and note the reading.

4 Remove the probe from 'C' and touch it to 'R' and note the reading.

One terminal reading that equals the sum of the other two terminals resistance reading

Record the readings in record sheet

Readings show terminals zero, winding is shorted C, S and R are the motor terminals of the compressor motor.

C - is common

S - is start

R - is run

The compressor winding also grounded to the casing. Check resistance between each terminal and the casing. If there is any reading shows in meter (or movement), there is some continuity to ground. Consider the compressor winding grounded and it is not used for service.

If the compressor motor windings are not shorted, not open, and not grounded, then electrically the motor is good.

Table 1

Sl.No	Teminals	Value	Result
1	C & R	1.0	Running winding good
2	C & S	4.0	Good starting winding
3	S & R	5.0	Start and run winding good
4	S & compressor casing	No movement	Good windings
5	C & S	'O'	Shorted winding

— — — — —

TASK 4: **Test relay by using 220 volts**

1 Take a relay and check position marks in cover top and open the cover and keep the relay on a table in position.

2 Take a test lamp (Fig 1) and plug it in test board.

3 Hold the probes carefully.

4 Switch on the test lamp.

5 Touch the probes in relay No.2 and 5 found it is clicking (sound)

6 Then touch the probes to No.1 and 5 it will chattering (sound). If the relay gives click and chattering sound found the relay will be good.

— — — — —

TASK 5: **Test O.L.P. (over load protector)**

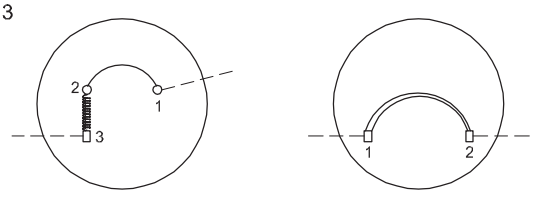
1 Take a O.L.P. (three terminal) and (two terminal).

2 Plug the test lamp (fig.1) in test board and switch ON.

3 Touch the test lamp probes to O.L.P. One terminal to another. Check two terminals and three terminals OLPs (check 1 and 2, 2 and 3, 3 and 1). (Fig 3)

The bulb will be glowing when the OLP continuity is good. If continuity is not in OLP, replace the OLP, it cannot be repaired.

Fig 3



4 Record it in record sheet.

Record sheet

Name of applicance :

Capacity :

Sl.No.	Components	Terminals	Value	Result	Remarks

— — — — —

TASK 6: **Acquainting all Electrical components used in window A/C**

1 Remove A/C from wall and place on work bench.

2 Remove air filter.

3 Clean the unit and identify selector switch, thermostat switch, relay, starting capacitor, running capacitor, overload protector.

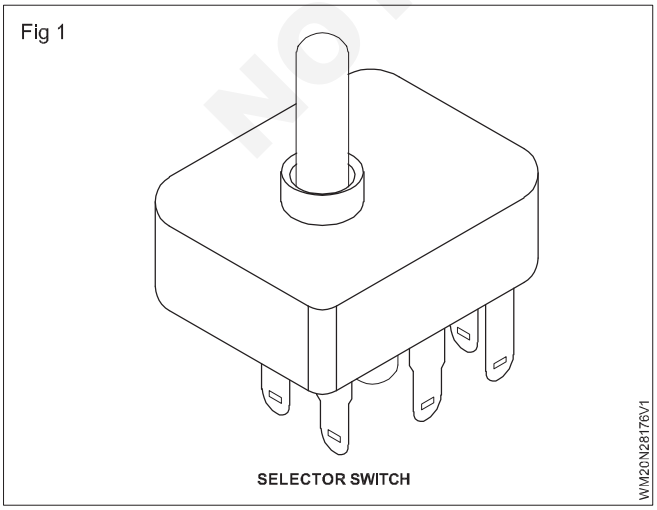
Selector switch

1 Control the power supply to all components

2 Check the unit is manual controlled their only selector (Fig 1) switch used.

3 Check with number of speed in fan motor.

Fig 1

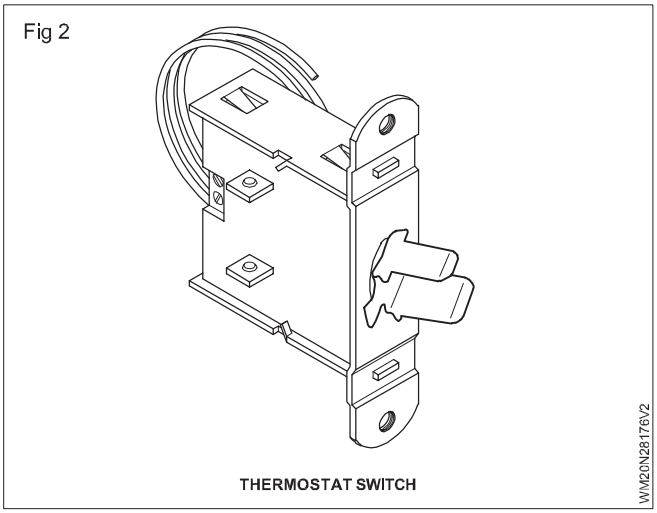


Thermostat switch

1 Check the room temperature by stopping and starting the compressor.

2 Connect between selector switch and compressor (Fig 2.

Fig 2

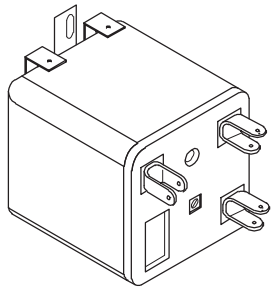


Relay

1 Identify the relay is used in window A/C (Fig 3)

2 Connect between thermostat and compressor.

Fig 3



COMPRESSOR RELAY

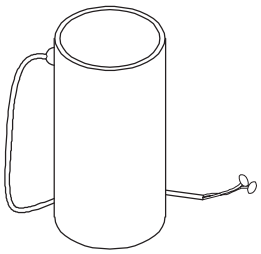
WM20N28176V3

Starting capacitor

1 Identify starting capacitor in window A/C only.

2 Check capacitance, it will higher than running capacitor (Fig 4)

Fig 4



STANDING CAPACITOR

WM20N28176V4

Note: It should not kept on line more than 30 seconds

Running capacitor

1 Identify the running capacitor in window A/C.

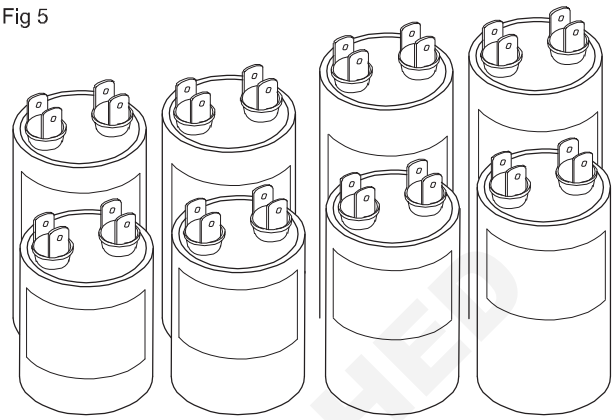
2 Connect in unit permanently (Fig 5).

Overload protector: Identify OLP in window A/C (Fig 6).

Note: Protect compressor from high current and high temperature.

Internal and external are two types.

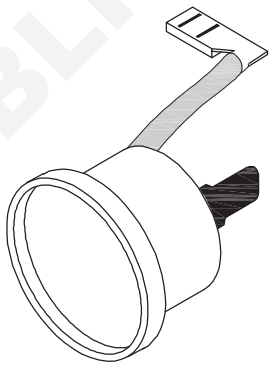
Fig 5



RUNNING CAPACITOR

WM20N28176V5

Fig 6



OVERLOAD PROTECTOR

WM20N28176V6

— — — — —

TASK 6**: Identify remote and PCB control**

1 Identify PCB. It is doing the function of selector switch, thermostat and all control.

2 Check the function of remote and display.

3 Change and set more functions according to manufacture. the relay will be good.

— — — — —

Identify electrical circuit of split A/C

Objectives: At the end of this exercise you shall be able to
- **identify the electrical circuit of A/C unit.**

Requirements

Tools / Instruments

- Screw driver 200mm - 1 No
- Tester 0-500V - 1 No
- Cutting plier 200mm - 1 No
- Nose plier 150mm - 1 No
- Spanners (D.E) 12mm, 13mm, 14mm, 15mm. - 1 set
- Screw spanner

Equipments

- Split A/C system - 1 No

Materials

- Wires
- Cotton waste - as reqd.
- Insulation tape - 1 Roll.

PROCEDURE

TASK 1: **Identify the circuit of split A/C**

1 Switch off the unit and remove plug from the socket

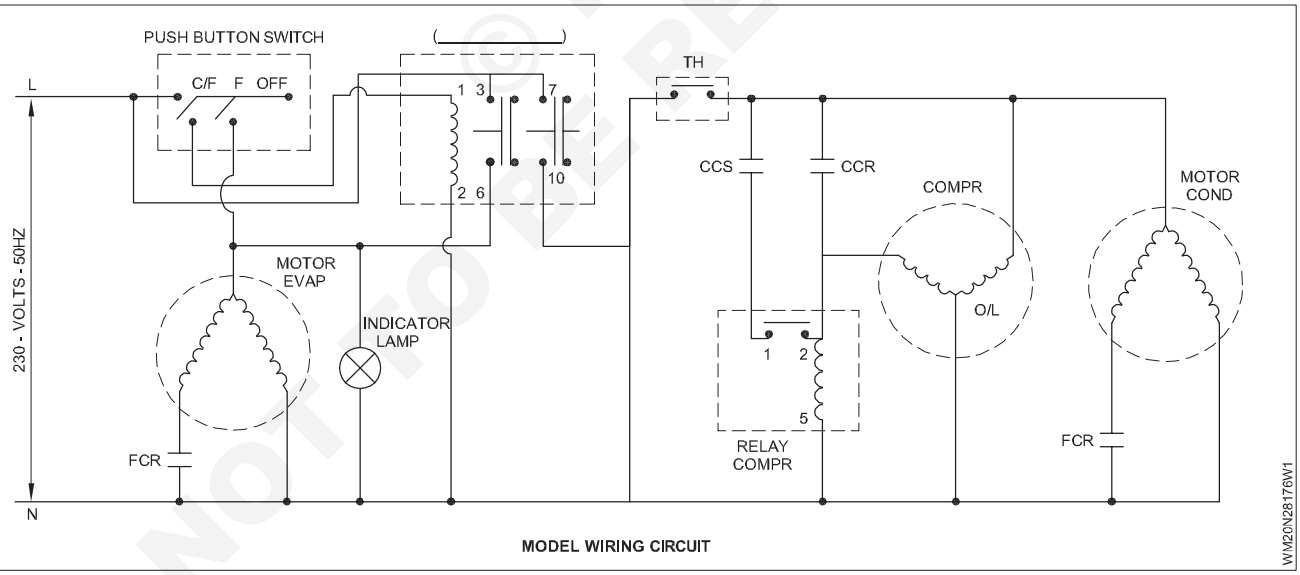
2 Remove the grill front panel from the indoor unit.

3 Remove the panels from the outdoor unit.

4 Short the capacitor, if present in the circuit.

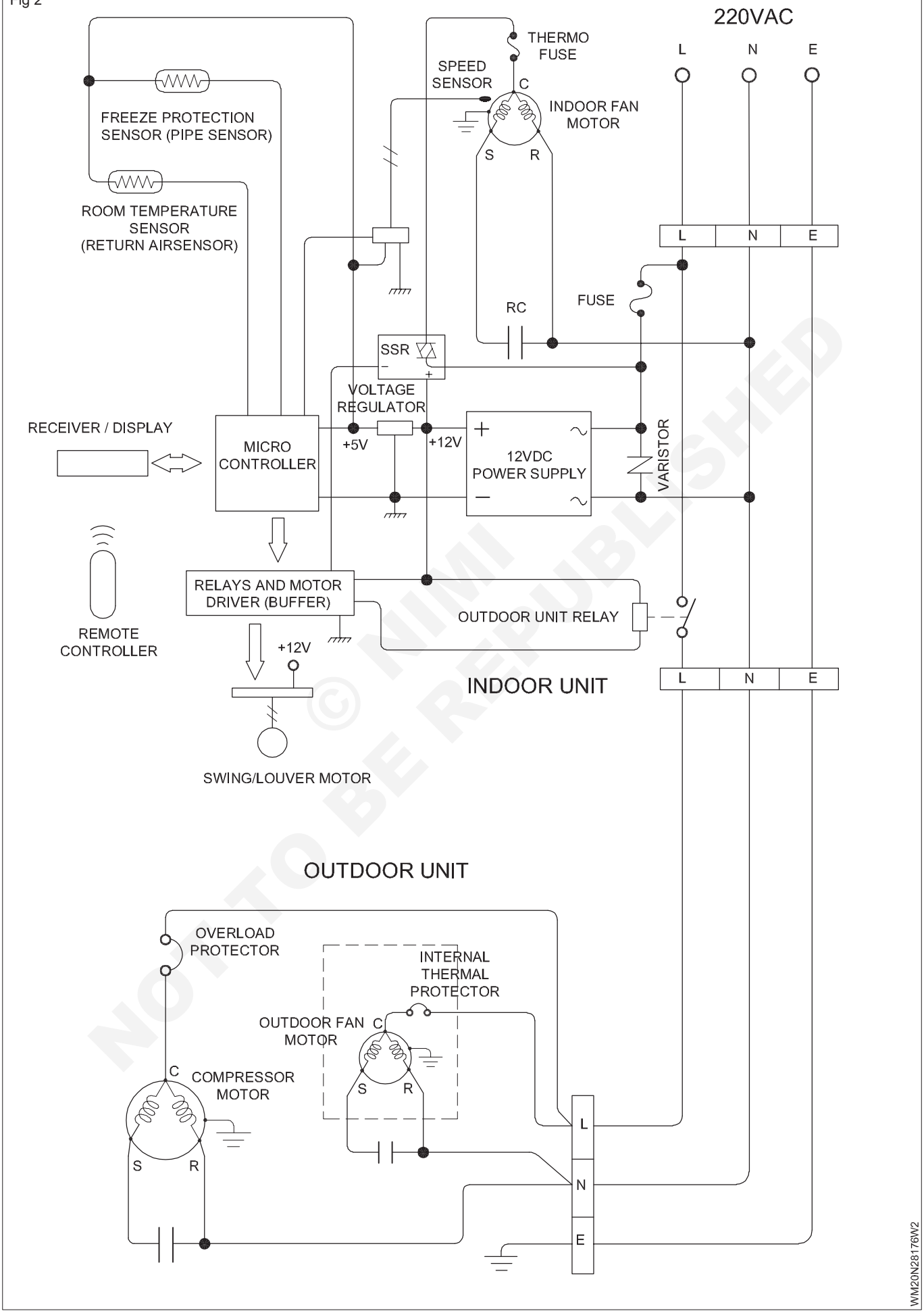
5 Identify the circuits given below.

Fig 1



MODEL WIRING CIRCUIT

Fig 2



WM20N28176W2

TASK 2: **Carry out a test on fan motor**

1 Prepare test cord with a 200 watts bulb in series
2 Plug the test cord to test board and ON
3 Touch both leads
4 If the bulb glows the circuit of test cord is completed
5 Disconnect electric supply of the A/C
6 Remove front panel
7 Draw the unit carefully from outer cover with help of three persons.
8 Keep the unit on the work bench, plug the unit in test board and ON the switch.
9 ON the fan switch if it is run the fan motor in good condition.
10 If the fan does not run trace the connection.
11 The junction box contains the motor connection.
12 OFF the fan motor switch.
13 With the test lamp check the motor leads in the junction box.
14 If the motor found faulty take it out from the base.
15 Check the motor and do necessary repairing
16 Fix back the motor and check the alignment

— — — — —

TASK 3: **Carry out a test on capacitors**

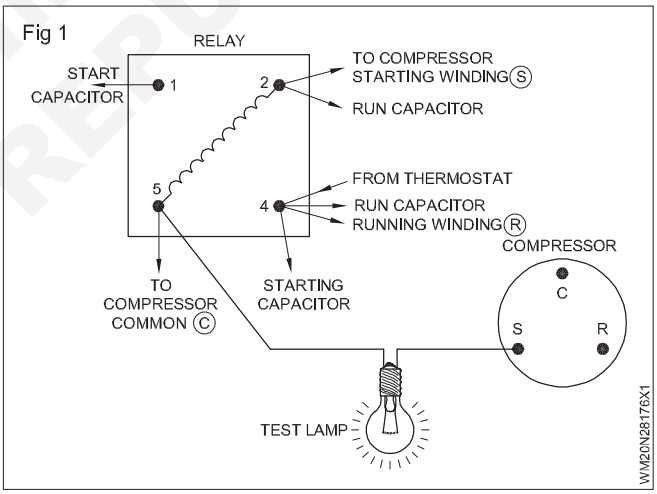
1 Disconnect the running and starting capacitors
2 Short the capacitor leads to discharge
3 Check the capacitors with ohmmeter/multimeter
4 Connect the capacitor leads to power connection for two seconds and short the capacitor leads. If the capacitor is good it will spark.

— — — — —

TASK 4: **Carry out a test on relay**

1 Connect the test lamp to '5' on the relay and 'S'(starting winding) to compressor before switch to cool. (Fig 1)
2 Turn switch ON to cool.
3 Observe the light, it will give less glow.
4 If the compressor does not take start, check for other electrical defects.

Fig 1



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TASK 5: **Carry out a test on OLP**

1 Check overload with help of test lamp.

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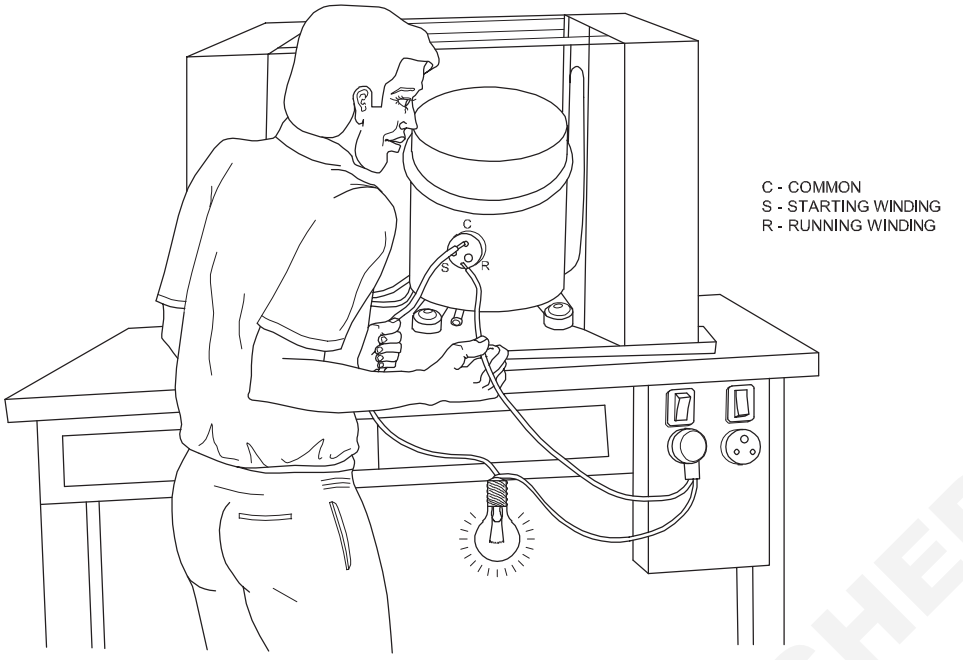
TASK 6: **Carry out a test on compressor**

1 Check compressor motor for open circuit.
2 Check compressor motor for ground.
3 Check compressor motor for short circuit.

Fig 1



TEST ON COMPRESSOR TERMINALS

WM20N28176Y1

TASK 7: **Open and check the remote**

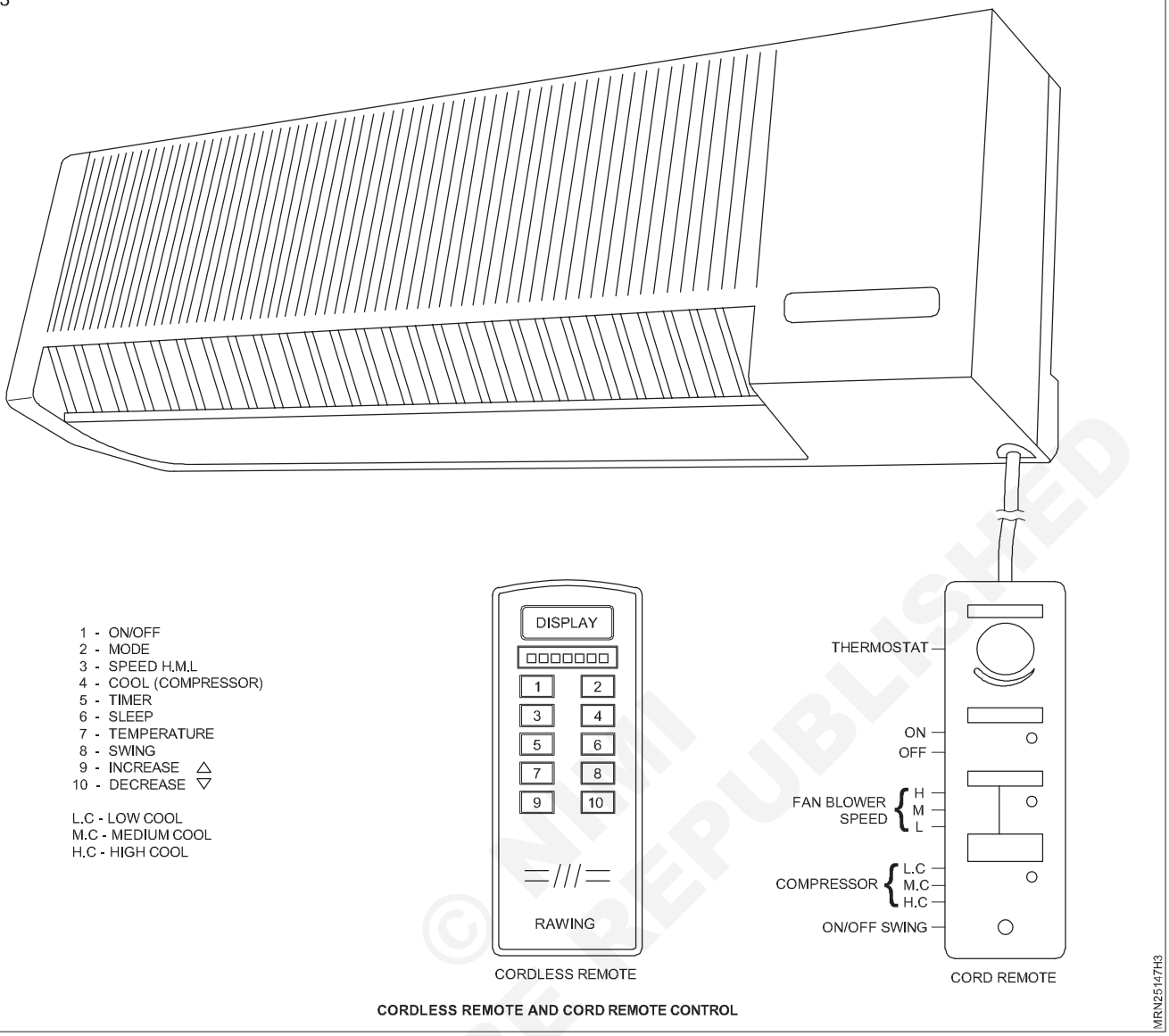
1 Switch On the air condoner
2 Press ON button in remote control
3 Start fan blower in high (H) medium (M) and low (L)
4 Check the evaporator fan blower in running
5 Set low cool medium cool and high cool
6 Check the condensing unit whether the compressor condenser fan and evaporator fans are running
7 Switch “ON’ the swing
8 Check cool air directions
9 Press the “OFF” button.

— — — — —

TASK 8: **Operate and check the remote**

1 Switch ‘ON’ the unit
2 Press ON in remote control (refer fig 1)
3 Press mode selection
4 Display fan blower
5 Press speed and select high medium or low.
6 Press mode
7 Display cool
8 Press cool button to run compressor
9 Press mode
10 Display timer
11 Press timer and press increase or decrease button to set sleep time.
12 Press sleep
13 Press mode- display temperature
14 Press temperature
15 Operate increase or decrease the temperature to cut out the unit
16 Press mode selection
17 Display swing
18 Press swing
19 Select ‘OFF’
20 Wait for 10min and press ‘ON’ (blower will start)
21 Press cool (Compressor and condensing fan will start)

Fig 3



CORDLESS REMOTE AND CORD REMOTE CONTROL

— — — — —

Power — Exercise 2.8.177

Wireman - Domestic Appliances

Demonstrate installation and maintenance of split AC using visual aids

Objectives: At the end of this exercise you shall be able to
- **understand the installation and maintenance of split AC.**

Requirements - visual aids

The instructor may arrange the visual aids to demonstrate installation and maintenance of spilit AC.

Practice winding of single phase transformer

Objectives: At the end of this exercise you shall be able to

- **dismantle the transformer cores**
- **measure and determine the size of winding wire for primary and secondary winding**
- **take the dimensions of bobbin and prepare the bobbin from suitable materials**
- **wind the primary and secondary windings layer by layer**
- **test the transformer for insulation, transformation ratio and performance.**

Requirements

Tools/Instruments

• Scissors 150 mm	- 1 No.
• Steel rule 300 mm	- 1 No.
• Firmer chisel 20mm	- 1 No.
• Hammer ball pein 0.5 kg	- 1 No.
• Iron soldering 25W, 240V	- 1 No.
• DE Spanner 6mm to 25 mm	- 1 Set.
• Mallet hardwood 0.5 kg	- 1 No.
• Nylon mallet 5cm dia.	- 1 No.
• D.B Knife 100mm	- 1 No.

Materials

• Super enamelled copper wires	- as reqd.
• Empire sleeves 1mm,2mm	- 1m each.
• Air dry vanish	- 100 ml.
• Resin core solder 16 SWG	- 10g.
• Soldering paste	- 5 g.
• Smooth emery paper	- 1 Piece.
• Fabric based fibre sheet -3mm and 6 mm thick	- as reqd.
• Cotton cloth for cleaning	- 500 sq. cm.
• Insulation papers	- as reqd.

PROCEDURE

TASK 1: **Rewinding of transformer**

1 Prepare/select a suitable mandrel for the prepared bobbin as shown in Fig 1 of prepare a wooden block as shown in Fig 2 depending upon the design of the winding machines.

2 Clamp the mandrel/wooden block in in winding machine.

3 Fit the bobbin tightly to the mandrel of the winding machine with the help of fasteners as the bobbin must turn along with the mandrel without play. (Fig 3).

4 Adjust the feed of the winding machine to suit the selected winding wire size by friction driver of by changing the gear as shown in number 1 Figs 4 and 5.

5 Adjust the transverse feed of the winding machine guides such that the length of movement of the feed, matches with the length of the inner side of the bobbin so as to maintain the length of the coil as in the original. Refer to number 2 of Figs 4 and 5. You may need several trials before final setting.

6 Place once layer of paper or cloth as core insulation on the bobbin smoothly without crease.

7 Solder a connecting lead and sleeve the same with the beginning end of the selected winding. Place the lead wire at one end of the bobbin and take it through the bobbin flange outlet and tie with a knot to avoid slipping as shown in Fig 6.

Fig 1

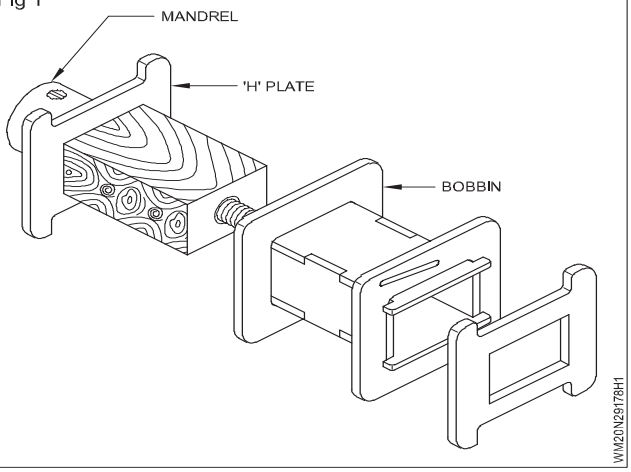
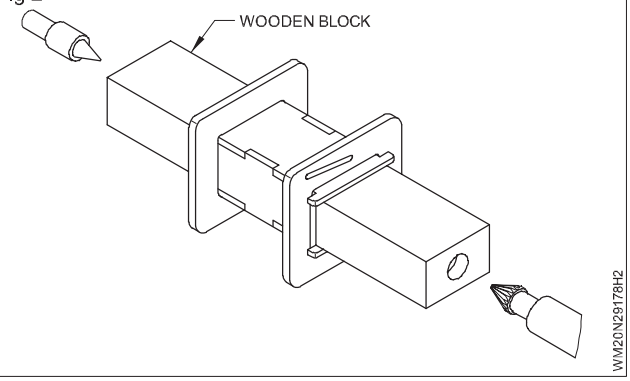
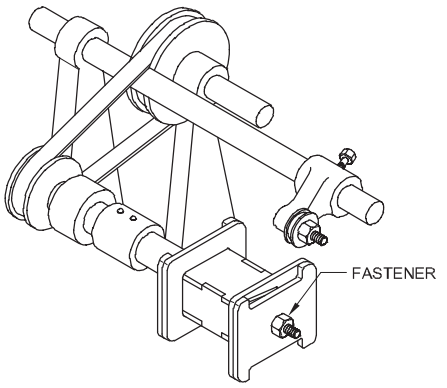


Fig 2



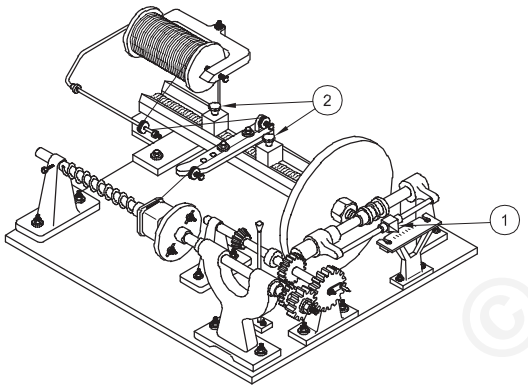
If the winding wire thickness is sufficiently large, soldering of connecting lead wire is not necessary.

Fig 3



8 Start the winding and complete atleast one layer to check whether the coil length is well within the bobbin as in the original. If not, readjust the transverse feed.

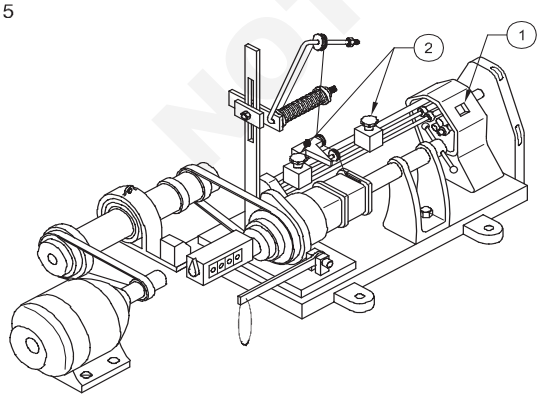
Fig 4



Adjacent turns of the winding wire should not overlap or have a gap in between them. If incorrect, readjust the feed.

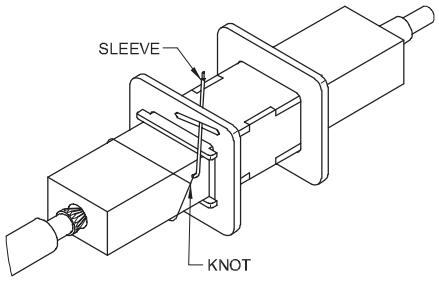
9 Start and continue the winding layer by layer providing the necessary in –between insulation and specified number of turns in each layer.

Fig 5



10 After the designated number of turns are wound, solder the end lead and take it out through the bobbin flange outlet.

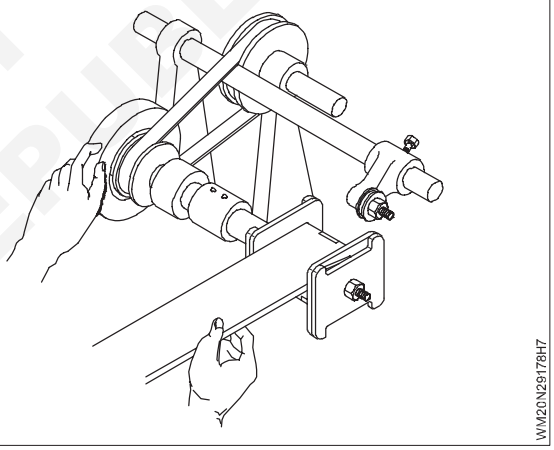
Fig 6



If a coil has a number of taps of winding, never cut the wire. Instead fold the length into a long loop and carry the wire to continue the winding. The looped wire can then be bared and connected outside the coil.

11 After inspecting the primary winding, wrap the winding as shown in Fig 7 with sufficient insulation.

Fig 7



12 Select a suitable secondary wire and proceed as in steps 4 to 7.

13 At the end of the winding, wrap and bind the insulation on the winding tightly.

Bindings must cover the winding fully and must be free of crease and must not project beyond the coil disc (Flange).

14 Inspect the coil for proper termination of lead and check the size by using a template.

15 Test the windings for continuity and short circuit.

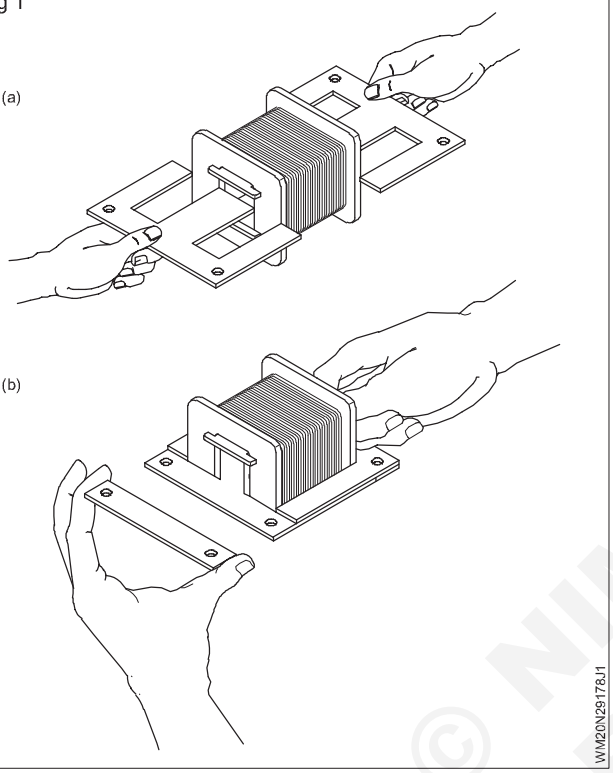
TASK 2: **Stacking of transformer cores (E & I)**

1 Insert an 'E' Lamination into the bobbin from both sides as shown in Fig 1a.

2 Place the right hand side (R.H.S) laminations below the one inserted from the left hand side (L.H.S).

3 Place an 'I' lamination to the free of the L.H.S 'E' piece as in Fig 1b.

Fig 1



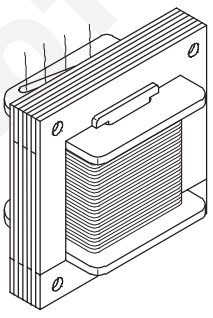
Ensure that the slot in the 'I' is above the corresponding slot in the R.H.S/ 'E' lamination.

4 Insert the second 'E' shaped laminations from the opposite sided.

5 Place an 'I' shaped lamination in position.

6 Likewise insert the laminations alternately without any gap as shown in Fig 2.

Fig 2



7 Fit both the top and bottom clamp plates on the assembly as in original (Figs 3a and 3b)

8 Push the fixing bolts through the clamp plates.

9 use the specified fasteners and tighten the assembly.

Fig 3

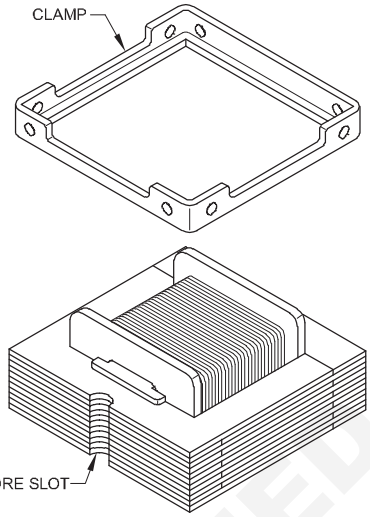
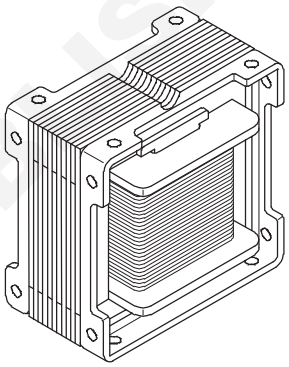


Fig 4



10 Varnish the transformer by dipping in an air –dry varnish and drain it.

11 Fit the specified insulting sleeves over the lead –Out wires.

12 Obtain the specified terminal board and phase each leading through specified hole.

Ensure that all the sleeved leads are correctly positioned.

Check the sleeves on all leads and terminate at each hole i.e. no bare leads should be visible in the terminal board.

13 Place the terminal board in position as shown in Fig 4.

14 Secure the terminal board with the specified studs.

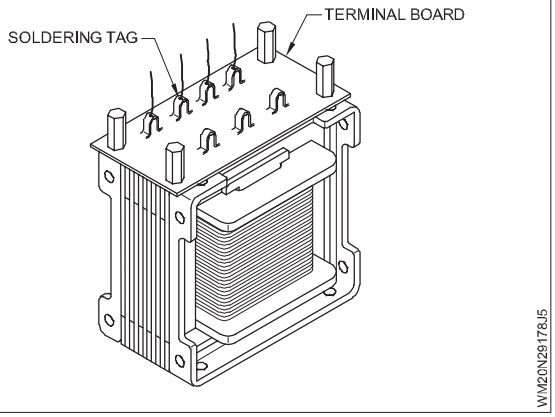
15 Check that no leads have been trapped between the terminal board and the core.

16 take the specified mechanical joint between each leading wire and its soldering tag.

17 Solder each joint and cut off the surplus wire ends as seen in Fig 5

18 Test the primary and secondary winding for continuty with a meggar

Fig 5



19 Carryout an insulation test on the winding completed transformer.

Practice on ceiling fan and table fan motor winding

Objectives: At the end of this exercise you shall be able to
- **wind starting and running winding coil**
- **insulate the slots with suitable insulation paper**
- **insert the coils into the slots**
- **make the end connections as per diagram**
- **test the winding**
- **assemble the ceiling fan.**

Requirements

Tools/Instruments

• Leathered paper	- as reqd.
• Enameled coper wire	- as reqd.
• Binding thread	- 1 No.
• Insulating varnish	- 1 No.

Materials

• ceiling fan	- 1 No.
• Electrician tool kit	- 1 No.
• Multi meter	- 1 No.
• Megger soldering iron	- 1 No.
• Mallet	- 1 No.

PROCEDURE

TASK 1: **procedure for rewinding ceiling fan**

1 Clean the stator as shown in fig 1

Fig 1

2 Insert the insulation paper in each slots

3 Form the winding coils separately (running & starting)

4 Place all the coils in slots properly

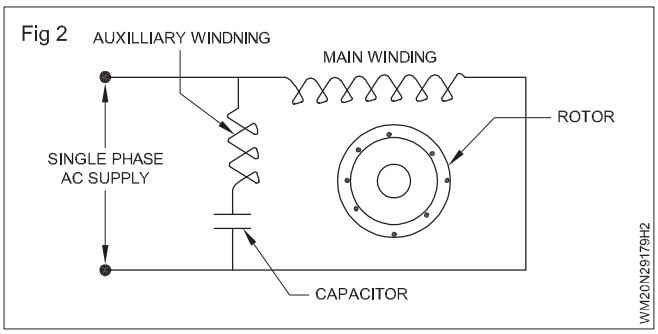
5 Fix coils in slots without any loose connection

6 Connect all coils and solder them

7 Use correct size of insulate joints

8 Make the connections as per the shown in fig 2

Fig 2



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TASK 2 : **Assemble the fan and test run**

1 Check the windings for open and short circuit using megger

2 Apply varnish, and dry it

3 Assemble the fan properly

4 Test the fan for proper functioning

— — — — — —

Wind a table fan

Objectives: At the end of this exercise you shall be able to
- **collect the widning data of the table fan**
- **insulate the slot**
- **Insert the coils into the slots**
- **shape, blind and tape the overhangs**
- **make the end connections as per data taken**
- **solder and insulate the end connections**
- **test the winding**
- **assemble the fan and test run.**

Requirements

Tools/Instruments

- Electrician tool kit - 1 No.
- Nylon hammer 5 cm dia x 8 cm long head - 1 No.
- Cold chisel 200 mm - 1 No.
- Multimeter - 1 No.
- Megger 500 volt - 1 No.
- Weighing machine 0-3 kg - 1 No.
- Scissors 200 mm - 1 No.
- Soldering iron 125 W, 240V - 1 No.
- Hacksaw frame with blade 300 mm - 1 No.

Equipment/machines

Burnt out table fan
- Capacitor type - 1 No.
- Shaded pole type - 1 No.

Materials

- Leatheroid paper/Milinex size and quantity - 1 No.
- Super enamelled copper wire - 1 No.
- Sleeves empire/PVC - 1 No.
- Binding/Hemp thread - 1 No.
- Bamboo wedges - 1 No.
- Insulating varnish (Air-dry) - 1 No.
- Resin-cored solder 60%:40% - 1 No.
- Fibre sheet 6 mm thick Fibre foot (to suit the stator slots to be prepared by the electrician himself) - 1 No.
- Used hacksaw blade - 1 No.

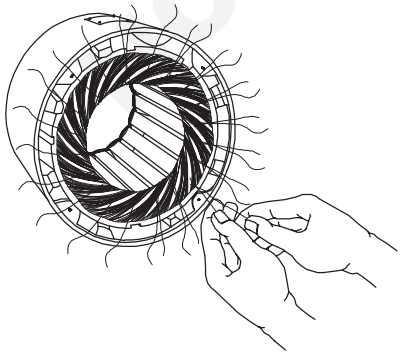
PROCEDURE

TASK 1: **procedure for rewinding table fan**

1 Untie the end connections from the winding by removing the twine thread or tape and spread out the connections as shown in Fig 1.

2 Draw the connection diagram in your record.

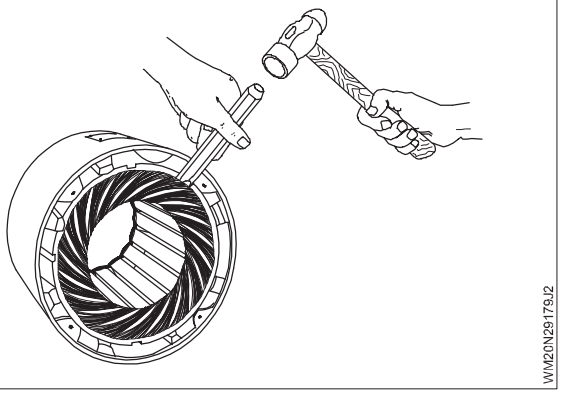
Fig 1



WM20N29179J1

3 Leaving one coil each in the main and starting winding for measurement, cut the other coils with a cold chisel and hammer as shown in Fig 2.

Fig 2

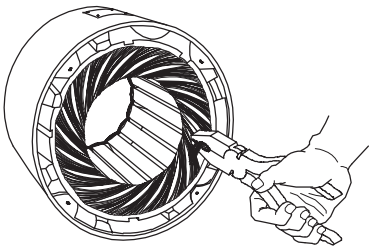


WM20N29179J2

4 Pull out the winding wires with the help of pliers or pincers as shown in Fig 3.

If the winding is hard to remove, use a blow lamp or thinner. Do not use the blow lamp when thinner is applied. The winding will catch fire.

Fig 3



WM20N29179J3

5 Remove one coil each of the main and starting windings carefully without distorting them.

6 Record the following data

- Slot insulation material - its size and thickness.
- Winding wire - particulars of starting and running winding.

7 Draw the shape of the coils, each of main and starting windings with dimensions your record.

8 After removing the coils clean the staror and the slots.

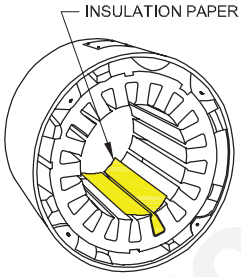
9 Make wooden former according to the old coil size and prepare the required of coils for starting and running windings with original turns and size of wire.

10 Select the insulation paper similar to the original and cut it to the dimensions as in the original.

11 Insert the insulation paper in each slot.

12 Insert the guide insulation paper in the slot where the winding is to b e started as shown in Fig 4. (Refer to this slot as slot number 1.)

Fig 4

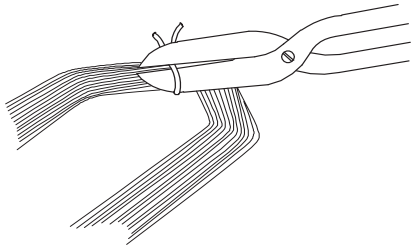


WM20N29179J4

Identify the connection end of the stator with respect to the terminal block and hold the coil to be inserted in such a way that the winding ends of the coils are at the connection end of the stator.

13 Take the running winding coils and cut the peice of the binding thread tied to the coil as shown in Fig 5.

Fig 5

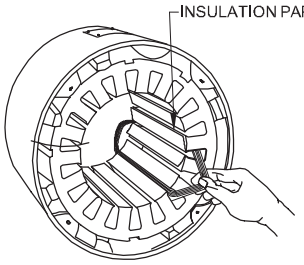


WM20N29179J5

Be careful no to cut the winding wire.

14 Spread out the turns of the left side of the coils and hold the coils at an angle so that all the turns could be fed into the slot as shown in Fig 6.

Fig 6



WM20N29179J6

15 Insert a thick leatheroid insulation paper between the right coil side and the core to avoid damage to the enamel insulation.

Study the diagram shown in Fig 6. The coil side you are going to insert acutually belongs to the top coil side. But you are going to temporarily insert the coils as bottom coil side now, and after, certain number of coils are inserted in the slots this coil side should be lifted after placing the bottom coil side (4th coil). This coil will be re-inserted as top coil side. This is only to facilitate easy advancement of the winding.

16 Feed the turns in small manageable bunches into the slot

The winding wire should fall inside the slot within the insulating paper. See no wire falls between the core and the insulation paper.

17 Slightly shake the coil side in both directions to allow the wires to fall easily into the slot.

18 Remove the guide paper and insert in the 3rd slot in anticlockwise direction.

19 use tow fibre foot over the inserted winding to secure the winding in position as shown in Figs 7a & 7b.

20 Insert the other coil side of the same coil in the 3rd slot as shown in Fig 8 following procedures outlined in steps 17 & 19.

21 Insert the layer separator paper over the inserted coil side in the slot 3.

22 Insert three coils one by one in alternate slots as shown in Fig 8. i.e.say 2nd coil in slot 3 and 5. 3rd coil in slots 5 and 7 and 4th coil in slot 7 only.

Remember to place the layer separator paper in the slots between bottom and top coil sides.

23 Remove the left coil side of the first coil from slot 1 which was inserted initially. (Refer to step 15)

Fig 7

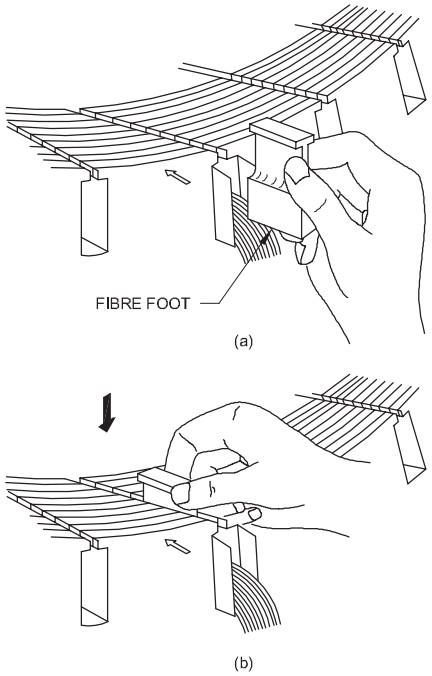
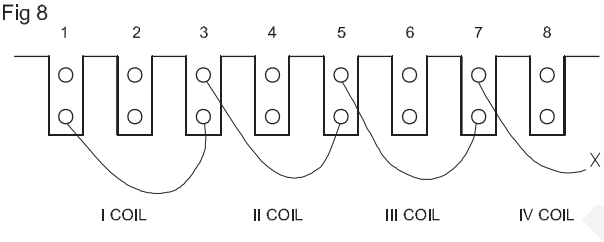


Fig 8

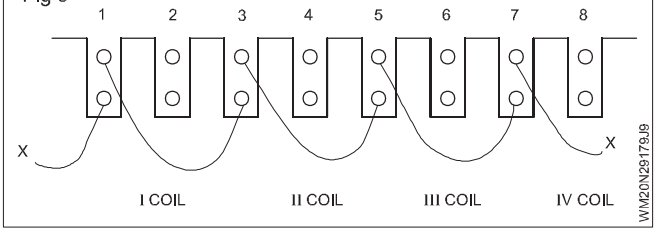


The right coil side of 4th coil will have to be inserted in slot No.1 as the bottom coil side. For procedural convenience you have already inserted 1st coils left coil side in slot number 1 as bottom coil side. Now this coil side of coil 1 has to be carefully taken out from the slot without any damage.

24 Insert the layer separtor paper over the bottom coil side.

25 Insert the left coil side of 1st coil in slot 1 as top coil side (Fig 9).

Fig 9

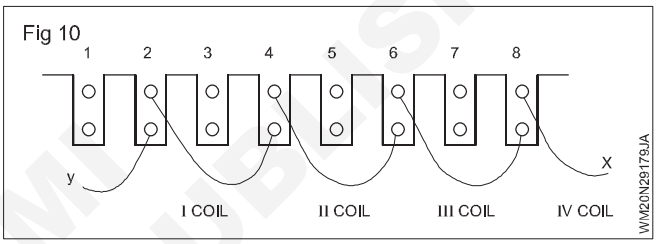


26 Insert the wedges in the slots where the coils have been inserted.

27 Similarly inserted the starting winding coils. First insert the left coil side of coil 1 of the starting winding in slot 2 temporarily.

28 Inserted the right side of the 1st coil in slot 4 as bottom coil side. Then the 2nd coil in slots 4 and 6, 3rd coil in slots 6 and 8 and 4th coil in slot 8 and in slot 1 similar to the main winding (Fig 10).

Fig 10



29 Connect all the coil ends according to the connection diagram with suitable sleeves as per connection diagram drawn in step 3.

30 After connecting the end connections, connect the lead cables to the winding ends and terminate them at the terminal box.

31 Check the connection once more with respect to the develped diagram as per the original diagram.

— — — — — —

TASK 2: **Assemble the fan and test run**

1 Check the windings for open circuit, shot circuit and leakage of insulation by a multimeter and Meggar.

2 Assemble the fan and test run the fan for a few minute.

3 If the test results are OK remove the wound stator, preheat to a temperature of 100° C and then impregnate the winding varinsh. Dry the varnish slowly either in impregnating bath or in open air.

4 After the varnish has dried up, reassemble the fan.

5 Test run the fan for atleast 8 hours.

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Maintenance service and repair of AC single phase motor

Objectives: At the end of this exercise you shall be able to
- **test the single phase motor prior to dismantling**
- **dismantle, identify faults and rectify them**
- **assemble and test the motor**
- **identify the general causes of failure and trouble shoot them.**

Requirements

Tools/Instruments

- Electrician kit - 1 No.
- Set of D.E. spanners 8 to 22 mm - 1 Set
- Pulleypuller 100 mm and 150 mm - 1 No.
- Nylon hammer 1/4 kg - 1 No.
- Ohmmeter 0 - 1 kilo ohms - 1 No.
- Industrial, thermometer, metric, 0 to 300° - 1 No.
- Megger 500 V - 1 No.
- Voltmeter M.I. type 0-300 V - 1 No.
- Ammeter M.I. type 0-5 amps - 1 No.

Equipments/Machines

- Fraction horse power AC single phase (split phase) motor - 1 No.

Materials

- ICDP switch 16A 250V - 1 No.
- Test lamp - 1 No.
- Test prods 500V - 1 Set
- PVC insulated copper cable 2.5 sq mm 660 V grade - 10 m
- Fuse wire 5 amps capacity - as reqd.
- PVC insulation tape 20 mm size - as reqd.
- Bearing - Grease -200gms.
- Kerosene oil - 1 litre.
- Cotton waste - 100 gms
- Shellac varnish - 1/4 litre
- Sandpaper `O' - as reqd.

PROCEDURE

TASK 1: **Perform maintenance service and repair of AC single phase Motor**

1 Read the name-plate details of the motor and record in Table 1.

Table 1

Name-plate details of the motor

Make. ____ Frame____ No. _____ Model _____

Type _____ HP _____ Volts _____

Amperes _____ Phase _____ Cycles _____

2 Switch 'OFF' the respective I.C.D.P. main switch.

3 Remove the fuses and keep in safe custody.

Remove the sub-circuit fuses which supplies power to the ICDP.

4 Clean the main switch with a brush.

5 Check the incoming and outgoing leads of the I.C.D.P. main switch for discolouring.

Discolouring normally indicates loose terminal connection.

6 Check the cable terminal connection screws and tighten them with the help of a screw driver.

7 Open the starter cover and clean the parts with a brush.

8 Check the leads and the terminal screws. Tighten the screws, if found loose.

9 Check the overload setting and if necessary, set it to the rated current of the motor.

10 Check the contact points of the starter for pittings.

If the contact points are lightly pitted, use a sandpaper to clean them. Badly pitted or damaged contacts need to be replaced.

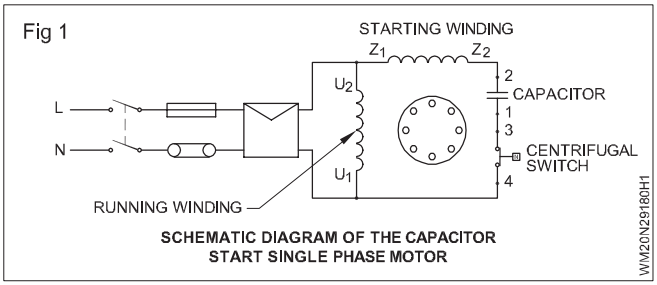
11 Clean the external surface of the single phase motor using brush, a piece of the cloth and a blower.

12 Open the terminal cover.

13 Note the incoming, starting winding, running winding, capacitor and centrifugal switch connections and draw a diagram in your record. Indicate the colour of cables in the diagram.

Fig 1 is the schematic diagram of a particular single phase motor

Fig 1



SCHEMATIC DIAGRAM OF THE CAPACITOR START SINGLE PHASE MOTOR

14 Open the shorting loops and incoming connections.

15 Check the continuity a) main winding b) starting winding c) centrifugal switch.

16 Record the finding in Table 2

17 Measure the resistance value of the windings and contact resistance value of the centrifugal switch with an ohmmeter and record it in Table 2.

18 Check the capacitor and the centrifugal switch for its condition with an ohmmeter and enter the result in Table 3.

19 Check the insulation value of the windings with the help of a Megger and enter the result in Table 4.

20 Dismantle the motor following the procedural steps.

21 Clean the stator and rotor with a brush and blower.

22 Clean the bearings and grease cups with kerosene and check the bearing.

23 Identify the bearing which is found worn out replace it with a similar type.

24 Check the internal connections and lead insulations.

27 Check the centrifugal switch for its tension and perfect contact between the points of contact.

26 Identify the insulation resistance value measured earlier. If found to be less than 1 megohm, dry the winding in an oven or with incandescent lamps and varnish it.

27 Assemble the motor following procedural steps.

28 Perform the earlier test and enter the results in Tables 2 and 4.

29 Connect the shorting loops and incoming leads as per your diagram.

30 Replace the fuses of correct value in the fuse grip and replace the carrier in the holder of the I.C.D.P. mains.

31 Check the earth connections to the motor starter and switch correct them if necessary.

32 Start the motor and test run for about 30 minutes.

33 Check the frame temperature of the motor and satisfy yourself that the temperature is within the reasonable limits.

34 Check for any undue noise or vibrations.

35 Stop the motor and write your observations in the maintenance card.

If any undue noise or vibrations is found stop the motor and recheck the tightness of the end plate bolts and frame bolts.

Table 2

Sl.No.	Description	Continuity check		Resistance value		Remarks
		Before dismantling	After dismantling	Before dismantling	After dismantling	
1	Main winding					
2	Starting winding					
3	Centrifugal switch					

Table 3

Sl.No.	Description	Condition
1	Capcitor	
2	Centrifugal switch	

Table 4

Sl.No.	Description of the test	Test result in megohms		Remarks
		Before dismantling	After dismantling	
1	Between main winding and starting windings (auxiliary)			
2	Between main winding and the body/frame			
3	Between starting winding and the body/frame			
4	Between centrifugal switch and the body/frame			
5	Between centrifugal switch and the winding (both the windings shorted)			

— — — — — —

Maintenance and repair of mixer and grinder

Objectives: At the end of this exercise you shall be able to
- **dismantle the mixer**
- **trace, identify and locate faults in the mixer**
- **replace faulty parts with good ones**
- **clean and lubricate the bearings**
- **assmble mixer and test for its working**
- **trace, identify and locate faults in a wet grinder**
- **replace faculty parts with good ones.**

Requirements

Tools/Instruments

- Electrician Tool kit -1Set
- Test lamp 100 W, 240 V -1 No.
- Box spanner set of 6mm to 22 mm -1 No.
- Multimeter Digital -1 No.
- Megger 500 V -1 No.
- Philips screwdriver 4 mm blade dia -1 No.
- Pulley puller 3leg 200 mm -1 No.

Equipment / Machines

- Mixer 250 V 50 Hz. 400 watts - 1 No.
- Grinder 250 V 50 Hz 0.25 HP - 1 No.

Materials

- Grease/lubricating oil - as reqd.
- Kerosene - as reqd.
- Cleaning brush - 1 No.
- Sandpaper smooth - as reqd.
- Soldering lead, 40:60, soldering flux - as reqd.
- Service manual (if available) - 1 No.

PROCEDURE

Refer Ex.No: 2.8.171

Maintenance, service repair of table fan

Objectives: At the end of this exercise you shall be able to
- **dismantle identify the parts**
- **rectify the faults in table fan**
- **service and repair the table fan**
- **assemble and test the table fan.**

Requirements

Tools/Instruments

- Electrician Tool kit -1Set
- DE spanner set -1 No.
- Pully puller -1 No.
- Multimeter Digital -1 No.
- Tacho meter -1 No.
- Megger 500V -1 No.

Equipment / Machines

- Table fan

Materials

- Test lamp - as reqd.

PROCEDURE

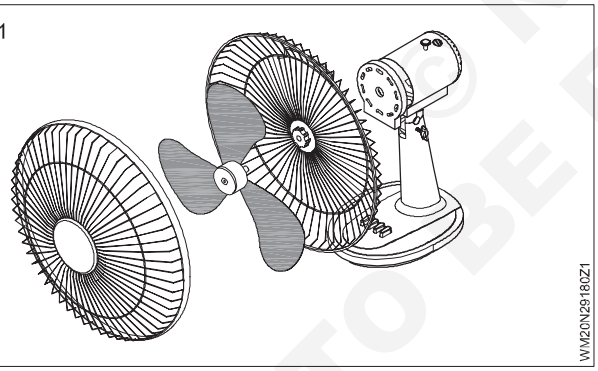
TASK 1: **Perform maintenance service and repair of table fan**

1 Switch off the supply mains.

2 Note the name plate details in table 1

3 Remove the front and back grill show in in Fig 1

Fig 1

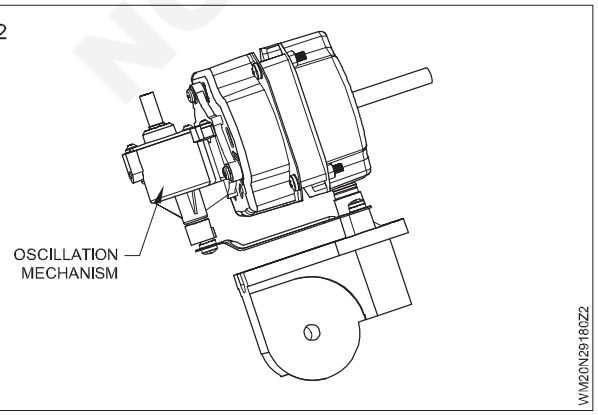


4 Remove the oscillation mechanism gently and clean it Fig 2

5 Clean table fan with help of vacuum cleaner

6 Check the switch. If it is working or not

Fig 2



7 Check the winding with test lamp.

8 Clean the oscillation mechanism and apply grease

9 Check the bearing bushes

10 Connect the table fan with supply and note down its functioning in the Table 2

Table 1

SI.NO	Table fan details	
1	Make	
2	SI.NO	
3	Model	
4	Voltage	
5	current	
6	Speed	

Table 2

SI.NO	Particulars	Working / Not working	Fault noticed
1	Switch		
2	winding		
3	capacitor		
4	Oscillation mechanism		
5	Bushes / bearings		

Practice on single /double layer and concentric winding for AC motors and testing

Objectives: At the end of this exercise you shall be able to

- **record the name plate details of the given single phase motor having single layer/double layer concentric type winding**
- **draw the connection and developed diagrams**
- **dismantle identify the parts**
- **strip the winding and clean the slots**
- **prepare the stepped former and wind the concentric group of coils**
- **lay the coil groups in the stator slots**
- **connect the coil groups and phase leads**
- **varnish the motor**
- **test and run the newly wound motor.**

Requirements

Tools/Instruments

- Electrician tool kit - 1 Set.
- Scissors 250mm - 1 No.
- Nylon hammer 80 mm dia, 120mm long head - 1 No.
- Soldering iron 125W, 240V - 1 No.
- Scale and weight 1 to 450 gms - 1 Set.
- Cold Chisel 100mm 200mm long - 1 No.
- Multimeter - 1 No.
- Centre punch 100mm - 1 No.
- Steel rule 300mm - 1 No.
- Wood rasp file, half round 200mm - 1 No.
- Tray 200mm x 200mm x 50mm - 1 No.
- Megger 500 V - 1 No.
- DE spanner 5 to 22 mm - 1 Set
- Outside Micro meter 0 - 25 mm - 1 No.

Equipment/Machines

- AC split phase motor FHP 250V - 1 No.

Materials

- Super-enamelled copper wire - as reqd.
- Millinex (or triplex paper) 10 Mili - as reqd.
- Empire sleeve 1 mm, 2mm, 3mm, 4mm & 5mm - 1m.each
- Cotton tape 20mm roll of 25 m - 1 Roll
- Bamboo wedge - as reqd.
- Resion Core solder 60:40 - as reqd.
- Varnish (air dry) - as reqd.
- Brush 25 mm - 1 No.
- Fibre sheet - as reqd.
- PVC insulated copper wire 21/0.2 mm - 3 m

PROCEDURE

TASK1: **Rewind a single phase split phase motor (concentric coil winding)**

Collection of data

1 Collect and record the machine data in Table 1.

2 Remove the pulley by using a pulley puller. Remove the fan cover and then remove the cooling fan blade assembly.

3 Mark both the end covers with distinguished markings with a centre punch, and correspondingly mark the body also.

Table 1

Name-plate details

Manufacturer's Name	Serial Number.....
Output.....KW/HP.	Voltage .....V Current .....Amps
Frequency .....Hz	Speed ..... r.p.m. Cycle .....
Insulation	Frame No. .....Startingcapacitor ..... Mfd

4 Mark and remove the connection leads from the terminal box. Enter the details in your note book.

5 Loosen the screw bolt/tie rod on both the end shield covers, and also remove the centrifugal switch connections.

6 Remove the rotor from the stator.

7 Inspect the rotor for any defect, and the bearing for its condition.

If any of the rotor bar is open correct the defect by brazing. If bearing is worn out replace it with a new one.

8 Take the winding data before removing the coil and record it in your note book.

9 Mark the stator for indicating connection lead side with respect to the terminal box. Enter the details in your note book.

10 Apply a thinner in the connection lead side to loosen the varnish and locate the end connection. Draw the group connection diagram and also prepare the developed diagram in a separate sheet of paper and attach with these sheets.

To avoid imaginary terms while writing the procedure, an example for a single phase capacitor motor having concentric coil winding is given below.

Certain procedural steps are specifically written for the motor given in this example. However, you have to follow the data taken strictly from the given motor, to get the required performance.

Information from collected data

Coil pitches	-	Main winding 5,3,1
		Starting winding 5,3
Coil throw	-	Main winding 1-6,2-5,3-4
		Starting winding 1-6, 2-5

This is the whole coil connection as the end of the 1st coil is connected to the end of the 2nd coil and the starting of the 2nd coil is connected to the starting of 3rd coil etc.

For your guidance, the group connection diagram is given in Fig 1 and the developed diagram is given in Fig 2.

Fig 1

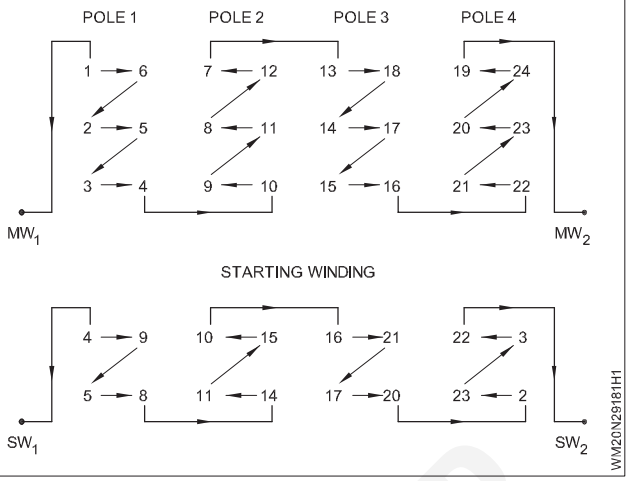
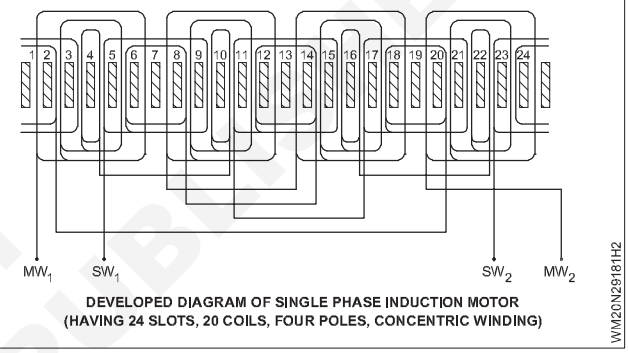


Fig 2



DEVELOPED DIAGRAM OF SINGLE PHASE INDUCTION MOTOR
(HAVING 24 SLOTS, 20 COILS, FOUR POLES, CONCENTRIC WINDING)

11 Measure the overhang at both sides of the winding.

12 Collect the possible data like, number of slots, coil pitch etc. and record in your note book.

13 Cut the coils except one set of coils each in the starting and main winding with the help of a cold chisel at the non-connection end (i.e. normally load side).

14 Strip the old winding from the stator slot. If it is hard use a blowlamp to heat the winding and pull out the coils.

15 Remove the left out coils in their original shape.

Use a thinner to loosen the coils. Once a thinner is used never use the blowlamp as the coils will catch fire.

16 Measure the size of the wire, size of the coil and collect other details as required and record them in Table 2.

— — — — — —

TASK 2 : **Rewind the motor**

1 Set the core if it is mangled and clean the slots.

2 Select the insulation paper of the same grade and thickness or equivalent as in the original and prepare the insulation paper to have the same shape and size as in the original insulation.

3 Insulate the slot with the prepared insulation paper.

4 Make a former or select a readymade former according to the size of the original set of coils.

5 Select the correct size of winding wire as in the original and wind the coil in the former taking care to maintain the same number of turns.

6 Make the required number of main and starting winding coils.

The running winding should be placed at the bottom of the slot. Then the starting winding should be placed at the top of them as per data taken.

7 Insert the newly wound main winding coils into the stator slots, placing the winding in the same position as in the original.

While placing the coil take care to insert the turns in small bunches without forcing them too much. The winding wire should not rub the core. Avoid this by placing a leatheroid paper between the coils and the core.

8 Wedge the slots permanently which are having single coil side only. Temporary wedges may be used in the other slots.

9 Shape the coil with a nylon hammer at both sides. After placing all the main winding coils,

10 Check individual groups of the main winding for continuity and insulation resistance.

11 Verify the test results of the main winding are found correct, then place the starting winding in the designated slots as per the group connection and developed diagram.

12 Identify wherever, the slot contains two coil sides, (according to the example given, all the slots except slot 1,6,7,12,13,18,19 and 24) soon after inserting the bottom coil side, place the separator insulation paper over it..

After the top coil side is inserted, fold the slot liners, place the separator and wedge the slots.

13 Provide a phase separator between the running and starting winding coils in the overhang.

14 Shape both the sides of the overhang as in the original with the help of a mallet/nylon hammer.

Apply uniform mild blows. Avoid damage to the wires or insulation.

15 Insert proper empire/PVC sleeves in the winding ends and connect all the coil ends and lead cables according to the connection diagram drawn earlier.

16 Check the connection once again by comparing the group connection and developed diagram.

17 Solder the end connections and put the sleeves in position.

18 Set the overhang sides so as to have a uniform thickness and bind the thread/tape similar to the one in original.

Use the templates and check the dimensions of the overhang at intervals to see the overhang has attained a shape as in the original winding. Make sure that the overhang does not touch the body or the end cover.

— — — — — —

TASK 3 : **Test the winding**

1 Check the winding for short circuit, open circuit and insulation resistance by a multimeter and Megger respectively.

2 Check the condition of the capacitor and centrifugal switch. If there is any fault replace them by new ones.

3 Connect the lead connections, capacitor and centrifugal switch according to the connection diagram and terminate them in the terminal box.

4 Assemble the motor and then run the motor for 15 minutes.

5 Observe the direction of rotation. If necessary change the connections.

6 If test is OK then dismantle the motor.

7 Preheat the stator and impregnate the winding with varnish.

8 Remove the excess varnish in the face of the stator slots after drying.

9 Reassemble the motor and test it on load for 8 hours.

— — — — — —

Carry out maintenance and servicing of universal motor

Objectives: At the end of this exercise you shall be able to
- **read and interpret the name-plate details of the motor**
- **inspect and ascertain the conditions of the motor**
- **dismantle the universal motor**
- **test and rectify the faults**
- **assemble and test the universal motor**
- **troubleshoot the universal motor.**

Requirements

Tools/Instruments

- Philips screwdriver 200mm - 1 No.
- Cold chisel 200 mm - 1 No.
- Spanner set double ended set of 8 Nos. 6mm to 25 mm - 1 Set
- Mallet (wooden) 7.5 cm dia - 1 No.
- Bearing puller - 1 No.
- Megger 500 V - 1 No.
- Ohmmeter 0 to 1 kilo ohm - 1 No.
- External and internal growler - 1 Set

Equipments/Machines

- Universal motor as available - 1 No.

Materials

- Test lamp 60W 250V - 1 No.
- Cotton waste - as reqd.
- Bearing grease quality and quantity - as reqd.
- Sandpaper smooth sheet of 300 mm square - as reqd.
- Kerosene oil - 1/2 litre.
- Empire cloth 1 mm - as reqd.
- Carbon tetrachloride - as reqd.
- Empire sleeves 3 mm to 6 mm - as reqd.
- Carbon brushes of suitable grade and size - 2 Nos.
- Lead and tin solder (Resin cored) -20grams.

PROCEDURE

TASK 1 : **General maintenance and servicing procedure**

1 Note the name-plate details of the motor and enter in complaint card shown in Table 1.

Table 1

Complaint card

Customer _____ Date _____ Job No. _____ Make _____

Frame No. _____ Model _____ Type _____ HP _____

Volts _____ Ampere _____ Phase _____ Cycles _____

Serial No. _____

Suggestion/Complaint : _____

Signature of Section in-charge

2 Inspect the motor visually and record the defects in Table 2.

3 Read the complaint card and ascertain the area of trouble.

4 Conduct, continuity, open circuit and insulation resistance tests and enter the values in Table 3.

Table 2

Results of visual inspection

Sl.No.	Description of visual inspection	Result of visual inspection

5 Mark the exact position of the end plates with yoke.

6 Dismantle the machine.

7 Clean the internal parts of the motor.

8 Check the following.

a Test the shorting between commutator segments (Fig 1)

b Clean the commutator with carbon tetra chloride.

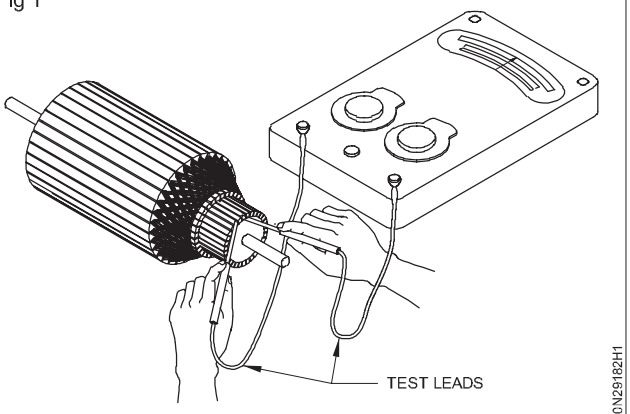
c Check the mica insulation; if found raised be yond the commutator surface undercut the mica (Fig 2)

Table 3

Test results

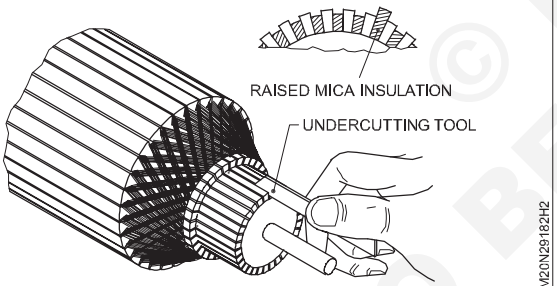
Sl. No.	Description	Continuity Test		Insulation resistance		Resistance Test		Re-marks
		Before Dismantling	After Assembling	Before Dismantling	After Assembling	Before Dismantling	After Assembling	
1	Field winding							
2	Armature winding							

Fig 1



ARMATURE RESISTANCE TEST

Fig 2



d Check the commutator surface for pittings. If necessary use sandpaper to remove the pittings.

e Check for overheated spot at raiser and resolder the wires if necessary.

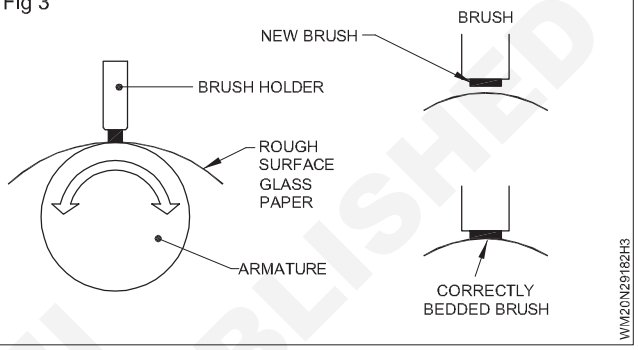
f Check the length of brushes. If found short, replace them with the same grade of correct size brushes.

g) Check the brushes for proper bedding. If necessary bed the brushes. Refer Fig 3.

Insert the new brush and shape the end to the curve of the commutator using glass paper wrapped around the commutator and light pressure on the brush.

h) Check the bearing for ply or damage.

Fig 3



i Replace the damaged or defective bearing with the new one having same specification.

If the old bearing is good, then clean the bearing and repack the bearing with grease approved by the manufacturer.

j Assemble the motor.

k Check whether the rotor shaft is free to rotate.

In case, the rotor shaft is hard to move or too tight, loosen the end covers and retighten them in a sequence till the rotor is free to rotate.

l Check the brush tensions and if necessary adjust it.

m Perform the earlier tests and enter the results in Table 3.

The present test results should be better than earlier ones. If not try to investigate the problem area and rectify.

n Check the earth connections of the motor, starter and switch and correct them if necessary.

o Start the motor with partial load and check its performance.

p Check for undue raise in motor temperature, noise and vibrations.

q Verify the defect following the trouble shooting chart if necessary.

— — — — — —

Carry out winding of submersible pump

Objectives: At the end of this exercise you shall be able to
- **make the winding coils submersible pump**
- **insulate the slots with suitable insulating paper**
- **insert the coils into the slots**
- **make the end connections as per data taken**
- **test the winding**
- **assemble the submersible pump.**

Requirements

Tools/Instruments

• Electrician tool kit	- 1 No.
• Multimeter Digital	- 1 No.
• Megger 500V	- 1 Set
• Mallet	- 1 No.
• Chisel hammer	- 1 No.
• Soldering iron 35W	- 1 No.

Materials

• Leathered paper	- 1 No.
• PVC insulated winding wire	- as reqd.
• Binding thread	- as reqd.
• Insulation warmish	- as reqd.

PROCEDURE

TASK 1: **Procedure for dismantling submersible pump and collect the winding**

1 Record the name plater details of the submersible motor in table 1

Table 1

SI.NO	
Current	
Voltage	
wattage	
RPM	

2 Loose the screws and remove end cover.

3 Remove the submersible motor from the pump

4 Check the bearings for its proper function, if there is any end play replace e the bearings.

5 Note the coil size table 2

6 Remove all coils from the core

7 Record the required data in table 2

Table 2

	Starting winding	Running winding
No.of slots		
No. of turns per slot		
winding wire diameter		
Insulation paper		
Size of winding coil		

— — — — — —

TASK 2 : **Motor re-winding of submersible**

1 Take suitable size of former according to the dimensions.

2 Attach the former securely to the winding stand.

3 The coil with twine thread on either side of coil after winding of the coil.

4 Remove the coil from frame and insert in slots.

5 Make the required no of coils.

6 Clean the core.

7 Insert the insulation paper in each slots.

8 Place all the coils in slots properly.

9 Fix coils in slots without any loose.

10 Make the connections as per winding diagram.

11 Use correct size of slaves for insulate joints.

12 Make end connections

Fig 1

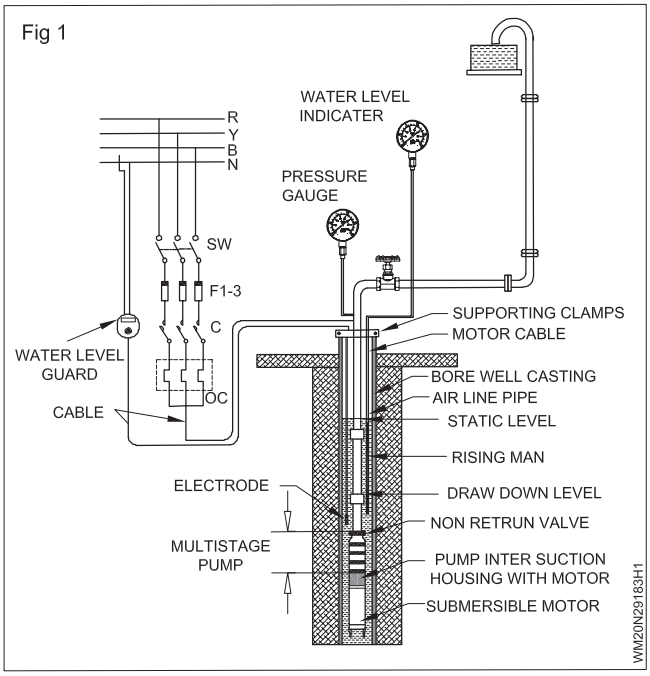
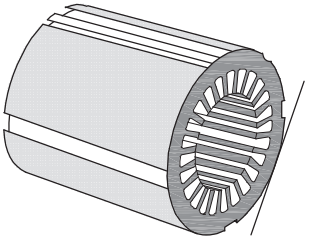


Fig 2



TASK 3 : **Assemble the submersible pump and motor**

1 Check the windings for open and short circuit

2 Apply varnish, and dry it in open air

3 Assemble the submersible pump properly.

4 Connect the submersible pump to the supply mains and observer its function.

Practice winding of small 3-Φ AC motor

Objectives: At the end of this exercise you shall be able to

- **read, record and interpret the winding data for a small 3-phase squirrel cage induction motor**
- **prepare and lay the coils for the distributed type winding, concentric group of coils**
- **make end connections and terminate the lead wire**
- **insulate, bind and shape the overhangs**
- **assemble the motor**
- **test the motor for performance.**

Requirements

Tools/Instruments

- Screwdriver 100, 150 and 200 mm - 1 No each
- DE spanner 5mm to 30 mm - 1 Set
- Ring spanner 5 mm to 30 mm - 1 Set
- Cold chisel 25 mm x 200 mm - 1 No.
- Ball pein hammer 500 grams - 1 No.
- Nylon mallet 75 mm x 100 mm - 1 No.
- Pulley puller 200 mm with 3 jaws - 1 No.
- Centre punch 10 mm x 150 mm - 1 No.
- Insulated cutting pliers 200 mm - 1 No.
- Side cutter 150 mm - 1 No.
- Micrometer outside 0-25 mm - 1 No.
- Fibre or Hylam knife of assorted sizes - 4 Nos.
- Soldering iron 125 W, 250V - 1 No.
- D.B.electrician knife 100 mm - 1 No.
- Multimeter - 1 No.
- Megger (insulation tester) 500V - 1 No.
- Ammeter (or multi-range) M.I. 0-10A - 1 No.
- Voltmeter M.I.Multi-range 0-300V-500V - 1 No.
- Tachometer 0-500-5000 r.p.m. - 1 No.
- Readymade former universal size - 1 Set
- Awl of required length and thickness - 1 No.
- Spatula - 1 No.
- Electirc air blower - 1 No.

Equipment/Machines

- Burnt out 3-phase motor with single layer distributed winding of available capacity & double layer - 1 No.
- Baking oven with temperature control - 1 No.
- Coil winding machine - 1 No.

Materials

- Super-enamelled copper wire - as reqd.
- Milinex sheet or triplex paper - as reqd.
- 20 or 25 mm cotton tape - 1 Roll
- Fibre glass sleeves 1 mm, 2 mm, 4 mm, 6 mm - as reqd.
- Bamboo/fibre wedges - as reqd.
- 25 mm painting brush - 1 No.
- Soldering lead 60%, Tin 40%, - 100 g
- Resin flux - 25 g
- Insulating varnish - 1 litre.
- Tray 600 mm x 600 mm x 100 mm - 1 No.
- Thinner - 500 ml
- Hemp thread - 1 Roll
- Used power hacksaw blade - 2 Nos.
- Leatheroid paper - as reqd.
- Empire sleeve - as reqd.

PROCEDURE

Instructor may select a motor having burnt out single layer distributed winding for this exercise.

TASK 1 : **Dismantling of the motor, recording winding data and stripping the winding**

1 Collect the name-plate details and record in Table 1.

2 Calculate the number of poles from the name-plate details.

Using the formula $P = \frac{120 \times f}{N_s}$

where P - number of poles

f - frequency in Hertz

Ns - synchronous speed in r.p.m.

(little higher than the rotor speed noted in the name-plate).

3 Enter the winding data.

4 Check, record the total weight of the coils, count the number of turns, measure the size of the wire, and record them in Table 3.

Some manufacturers may use parallel conductors of the same size or different sizes of wires instead of using a single wire. Take care of this while recording and entering the details in Table 3 against 'wire multiple'.

5 Remove all the remaining foreign matter from the slots by scraping with a knife.

6 Clean it by blowing compressed air.

7 Measure the size and shape of the coil. If the full shape of the coil is available record the details in Table 4.

In case the full shape of the coil is not available, prepare a trial coil of single turn and insert it in the slots at the given pitches. Verify the overhang projection, clearance, correct size etc.

Table 1

Induction motor name-plate details

Make	Frame No.....	Model .....
Phase	Kilo watt	r.p.m .....
Volts.....	Amperes	Frequency .....
Rating		Insulation .....
Connection.....Star/Delta		Class .....

Table 2

Winding Data

No.of coils	No.of slots.....	Coil pitch .....
No.of Poles		
Overhang projection	a) connection end .....mm	
	b) Non-connection end .....mm	

Table 3

No. of circuits.....	Turns/Coils.....	Size of the wire.....
Wire multiple.....	Wt.of scrap.....	Wire insulation.....

Table 4

Coil shape: Diamond / Rectangular / Oval	
A.	Coil length ..... mm
B.	Coil width ..... mm

— — — — — —

TASK 2 : **Prepare and provide slot insulation**

1 Check the slot dimension and record it in Table 5.

2 Check the core thickness and record the same in Table 5.

3 Select the slot liner of thickness as in the original.

4 Cut the paper as per slot length/core thickness with an additional length of 10 to 15 mm so as to make the insulation paper to project 5 mm on either side of the slot with cuffed ends.

10 to 15mm on either side is just an approximate requirement. Large motors may require a longer length or vice versa.

5 Cuff either end of the slot liner (Fig 1) and fold the same to the slot size.

Prepare a sample of the slot liner and try inserting it in the slot to see the correctness.

6 Cut and prepare the necessary number of slot liners as per the correct sample.

7 Insert the slot liners in all the slots properly and see that the slot liners project evenly on both sides of the core. (Fig 2)

Fig 1

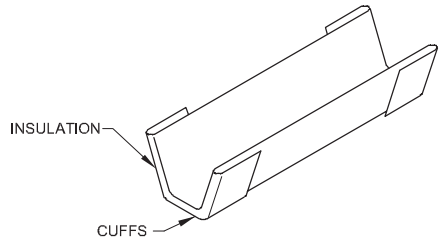
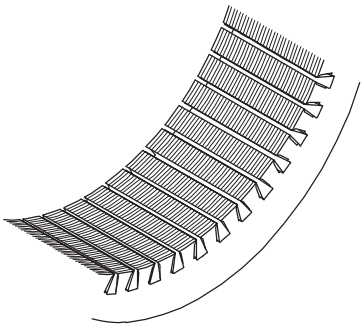
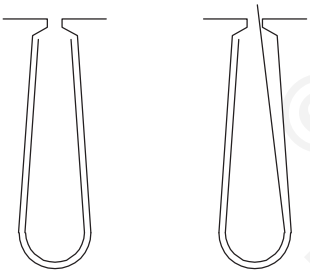


Fig 2



The slot liner should properly adhere to the surface of the slots as shown in Fig 3(a). A wrong method of placing the slot liner. (Fig 3b).

Fig 3



8 Check the group/lead connections draw the developed diagram of the winding for the given motor.

For your guidance the end connections and the developed diagram are given in Figs 4 and 5 respectively for a certain motor having a single layer distributed type winding with the following data: 24 slots, 12 coils, 4 poles, 3-phase balanced winding.

Table 5

Slot dimension

Lower width .....mm

Upper width (W) .....mm

Depth .....mm

Slot lenfth .....mm

Fig 4

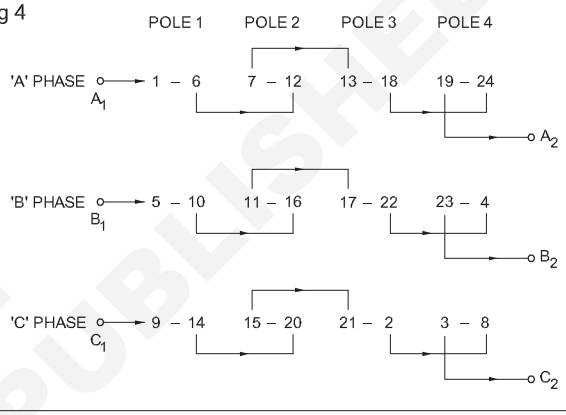
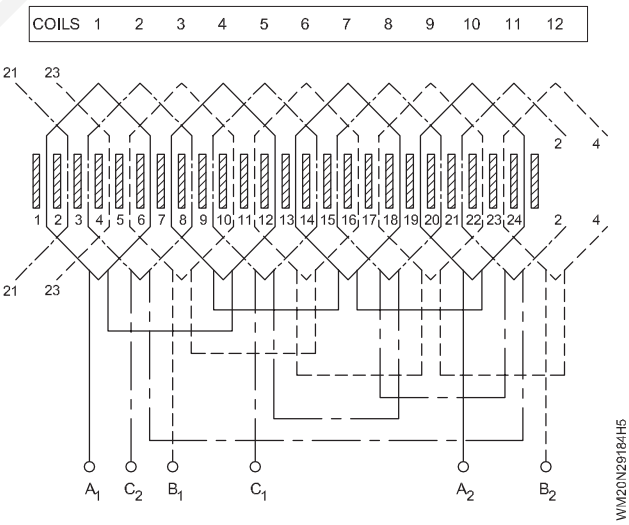


Fig 5



TASK 3 : **Prepare coil winding and forming**

1 Select a suitable size of former according to the dimension recorded in Table 4.

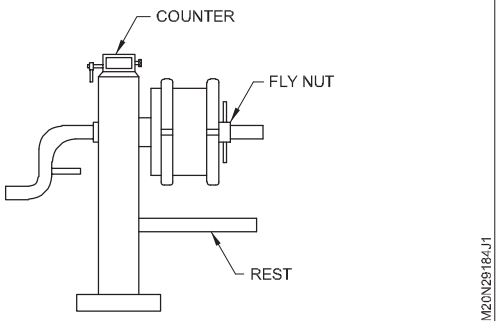
The former is cut with a distinct bevel edge for two reasons: to permit the coil to slip off the former and to allow a longer peripheral length of the coil at the back. Only one size of former is sufficient for the distributed type of winding.

2 Attach the former securely to the winding stand. (Fig 1) .

3 Confirm and select the size of winding wire i.e. given in Table 3.

4 Wind the designated number of turns (Table 3) by leaving 150 mm extension wire.

Fig 1



Make sure the number of turns is small as in the original.

5 Tie the coil tightly with twine thread on either side of the coil, after winding the coil.

6 Cut the remaining length of wire by leaving 150 mm extension.

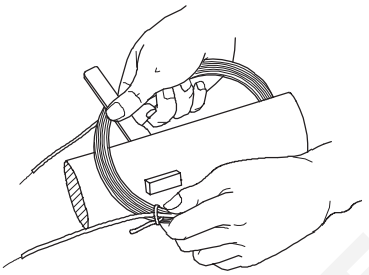
7 Remove the coil from the former and check its correctness by inserting in the slots.

If the size is found OK proceed to step 8. Otherwise make necessary changes in the former till the coil shape is correct.

8 Make the required number of coils.

9 Shape the coils by folding the ends of the straight parts of the coils. (Fig 2)

Fig 2

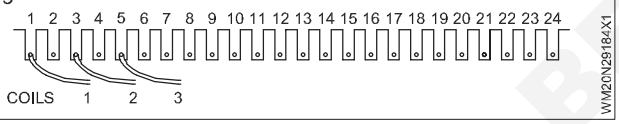


TASK 4 : **Insert the coils in the slots in proper sequence**

Procedure for 24 slots, 12 coils, 4 pole distributed winding is given below. You can adopt the same procedure for other stators of different slots and poles with necessary modification. Observe keenly the developed diagram shown in Fig 5.

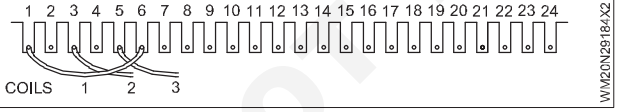
1 Follow the procedure given below. First insert the left coil sides of 1st coil, 2nd coil and 3rd coil in slot 1, 3 and 5 respectively. (Fig 1)

Fig 1



2 Insert the right coil side of the 1st coil in slot number 6. (Fig 2)

Fig 2



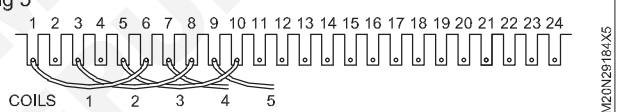
3 Insert the left coil side of coil 4 in slot 7 (Fig 3) and then insert the right coil side of coil 2 in slot 8. (Fig 4)

Fig 3

Fig 4

4 Insert left coil side of coil 5 in slot 9 and then insert the right coil side of coil 3 in slot 10. (Fig 5)

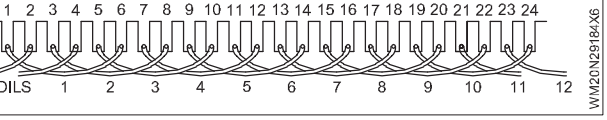
Fig 5



5 Proceed likewise till you are left with the right coil sides of coils 11 and 12.

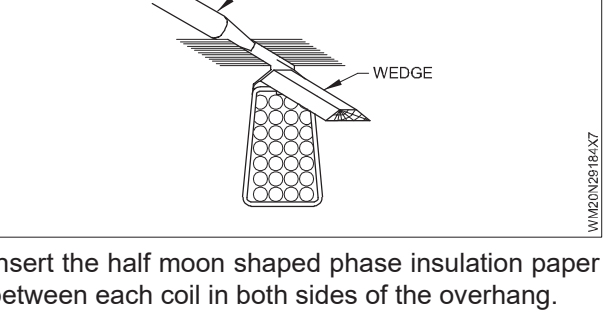
6 Insert the 11th coil right coil side in slot 2 and then the 12th coil right coil side in slot 4. (Fig 6)

Fig 6



7 Insert the wedges in the slots so that the coil sides are well packed in the slots. (Fig 7)

Fig 7



8 Insert the half moon shaped phase insulation paper between each coil in both sides of the overhang.

9 Follow the developed diagram and connect the end, group and terminal connections.

10 Tie the connections with overhangs and shape the overhang.

11 Test the winding .

12 Measure the resistance between A1 - A2 , B1 - B2 and C1 - C2 and record the values in Table 6.

Table 6

Resistance between A1 - A2 .....ohm
Resistance between B1 - B2 .....ohm
Resistance between C1 - C2 .....ohm

All the three resistances should be equal.

13 Measure the insulation resistance between the windings and the stator core with 500 V Megger and record it in Table 7.

Table 7

Insulation resistance

between core and A phase.....MEGOHM
between core and C phase.....MEGOHM
between core and B phase.....MEGOHM

14 Measure the insulation resistance between the windings with a 500V Megger and record it in Table 8.

The above values should not be less than one megohm in any case.

Table 8

Insulation Resistance

Between A phase and B phase...MEGOHM
Between B phase and C phase...MEGOHM
Between C phase and A phase...MEGOHM

15 Varnish the winding,

16 Assemble the motor and test run the motor with load for 8 hours.

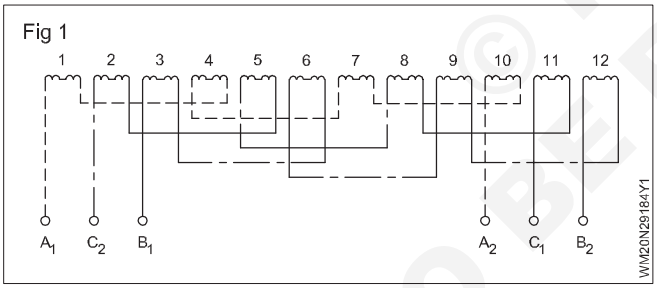
The instructor should select a 3-phase induction motor having a single layer concentric (half coil) winding for this exercise.

— — — — — —

TASK 5: **Connect group leads - testing and varnishing**

1 Bring out the group ends, connect, solder and insulate the groups. (Fig 1)

Fig 1



2 Connect the lead cables to the group connections and solder them.

3 Tie the hemp threads in the overhangs, to secure the sleeved joints and phase separator insulations.

4 Shape the overhangs and check with a template.

5 Test the winding for continuity and ground as per Exercise 3.3.138.

6 Assemble the motor if the test results are satisfactory and run it for ten minutes.

7 Dismantle the motor, impregnate the windings and dry them, if the results are O.K.

8 Assemble and test the motor on load.

— — — — — —

Perform estimation and costing for different types scheme of wiring for labour materials and accessories as per layout

Objectives: At the end of this exercise you shall be able to

- **draw the schematic and layout diagram keeping in view of the light points and power sockets**
- **estimate the materials, accessories, cable PVC conduit as required**
- **mark the route of the PVC conduit to the layout**
- **Select and draw the cables separately for light and power outlet according to the layout with earth continuity conductor.**

PROCEDURE

Details of the proposed work

Plan of the completed house to be wired is given in Fig 1

Details of civil work are as under

i Walls are of backed bricks with cement mortar and plastered with cement mortar.

ii Roof is of concrete and of 300cm height from the floor.

iii Conduit runs at a height of 250cm from the floor.

Requirement of electrical distribution

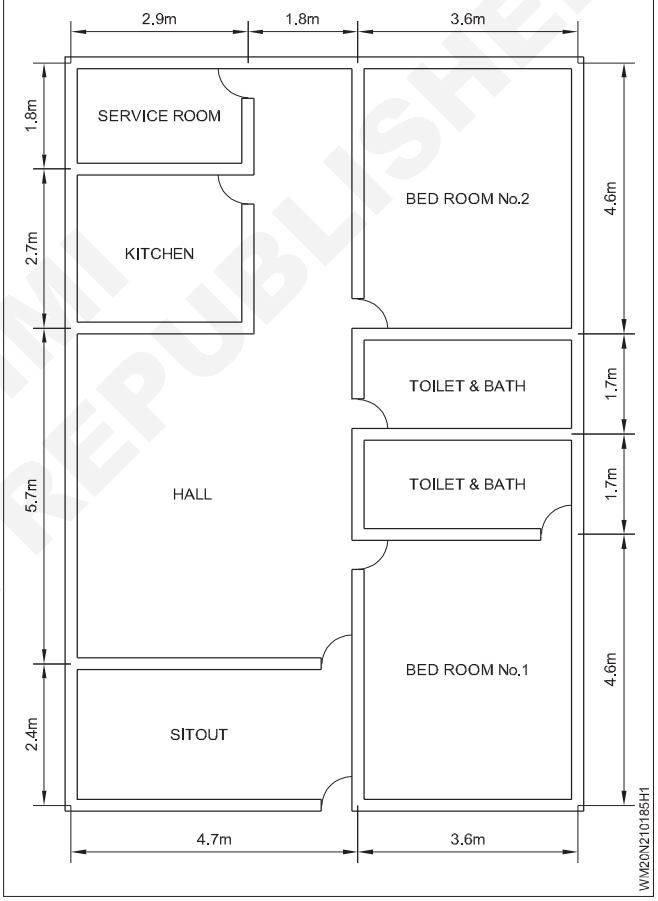
i The house is to be provided with 3-phase supply.

ii Distribution of the load in L1,L2,L3 phases are given in the Fig 1 and 2 and details of loads are given in Table 1.

Surface conduit wiring is proposed with proper earthing at metal boxes, fans ,regulators and 3-pin sockets (Lighting & Power.)

As per local electricity board rules, separate lines shall be drawn for power circuit.

Fig 1



TASK 1: **Estimation of materials, accessories, cable and PVC conduit**

Trainees are required to

1 Calculate the wattage of light, fan and power circuit in individual branch circuits as well as for the phase L1,L2 and L3. Enter the details in Table 1.

2 Calculate the total connected load of the installation and enter in Table 2.

3 Calculate the load currents in individual phases and branch circuits and enter in Table 3

4 Calculate the length of PVC conduit required for phase L2 and phase L3 as per given layout diagram Fig 2. Enter the final requirement in table 4.

5 Calculate the size and length of cable required for wiring phase L2 and L3 as per given layout diagram Fig2 and enter the total requirement in Table 5.

Method of calculating the length of PVC conduit, size and length of cable required for wiring phase L, are given in related theory book and consolidated requirement is given in Table 4 and 5 for conduit length and cable length respectively for your reference and the wiring diagram for phase L1 is given in Fig 3.

6 Calculate the accessories required for wiring phase L2 and L3 and enter the total requirement in Table 6.

Accessories required for wiring phase L1 is given in Table 6 for your reference.

7 Consolidate the total requirement of accessories, PVC conduit and cables in table 4, 5 and 6.

8 Find the cost of materials from local market and enter the value in Table 4, 5 , and 6.

9 Estimate the power in each circuit and total power in L1 phase for the loads detailed below.

TABLE 1

Load in light circuit (one) in L1 phase

1 6A socket	1 No ….	x1	=.....	watt
2 Lamp	6 Nos ….	x6	=	watt
3 Tubelamp	1No ….	x1	=	watt
4 Fan	1 No ….	x1	=	watt

Load in light circuit (Two) in L, phase

1 6A socket	4Nos ….	x1	=	watt
2 Lamp	2Nos ….	x2	=	watt
3 Tube lamp	2Nos ….	x2	=	watt
4 Fan	2Nos ….	x2	=	watt

Load in circuit (three) in L, Phase

1 6A, socket	3 Nos ….	x3	=	watt
2 Lamp	2 Nos ….	x2	=	watt
3 Tubelamp	2 Nos ….	x2	=	watt
4 Fan	3 Nos ….	x3	=	watt

Load in power circuit (One) in L, phase

1 20A socket With MCB	1 No ….	x1	=	watt

Total watt

10 Estimate the power in each circuit and total power in L_2 phase for the loads, detailed below.

Load in light circuit (one in L2, phase)

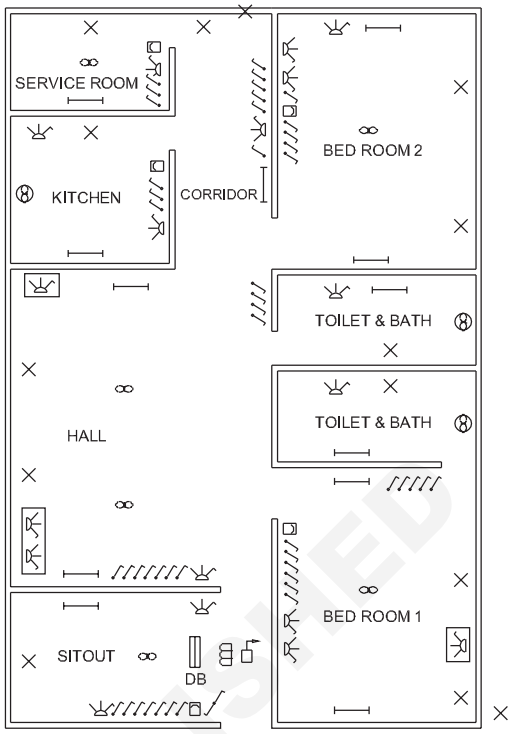
1 6A socket	2 No ------ x2	.....watt
2 Lamp	3 Nos ------ x3	..... watt
3 Tube lamp	3 Nos ------ x3	..... watt
4 Fan	2 Nos ------ x2	..... watt

Load in power circuit (one) in L_2 phase

1 15A, socket	1 Nos -------x1	.....watt

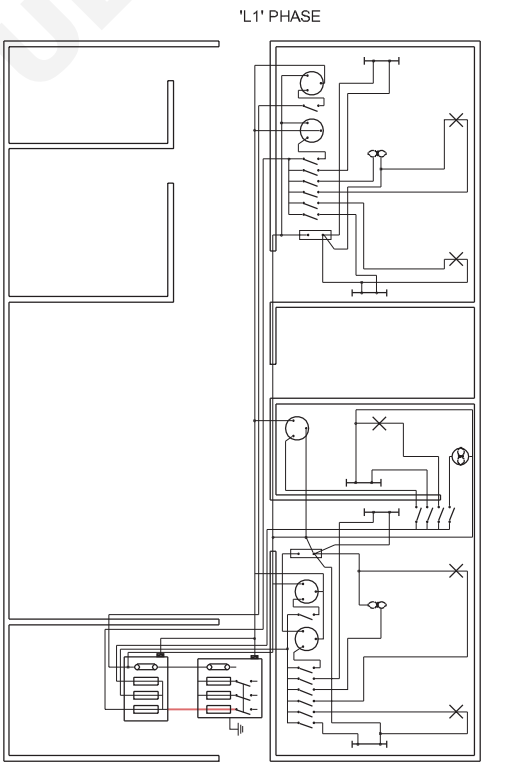
Total power .....watt

Fig 2



ACCESSORIES POSITION DIAGRAM

Fig 3



Estimate the power in each circuit and total power in L3 phase for the loads , detailed below:

Load in light circuit (one) in L3 phase

1 5A, socket 1 Nos ------ x 1 .....watt

2 Lamp 5 Nos ------ x 5 .....watt

3 Tube lamp 2 Nos ------ x 2 .....watt

4 Fan

Load in power circuit (one) in L3 phase

1 15A Socket 1 No ------ x 1 .....watt

Load in power circuit (Two) In L3 phase

1 20A, Socket 1 No ------ x1 .....watt
With MCB

Total power .....watt

Table 2

12 Estimate the total power of the installation

i Power in 'L1' phase .....watt

ii Power in 'L2' phase .....watt

iii Power in 'L3' phase .....watt

Total watt

Table 3

13 Estimate the load current in each circuit or L1, phase

L_1 phase

1 Load current of light & fan circuit 1 ..... amp

2 Load current of light & fan circuit 2 ..... amp

3 Load current of light & fan circuit 3 ..... amp

4 Load current of light & fan circuit 1 ..... amp

14 Estimate the load current in each circuit of L2 phase

L_2 phase

1 Load current of light & fan circuit 1..... amp

2 Load current of light & fan circuit 2 ..... amp

3 Load current of power circuit 1000w 1 .....amp

15 Estimate the load current in each circuit of L3 phase

L_3 phase

1 Load current of light & fan circuit 1 ..... amp

2 Load current of power circuit 1000w 1 .....amp

3 Load current of power circuit 4000w 2 ..... amp

Fig 4

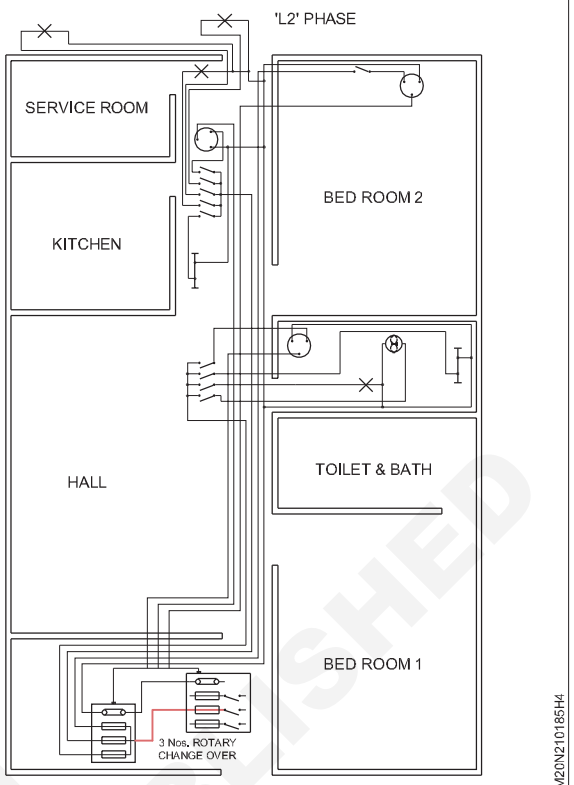


Fig 5

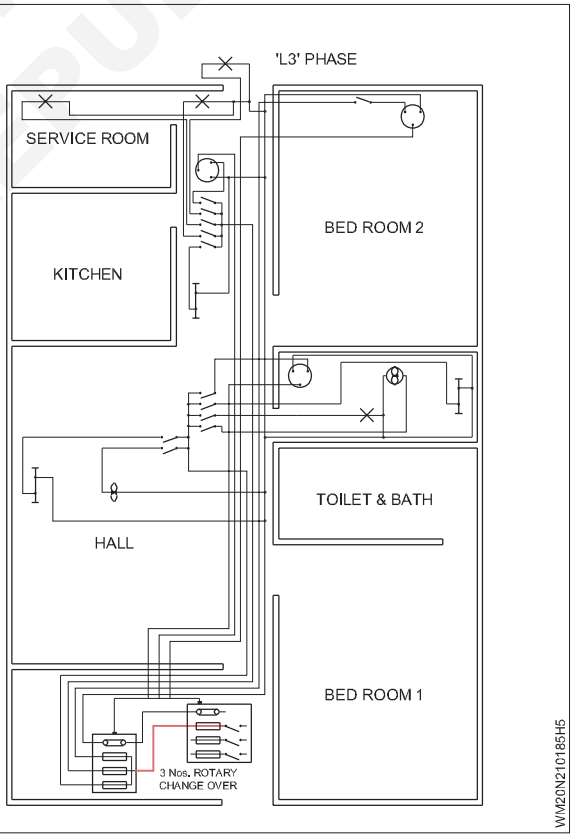


Table 4

Length of Conduit

SL . No	Description	size of conduit	L1	L2	L3
1	From meter board to Db	19mm	1.36m		
2	Down drops	“	10.8m		
3	Vertical runs	“	4.0m		
4	Roof runs	“	9.4m		
5	Horizontal runs	“	48.25m		
6	Total length	“	73.81m		
7	Add 10% wastage	“	7.38m		
8	Total required length of 19mm PVC conduit	“	80.0m		

Table 5

Length of Cable

Sl.No	**Description**	**Size of cable**	**L1**	**L2**	**L3**
1	Length of cable required for the Wiring from meter load to the DB	4 sqmm copper	20m		
	Length of cable for power circuit	“	25m		
	Length and fan circuit	1 sq mm of Copper 1/1.12	360m		
2	Total length of cable	copper			
		4 sqmm	45m		
		1 sqmm	360m		
3	Copper cable required	4 sqmm	125m		
		1 sqmm	580m		

Table 6

Requirement Accessories

Sl No	Description of Accessories	Common	L1	L2	L3	Total per unit	Cost	cost
1	TPIC N main switch 32a 415v	1 No.						
2	Distribution box 3-Phase 4-way 16A 415v with neutral link and earth terminal	1 No.						
3	Rotary type-3 phase change Over switch 32A 415V with neon indicator	1 No.						
4	Ceiling rose 2 plate 6A 240V	9 Nos.						
5	Bakelite batten holder 6A 240V	6 Nos.						
6	SP Switch 6A 240V (Flush type)	19 Nos.						
7	SP Switch 6A 240V two way (Flush type)	20 Nos.						
8	Wall socket 3-pin 16A 240V with switch (Flush type)	8 Nos.						
9	Wall socket 3-pin 16A 240V with switch (flush type)	-						
10	Bell push 6A 250V							
11	PVC conduit pipe 19mm dia with wall thickness 1.5 mm	80m						
12	PVC junction box single Way 19mm	3 Nos.						
13	PVC junction box two way 19mm	4 Nos.						
14	PVC junction box Three Way 19mm	7 Nos.						
15	PVC bend 19mm	20 Nos.						
16	PVC inspection Bend 19mm	2 Nos.						
17	GI saddles with base 19mm	120 Nos.						
18	Industrial socket 20A 240V with MCB 32A 240V	1 Nos.						
19	Electrical bell 240v 50Hz	1 Nos.						
20	Hardware items like screws Hacksaw blade etc.	as required						
21	Wooden or Metal switch Boxes	as required						

Demonstrate structure wiring/Smart wiring for home & office automation through visual aids

Objectives: At the end of this exercise you shall be able to
- **demonstrate home automation device**
- **understand the AV equipment & technology**
- **demonstrate office automation technology.**

Requirements

Tools / Instruments

- Electrician tool kit - 1 No.
- Internet router with wi-fi - 1 No.

Equipment/Machines

- Automation Device with all accessories - 1 No.
- Camera (CC) - 2 Nos.
- Projector (Mobile phone, Remote) - 1 No.
- Smart thermostat Audio/Vedio equipments - 1 No.

Materials

- Cables - RG 59 - as reqd.
- Cable 1.5 mmv - as reqd.
- UTP (CAT 5 to CAT 6) cable- - as reqd.

PROCEDURE

Instructor may arrange all required smart switches, sensors, smart phone with internet required app for remote control, remote, speakers for voice controllings of device

TASK 1: **Stuctured wiring for home and office automation**

1 Identify the central distribution point (Determine location where all the cables will converge. Typicallyl, this is a utility closet, basement, or dedicated structured wiring).

2 Create a wiring plan that out lines the cable routes from the control distribution point to various rooms and areas in the home.

3 Select appropreate cable based on the requirements the connected devices.

4 Use conduits or cable path ways to route the cables from the central distribution point to the designated area.

5 At each end point terminate the cables using connectors or jacks specific to the cable type.

6 Bring all the cables to the central distribution point and connect them to a structured wiring panel.

7 Depending on your needs install distribution modules with in the structured wiring panel.

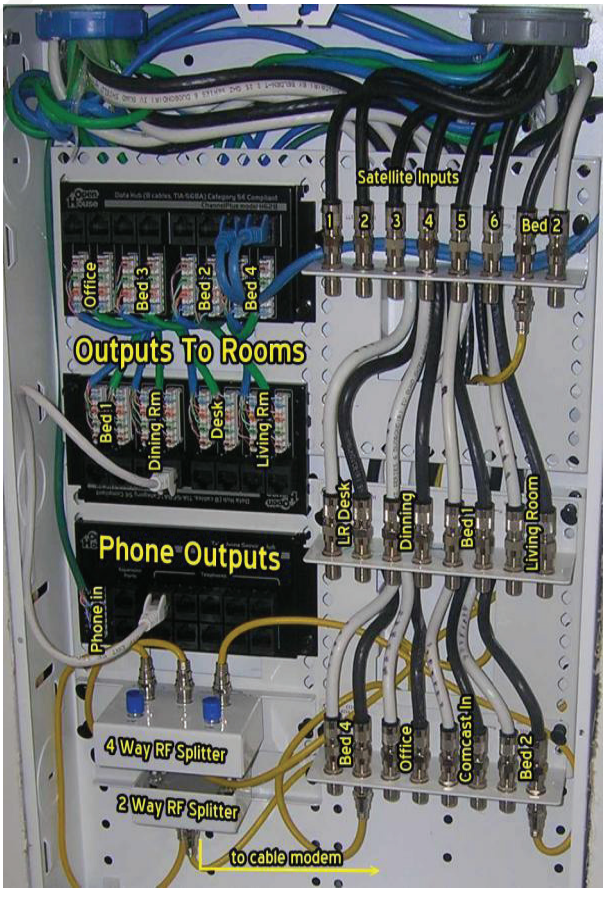
8 Use appropreate testing equipment to verify that all the cables are property terminated and providing the expected connectivity.

9 Label each cable and termination point with clear identifies.

10 Oneces the structured wiring is complete and verified connect and integrate your home automation devices.

11 Refer the Fig 1. fir complete structured wiring panel.

Fig 1



TASK 2 : **Demonstration smart wiring for home and office automation**

1 Identify the areas and devices you want to automate such as lighting, AC's security systems and etc, as shown in Fig 1.

2 Determine the control mechanism you will use such as smart switches, motion sensors, voice assistants.

Smart phone apps

3 Setup a central hub or controler that will serve as the brain of your home automation system.

4 Connect the hub to your home network for communication with other devices.

5 Install smart switches, or dimmers for lighting control consider adding motion sensors to automate lighting bases on occupency.

6 Installa smart thermostat that can be progammed and controlled remotedly.

7 Install smart doors locks that can be remotly controlled and monitor.

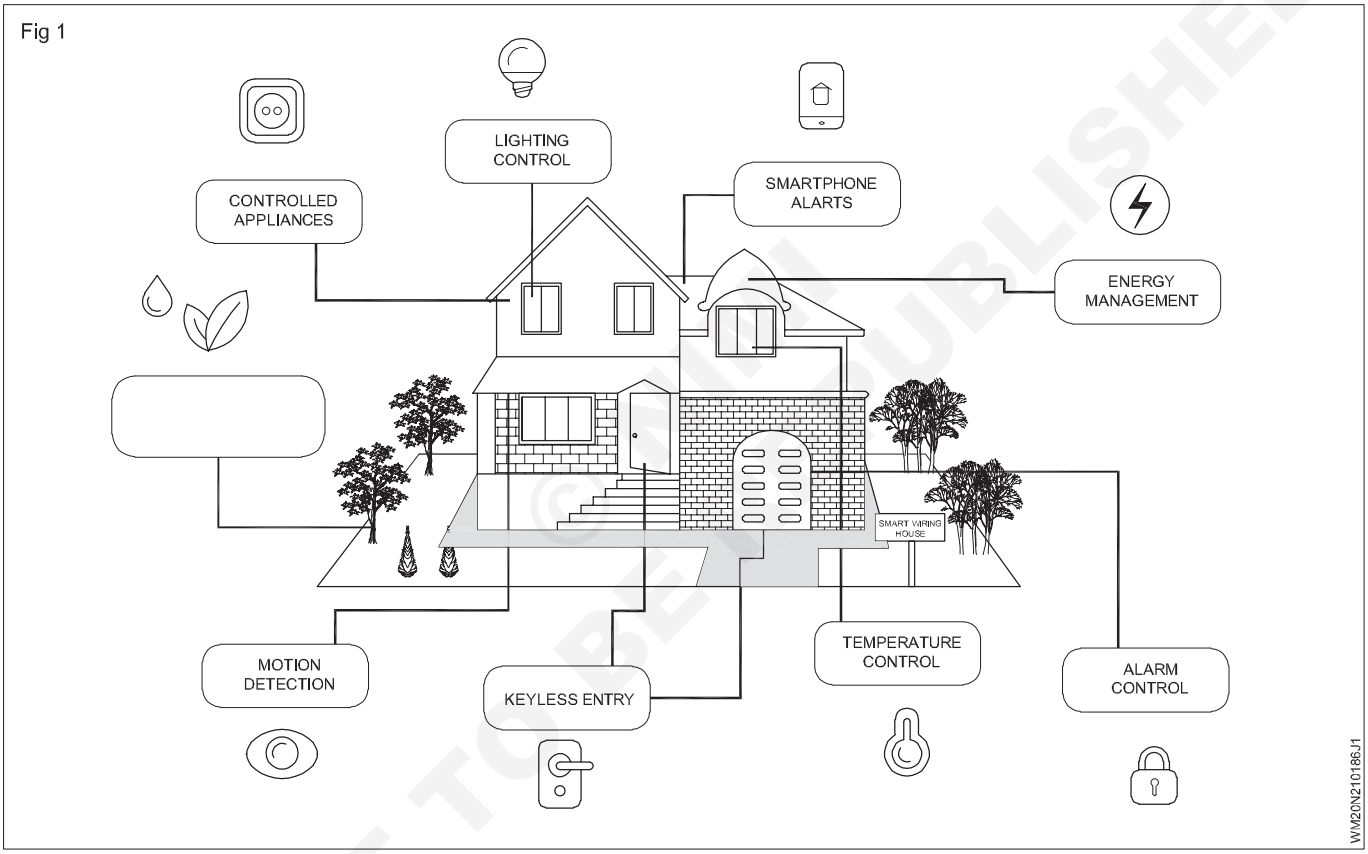
8 Connect your audio/Video equipment.

9 Setup a robust wifi network throughout your home.

10 Configure your central hub home automation software to intigrate different devices and create automation routines.

Ensure proper safety guidelines when working with home automation installations

Fig 1



Visual demonstration of IOT based home automation / control of electrical appliances through smart phone

Objectives: At the end of this exercise you shall be able to
- **explain how to control air conditioner through smart phone**
- **explain how to control ceiling fan through smart phone**

Requirements

Tools / Instruments

- Smart Air conditioner 1.0 ton - 1 No.
- Android phone - 1 No.
- Ceiling fan 1300mm - 1 No.

Materials

- Smart ceiling fan wall switch- 1 No

PROCEDURE

TASK 1: **control air conditioner through smart phone**

1 Check to see which remote control applications works with air conditioner

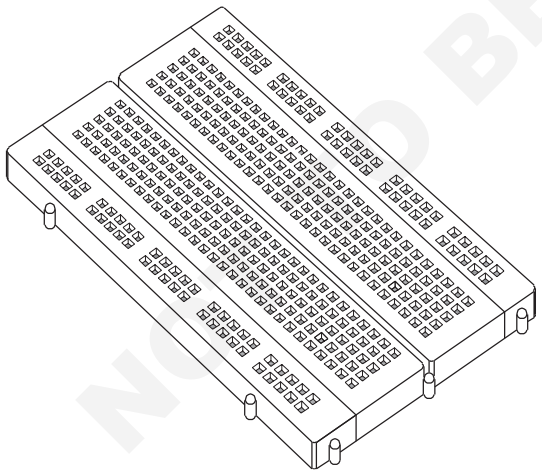
2 Then install a universal app on your mobile phone from play store.

3 Go to apps home page you should be able to control things like fan speeds and temperature

4 To Ensure that your ac has the most recent firmware installed use the app to check for important software updates.

5 Learn about features that the app already has built in if you want the air conditioner to cool to a particular degree depending whether you're at home a sleep or away you should be able to put timer on it or schedule using the app.

Fig 1



BREADBOARD

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Fig 2

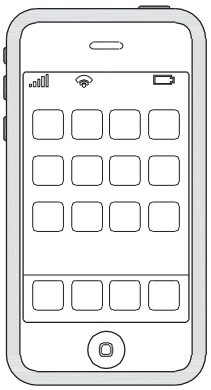

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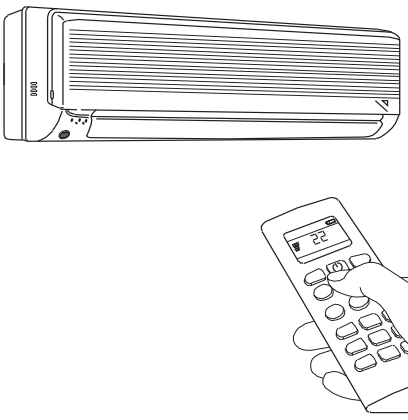
Fig 3



WM20N210187H3

Task 2 : **control ceiling fan through smart phone**

1 Check whether wifi or internet connection is there inside room

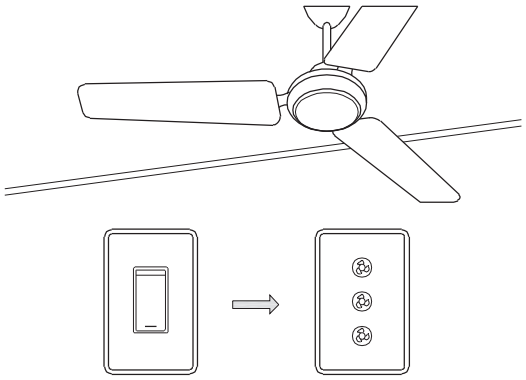
2 Replace existing wall switch with a “smart ceiling fan wall switch”

3 This touch panel that allows anyone entering the room to control the fam and its lights. it has smart features such as programming

4 Switch on ceiling fan to control fan and lights

5 Check whether fan is controlled by smart phone

Fig 1



WM20N210187J1

Demonstrate software available for electrical wiring and circuits

Objectives: At the end of this exercise you shall be able to
- **explain software required for electrical wiring and circuits.**

Requirements

Tools / Instruments

- Computer with latest configuration - 1 No.
- Relavant software required for demo - 1 No.

Materials

- Notebook - 1 No.
- Pencil - 1 No.
- Eraser - 1 No.

Instructor may arrange to install the mentioned softwares in the computer and demostrate briefly

PROCEDURE

TASK 1: **software required for electrical wiring and circuits**

Here are the top 7 electrical drawing software which you can use quickly and easily

1 Edraw max

2 ETAP

3 Auto cad Electrical

4 Solidworks electrical schematics

5 Electro E8

6 Profi CAD

7 Smart Draw

1 Edrawmax

With the help of this software we can create professional electric drawings.

2 ETAP

ETAP or electrical power system analysis software is an excellent tool for making electrical diagrams of different electric power systems.

3 AUTO CAD Electrical

Autocad electrical is a drawing tool by autodesk to create a wide range of electrical drawings using specially developed drawing tools to enhance productivity.

4 Solid works electrical schematics

It is a professional drawing software for collaborative diagram and design tools which can be used to make complete electrical systems.

5 Electra E8

It is an easy rapid and affordable tool for electrical drawing. It is very useful and powerful

6 Profi CAD

It is a drawing tool specially designed for electrical diagrams as it contains many drawing tools for circuit boards.

7 Smart draw

It is a practical diagramming tool for all purposes whether you want to create charts graphs or illustrations.