REFRIGERATION AND AIR CONDITIONING TECHNICIAN

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

SECTOR: CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200Hrs)

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Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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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, an autonomous body under Ministry of Skill Development & Entrepreneurship is entrusted with developing producing and disseminating Instructional Media Packages (IMPs) required for ITIs and other related institutions.

The institute has now come up with instructional material to suit the revised curriculum for **R&ACT 1st Year Trade Practical NSQF Level - 4 (Revised 2022) in Capital Goods & Manufacturing Sector under Annual Pattern.** 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 Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

MS.TRISHALJITH SETHI

Addl.Secretary / Director General (Training)
Ministry of Skill Development & Entrepreneurship,
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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) 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**

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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 **R&ACT NSQF Level - 4 (Revised 2022)** under **Capital Goods & Manufacturing** 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.

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

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INTRODUCTION

This manual for trade practical is intended for use in the ITI workshop. It consists of a series of practical exercises that are to be completed by the trainees during the first year of course is the **R & ACT trade under Capital and Goods & Manufacturing Sector. It is National Skills Qualifications Framework NSQF Level - 4 (Revised 2022),** supplemented and supported by instructions/information to assist the trainees in performing the exercise. The exercises are designed to ensure that all the skills prescribed in the syllabus are covered including the allied trades. The syllabus for the 1st Year **R & ACT** Trade under **Capital Goods & Manufacturing Sector** Trade Practical is divided into Twelve Modules. The allocation of time for the various modules is given below .

Module 1 - Fitting

Module 2 - Sheet Metal

Module 3 - Electrical

Module 4 - Electronics

Module 5 - Welding

Module 6 - Basic refrigeration

Module 7 - Refrigerator (Direct tool)

Module 8 - Frost free refrigerator

Module 9 - Refrigerator (Inverter technology)

Module 10 - Compressor and motor

Module 11 - Condenser

Module 12 - Expansion Valve

Module 13 - Drier & Evaporator

Module 14 - Refrigerant

Module 15 - Thermal Insulation

Module 16 - Window Air Conditioner

Module 17 - Split A/C

The syllabus and the content in the modules are interlinked. As the number of workstations available in the electrical section is limited by the machinery and equipment, it is necessary to interpolate the exercises in the modules to form a proper teaching and learning sequence. The sequence of instruction is given in the schedule of instruction which is incorporated in the Instructor's Guide. With 25 practical hours a week of 5 working days 100 hours of practical per month is available.

Contents of Trade Practical

The procedure for working through the 106 exercises for the 1st Year with the specific objectives as the learning out comes at the end of each exercise is given is this book.

The skill objectives and tools/instruments, equipment/machines and materials required to perform the exercise are given in the beginning of each exercise. Skill training in the shop floor is planned through a series of practical exercises/experiments to support the related theory to make the trainees get hands on trainning in the Electrician trade along with the relevant cognitive skills appropriate for the level. A minimum number of projects have been included to make the training more effective and develop attitude to work in a team. Pictorial, schematic, wiring and circuit diagrams have been included in the exercises, wherever necessary, to assist the trainees broaden their views. The symbols used in the diagrams comply with the Bureau of Indian Standards (BIS) specifications.

Illustrations in this manual, help trainess visual perspective of the ideas and concepts. The procedures to be followed for completing the exercises is also given. Different forms of intermediate test questions have been included in the exercises, to enhance the trainee to trainee and trainee to instructor interactions.

Skill Information

Skill areas which are repetitive in nature are given as separate skill information sheets. Skills which are to be developed in specific areas are included in the exercises itself. Some subexercises are developed to fulfill the sequence of exercises in keeping with the syllabus.

This manual on trade practical forms part of the Written Instructional Material (WIM). Which includes manual on trade theory and assignment/test.

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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No.	Learning Outcome	Ref.Ex.No
1	Identify trade related hazards and safety procedures following safety precautions.	1.1.01 - 1.1.04
2	Produce fitting jobs as per drawing (Range of operations, marking, sawing, filing, drilling)	1.1.05 - 1.1.06
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4	Identify electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase motors.	1.3.11 - 1.3.13
5	Identify the electronic components and their colour code i.e tranisistor, capacitor, diode, amplifier, I.C and able to work soldering.	1.4.14 - 1.4.20
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SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 25 Hrs.; Professional Knowledge 04 Hrs.	Identify trade related hazards and safety procedures following safety precautions.	1. Identify workshop & machineries. (10 hrs.) 2. Demonstrate Safety precautions and First aid. (05 hrs.) 3. Demonstrate firefighting (05 hrs.) 4. Demonstrate working at height using PPE's and identify the hazards and take personal safety precautions. (5 hrs.)	Introduction to trade and related industries. General safety precautions and first aids, firefighting equipment and electrical safety. History of Refrigeration and Air conditioning. Grooming of technicians. (04hrs..)
Professional Skill 25Hrs.; Professional Knowledge 5 Hrs.	Produce fitting jobs as per drawing (Range of operations, marking, sawing, filing, drilling.)	5. Identify general tools, instruments & equipment. Care and maintenance of tool, instruments and equipment. (10 hrs.) 6. Perform measuring, marking, punching, hacksawing and flat filing, to make a job as per drawing. (15 hrs.)	**Fitting** Different types of Fitting hand tools,- their use. Function, construction, working and Specification. Machineries and equipment used in fittings like drilling machine and grinding machine. (05 hrs)
Professional Skill 25 Hrs.; Professional Knowledge 04 Hrs.	Produce Sheet metal components (range of operation marking, metal cutting, bending, riveting and soldering etc.)	7. Perform Sheet Cutting by straight snip as per drawing. (07 hrs.) 8. Perform Sheet Cutting by bent snip as per drawing. (07 hrs.) 9. Bend, fold and join metal sheets in different process. (06 hrs.) 10. Join sheet metal by using rivet set and snap. (05 hrs.)	**Sheet Metal** Function, construction, working, use, and application, specification of Sheet metal tools, instruments and equipment. Care and maintenance of tools. Rivet & riveting- their types and use. (04 hrs..)
Professional Skill 35 Hrs.; Professional Knowledge 06 Hrs.	Identify electrical safety. Join different wire, measure power, currents, volts and earth resistance etc. Connect single phase motors.	11 Demonstrate electricalsafety precautions and first aid. (05 hrs.) 12 Identify, use and maintain electrical tools. (05 hrs.) 13. Measure current, voltage, resistance ,power, energy using analog and digital meter through a single phase circuit. (25 hrs.)	**Electrical** Electrical terms such as AC and DC supply, Voltage, Current, Resistance, Power, Energy, Frequency etc. Safety precautions to be observed while working on electricity. Conductors and Insulators, Materials used as conductors. Series and parallel circuit, open circuit, short circuit, etc. Measuring Instruments such as voltmeter, ammeter, ohm meter, watt meter, energy meter and frequency meter. Earthing and its importance. Earth resistance. Insulation and continuity test. (06 hrs..)

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Professional Skill 47 Hrs.; Professional Knowledge 10 Hrs.	Identify the electronic components and their colour code i.e. transistor, capacitor, diode, amplifier, I.C and able to work soldering.	14. Identify basic electronic components, tools & instrument. (08 hrs.) 15. Colour coding of resistors. (05 hrs.) 16. Use voltmeter, ammeter and multimeter. (8 hrs.) 17. Practice soldering & de-soldering. (8 hrs.)	**Electronics** Introduction to Electronics. Basic Principles of semiconductors, Principles and application of Diodes. Solder – its composition and paste.(05 hrs..)
		18. Identify transistors, resistors, capacitors, diodes, S.C.R., U.J.T., amplifier andI.C. (08hrs.) 19. Construct and test full wave rectifier using diodes. (05hrs.) 20. Construct and test a bridge rectifier. (05hrs.)	Rectification, Zener diode as voltage regulator – transistors parameters- diodes, ICs. (05 hrs..)
Professional Skill 39 Hrs.; Professional Knowledge 7 Hrs.	Perform gas welding, brazing, soldering Observing related safety.	21. Identify gas welding equipment & accessories. (05 hrs.) 22. Demonstrate safety precaution in handling of Oxy-acetylene cylinders, regulators etc. (04 hrs.) 23. Setting up of AIR-LPG, O2- LPG and O2-C2H2 using can type portable flame set. (04 hrs.) 24. Oxy-acetylene gas welding, brazing and cutting on thin sheet metal. (7hrs.) 25. Demonstrate Care & Safety of welding tools and equipment. Back fire arrester. (03 hrs.) 26. Set Oxy-acetylene plant, use two stage regulator, adjustment of flame, gas pressure – O2 and DA. (07 hrs.) 27. Perform brazing between Cu to Cu and Cu to MS, Cu to aluminum pipes. (9 hrs.)	**Welding** Introduction to basic principles of commonly used Welding processes, oxy fuel gas welding / cutting, brazing & soldering, nozzles, base metal and filler metal. Use of flux. Difference between soldering and Brazing in terms of temperatures, filler materials, joint strengths and application. Use of Oxy Acetylene, Oxy LPG, Air LPG and two stage regulators for brazing/soldering. Description of back fire arrester. (7 hrs..)
Professional Skill 100Hrs.; Professional Knowledge 15Hrs.	Identify RAC tools and equipment and recognize different parts of RAC system. Perform copper tube cutting, flaring, swaging, brazing.	**Basic Refrigeration** 28. Identify & use of general hand tools, instruments & equipment used in refrigeration work. (12hrs.) 29. Identify & use of special tools, instruments & equipment used in refrigeration work.(13hrs.) 30. Identify various refrigeration equipment and components of vapour compression system like compressor, condenser, expansion device and evaporator.	**Basic Refrigeration** Basic principle of refrigeration, working, use, specifications of refrigeration tools, instruments and equipment. Fundamentals of Refrigeration and its units. Thermodynamics law.(05hrs..) Science related to refrigeration, work, power, energy, force, Heat and Temperature, Differenttemperature scales, Thermometers, Units of

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		Identify and Check vapour absorption refrigeration cycle (VARC) (12 hrs.) 31. Unroll, cut and bend soft copper tubes. (04 hrs.) 32. Swage and make a brazed joint on copper tubing. (10 hrs.) 33. Make flare joints and test them with flare fittings. (10 hrs.) 34. Pinch off copper tubing. (04 hrs.) 35. Use lock ring tool and various fittings of lock ring for servicing of appliances. (10 hrs.). 36. Brazing of Cu to Cu, Cu to steel, Cu to brass using AIR LPG suitable in RAC machine. (07 hrs.) 37. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-LPG. (07 hrs.) 38. Brazing of Cu to Cu, Cu to steel, Cu to brass using Oxy-Acetylene. (11 hrs.)	heat, sensible heat, latent heat, super heating and sub-cooling, saturation temperature, pressure, types, units. Types of Refrigeration systems, including vapour absorption refrigeration cycle (VARC), water – combination. Study the construction and working of vapor compression cycle, low side & high side of vapour compression system. Applications of vapour compression cycle. Coefficient of Performance (COP), Ton of Refrigeration.(7hrs..) Construction and working ofV.C Cycle, fundamental operations, sub cooling and super heating.(03 hrs..)
Professional Skill 49 Hrs.; Professional Knowledge 10 Hrs.	Test mechanical & electrical components. Perform leak test, vacuuming, gas charging, wiring in refrigerator.	39. Identify electrical and mechanical components of refrigerator direct cool and frost free. (05 hrs.) 40. Check and replace electrical components of refrigerators. (14 hrs.) 41. Leak test, evacuation, gas charging in a refrigerator. (15 hrs.) 42. Wiring circuit of refrigerator. (15 hrs.)	**Refrigerator (Direct cool & Frost free)** Function, construction, working of single door direct cool refrigerator, frost free refrigerator, specifications, trouble shooting. Heat Insulation materials. Care and maintenance of refrigerators. (10 hrs.)
Professional Skill 16Hrs.; Professional Knowledge 03 Hrs.	Identify electrical and mechanical components of a refrigerator.	43. Installation of refrigerator. (8 hrs.) 44. Check, Find Fault and test the electrical and other system components of refrigerator. (8 hrs.)	**Refrigerator (Direct cool & Frost free)** Study the electrical components of refrigerator. Study the mechanical components of refrigerator and their types. (03 hrs..)
Professional Skill 30 Hrs.; Professional Knowledge 07 Hrs.	Test compressor motor terminal, start compressor with relay & without relay, technique of flushing, leak testing, replacing	45. Testing of compressor. (05 hrs.) 46. Identification of motor terminals. (05 hrs.) 47. Start the compressor with and without relay. (05 hrs.)	Importance of flushing in evaporator and condenser, use of dry nitrogen for flushing, necessity of replacing capillary and drier. Evacuation, leak

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	capillary & filter drier, evacuation &gas charging.(NOS: Not available)	48. Test performance of direct start refrigerator. (05 hrs.) 49. Cleaning and flushing of evaporator and condenser with dry nitrogen. (05 hrs.) 50. Replacement of capillary tube and drier. (05 hrs.)	testing, gas charging method in refrigerator, (07 hrs..)
Professional Skill 42 Hrs.' Professional Knowledge 10 Hrs.	Check components of frost-free refrigerator (electrical/ mechanical), wiring of frost-free freeze & air distribution in refrigerator sector. Leak detection, evacuators & gas charging.	51. Tracing electrical circuit of Frost-Free refrigerator. (10 hrs.) 52. Checking, fault finding and testing of electrical accessories like thermostat, timer, defrost heaters, bi-metal, air louvers etc. and other system components. (10 hrs.) 53. Checking air distribution system. (03 hrs.) 54. Servicing of refrigerator. (07hrs.) 55. Testing the performance of refrigerator. (02 hrs.)	**Frost Free Refrigerator** Study the construction and working of Frost Free (2 or 3 door) Refrigerator parts particularly, the forced draft cooling, Air Duct circuit, temperature control in Freezer & cabinet of Refrigerator, air flapper / louver used in refrigerator section, automatic defrost system. Study of Electrical accessories & their functions (Timer, Heater, Bimetal, Relay, OLP, T/S etc.) Refrigerator cabinet volume calculation.5hrs..)
		56. Identify three and four door no frost refrigerator. (07 hrs.) 57. Testing components of three/ four door refrigerator. (03 hrs.)	**Refrigerator (Inverter Technology)**Study the construction and its working of two and three door frost free refrigerator with inverter technology Care and maintenance. (05 hrs..)
Professional Skill 39 Hrs.; Professional Knowledge 10 Hrs.	Dismantle, repair and assemble hermetic, fixed and variable speed compressor, and testperformance.	58. Identify different types of compressor. (09 hrs.)	**Compressor** Function, construction, working, application of hermetic compressor,(Fixed speed and variable speed compressor)like Reciprocating, rotary, scroll and inverter type.(5Hrs..)
		59. Dismantle /assembling reciprocating/rotary compressor. (15 hrs.) 60. Identify different parts of dismantled compressor. (15 hrs.)	Study the construction & working of reciprocating, rotary, scroll, wobble & swash plate compressor. wet compression, oil, properties, lubrication methods. (05 hrs..)
Professional Skill 50 Hrs.; Professional Knowledge 8 Hrs.	Identify the terminals of sealed compressor and their wiring and measure current, volts, watts and use of DOL starter with different types of motors.	61. Identify terminal sequence of hermetic compressor motor by using digital multimeter and measure starting current and running current by using ammeter and AVO meter. (12 hrs.)	AC motors and their types. Advantages of AC motor over DC motor. Split phase induction motors, working principle and construction.Starting winding and running winding.Starting current and running current. Study the shaded pole motor, RSIR, CSIR, CSR and PSC motors.(6 Hrs..)

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		62. Identification of terminal sequence of CSIR motor by using digital multimeter and measure starting current and running current by using Ammeter and AVO meter. (13 hrs.)	
		63. Start CSR motor and measure starting current and running current. (07 hrs.) 64. Start shaded pole motor and measure starting current (18 hrs.)	Centrifugal switch and its function. Common faults, causes and remedies in motors. (02 hrs..)
Professional Skill 25 Hrs.; Professional Knowledge 4 Hrs.	Perform selection of Hermetic compressor for different appliances, starting methods, testing controls & safety cut out used in sealed compressor.	65. Test open, short, continuity and earth of a hermetic compressor. (04 hrs.) 66. Start the compressor motor by RSIR, CSIR, PSC & CSR method by using different type relay, capacitors, OLP's, etc. (10 hrs.) 67. Check and Test different type relay, Capacitors, OLP's, find out faults and rectification (11 hrs.)	**Motors** Function of Starting relay, Capacitors, OLP's.(04 hrs..)
Professional Skill 16Hrs.; Professional Knowledge 04 Hrs.	Identify theComponents of control system of Inverter AC and wiring of control system.	68. Check control circuit of variable speed air conditioners (Inverter ACs). (08 hrs.) 69. Identify components of control system of Inverter ACs including printed circuit board (PCB) NTC,PTC e.g. Power PCB, Filter PCB, Heat sink reactor. (08 hrs.)	Working principle of inverter technology, advantages of variable speed technology over fixed speed. Working principle of control system for inverter Air Conditioners (ACs). (04 hrs..)
Professional Skill 46 Hrs.; Professional Knowledge 10 Hrs.	Perform servicing & de scaling of condenser (internals &externals) used in different appliances.Perform Fitting & adjustment of drier, filter & refrigerant controls used in different refrigeration system.	70. Familiarize with different types of condensers used in refrigerators, Bottle coolers, visible coolers, deep freezers, Window and Split AC. (10 hrs.) 71. Clean, flush, service and leak test different type of air-cooled condensers, micro channel condensers. Remove dust from fins in air cooled condenser, micro channel condensers. (10 hrs.) 72. Identify different items necessary for de-scaling like diluted Hcl, Pump & motor, hose, etc. (07 hrs.)	**Condenser** Function of condenser, types, Construction of air-cooled condenser. Effect of chocked condenser. Advantages, de scaling of air-cooled condenser, application, and advantages. Liquid receiver, pump down, application, types, function and working. **Drier** Function of drier, types, application and its advantage. Description of desiccants.

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		73. Identify drier and capillary tube used in different cooling machines. (09 hrs.) 74. Replace drier and capillary tube at the time of gas charging according to manufacturer's direction. (10 hrs.)	**Expansion Valve** Expansion valve used in domestic refrigeration and air conditioning systems. Capillaries, Automatic and Thermostatic Ex. Valves, and electronic expansion valves.(10 hrs..)
Professional Skill 16 Hrs.; Professional Knowledge 05 Hrs.	Perform servicing of different evaporator used in different appliances.	75. Identify and service different types of evaporators like plate and tube type, Fin andtube type, etc. fitted in refrigerators, Bottle coolers, water cooler, Window and split AC. (08 hrs.) 76. Perform leak test, flush to remove oil by dry nitrogen in evaporator. (08 hrs.)	**Evaporator** Working principle, Function, types of evaporators used in refrigerator, water coolers, bottle coolers, window and split A.C, Super heating in evaporators, Function of accumulator and types. Methods of defrosting. (05 hrs..)
Professional Skill 30 Hrs.; Professional Knowledge 06 Hrs.	Carry out Recovery and Recycling of Refrigerant used, alternative of CFC, HFC re-cover, transfer & handing of gas cylinders.	77. Identify and explain different colour code of different type refrigerant cylinder like HCFCs (HCFC-22, HCFC-123). HFCs (HFC-134a, HFC-32, R- 410A, R-407C and R-404A) and low-Global Warming Potential (GWP) refrigerants like ammonia, R-290, HFC- 32, blends of HFCs (R-410A, R-404A, R-407C etc.) and hydro Fluor olefins (HFOs: HFO-1234yf, HFO-1234ze, HFO-1233zd, HFO-1336mz), blends of HFCs and HFOs. (10 hrs.) 78. Recover refrigerant from a faulty machine. (07 hrs.) 79. Transfer refrigerant from one cylinder to another using ice. (04 hrs.) 80. Measure pressure andtemperature of refrigerants including HCFC-22, ammonia, R-290, HFC-32, HFC-134a, R-404A, R-407Cand R-410A, HFOs. Identify flammability and toxicity of A3 and A2L of refrigerants. (09 hrs.)	**Refrigerant** Classification of refrigerants, nomenclature of refrigerants including chemical name and formulas, hydro chloro fluorocarbons (HCFCs), hydro fluorocarbons (HFCs) and hydro fluoroolefins (HFOs), blends of HFCs and blends of HFCs/HFOs. Climatic impact of refrigerants: Stratospheric ozone depletion, global warming, mechanism of ozone depletion; the Montreal Protocol phase-out schedule of ozone depleting refrigerants (HCFCs) and high global warming refrigerants (HFCs). Brief introduction of Ozone Depleting Substances (Regulation and Control) Rules, 2000 and its amendments. Introduction of properties of refrigerants; environment related properties: Ozone Depleting Potential (ODP), GWP; ODP and GWP of various refrigerants, thermo chemical properties: flammability and toxicity of refrigerants, lower flammability limit (LFL) and upper flammability limit of A3 and A2L refrigerants. Thermo physical properties: pressure temperature of different refrigerants.(06 hrs..)

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Professional Skill 22 Hrs.; Professional Knowledge 07 Hrs.	Retrofit CFC/HFC machine with ozone friendly refrigerant with understanding of the compatibility.	81. Demonstrate safe handling of refrigeration cylinders. (10 hrs.) 82. Recover CFC by recovery pump and cylinder on CFC filled domestic refrigerator. (12 hrs.)	Safe handling of flammable refrigerants. Refrigerant leak detection methods, evacuation and charging of refrigerant, temperature glides of refrigerant blends, procedure of charging of refrigerant blends especially the zeotropic lends,hydrocarbon blends, HFC blends (R-404A, R-407C,R-410A) and blends of HFCHFO. **Retrofitting** Changes of components & practices while retrofitting CFC appliances with HC Refrigerants. Properties of HCs(07 hrs..)
Professional Skill 13 Hrs.; Professional Knowledge 02 Hrs.	Pack thermal insulation and prevent cooling leakage.	83. Identify different insulating materials.(polyurethane rigid foam and polystyrene). (03 hrs.) 84. Fill with insulation material like PUF and glass wool. (10hrs.)	**Thermal Insulation** Function,types,thermodynamic properties of heat insulation materials used in refrigeration and Air Conditioning systems. (02 hrs..)
Professional Skill 50 Hrs.; Professional Knowledge 7 Hrs.	Install window AC, test Electrical & electronics components & Fault diagnosis & remedial measures.	85. Acquainting with mechanical and electrical components (electrical components like selector switch, thermostat switch, relay, starting capacitor, running capacitor, overload protector, remote and PCB control, etc.) used in window air- conditioner. (15 hrs.) 86. Troubleshooting, installation, tracing wiring circuit. (5 hrs..) 87. Leak testing, evacuation and gas charging, Show discharge pressure and suction pressure during running time. (15 hrs.) 88. Hands on practice on installation of window AC following step by step procedure. (15 hrs.)	**Window Air Conditioner** Study the constructionand working principle of window AC and its components; electrical controls and wiring. Installation, troubleshooting and servicing. (7 Hrs)
Professional Skill 100 Hrs.; Professional Knowledge 18Hrs.	Perform servicing of electrical& electronic control, test, Installation, wiring, fault finding & remedial measures of different split AC.	**Split AC (wall/floor/Cassette)** 89. Identify various components of split AC like wall mounted, floor and ceiling mounted, duct able and multi split AC. (04hrs.) 90. Identify electrical circuits of wall mounted split AC. (04hrs.)	**Split AC (wall/floor/Cassette)** Construction and working principle, troubleshooting & care and maintenance. Selection of location of indoor and outdoor units.

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		91. Test different components and fault finding. (03 hrs.) 92. Leak testing of the system, evacuation and gas charging. (03hrs.) 93. Trouble shooting in split AC. (06hrs.)	**Split AC (Wall Mounted)** Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
		94. Install IDU and ODU of wall mounted split AC. (16hrs.) 95. Install IDU of floor, Ceiling / Cassette mounted Split AC. (16hrs.)	**SPLIT A.C (floor, Ceiling / Cassette mounted Split A.C)** Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
		96. Install IDU and Duct of Ductable split AC. (16hrs.)	**SPLIT A.C (Ducted)** Study of the Duct able split AC, its Construction and working principle, types, trouble shooting. Description of electrical components used in split A.C. Study the wiring circuit.
		97. Servicing of Multi Split AC. (16hrs.)	**MULTI SPLIT A.C** Study the construction and working, various components, electrical circuits, testing components, fault detection
		98. Identify the parts of Inverter Split AC. (16hrs.)	**INVERTER SPLIT A.C.** Study of construction and working principle of inverter AC and its components, electrical circuit and controls, installation, servicing, trouble shooting, fault detection, leak testing and gas charging. Concept of Indian Seasonal Energy Efficiency Ratio ISEER). Energy Efficiency leveling oninverter AC. (18 hrs..)

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Identify workshop and machineries

Objectives: At the end of this exercise you shall be able to
- **visit various sections of ITI and familiar with the staff members**
- **draw the layout of R&ACTsection of ITI**

Requirements

Tools/Instruments

• Steel rule 300mm	- 1 No.	• Pencil HB	- 1 No.
• Measuring tape 20m	- 1 No.	• Eraser	- 1 No.
• Set square 30^0 & 45^0	- 1 set.	• Papers	- as reqd.

PROCEDURE

TASK 1: **Visit various sections of ITI and familiar with different section and staff members.**

Instructor will lead the new recruits to various sections of ITI and explain about the training scheme.

1 During the visit collect information like the designation of staff member and their name.

2 Identify the sections of ITI and list the trades in which training is given.

3 Take introduction about the major equipments of different trade with respective instructor during visit and note down.

4 Take brief knowledge about the scope and application of particular trade in industry.

TASK 2: **Draw the layout of the R&ACT section of ITI.**

1 Draw the plan of the R&ACT section to a suitable scale in a separate sheet of paper. (A4 size)

2 Draw the layout of lab as per the equipment located.

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Demonstrate safety precautions and first aid

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

- **identify the four basic categories and meaning of the safety sign**
- **read & record the meanings of road safety signs**
- **prepare the victim's to receive artificial respiration**
- **resuscitate the victim by nelson's arm lift back pressure method, Schafer's method, mouth -to- mouth method**
- **resuscitate the victim by mouth -to- nose method**
- **resuscitate a victim who is under cardiac arrest (CPR) cardio pulmonary.**
- **perform treatment for stopping or bleeding victims.**

PROCEDURE

TASK 1: **Identify the four basic categories and meaning of the safety signs**

Instructor may provide various safety signs chart categories and explain their categories and their meaning, description. As the trainee to identify the sign and record in Table 1.

1 Identify the safety sign from chart

2 Record the name of the category in Table1.

3 Mention the meaning description of the safety sign in Table 1

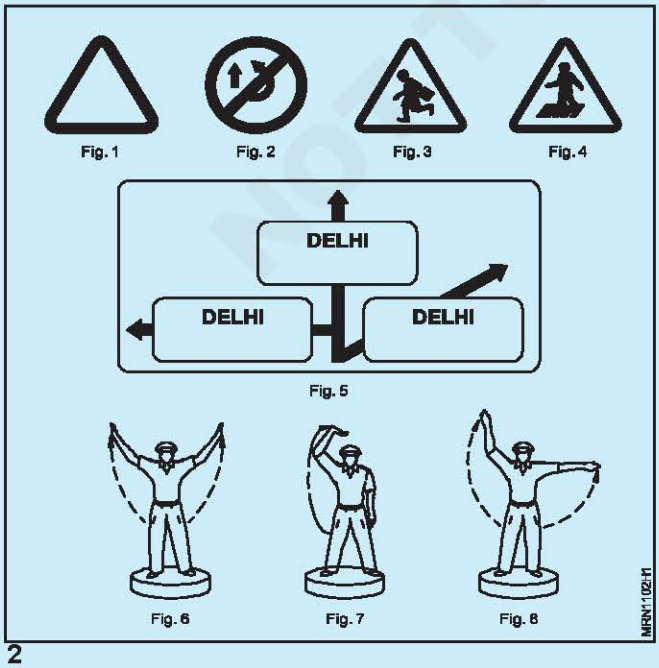
4 Get it checked by your instructor

Table 1

Fig No.	Basic categories / safety sign	Meaning descriptions
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

TASK 2: **Read and record the meaning of road safety signs**

Instructor will explain all the road safety sign and traffic police signals



1 Read the sign given in the chart and mention their kinds and the meaning in the Table 2.

2 Get it checked by the instructor

Table 2

Fig No.	Basic categories / safety sign	Meaning descriptions
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

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Assumption - for easy manageability Instructor may arrange the trainees in group and ask each group to perform one method of resuscitation.



Fig 1



Fig 2

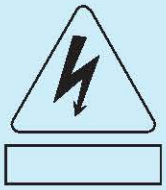


Fig 3

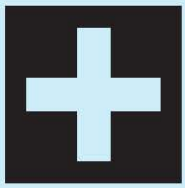


Fig 4



Fig 5



Fig 6



Fig 7



Fig 8



Fig 9



Fig 10



Fig 11



Fig 12



Fig 13



Fig 14



Fig 15

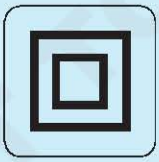


Fig 16



Fig 17



Fig 18



Fig 19



Fig 20

TASK 3: **Prepare the victim's to receive artificial respiration.**

1 Loosen the tight clothing which may interfere with the victim's breathing.

2 Remove any foreign materials or false teeth in his mouth and keep the victim's mouth open.

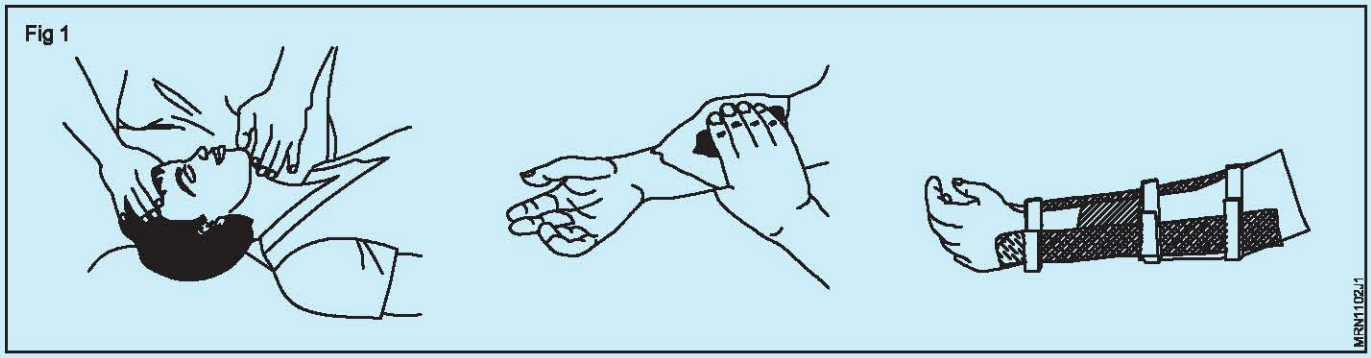
3 Bring the victim safety to the level ground, taking necessary safety measures.

4 Start artificial respiration immediately without delay. Do not waste too much time in loosening the clothes or trying to open the tightly closed mouth.

5 Avoid violent operation to prevent injury to the internal parts of the victim.

6 Word send for a doctor immediately.

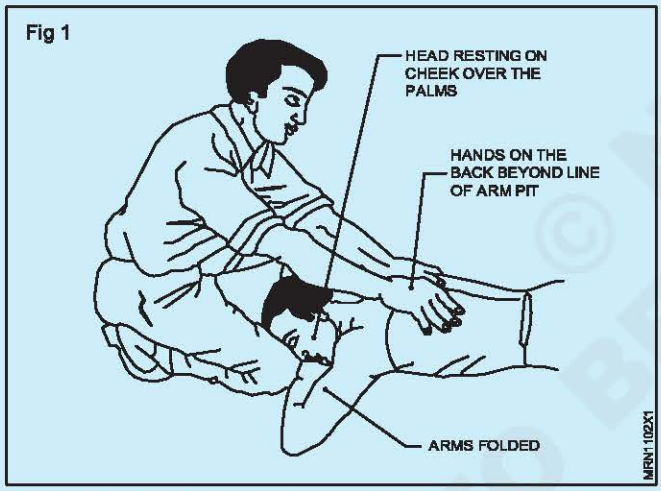
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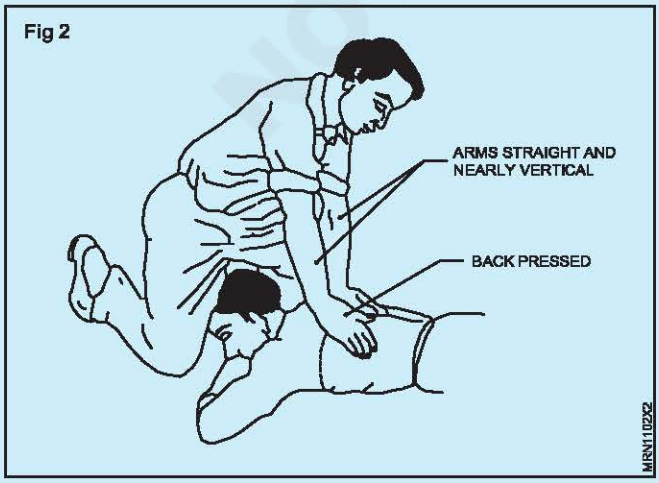
TASK 4: **Resuscitate the victim by Nelson's arm Lift back pressure method.**

Nelson's arm-lift back pressure method must not be used in case there are injuries to the chest and belly.

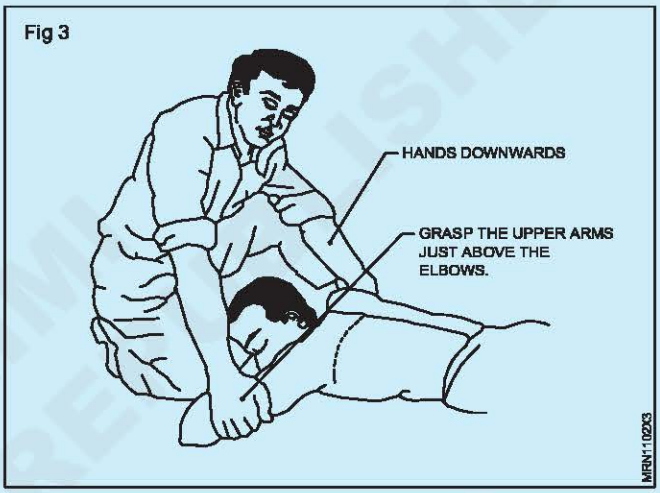
1 Place the victim prone (that is face down) with his arms folded with the palms one over the other and the head resting on his cheek over the palms. kneel on one or both knees near the victim's hand. Place your hands on the victim's back beyond the line of the armpits, with your fingers speared outward and downward, thumbs just touching each other as in Fig 1.



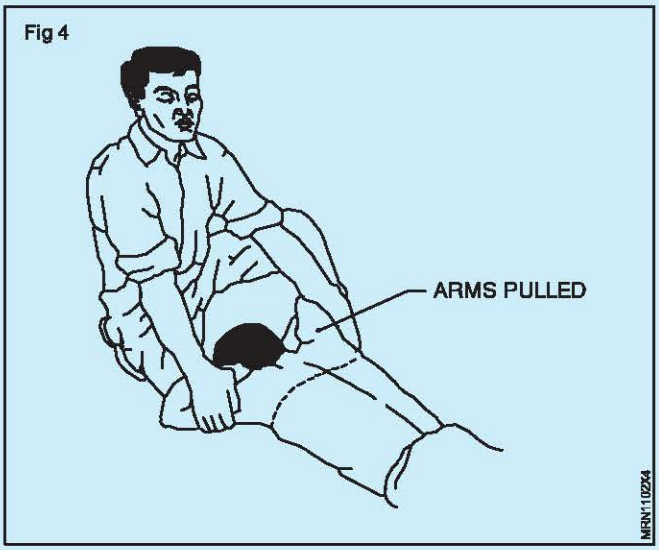
2 Gently rock forward keeping your arms straight until they are nearly vertical, and steadily pressing the victim's back as shown in Fig 2 to force the air out of the victim's lungs.



3 Synchronies the above movement of rocking backward with your hands sliding downwards along the victim's arms and grasp his upper arm just above the elbows as shown in Fig 3. Continue to rock backwards



4 As you rock back, gently raise and pull the vitim's arms towards you as shown in Fig 4 until you feel tension in his shoulders. To complete the cycle lower the victim's arms and move your hands up to the initial position.



5 Continue artificial respiration till the victim's begins to breathe naturally. please note, in some cases, it may take hours.

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6 When the victim revives, keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

7 Keep him in the lying down position and do not let him expert himself.

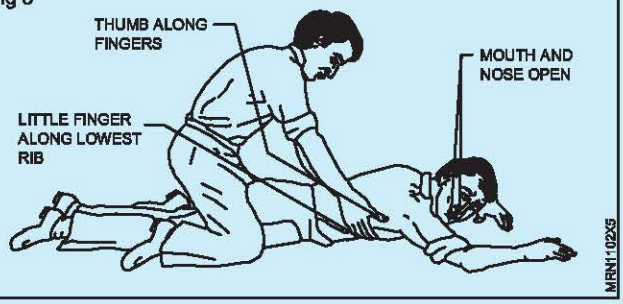
Do not give him any stimulant until he is fully conscious

TASK 5: **Resuscitate the victim by Schafer's method.**

Do not use this method in case of injuries to victim on the chest and belly

1 Lay the victim on his belly, one arm extended direct forward, the other arm bent at the elbow and with the face turned sideward and resting on the hand or forearm as shown in Fig 5

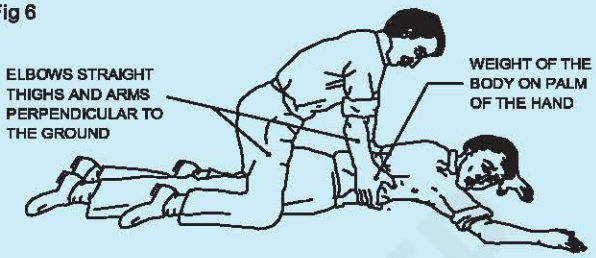
Fig 5



2 Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as in Fig 5

3 With the arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the lower ribs of the victim to force the air out of the victim's lungs as shown in Fig 6

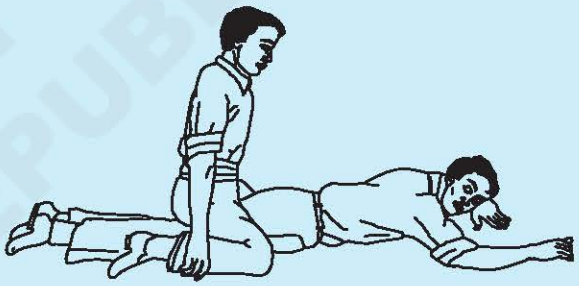
Fig 6



4 After two seconds, swing forward again and repeat the cycle twelve to fifteen times a minute.

5 Continue artificial respiration till the victim begins to breathe naturally.

Fig 7

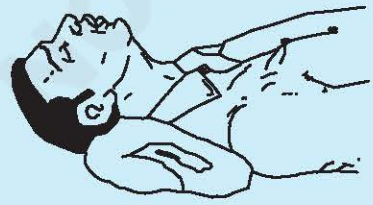


TASK 6: **Resuscitate the victim by mouth -to- mouth method**

1 Lay the victim flat on his back and place a roll of clothing under his shoulders to ensure that his heads is thrown well back (Fig 8)

2 Till the victim's head back so that the chin points straight upward (Fig 9)

Fig 8



3 Grasp the victim's jaw as shown in Fig 10, and raise it upward until the lower teeth are higher than the upper teeth; or place fingers on both sides of the jaw near the ear lobes and pull upward. Maintain the jaw position throughout the artificial respiration to prevent the tongue from blocking the air passage.

Fig 9



4 Take a deep breath and place your mouth over the victim's mouth as shown in Fig 11 making airtight contact. Pinch the victim's nose shut with the thumb and forefinger. If you dislike direct contact, place a porous cloth between your mouth and the victim's. For an infant, place your mouth over its mouth and nose. (Fig 11).

Fig 10

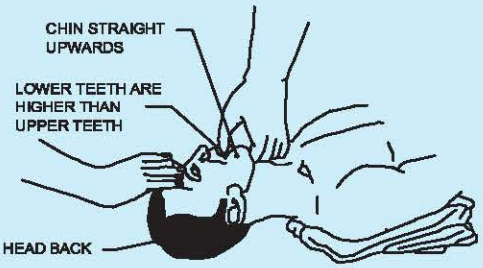


Fig 11



5 Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth and release the hold on the nose, to let him exhale, turning your head to hear the out-rush of air. The first 8 to 10 breaths should be as rapid as the victim responds, thereafter the rate should be slow down to about 12 times a minute (20 times for an infant)

If air cannot be blown in, check the position of the victim's head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise, turn the victim's face down and strike his back sharply to dislodge obstructions.

Sometimes air enters the victim's stomach as evidenced by a swelling stomach. Expel the air by gently pressing the stomach during the exhalation period.

TASK7: **Resuscitate the victim by Mouth-to-Nose method.**

Use this method when the victim's mouth will not open or has a blockage you cannot clear.

1 Use the fingers of one hand to keep the victim's lips firmly shut seal your lips around the victim's nostrils and breathe into him. Check to see if the victim's chest is rising and falling (Fig12)

2 Repeat this exercise at the rate of 10-15 times per minute till the victim responds

3 Continue this exercise till the arrival of the doctor.

Fig 12



TASK 8: **Resuscitate a victim who is under cardiac arrest (CPR) cardio pulmonary.**

In cases where the heart has stopped beating, you must act immediately

1 Check quickly whether the victim is used cardiac arrest

Cardiac arrest could be ascertained by the absence of the neck (Fig 13), blue colour around lips and widely dilated pupil of the eyes.

2 Lay the victim on his back on a firm surface

3 Kneel alongside facing the chest and locate the lower part of the breast bone (Fig 14)

4 Place the palm of one hand on the centre of the lower part of the breastbone keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in (Fig 15)

5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure (Fig 16)

Fig 13

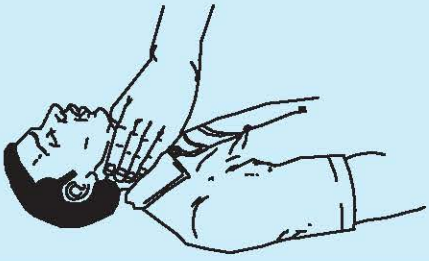
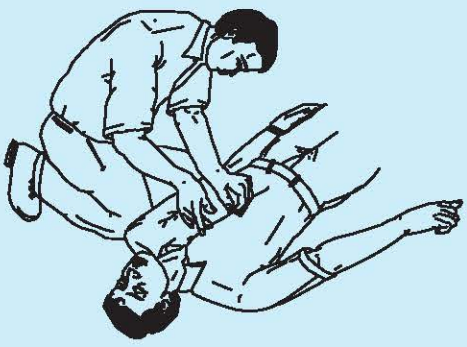
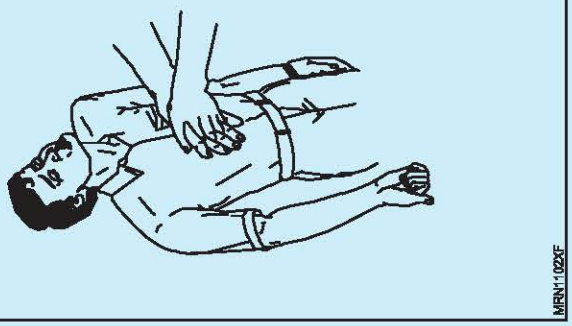


Fig 14



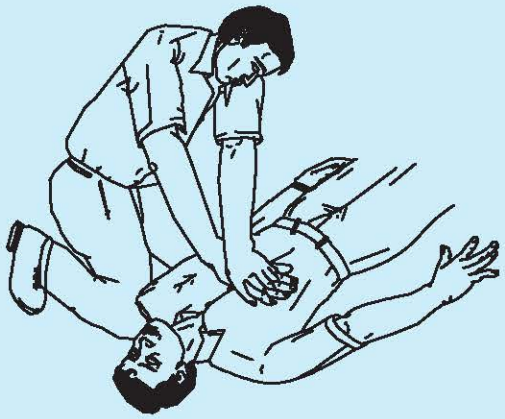
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Fig 15



MRN11022F

Fig 16

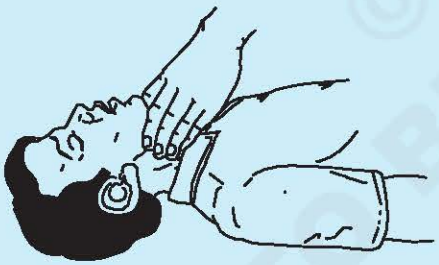


MRN11023G

6 Repeat step 5, fifteen times at the rate of at least once per second

7 Check the cardiac pulse (Fig 17)

Fig 17



MRN11023H

8 Move back to victim's mouth to give two breaths (mouth-to-mouth resuscitation) (Fig 18)

Fig 18



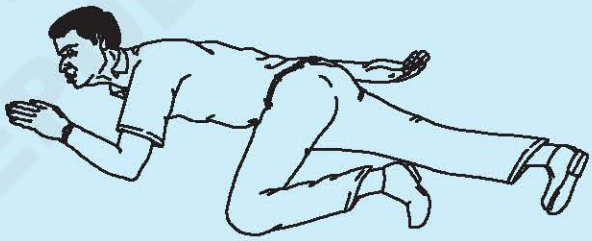
MRN11023I

9 Continue with another 15 compressions of the heart following by further two breaths of mouth-to-mouth resuscitation, and so on, check the pulse at frequent intervals.

10 As soon as the heartbeat returns, stop the compression immediately but continue with mouth -to-mouth resuscitation until natural breathing is fully restored

11 Place the victim's in the recovery position as shown in Fig 19. Keep him warm and get medical help quickly.

Fig 19



MRN11023J

Others step

1 Send for a doctor immediately

2 Keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

— — — — — — — —

TASK 9: **Perform treatment for stopping bleeding victims.**

1 Determine the location of the bleeding

2 Elevate the injured area above the heart if possible

3 Apply direct pressure to the bleeding area with sterile cloth

4 Keep the pressure on for 5 seconds

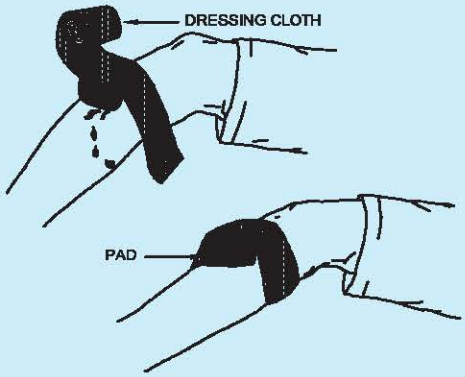
5 Check to see if the bleeding has stopped if not apply further pressure for 15 minutes

6 Clean the wound

7 Bandage the wound with pad of soft material (Fig 20)

8 Advice victim to take treatment from doctor.

Fig 20



MRN11023K

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Demonstrate - fire fighting

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

- **demonstrate the ability of fire-fighting,**
  - **as a leader of the group**
  - **as a member of the fire-fighting team.**
- **general procedure to be adopted in the event of fire**
- **extinguisher the fire**

Requirements

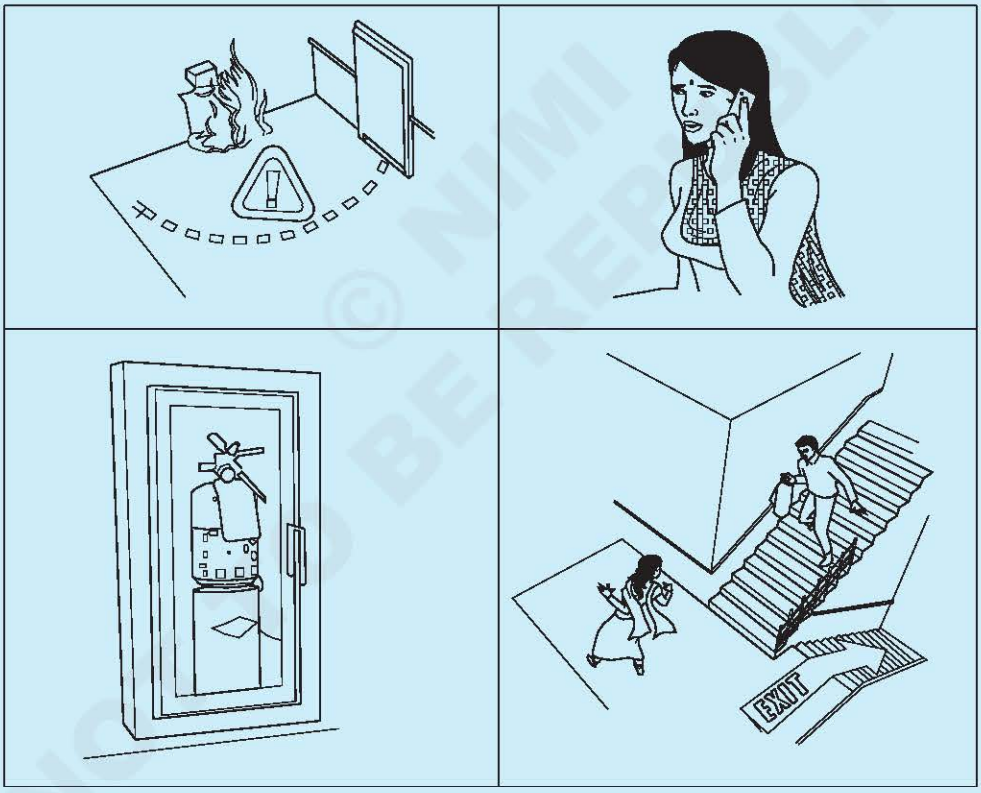
Equipment/Machines

- Fire extinguishers different types - 1 No. each

PROCEDURE

TASK 1: **General procedure to be adopted in the event of fire.**

Fig 1



1 Raise an alarm. Follow the method written below for giving an alarm signals when fire breaks out:
   - by raising your voice and shouting Fire! Fire! to call the attention of others
   - running towards fire alarm/bell to actuate it
   - other means

2 On receipt of the alarm signal:
   - stop working
   - turn off all machinery and power
   - switch off fans/air circulators/exhaust fans. (Better switch off the main)

3 If you are not involved in fighting the fire:
   - leave calmly using the emergency exit.
   - evacuate the premises
   - assemble at a safe place along with the others
   - check if anyone has gone to inform about the fire

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break to the concerned authority

- close the doors and windows, but do not lock or bolt

4 If you are involved in fire fighting:

- take instructions/give instructions for an organised way of fighting the fire

If taking instructions:

- follow the instructions, and obey, if you can do so safely; do not risk getting trapped.

If giving instructions:

- assess the class of fire
- send for sufficient assistance and inform the fire brigade
- locate locally available suitable means to put out the fire
- judge the magnitude of the fire, ensure emergency exit paths are clear of obstructions and then attempt to evacuate (Remove explosive materials, substances that can serve as a ready fuel for fire within the vicinity of the fire break)
- fight out the fire with assistance to put it out, by naming the person responsible for each activity.

5 Report the fire accident and the measures taken to put out the fire, to the authorities concerned

Reporting all fires however small helps in the investigation of the cause of the fire. It helps to prevent the same kind of accident occurring again.

TASK 2: **Extinguisher the fire**

1 Alert people surrounding by shouting fire, fire, fire when observe fire

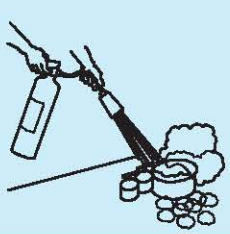
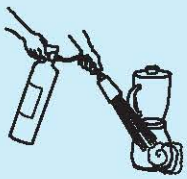
2 Inform fire service or arrange to inform immediately open emergency exist and ask them to go away

3 Put Off electrical power supply

Do not allow people to go nearer to the fire

4 Analyze and identify the type of fire. Refer Table1.

Table 1

Class A	Class B	Class C	Class D
Fig 4 			
Wood, paper, Cloth, Solid material	Oil based fire (grease, gasoline oil) Liquefiable solids	Gas and liquefied gases	Metals and electrical equipment task

5 Assume the fire is B type

6 Select CO_2 (carbon dioxide fire) extinguisher

7 Locate and pick up CO_2 fire extinguisher Check for its expiry date.

8 Break the seal (Fig1)

9 Pull the safety pin from the handle (Pin located at the top of the extinguisher) (Fig2)

10 Aim the extinguisher nozzle or hose at the base of the fire (this will remove the source of fuel fire)

Keep yourself low.

Fig1

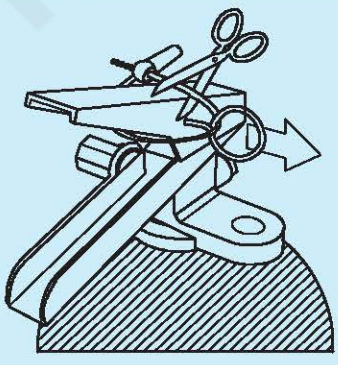
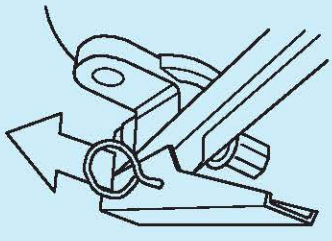


Fig 2



Demonstrate working of height using PPE'S and identify the hazards, and take personal safety precautions

Objectives: At the end of this exercise you shall be able to
- **demonstrate how to work at height using PPE'S**
- **identify personal protective equipments (PPE).**

Requirements

Safety accessories

• Safety shoes	- 1 Pair	• Safety belt	- 1 Set
• Safety goggles	- 1 No	• Safety ear plug	- 1 Pair
• Safety helmet	- 1 No	• Safety jacket	- 1 No

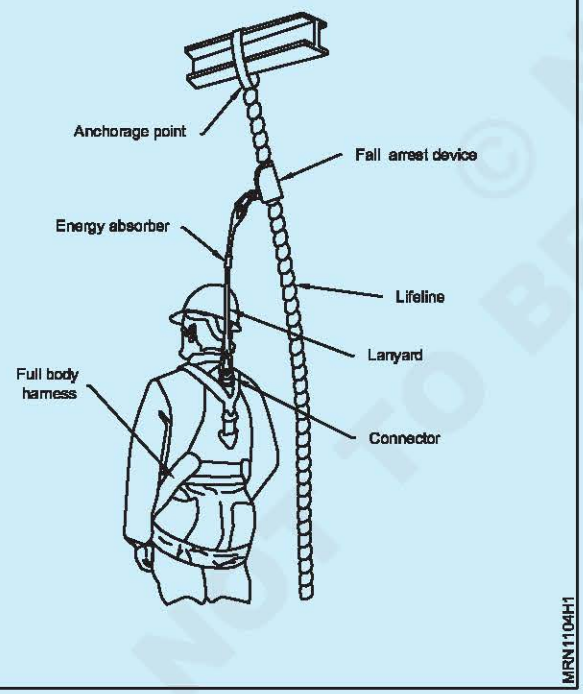
PROCEDURE

TASK 1: **Demonstrate how to work at height using PPE's**

1 Work at height is properly planned and organized Fig 1.

2 The risk from work at height are assessed and appropriate PPE's selected and used

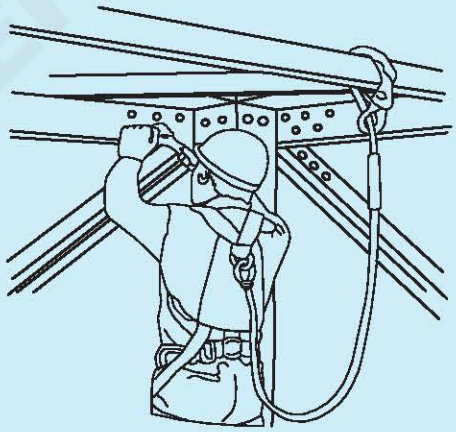
Fig 1



3 Choose required proper working tools and equipment before start the work at height.

Safety : Ensured hanging belt and other safety measure are taken before going at height Fig 2

Fig 2



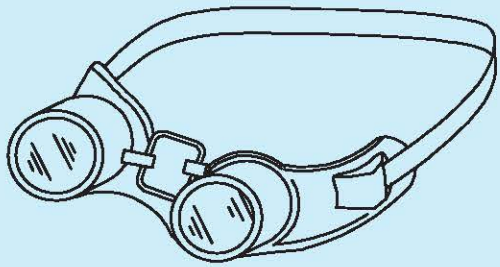
TASK 2: **Identify the personal protective equipment (PPE)**

1 Identify the PPE in the Table - 1

2 Mention the name of the PPE nature of Hazards and type of protection

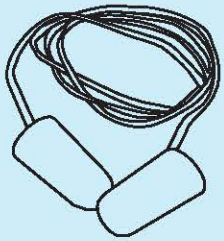
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Fig 1



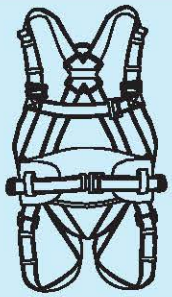
MRN1104J1

Fig 2



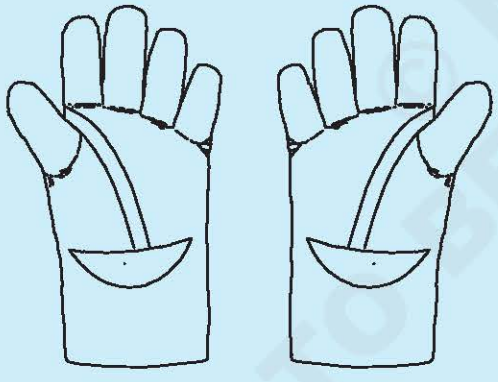
MRN1104J2

Fig 3



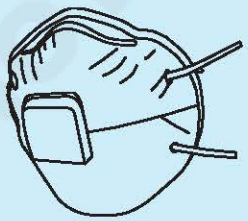
MRN1104J3

Fig 4



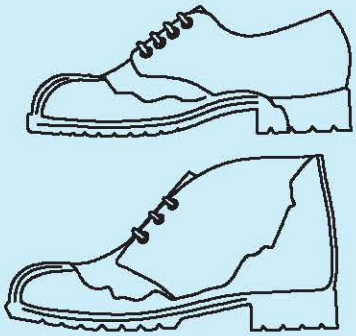
MRN1104J4

Fig 5



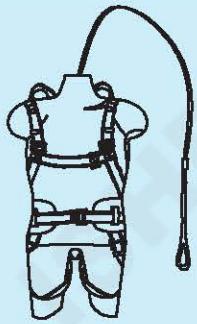
MRN1104J5

Fig 6



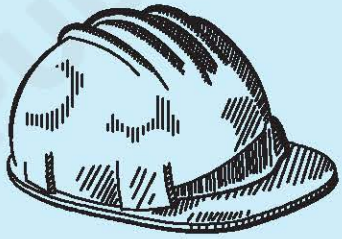
MRN1104J6

Fig 7



MRN1104J7

Fig 8



HELMET

MRN1104J8

Fig 9



MRN1104J9

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Table 1

Sl No	Name of PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			

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Identify general tools instruments & equipments with care and maintenance

Objectives: At the end of this exercise you shall be able to
- **identify general work shop tools**
- **identify workshop equipments**
- **identify precision instruments**
- **care & maintain of tools, and equipments**

Requirements

Tools/Instruments
- General workshop tools - as per table
- Precision measuring Instruments - as per table

Equipment/Machine
- Workshop equipments - as per table

PROCEDURE

TASK 1: **Identify the general workshop tools**

Table 1

Sl No	Name	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Fig 1

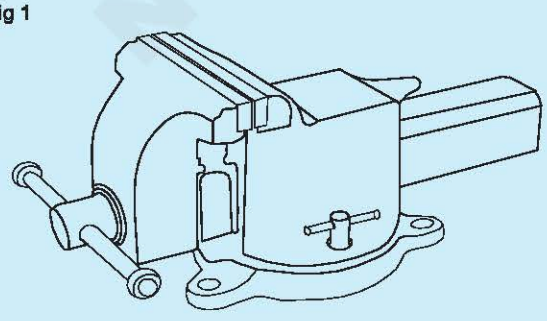


Fig 2

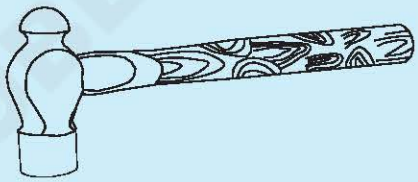


Fig 3

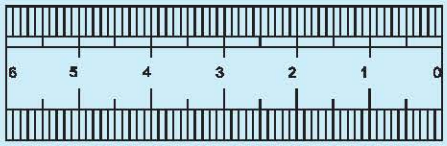


Fig 4

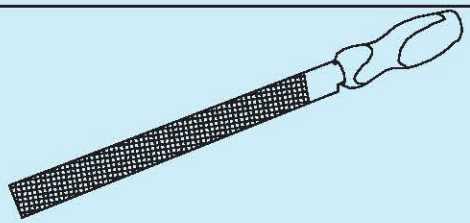
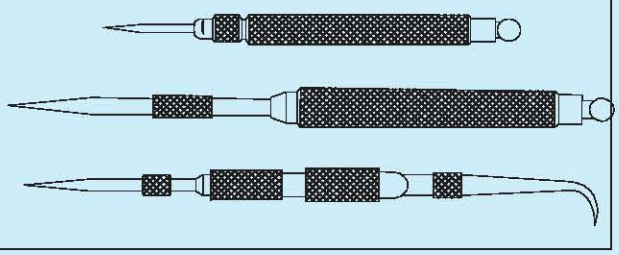


Fig 5



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Fig 7

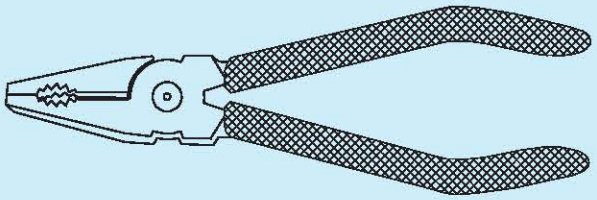


Fig 8

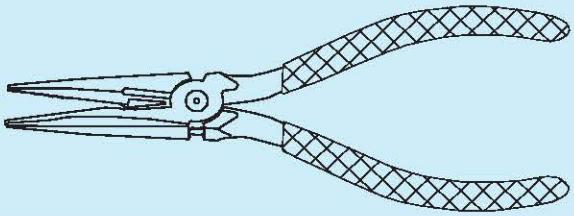


Fig 9



Fig 10

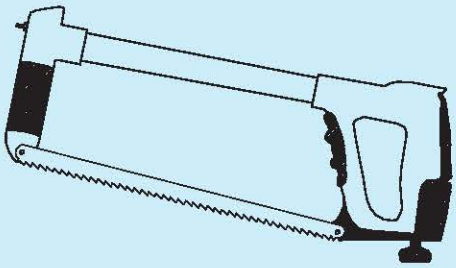
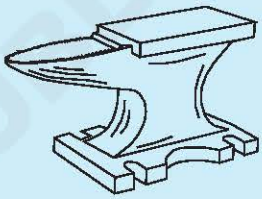


Fig 11



Fig 12



TASK 2: **Identify workshop equipments**

Table 2

Sl No	Name	Uses
1		
2		
3		
4		

Fig 1

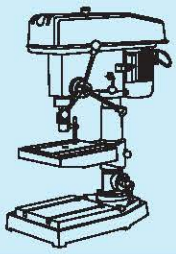


Fig 2

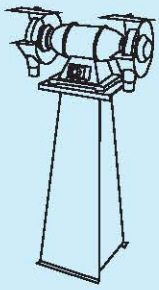
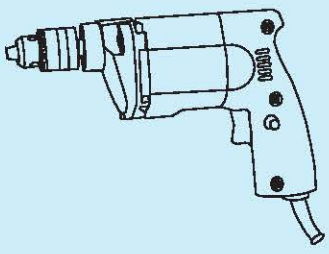
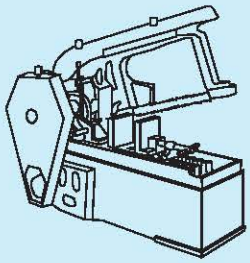


Fig 3



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Fig 4



TASK 3: **Identify precision equipments**

Table 3

Sl No	Name	Uses
1		
2		
3		
4		
5		

Fig 1

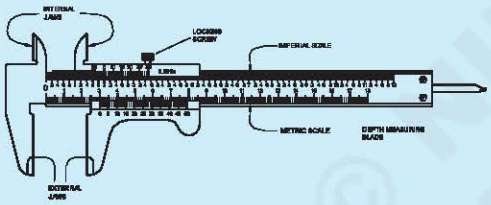


Fig 2

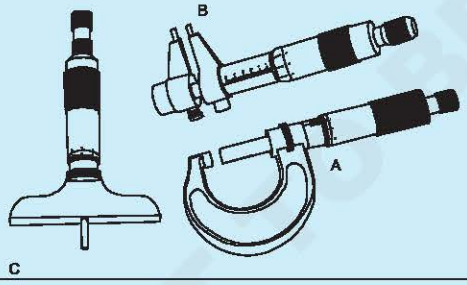


Fig 3

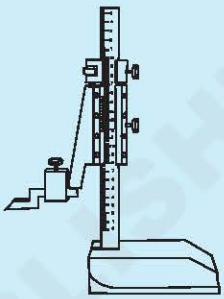


Fig 4

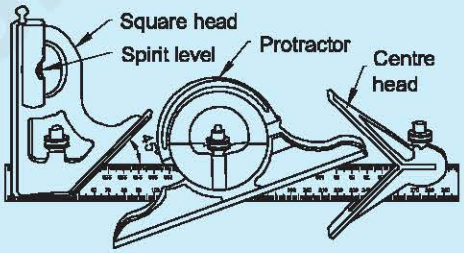


Fig 5



TASK 4: **Care and Maintenance of Tools Instruments and equipments**

1 Do not over tight in bench vice.

2 Do not use a hammer with a loose handle.

3 The face of the hammer must be free from oil, grease and mushroom heads

4 Do not use steel rule as a screw driver.

5 Do not use the file without the handle.

6 Do not throw a file since the teeth get damaged.

7 Do not use pliers as hammers.

8 The edge of a Chisel must be maintained as per the required angle.

9 In Chisel, Avoid mushroom heads.

10 While drilling, Do not apply excess pressure on small bits.

11 In the case of an electric drilling machine it must be properly earthed and the insulation should be sound.

12 After measuring Vernier Caliper, keeping the box.

13 While measuring in micrometer, do not over tight.

14 All measuring Instruments after use should be cleaned of grease, oil, dust etc., using a banyan cloth and store it in a pouch or in the container from the supplier.

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Perform measuring marking, punching, hack sawing, and flat filing

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

- **practice on flat filing and check the flatness**
- **mark parallel lines to the given dimension**
- **punch with centre punch & ball pein hammer**
- **fix the hacksaw blade & practice sawing**

Requirements

Tools/Instruments

- File flat Bastard double cut 150mm - 1 No
- File flat second cut double cut 150mm - 1 No
- Try square 150mm - 1 No
- Ball pein hammer 220gms - 1 No
- Steel Rule 300mm - 1 No
- Centre punch 100mm - 1 No
- Marking block with scale 150mm - 1 No
- Hacksaw blade with frame 300mm, 24 TPI - 1 No
- Drill bit - 1 No
- Reamer - 1 No
- Counter sinking tool - 1 No
- Tap set - 1 No
- Die set - 1 No

Equipment/ machine

- Bench vice 150mm - 1 No
- Angle plate 150mm - 1 No
- Surface plate 450 mm x 450mm - 1 No
- Machine vice 100 mm - 1 No
- Bench type drill machine capacity 25mm - 1 No
- Drill chuck with key 12mm capacity - 1 No
- Anvil 200mm with stand 100 kg

Materials

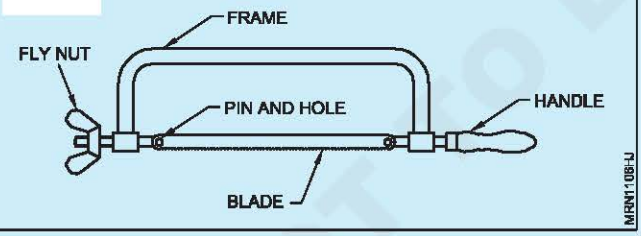
- MS equal channel 75 x 40 x 155mm -1 piece

PROCEDURE

TASK 1: **Fix the hacksaw blade & practice sawing.**

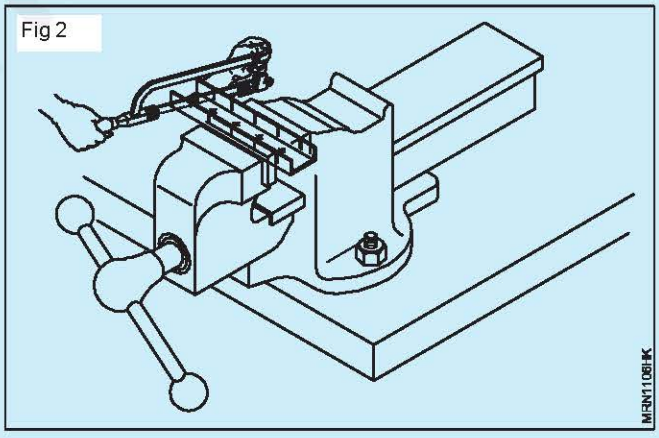
1 Fixing of hacksaw blade the teeth of the blade should be away pointing from the handle. Fix the blade to the frame in good tension. (Fig 1)

Fig 1



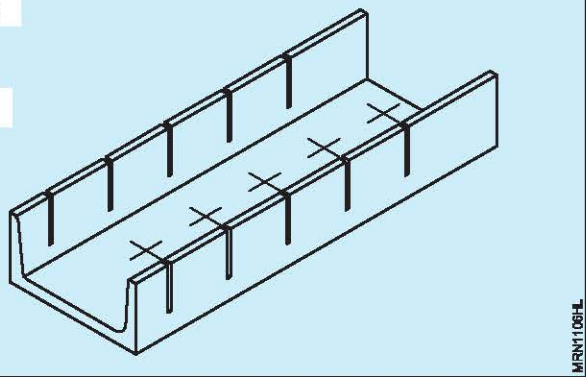
2 Set your thumb nail/vertically to the location of the cut, and this location should be at least 10 mm from the vice. Hold and press the hacksaw straight forward. Do not use force when pulling it back. Apply cutting compound occasionally while cutting. Use the full length of the hacksaw blade. Make the last few cuts while holding the piece to be cut with your left hand. For this section use a fine grade blade. A minimum of two or three teeth should be in contact with the work. (Fig 2)

Fig 2



3 Open the vice, take out the job and remove the burrs. (Fig 3)

Fig 3

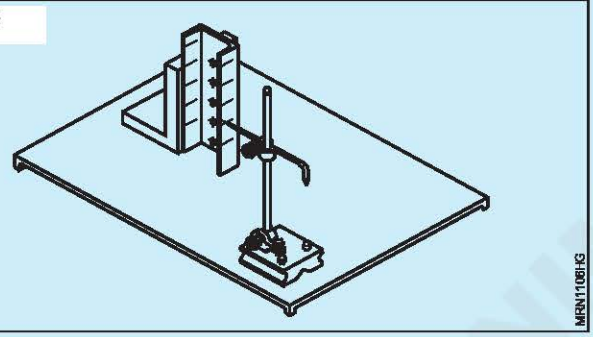


MRN1106HL

TASK 2: **Punch with centre punch and ball pein hammer**

1 Place the job on surface plate and place with support of angle plate and mark on the side o f the channel as figure. (Fig 4)

Fig 4



MRN1106HG

2 Take out the job and inspect.

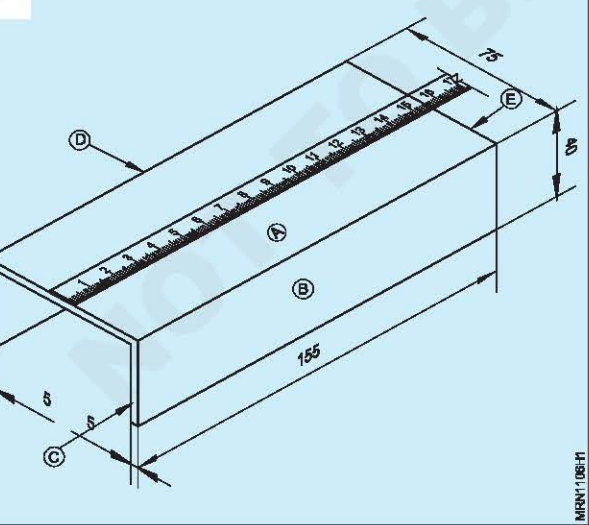
3 Place the job on anvil and hammer

4 Check the channel punch all the points are correct

TASK 3: **Practice on flat filing and check the flatness**

1 Check the material size 155 x 75 x 40mm equal angle MS channel.(Fig 5)

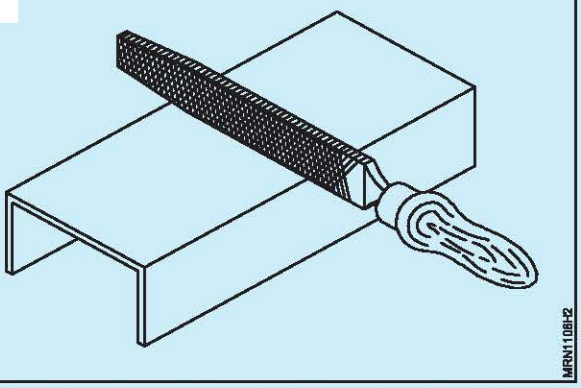
Fig 5



MRN1106H1

2 Remove all the rust from all the surface by the edge of file, clean by cotton waste.(Fig 6)

Fig 6



MRN1106H2

3 Hold file handle with thumb will be placed firmly to grip the file, left leg will be in forward direction right leg will 300 mm from front leg. Also check the height of your vice should be on the level of your elbow as in Fig 7.

4 Hold the job in bench vice grip firmly from width of the channel. (Fig 8)

5 Place file on the job and start filing. Exert pressure on file while moving forward direction. At return stroke release the pressure. Shift to the next area and continue in the same way complete the entire process and check flatness with the help of try square blade. If light appear surface is not flat. (Fig 9)

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Fig 7

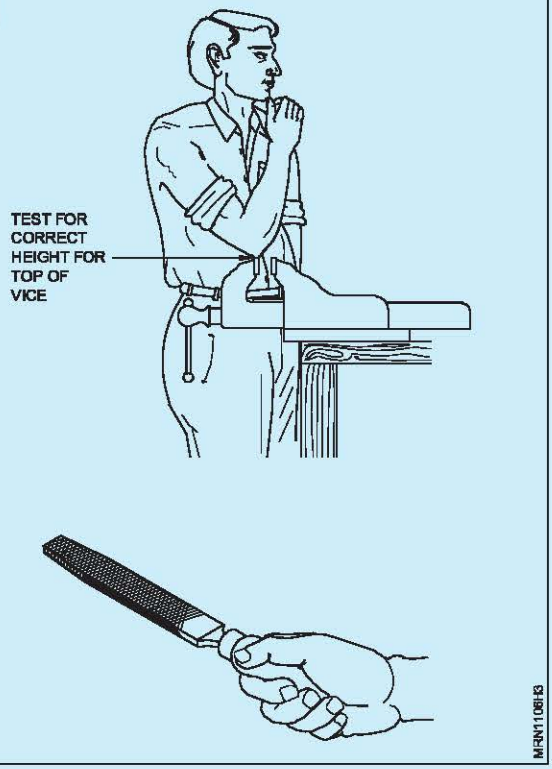


Fig 8

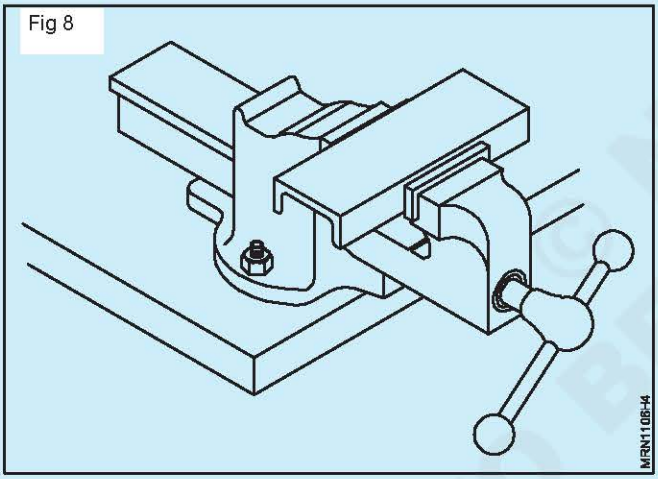
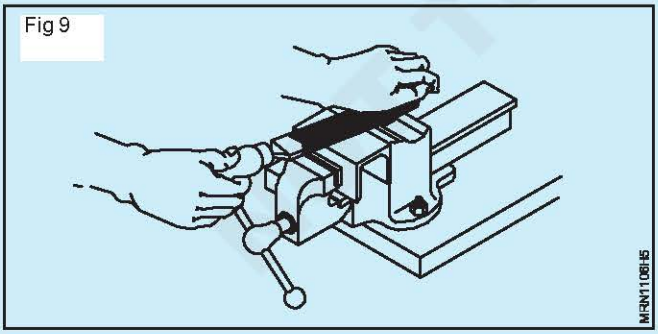


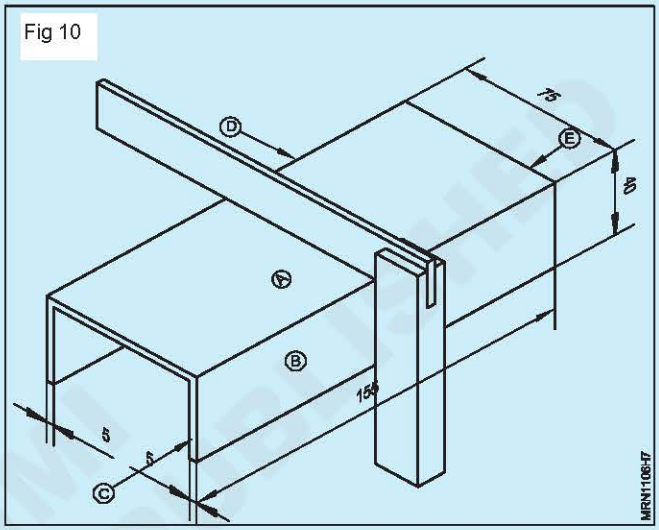
Fig 9



6 Open the job and start on (A) side filing as directed previously. Check the squareness along with(B). (Fig 10)

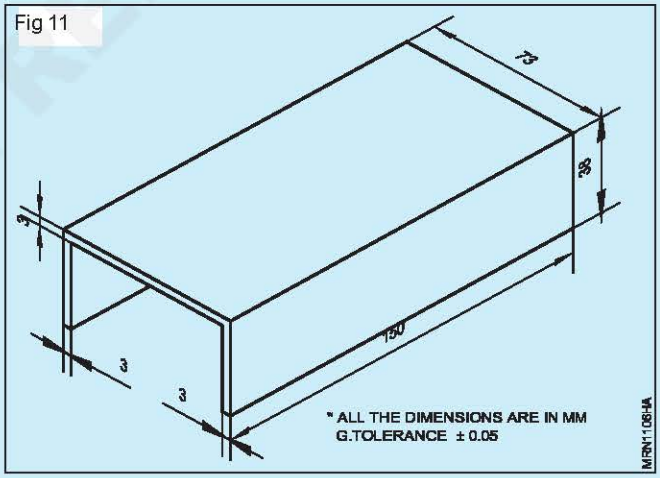
- Open the job and start on (D) side filing as directed previously. Check the squareness along with (A)
- Open the job and start on (C) side filing as directed previously. Check the squareness along with (A,B & D).
- Open the job and start on (F) side filing as directed previously. Check the squareness along with (A,B,C & D)

Fig 10



7 Finally we got the piece.(Fig 11)

Fig 11



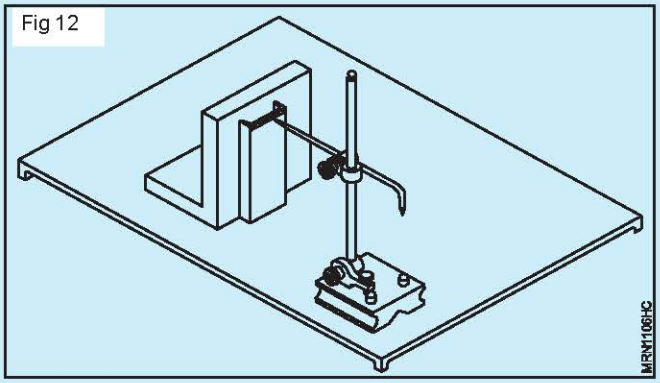
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TASK 4: **Mark parallel lines to the given dimension**

1 Apply marking media on B surface allow it to dry

2 Now place the marking block on surface plate and placing steel rule with support angle plate and fix scriber as per drawing length required. Tight the scribing block nut and take away the steel rule. (Fig 12)

Fig 12

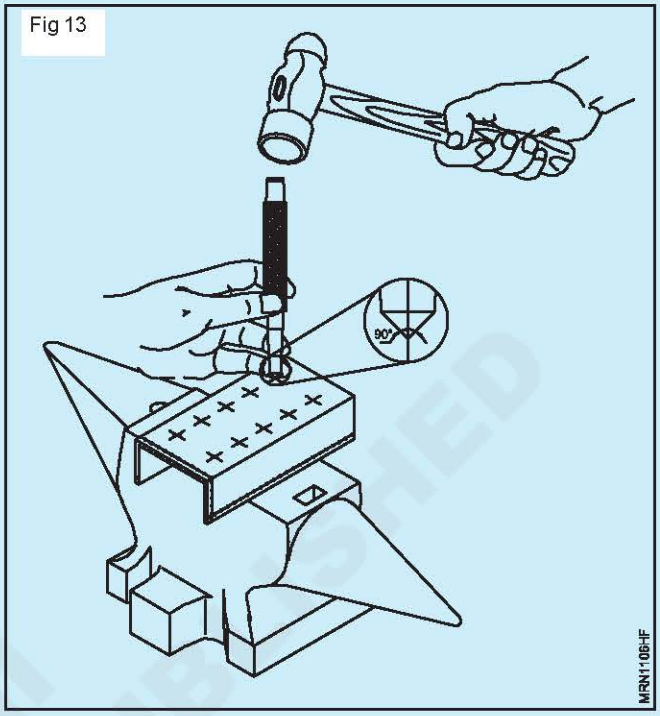


3 Now places the MS channel on surface plate touching C direction on surface plate face support of B will be with angle plate hold the job with your left hand along with the scriber point over the marking medias. Like that mark the job as per drawing.

4 Place the job on anvil.

5 Start punching over the line with the help of centre punch and hammer on crossing point must dipped punch (Fig 13)

Fig 13



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Perform sheet cutting by straight snip as per drawing

Objectives: At the end of this exercise you shall be able to
- **mark a straight line on the sheet**
- **cut sheet metal by a straight snip.**

Requirement

Tools / Instruments

- Wooden mallet 500 gm - 1 No.
- Straight Snip 200mm - 1 No.
- Scriber 150 mm - 1 No.
- Try square 150 mm - 1 No.
- Smooth file single cut 150 mm - 1 No.
- Wing compass 150 - 1 No.
- Bench vice 150mm - 1 No.
- anvil 200mm 100kg - 1 No.

Material

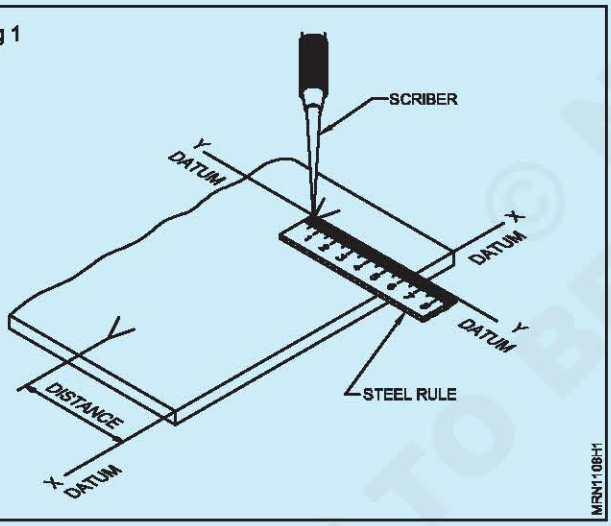
- G.I Sheet 65 × 120 mm 22SWG - 1 pieces for each trainees

PROCEDURE

TASK 1: **Mark a straight line on the sheet**

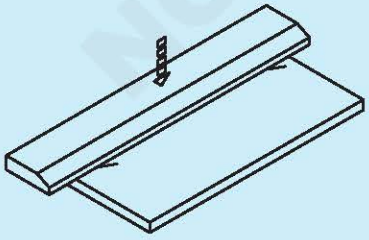
1 Mark off two 'V' marks from the datum xx at a distance as required by a measurement, using a steel rule and a scriber. Datum xx is a right angle to datum yy. (Fig 1)

Fig 1



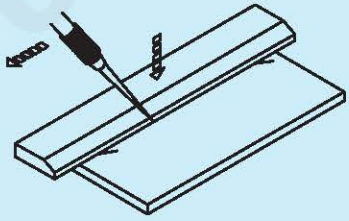
2 Set the straight edge in between the 'V' marks and press with your fingers. (Fig 2)

Fig 2



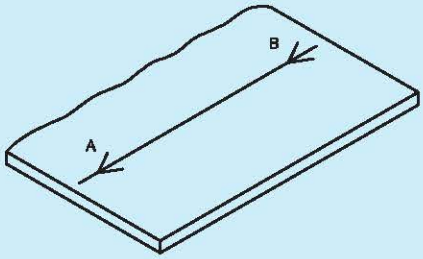
Scribe the line towards you with a proper inclination of the scriber on the level edge of the straight edge. (Fig 3)

Fig 3



3 The line AB is the parallel line to the datum xx. (Fig 4)

Fig 4



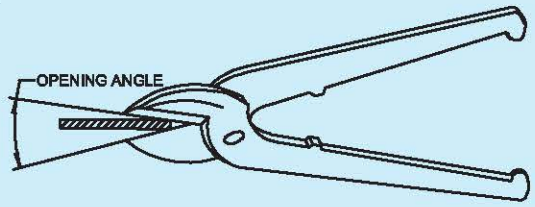
Draw parallel lines as per dimension following the above procedures

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TASK 2: **Cutting sheet metal by straight snip**

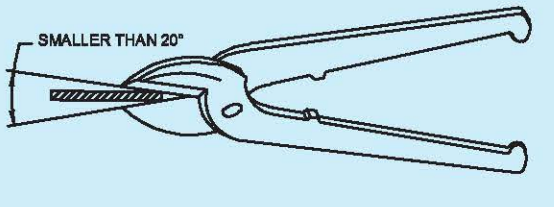
Hold the sheet by one hand, and with the other hand, hold the snip handle at the end, and place the upper blade of the snip on line by keeping a smaller opening angle. (Fig 1)

Fig 1



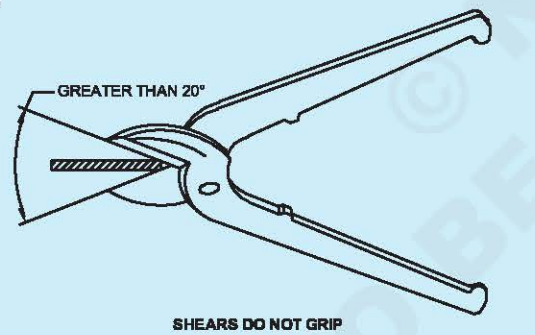
Maintain the gap in between the blades, less than 20°. (Fig2)

Fig 2



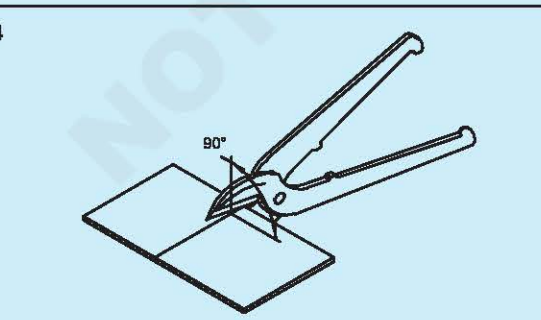
If the blade gap is more than 20°, shears cannot be gripped properly.(Fig 3)

Fig 3



Keep the blade perpendicular to the surface of the sheet metal. Hold the snips straight. (Fig 4)

Fig 4

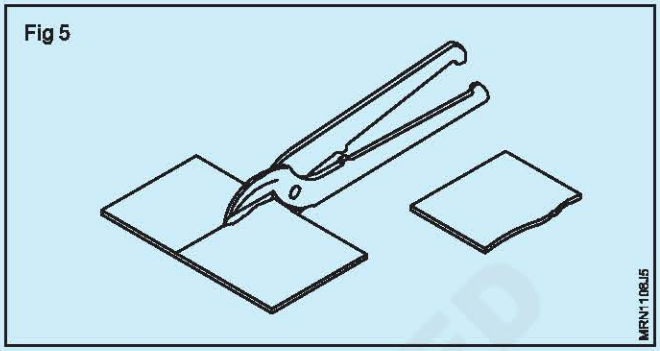


Caution

Do not use the full length of the blade by a single stroke

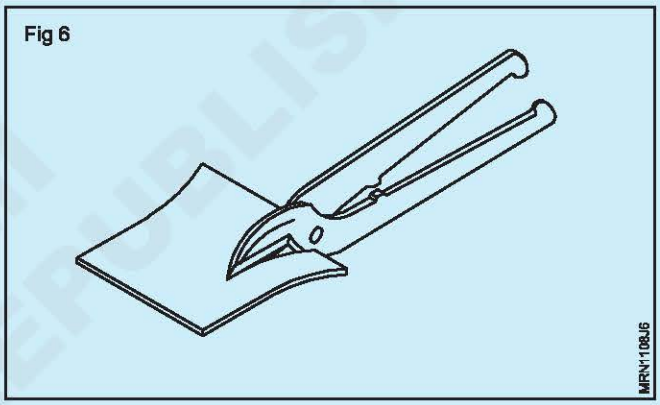
If you use the full length of the blade by a single stroke then the cutting or shearing line will not be straight (Fig 5)

Fig 5



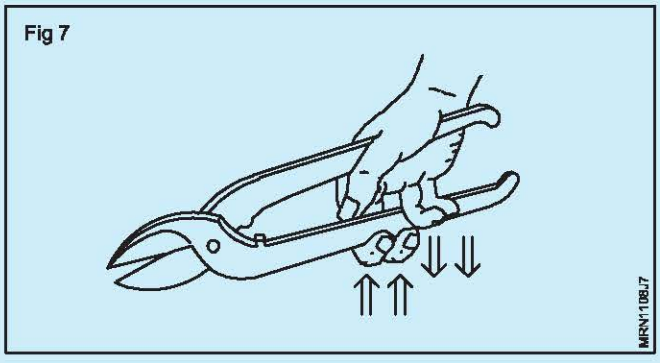
Keep less metal (sheet) as far as possible on the left hands side at the time of cutting the sheet. (Fig 6)

Fig 6



Where stops are not fitted, care should be taken not to palm of the hand between the turned-in ends of the handles when closing the cutting blades. (Fig 7)

Fig 7



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Perform sheet cutting by bent snip as per drawing

Objectives: At the end of this exercise you shall able to
- **mark curved lines on a sheet using a wing compass**
- **cut along the marked outside and inside carved lines using straight snips and bent snips.**

Requirement

Tools / Instruments

- Wooden mallet 500 gm -1 No.
- Curved nose snip 200mm -1 No.
- Scriber 150 mm -1 No.
- Try square 150 mm -1 No.
- Smooth file single cut 150 mm -1 No.
- Wing compass 150 -1 No.
- Bench vice 150mm -1 No.
- Anvil 200 mm x 100 kg -1 No.

Material

- G.I Sheet 65 x120 mm 22 SWG - 1 pieces for each trainees

PROCEDURE

TASK 1: **Mark curved lines on a sheet using a wing compass**

1 Check the size of the rectangular sheet as per sketch, using a steel rule

2 Level the sheet on a levelling plate using a mallet.

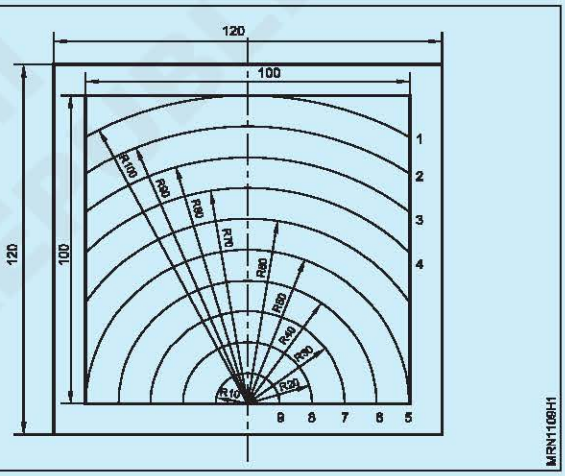
3 Attach another sheet for marking the larger curve.

4 Transfer the measurement from the steel rule to the wing compass for the desired radius.

5 Mark the first curved line on the sheet.

6 Mark 10 curved lines equal distance of 6mm.

Fig 1



TASK 2: **Cut along the marked outside and inside carved lines using straight snips and bent snips**

1 Cut on the marked curved lines by bent snips.

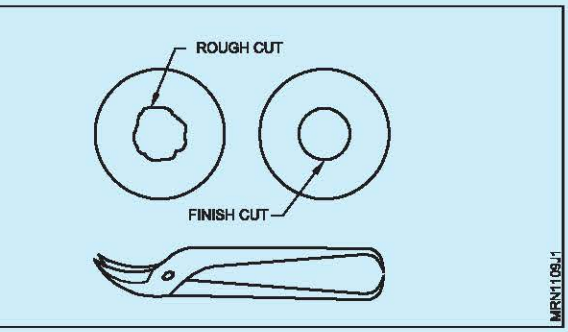
Start cutting the curved line always from the nearest edge with the straight snips.

2 A bent snip can be used for cutting internal and external curves.

3 For cutting holes bent snips are used.

4 First a rough cut is made. Then the hole is finished off (Fig1)

Fig 1

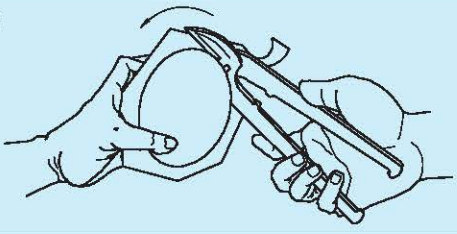


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5 For circular cutting rotate the sheet while making continuous cut.

6 First a rough cut can be made, (Fig 2)

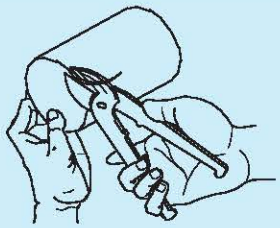
Fig 2



MRN1109J2

7 For trimming a cylinder, keep the lower blade on the outside of the cut. (Fig 3)

Fig 3



MRN1109J3

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Bend, fold, and join metal sheet in different process

Objectives: At the end of this exercise you shall be able to
- **bend and fold sheet metal as per marking**
- **make the locked grooved joint**
- **make notches using snips.**

Requirement

Tools / Instruments

• Mallet wooden 500 gms	-1 No	• 200mm 100kg anvil	-1 No
• Straight Snip 200 mm	-1 No	• Bench vice 150mm	-1 No
• Steel Rule 300 mm	-1 No	**Material**	
• Scriber 150 mm	-1 No	• G.I Sheet as required	
• Try square 150 mm	-1 No		
• Smooth file single cut 150 mm	-1 No		

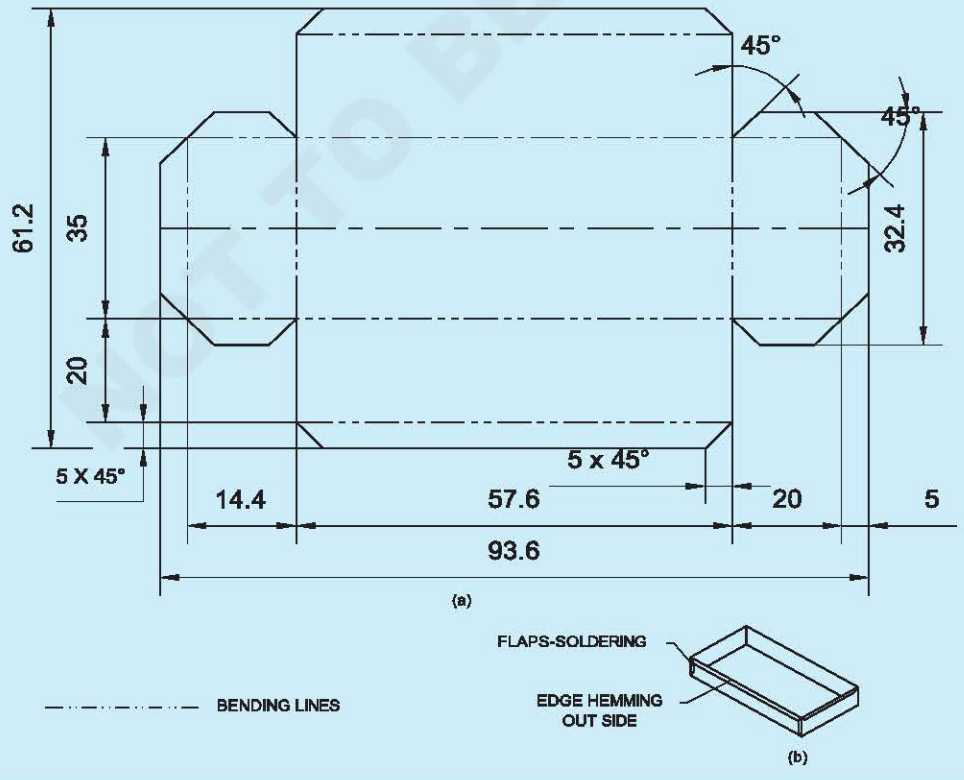
PROCEDURE

TASK 1: **Bend and fold sheet metal as per marking**

- Check the size of sheet as per sketch using a steel rule.
- Level the sheet on the levelling plate using a mallet.
- Develop the tray by the parallel line method
- Cut the sheet as per line by straight snips.
- Cut the corners by straight snips.
- Make a single hemming on the four side of the tray (Fig 1a)
- Bend the four sides to 90° using a Tin man's anvil.

TASK 2: M**ake the locked grooved joint**

Fig 1



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Interlock the folds and press the joint on the four corners (Fig 1b)

Occasionally, in laying out a job, you will have to make some provision for bent sections that have folded edges. Otherwise there will be overlapping of the metal where the corners come together.

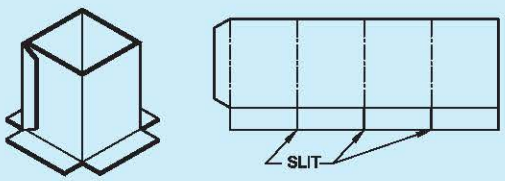
To prevent a bulge from forming at such a point, it is necessary to chip the metal or provide small openings.

The openings left at some seams and edges are known as notches.

Shapes of notches

- Straight notch - Fig 1
- Square notch - Fig 2
- `V' notch (Fig 3)

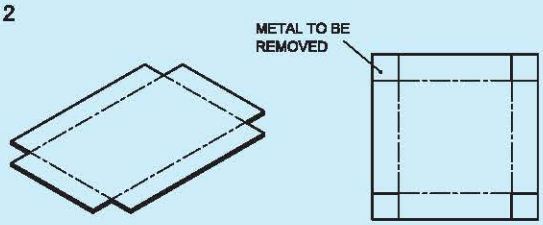
Fig 1



LAYING OUT STRAIGHT NOTCHES

MR1112U1

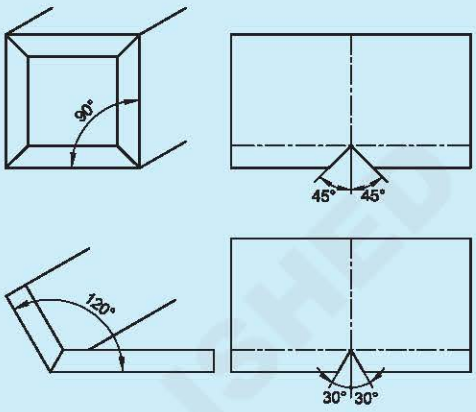
Fig 2



LAYING OUT SQUARE NOTCHES

MR1112U2

Fig 3



LAYING OUT 'V' NOTCH FOR 90° BEND.
LAYING OUT 'V' NOTCH FOR OTHER THAN 90° BEND.

MR1112U3

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Joining sheet metal by using rivet set and snap

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

- **join the sheet metal using rivet with a rivet set and snap**

Requirements

Tools /Instruments

- Steel rule 300mm - 1 No.
- Scriber 150mm - 1 No.
- Centre punch 150mm - 1 No.
- Hammer 220gms - 1 No.

Equipment/Machines

- Hand drilling machine

Materials

- Sheet steel ISST 55 x 0.5 x 105 - 2 Nos.
- No.14 Tinman's rivets - 10 Nos.

PROCEDURE

TASK 1: **Joining sheet metal by using rivet set and snap**

1 Check the dimension of the given sheet iron.

2 Mark straight line for centre line of the rivet. (Fig 1)

3 Mark centres for drilling with centre punch.

4 Drill holes using the hand drilling machine.

5 Place together the two pieces of sheet metal on a suitable solid plate. (Lead piece)

6 Insert the rivet in the hole, that is nearest to the centre of span, resting the head of the rivet on the place.

7 Draw the material and the rivet together tightly by placing the hole in the rivet set and striking the set one or two sharp blows with hammer.

8 Place the cup shaped hole on the rivet and give the rivet set one or two sharp blows with the hammer to head the rivet.

9 Rivet alternately in each direction, beginning with the nearest centre hole.

10 Insert the rivet in the holes made in the sheets.

11 Draw the rivet and the sheet together by striking one or two sharp blows with a hammer. (Fig 2)

12 Perform heading the rivet with the cup shaped hole of the rivet set and hammer.

Fig 1

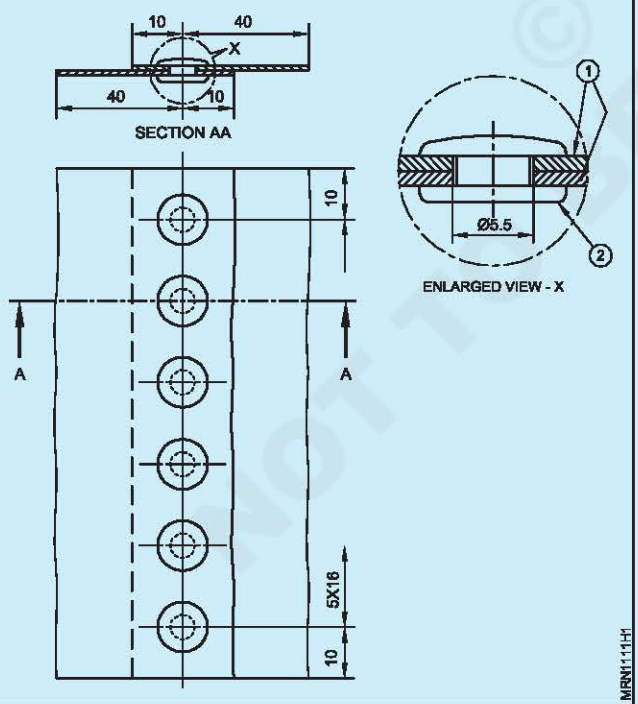
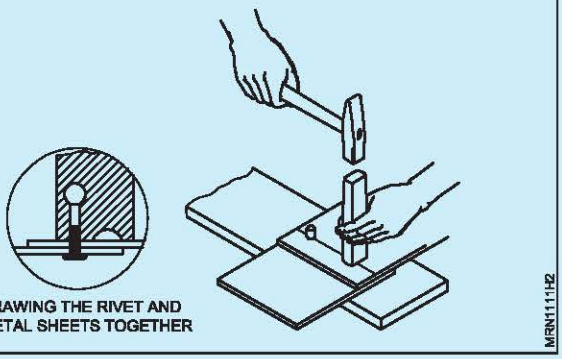


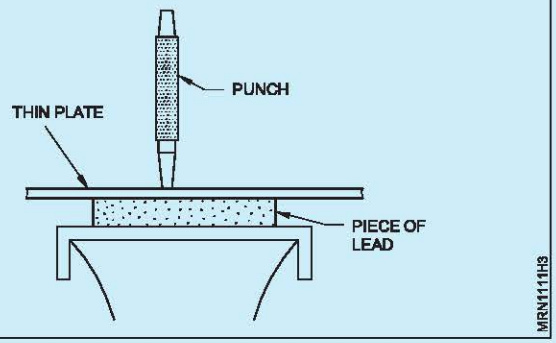
Fig 2



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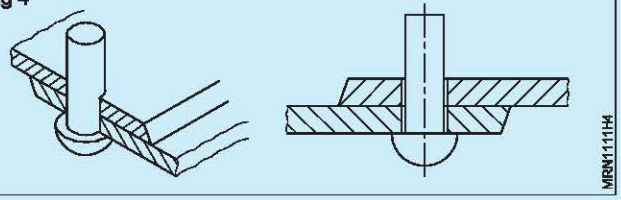
In thin plates the holes for rivets are punched as shown in Fig 3.

Fig 3



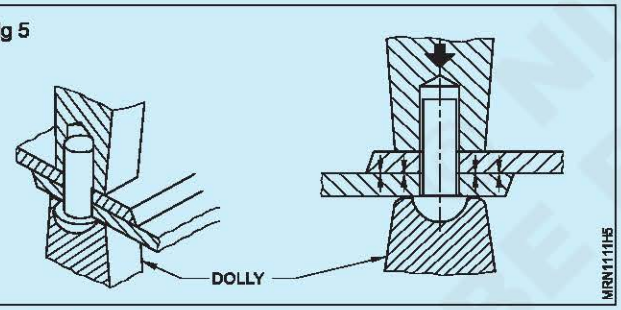
Pass the rivet through the punched hole in the sheet as shown in Fig 4.

Fig 4



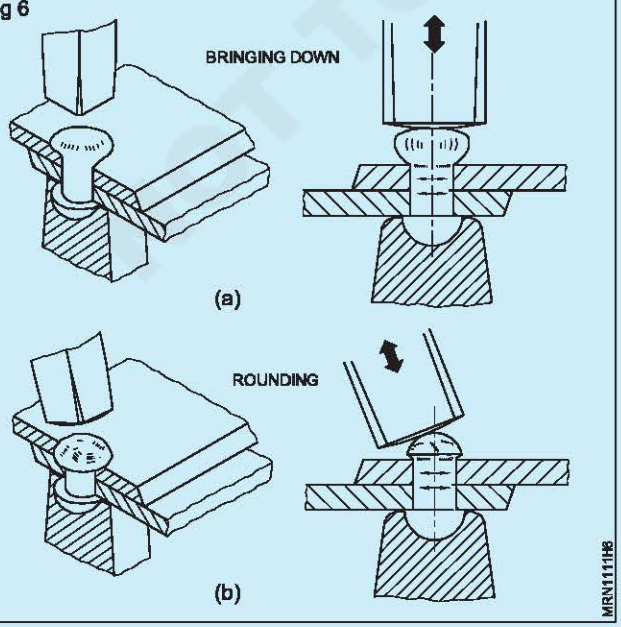
To set the rivet firmly in the sheet, use a rivet set. The rivet head is to be supported with a dolly. A dolly is used to prevent the rivet head from expanding when it is struck with the hammer. (Fig 5)

Fig 5



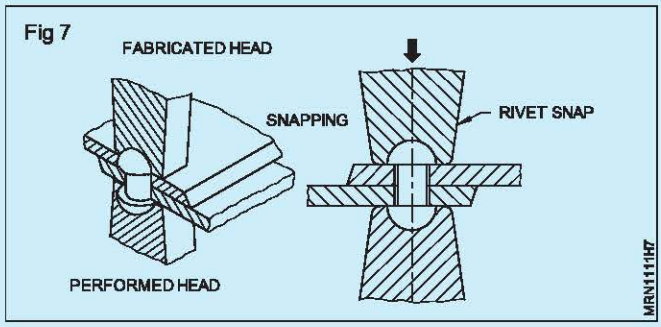
The shank is to be rounded by giving glancing blows with the hammer (as shown in Fig 6) for firming the head.

Fig 6



Finally, place the rivet snap on the rivet (as shown in Fig 7 and finish the work by giving a few blows with the hammer.

Fig 7

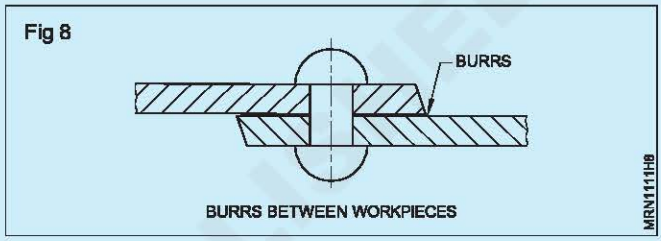


Fault in riveted joints

The following faults may be noticed in riveted joints.

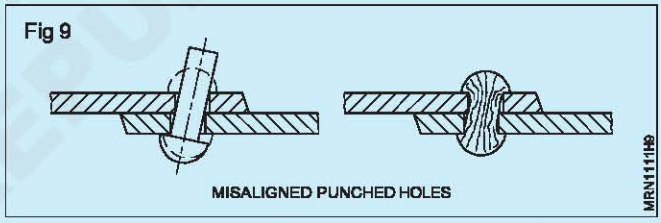
Burrs between work pieces as shown in (Fig 8).

Fig 8



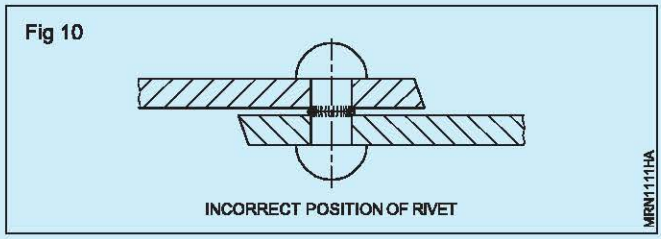
Punched holes in work pieces are not correctly aligned (Fig 9)

Fig 9



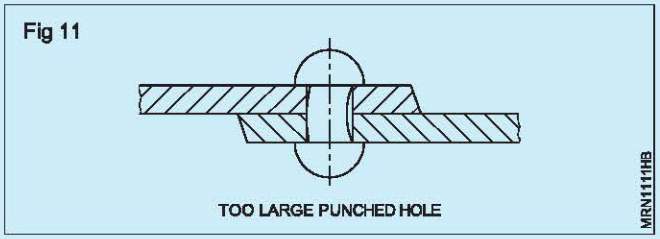
Rivet not set correctly with the rivet set. (Fig 10)

Fig 10



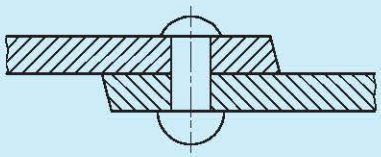
Punched holes too large. (Fig 11)

Fig 11



Rough rivet length too short. (Fig 12)

Fig 12

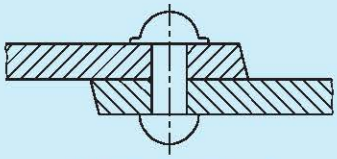


RIVET LENGTH TOO SHORT

MRN1111HC

Rough rivet length too long. (Fig 13)

Fig 13



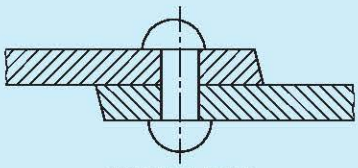
RIVET LENGTH TOO LONG

MRN1111HD

Closed head displaced. (Fig 14)

The rivet set and rivet snap must be free from burrs.

Fig 14



DISPLACED HEADS

MRN1111HE

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Demonstrate electrical safety precaution and first aid

Objectives: At the end of this exercise you shall be able to
- **disconnecting a person (mock victim) from a live supply (simulated)**
- **artificial respiratory resuscitation**
- **resuscitation of a victim by the Holgen-Nelson method**
- **resuscitation of a victim by the Schafer's method**
- **resuscitate a victim who is under cardiac arrest (CPR) cardio pulmonary**

Requirements

Equipment/Machines

- A wall mounted/ pedestal bus-bar chamber controlled by an isolator - dummy - not connected to mains - an Electrical machine connected through an isolator- (dummy - not connected to mains).

Material

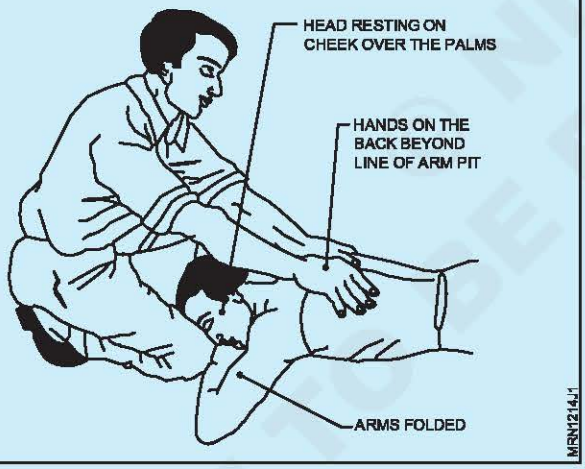
- Workshop coats, sacks, long handled wooden brush, length of timber, rubber mat, hot water bag.

PROCEDURE

TASK 1: **Disconnecting a person (mock victim) from a live supply (simulated).**

1 Observe the person (mock victim) receiving an electric shock. Interpret the situation quickly.

Fig 1



2 Remove the victim safety from the 'live' equipment by disconnecting the supply or using one of the items of insulating material.

Do not run to switch off the supply that is far away.

Do not touch the victim with bare hands until the circuit is made dead or the victim is moved away from the equipment.

Push or pull the victim form the point of contact of the live equipment, without causing serious injury to the victim.

3 Move the victim physically to nearby place.

4 Check for the victim's natural breathing and consciousness.

5 Take steps to apply respiratory resuscitation if the victim is unconscious and not breathing.

TASK 2: **Artificial respiratory resuscitation**

1 If breathing has stopped, apply immediate artificial respiration

2 Loosen the tight clothing of the victim. If not possible to loosen quickly, do not spend too much time in this, activity.

3 Remove obstruction from the mouth, if any.

4 Send word for professional assistance. (If no other person is available, you stay with the victim and render help as best as you can.)

5 Look for visible injury in the body and decide on the suitable method of artificial respiration.

6 Have you observed? (In this case you are told by the instructor)

7 In the case of injury /burns to chest and /or belly follow the mouth to mouth method.

8 In case the mouth is closed tightly. Use Schafer's or Holden Nelson method.

9 In the case of burn and injury in the back, follow Nelson's method.

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10 Arrange the victim in the correct position for giving artificial respiration. Follow the steps explained, given under skill information for each method of artificial respiration, until the victim breathes naturally or professional help arrives.

All action should be taken immediately.

Delay even by a few seconds may be dangerous.

Exercise extreme care to prevent injury to internal organs.

11 Place the mock victim in the recovery position

12 Cover the victim with coat, sacks or improvise your own method. It helps to keep the victim's body warm.

TASK 3: **Resuscitation of a victim by the Holgen-Nelson method.**

Refer Ex No 1.1.02 TASK - 4, 5, 6, 7, 8

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Identify, use and maintain electrical tools

Objectives : At the end of this exercise you shall be able to
- **identify the tools when specification is given**
- **identify the tools for specific uses**
- **care and maintenance of tools.**

Requirements

Tools/Instruments

• Trainee's tool kit	- 1 set
• Triangular file bastard 150 mm	- 1 No.
• Long round nose pliers 200mm	- 1 No.
• File flat 150 mm bastard	- 1 No.
• Rawl jumper and bit No.8	- 1 No.

Equipment/Machines

• Electric bench grinder	- 1 No.

Materials

• Lubricating oil	- 100 ml.
• Cotton waste	- as reqd.
• Cotton cloth	- 0.50 metre square.
• Grease	- as reqd.
• Emery sheet 00	- 1 sheet.

Note: The instructor shall arrange for the necessary tool/equipment like saw-tooth setter , grinder etc. from other sections and also arrange for the required materials from scrap for practicing the functioning of tools.

PROCEDURE

TASK 1: **Identify the tools when specification is given.**

Assumption - A set of trainee's tool kit and specified tools as given in this exercise are displayed on the workbench. Trainees are required to identify the tools from the specification given below and draw the sketch of the tools.

In case of change in specification, rewrite the correct specification of the items given to you.

Specification	Change in glerfieation (of any)
i Combination pliers with pipe grip, side cutter and insulated handle-size 200 mm.	
ii Long round nose pliers 200 mm.	
iii Screwdriver 0.8 x 6 x 150mm	
iv Firmer chisel 12 mm	
v Wood rasp file 250 mm	

Specification	Sketch
vi Flat file bastard 250 mm	
vii Bradawl 6 mm x 150 mm square-pointed	
viii Gimlet 4 mm x 150 mm	
ix Ratchet brace 6 mm capacity	
x Raw l jumper holder with bit No.8	

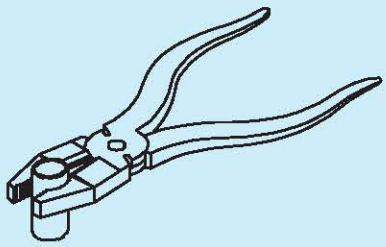
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TASK 2: **Identifying tools for specific uses**

Practice the use of each tool for different operations as given below.

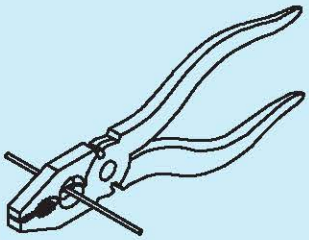
1 Combination pliers (Fig 1)

Fig 1



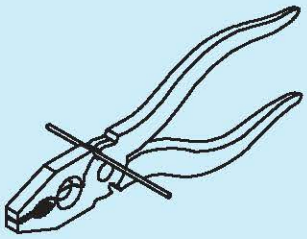
Pipe grip is serrated for griping cylindrical objects. Two joint cutters are provided for cutting or shearing off wires. (Fig 2)

Fig 2



Side cutting edges are provided for cutting of soft wires. (Fig 3)

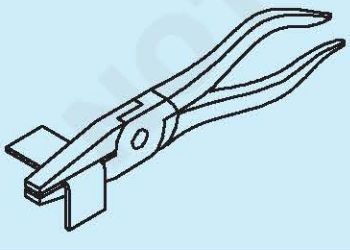
Fig 3



2 Pliers-flat nose

It is used for bending and folding narrow strips of thin sheet metal. (Fig 4)

Fig 4



3 Pliers-diagonal cutting

It is used for shearing off wires in confined spaces and cutting off wires close to the surface level. (Fig 5)

4 Pliers-round nose

It is used to shape loops in wires and to form curves in light metal strips. (Fig 6)

Fig 5

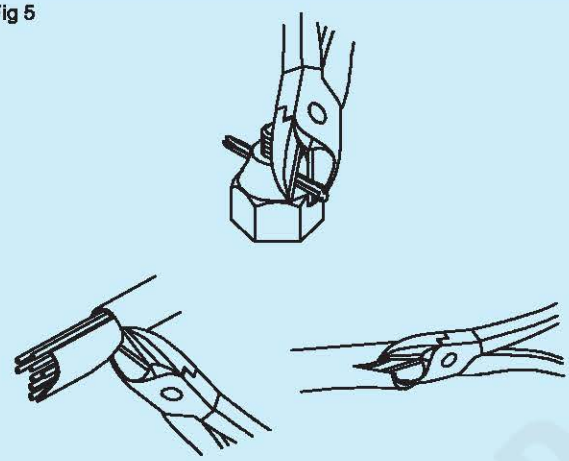
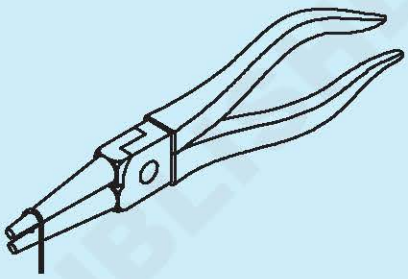


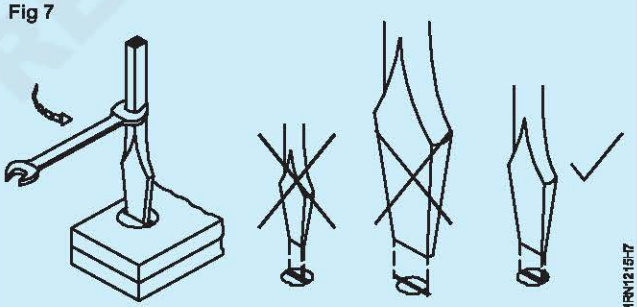
Fig 6



5 Screwdriver

It is used for slot head screws.

Fig 7



Use screwdrivers with tips correctly fitting into the screw slot. (Fig 7)

Fig 8



6 Screwdriver-Phillips - heard (star)

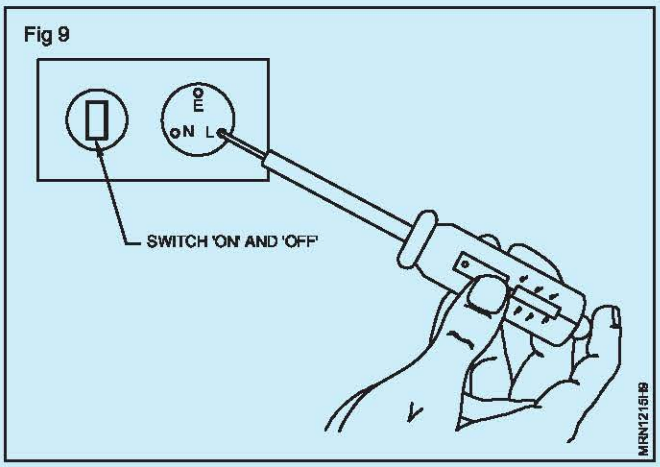
It is used for star-headed screws. (Fig 8)

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7 Neon tester

It is used for testing live terminals.(Fig 9)

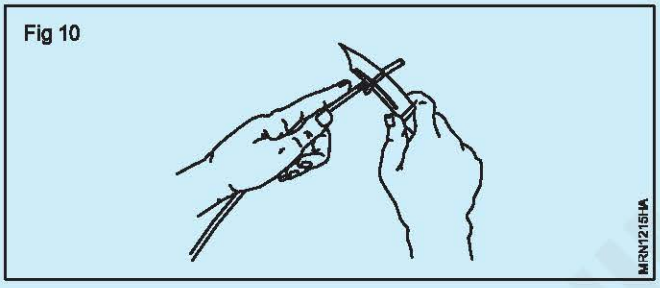
Fig 9



8 Electrician's knife

It is used for skinning the insulation.(Fig 10)

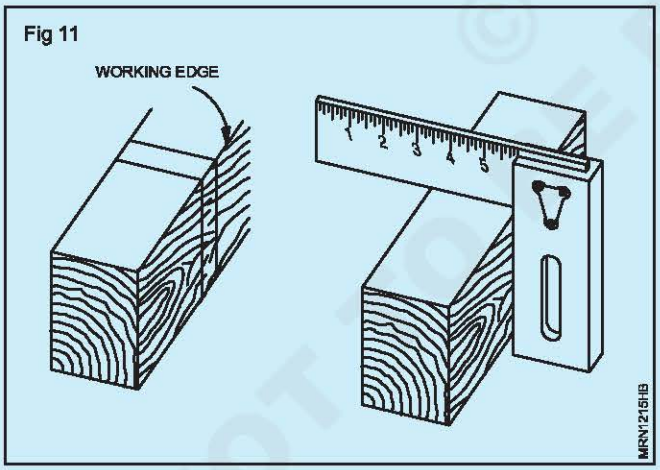
Fig 10



9 Try-square

It is used for checking surfaces and squareness. (Fig 11)

Fig 11



10 Firmer chisel

It is used for chiseling wood.(Fig 12)

11 Ten on-saw

It is used for cutting battens.(Fig 13)

12 Plumb-bob

It is used for drawing vertical lines on walls.(Fig 14)

13 Centre punch

It is used for making punch marks on metals.(Fig 15)

Fig 12

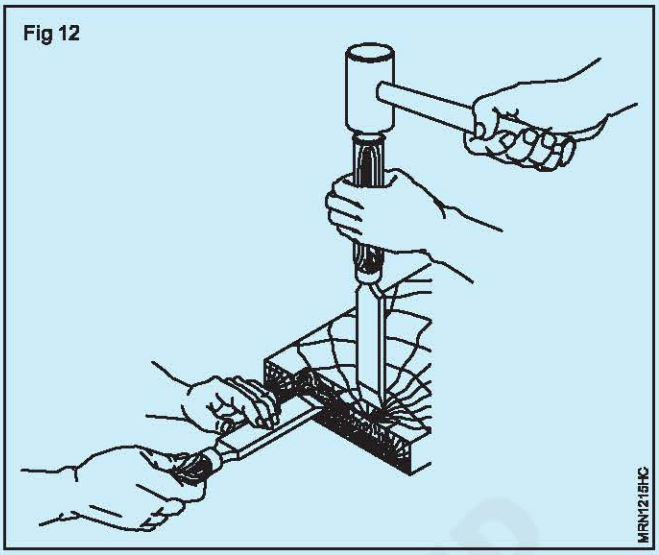


Fig 13

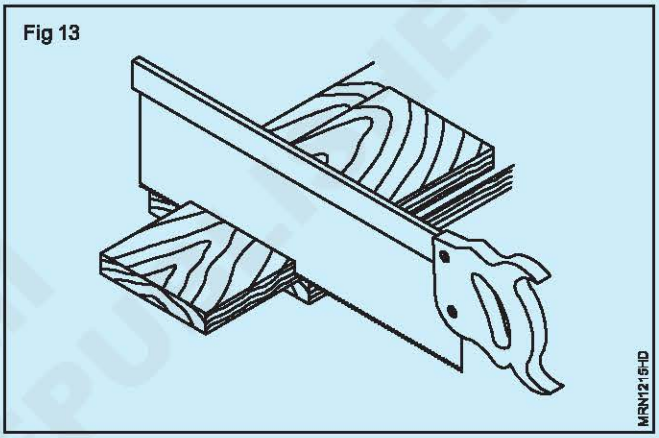


Fig 14

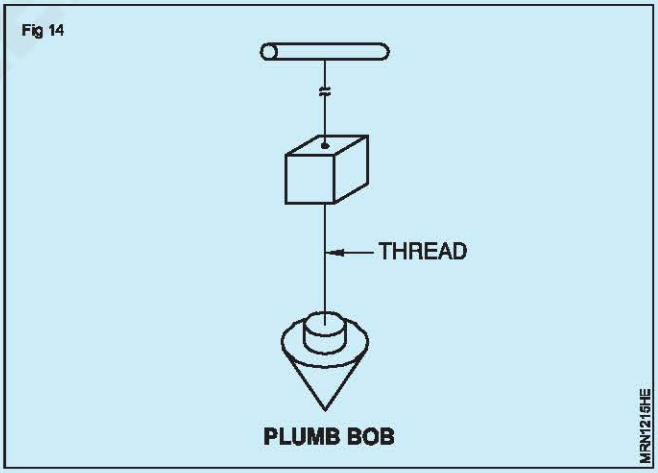
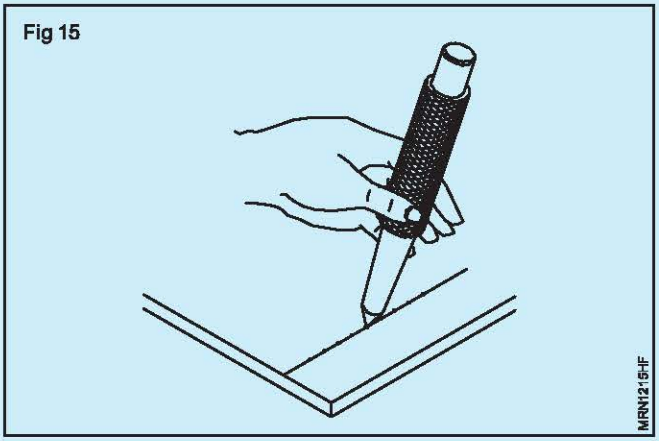


Fig 15

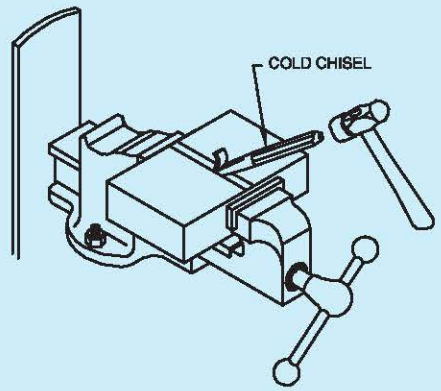


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14 Cold chisel

It is used for chipping metals.(Fig 16)

Fig 16



15 Hacksaw

It is used to saw metal pieces.(Fig 17)

16 Portable electric drilling machine

It is used for drilling holes in wood or metals. (Fig 18)

Fig 17

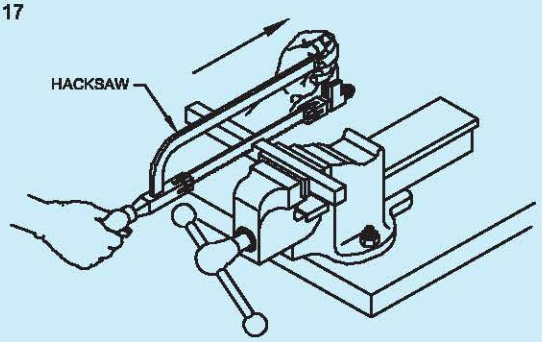
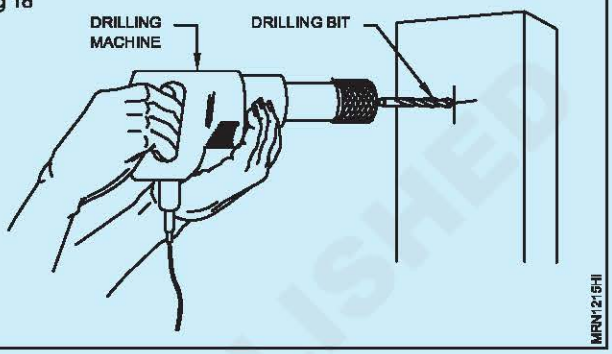


Fig 18



TASK 3: **Care and maintenance of tools**

Prevent rust formation

1 Inspect all the tools; if rusted, use fine emery-paper to remove the rust.

While removing rust keep your hands clear off sharp edges. Do not use emery paper on steel rule or tape.

2 Apply a thin coat of oil over the surface of the rusted tools and clean with cotton cloth.

A hammer should not have even a trace of oil on its striking surface.

3 Check and lubricate the tools for easy movement of jaws of pliers, blades of knife, jaws of wrench, pinchers, gears of the hand drilling machine.

4 Apply a drop of oil at the hinged/geared surfaces, if the movement is found to be hard or slaggy.

5 Activate the jaws and gears till the muck/grim in the surfaces comes off.

6 Apply a drop of oil again and clean the tools with cotton cloth.

Remove the mushrooms

7 Check the cold chisel and hammer striking face for mushrooms. If found report to your instructor to enable him to remove the mushroom through grinding.

Reshaping the screwdriver tip

8 Check the tips of the flat tipped screw drivers. If the tip is blunt or disfigured report to the instructor.

Observe how the screwdriver tip is ground to form the perfect cornered tip for effective usage.

Sharpen and set the saw-teeth

9 Check the teeth of the ten on-saw.

10 Report to your instructor, if the saw-teeth are blunt.

Observe how the saw-teeth are filed to make the saw-teeth sharp.

11 Check the saw-teeth setting.

The teeth for the ten on-saw should be off set alternatively to enable the dust to be removed while sawing.

12 Report to the instructor, if the setting is not proper.

13 Observe how the teeth are set by a saw-setter.

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Measure current, voltage, resistance, power, and energy using analog and digital meter

Objectives At the end of this exercise you shall be able to
- **use voltmeter and check voltage**
- **use Ammeter and check current**
- **operate multimeter**
- **measurement of power by direct and indirect method**
- **measurement of energy by the direct method**

Requirements

Tools/Instruments

- Cutting plier 200mm - 1 No.
- Flat Nose plier 150 mm - 1 No.
- Screw driver set - 1 set .
- Line tester 500 V - 1 No.
- Voltmeter 0 -500 VAC - 1 No.
- Ammeter - 0 - 30 A - 1 No.
- Multimeter Multirange - 1 No.
- Watt meter, energy meter & frequency meter -1 No each.

Materials

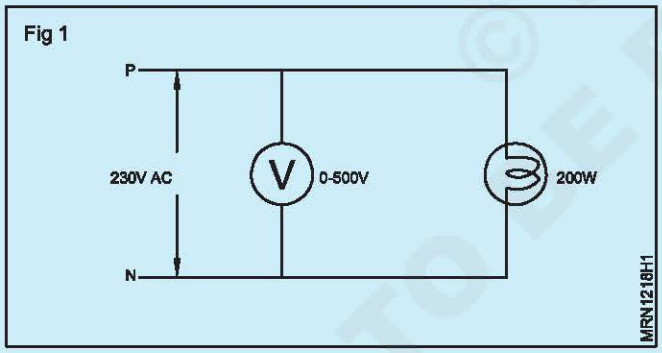
- Wire pieces - as reqd.
- Wire clips - 2 Dozen.
- Switch 5 A - 4 Nos.
- Lamp 200 W - 4 Nos.
- Lamp Holder 5A - 4 Nos.

PROCEDURE

TASK 1: **Use voltmeter and check voltage**

1 Take the required length wire & skin the ends.

Fig 1



2 Connect the lamp holder with phase & neutral wire (prepare test lamp).

3 Connect voltmeter parallel to the supply.

4 Connect Voltmeter terminals with phase and neutral connection.

5 Fix the 200W bulb & switch on the supply.

6 Check the voltage in voltmeter & record.

7 Switch off the supply & remove the connections after talking the readings.

TASK 2: **Use Ammeter and check current**

1 Take the required length wire and connect 01 Hp motor with phase &neutral.

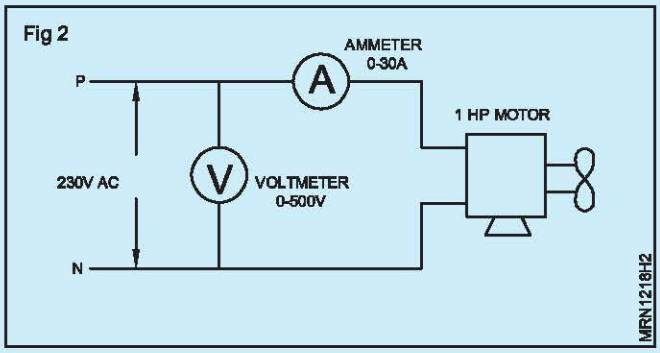
2 Connect Ammeter 0-30 A series with the phase line (in between the phase line).

3 Connect voltmeter parallel to the supply.

4 Switch on the supply and check the current drawn by the motor in Ammeter.

5 Switch off the supply & remove connections after taking the readings.

Fig 2



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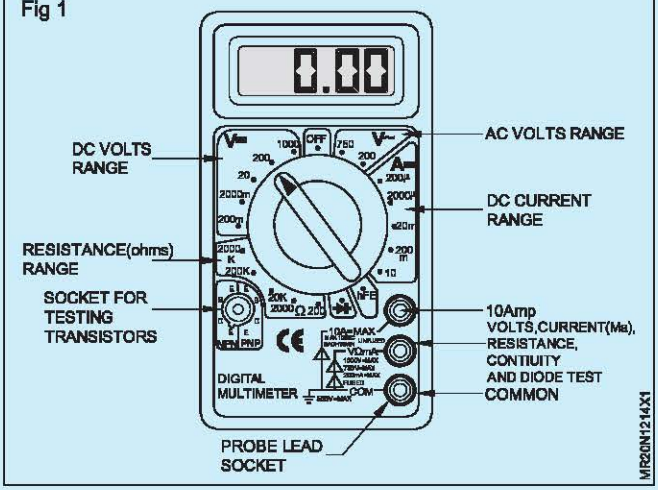
TASK 3: **Operate multimeter**

AC Voltage Measurements

1 Turn the Range Selector Switch to 750 ACV setting, Always start with the highest range if the voltage is unknown.

2 Plug the red lead into the VΩ mA (Centre) Jack. Plug the black lead into the COM (Bottom) Jack. Switch the Multimeter ON. (Fig 3)

Fig 1



3 Carefully touch the exposed conductors with the tips of the probes to measure the voltage (not amperes).

4 Read measurements. If the voltage is less than 200 volts, set the Range Selector Switch to the lower range.

5 When testing is complete, remove Test Leads and store with multimeter.

DC Voltage Measurements

1 Turn the Range Selector Switch to 1000 DC setting.

2 Follow the direction above under "AC Voltage Measurements", only use the DC setting instead.

DC Current Measurements

1 Turn the Range Selector Switch to the 10 A position Always start with the highest range if the amperage is unknown.

2 Plug the red lead into the 10A (Top) Jack . Plug the black lead into the COM (Bottom) Jack. Switch the Multimeter.

3 Carefully touch the exposed conductors with the tips of the probes to measure the amperage.

Note : Amperage is always tested in series with the circuit under test.

4 Read measurement. If the reading is less than .2 AMPs, switch the red lead to the VΩ mA (centre) Jack and set the Range Selector Switch to the 200 mA setting.

5 When testing is complete, remove Test Leads and store with multimeter.

Resistance Measurements

Never measure resistance on a circuit with voltage running thread it.

1 Turn the Range Selector Switch to the 200 mA position.

2 Plug the red Test Lead into the VΩ mA (Centre) Jack. Plug the black Test Lead into the Com (Bottom) jack. Switch the Multimeter ON. Short the Test Leads together. The meter should read "0" Ohms.

3 Touch the exposed conductors with the tips of the test leads.

4 Read measurement. If the reading is "1", set the Range Selector Switch to the next higher Ohm (Ω) position.

TASK 4: **Measurement of power by direct and indirect method**

Direct method

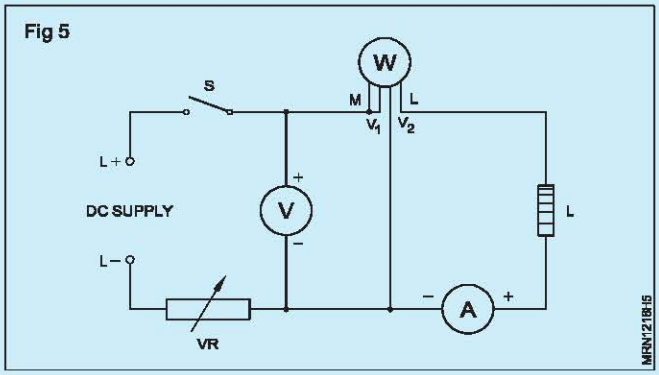
1 Identify the wattmeter terminals.

2 Connect the wattmeter terminals in the circuit on shown in in Fig 5.

3 Switch circuit with load.

4 Note the wattmeter reading.

Fig 5



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Indirect method

1 Connect the ammeter series to load.

2 Connect the voltmeter parallel to load.

3 Switch on the load.

4 Measure Ampere and voltage

5 Calculate the power as power P = V I

TASK 5 : **Measurement of energy by the direct method**

1 Identify the energy meter terminals - line and load, after removing the terminal cover.

Always mount the meter vertically.

2 Associate the circuit diagram (inside) with the terminal markings of the instrument.

3 Connect the energy meter terminals (line & load) in the circuit as shown in Fig 1.

4 Note the meter constant from the name-plate of the energy meter. (Fig 2)

5 Record the initial meter reading.

6 Switch ON the circuit with load.

7 Record the reading after 30 minutes.

8 Calculate the energy consumed which is the difference between the current and previous reading.

9 Repeat the steps 5 to 8 for changed load condition.

10 Repeat step 9 at least 3 times.

Fig 1

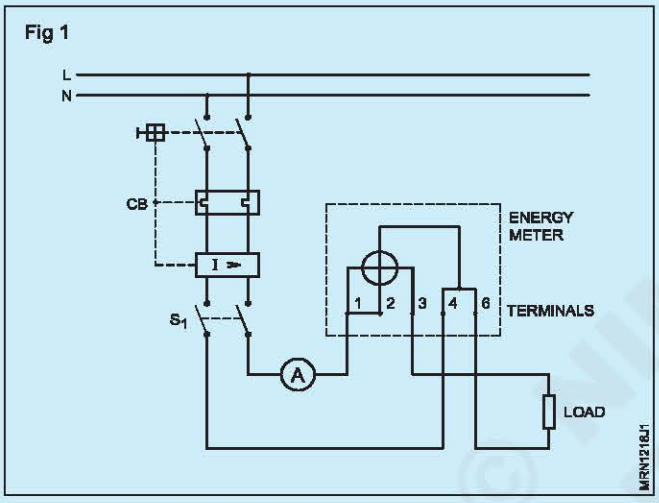
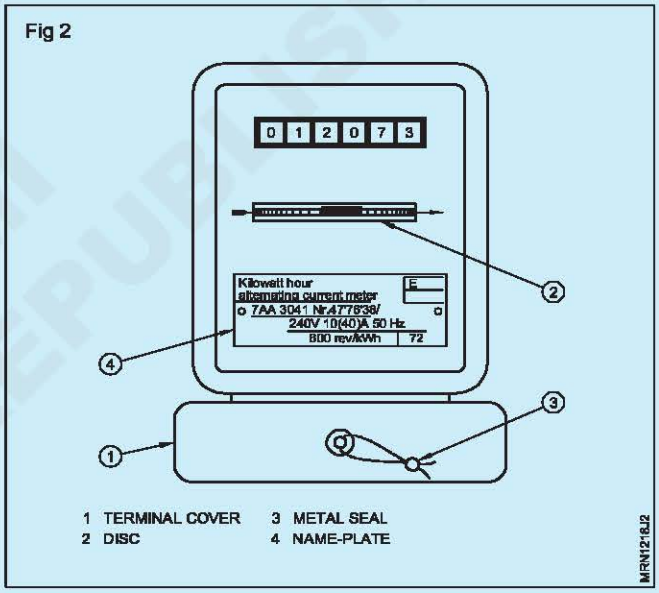


Fig 2



TASK 6: **Measurement of energy by the indirect method**

1 Select a suitable range of voltmeter and ammeter.

2 Connect the ammeter and the voltmeter to the line and load as shown in Figure 3.

3 Close the switch S of the circuit.

4 Start the stopwatch.

5 Observe the readings of the voltmeter and ammeter.

Watch the instruments constantly. No change in the reading should take place during the period of measurement.

6 Record the reading and time in the tabulation form (Table 1) after 30 seconds.

7 Calculate the energy with the given formula.

8 Repeat the steps 3 to 7 for 60 seconds and 90 seconds time and record the values of the ammeter and the voltmeter. Calculate the energy consumption.

Fig 3

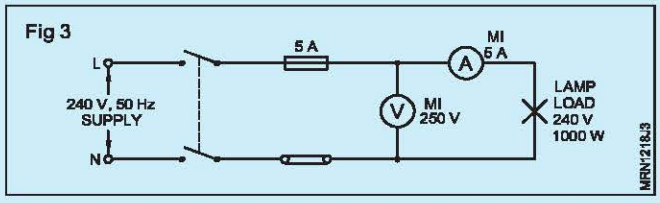


Table 1

Voltage (V)	Current (I)	Time(s)	Energy(Ws)

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Identify basic electronic components, tools and instruments

Objectives: At the end of this exercise you shall be able to
- **identify the passive components by visual inspection**
- **identify the active components by visual inspection**
- **identify the tools ans instruments and equipments.**

Requirements

Tools and Instruments

- Multimeter/ohm meter - 1 No.

Materials

- Assorted active and passive components like capacitors, Inductors, Resistor diodes assorted types etc - 5 Nos.each

PROCEDURE

TASK 1: **Identify the passive components by visual inspection**

Electronic components like resistors, inductors and capacitors few can be visually identified and other can be identified by coding only.

1 Identify the passive components referring to Fig 1. and write the type of passive component in table 1.

2 Sketch the appropriate symbol against the corresponding type of passive components in table 1.

3 Get your result corrected by your instructor.

4 Collect assorted size, shape and type of passive components from your instructor.

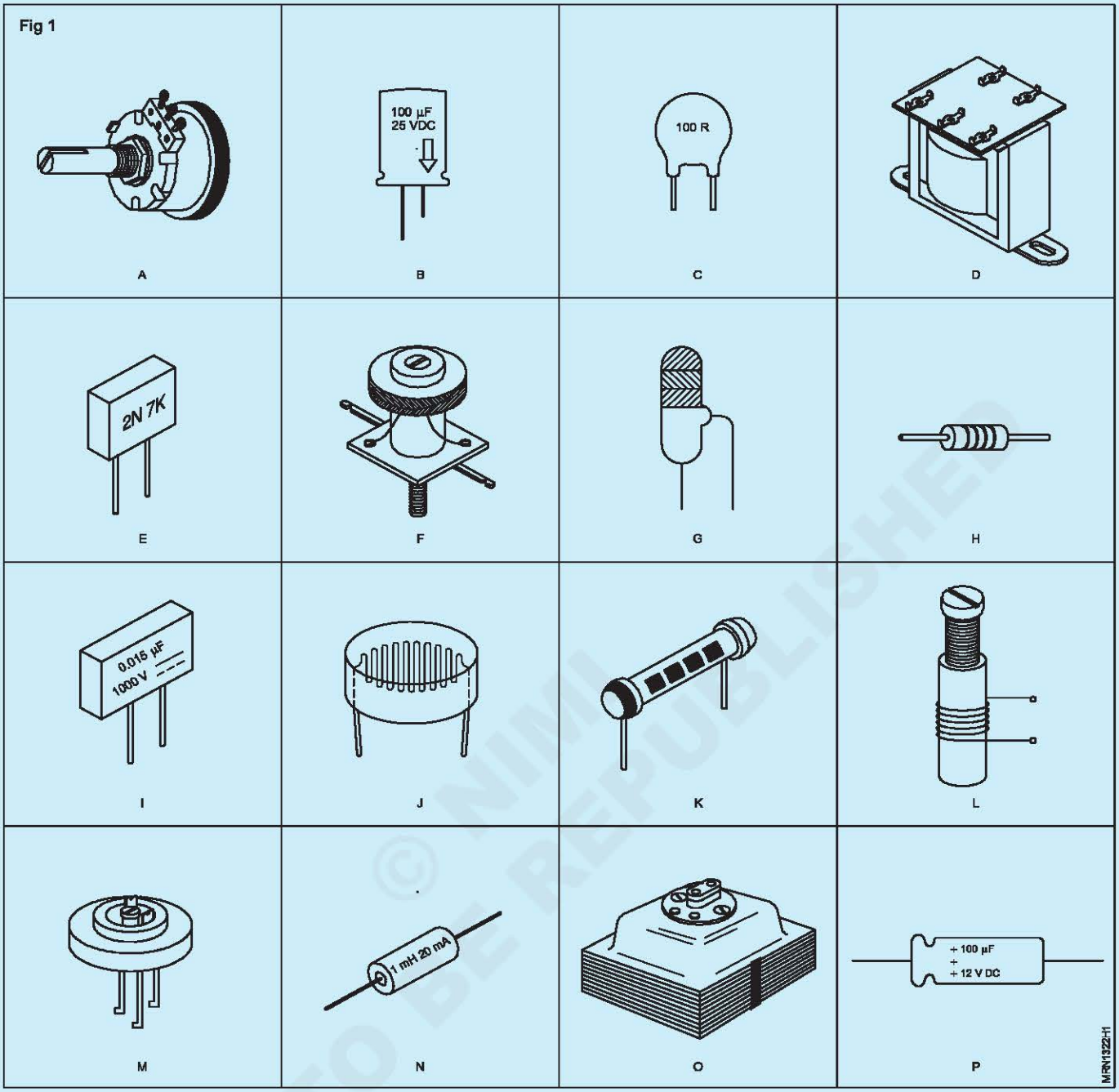
5 Divide the passive components into separate groups as resistor, inductor and capacitor by their appearances (or) code references.

TABLE 1

Sl.No	Fig Alphabets	Components Identified as	Reasons for Identifications	Symbols	Remarks
1	A				
2	B				
3	C				
4	D				
5	E				
6	F				
7	G				
8	H				
9	I				
10	J				
11	K				
12	L				
13	M				
14	N				
15	O				
16	P				

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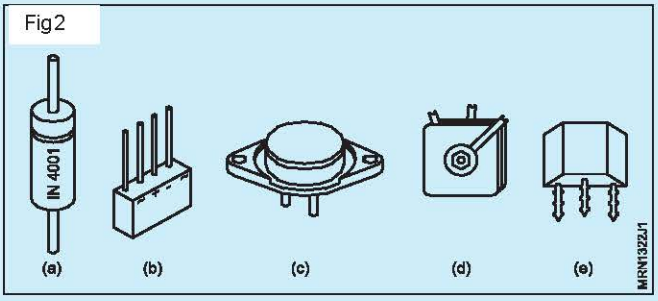
Fig 1



TASK 2: **Identify the active components by visual inspection**

Assumption : Given components have their code number, lead identification marks as well as related data books are available

Fig2



1 Look at the Fig 2. Identify the component from the pictorial representation. Give your response in Table 1.

TABLE 1

Sl. No.	Figure alphabets	Component's name
1	a	
2	b	
3	c	
4	d	
5	e	

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2 Write the figure Nos. that indicate the components given in Fig 3, in Table 2

Fig 3

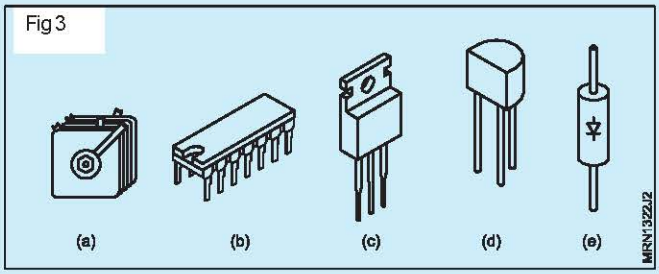


Table 2

Sl. No.	Figure number	Component's name
1		Transistor
2		Diode bridge
3		Integrated circuit
4		Diode

3 Match the names and pictorial representations of the active components shown in Fig 4. Record your response in the space provided.

Fig 4

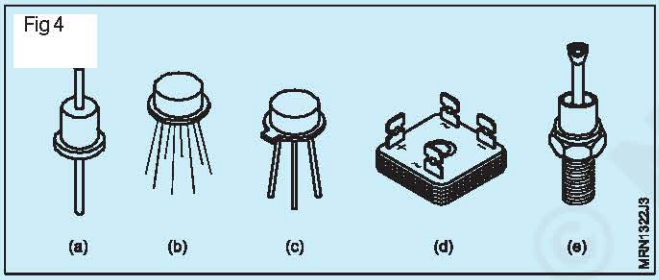


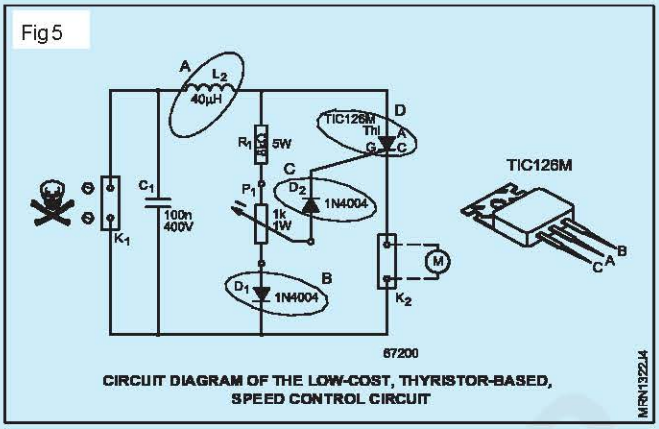
Table 3

Sl. No.	Component indicating symbol	Component's name
1	A	
2	B	
3	C	
4	D	
5	E	
6	F	
7	G	
8	H	
9	I	
10	J	

4 Collect the electronic (ACTIVE) components from your instructor. Identify the components and record your response in your record book along with sketches of the components. (Refer Fig 4 for guidance)

5 Identify the electronic components from the given circuit diagram Nos 5,6 and write the names of the components in the Table 4.

Fig 5



6 Decode and name the semiconductor devices from their letter designation given in Table No. 4 with the help of the data book.

Table 4

Sl. No.	Code No. of	Component's name
1	OA79	
2	DR25	
3	IN4007	
4	AA119	
5	BY127	
6	BZ148	
7	BC147	
8	2N904	
9	BD115	
10	BFW10	
11	3N187	
12	BTY87	
13	2N2646	
14	D3202Y	
15	T2801B	
16	CA741	
17	CA723	

7 Identify the leads by decoding the marking in the base diagram in the data book for the semiconductor devices.

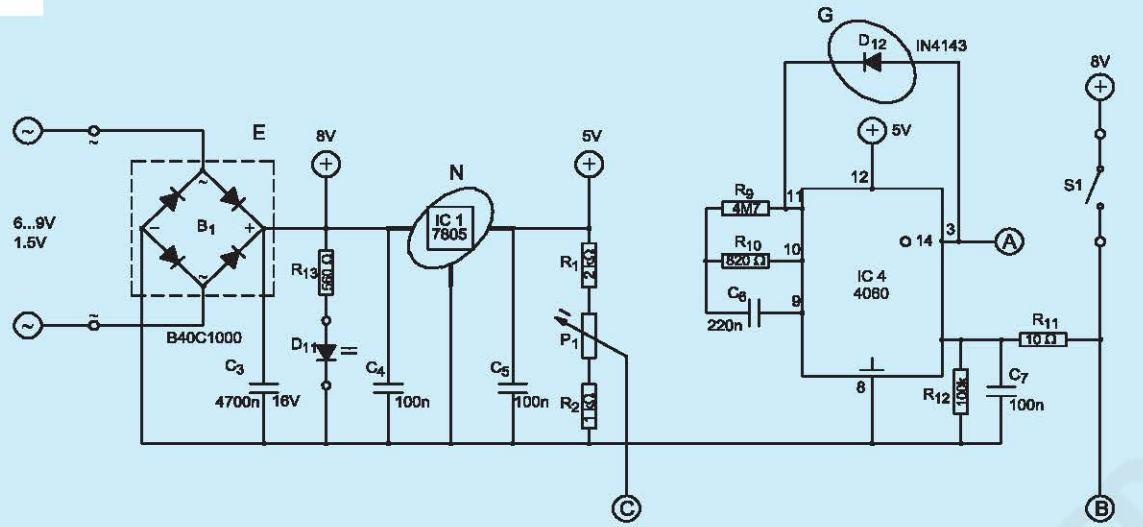
Draw a neat sketch against each item given below

Assumption :

A set of specified tools as given in this exercise are displayed on this work bench. Trainees are required to identify the tools given in the exercise and the tool name is allotted in column.

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Fig 6



A SECTION OF A BATTERY CHARGER CIRCUIT DIAGRAM

TASK 3: **Identify the tools and instruments and equipments.**

Identify the tools, instruments & equipments

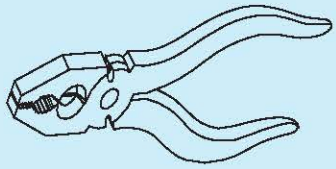
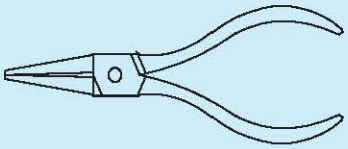
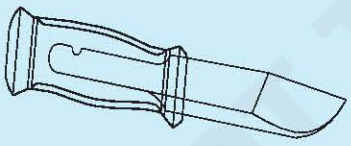
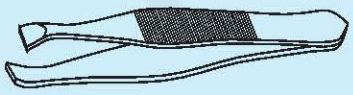
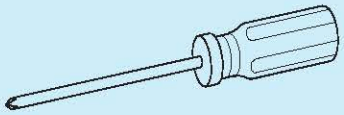
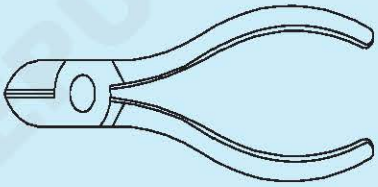
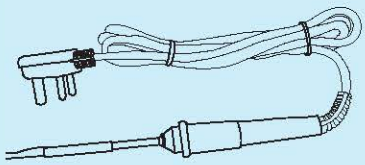
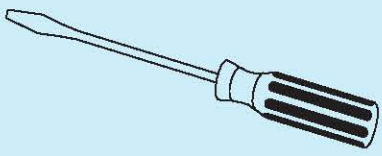
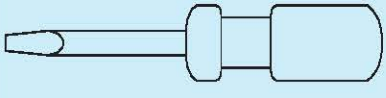
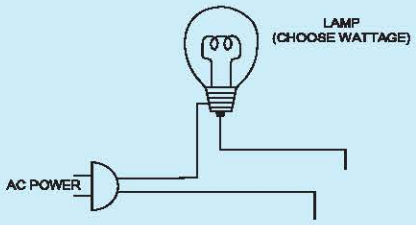
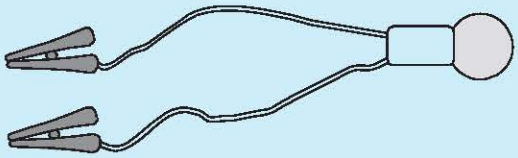
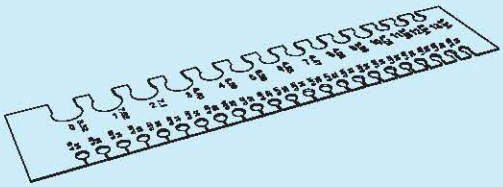
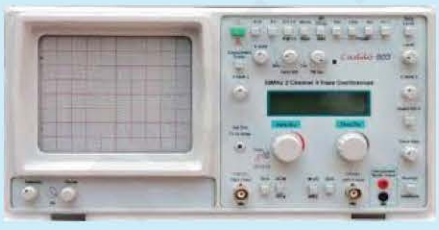
Figure	Name the tools
	
	
	
	
	

Figure	Name the tools
	
	
	
	

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Figure	Name the tools
	
	
	
	
	
	
	

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Colour coding of resistor

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

- **identify different types of fixed value resistors by their appearance and measure the value using ohmmeter.**

Requirements

Materials/Components

- Ohm meter / multimeter - 1No
- Assorted types & values of fixed value resistors - 20 Nos./batch.

PROCEDURE

TASK 1: **Identify different types of fixed value resistors by their appearance and measure the value using ohmmeter.**

1 Take a colour coded resistor from the given lot and identify the colours of bands starting from one end of the resistor as shown in Fig 1. Record the colours of the bands in Table 2 of record sheet.

2 Refer appendix D of this book and calculate the nominal, minimum, maximum value of the resistor. Record values in Table 2 of record sheet.

3 Repeat steps 1 & 2 for the remaining colour coded resistors and get your work checked by your instructor.

4 Decode the resistor value by using colour code chart.

5 Measure the value of the resistor by using ohm meter

6 Compare the calculate value with measured value.

Fig 1

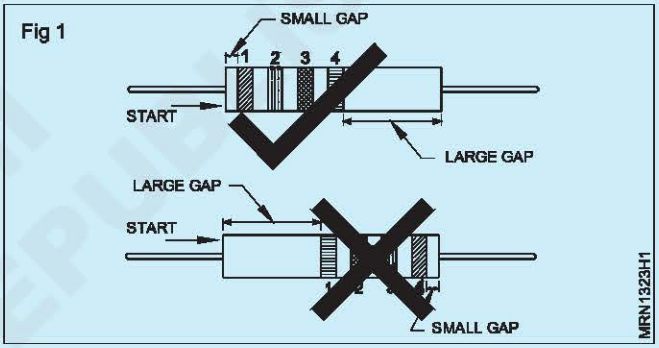
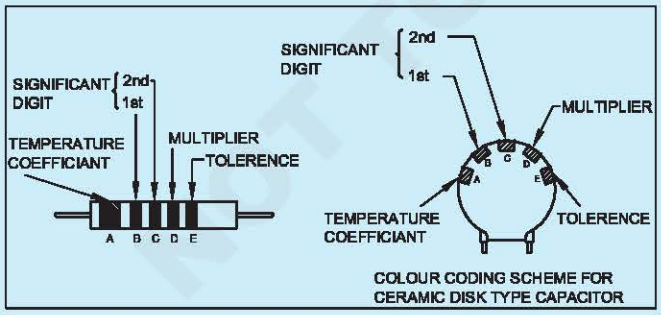


Table - 20/1 (LE: 8.01)

Coding scheme for ceramic capacitors



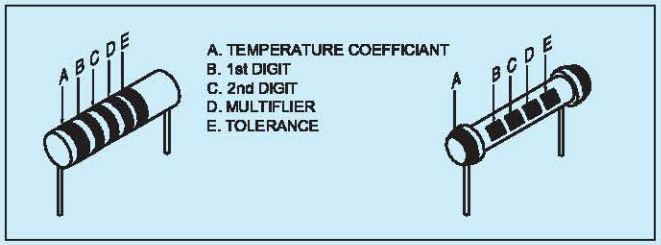


Table - 20/2 (LE: 8.01)

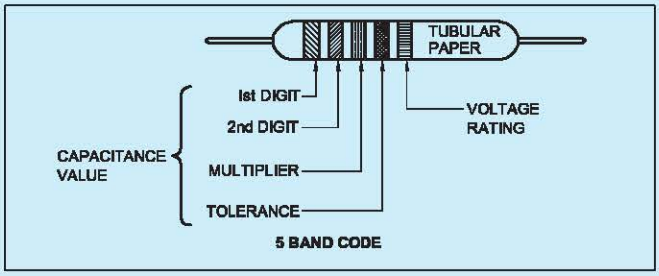
Colour	Temperature Coefficient	First Digit	Second Digit	Multiplier	Tolerance	
					More than 10pf (%)	Less than 10 pf (pf)
	(A)	(B)	(C)	(D)	(E)	
Black	0	0	0	1.0	±20	±2
Brown	-30	1	1	10	±1	---
Red	-80	2	2	100	±2	---
Orange	-150	3	3	1000	±3	---
Yellow	-220	4	4	10,000	±4	---
Green	-330	5	5	----	±5	±0.5
Blue	-470	6	6	----	±6	---
Violet	-750	7	7	----	±7	---
Gray	+30	8	8	0.01	±8	±0.25
White	+120 to -750	9	9	0.1	±10	±1
Gold	--	--	--	0.7	±5	--
Silver	--	--	--	0.01	±10	--

NOTE: Capacitance values formed using colour code is always in PF

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Table - 21/1 (LE: 8.01)

Coding scheme for moulded, tubular paper and mica capacitors



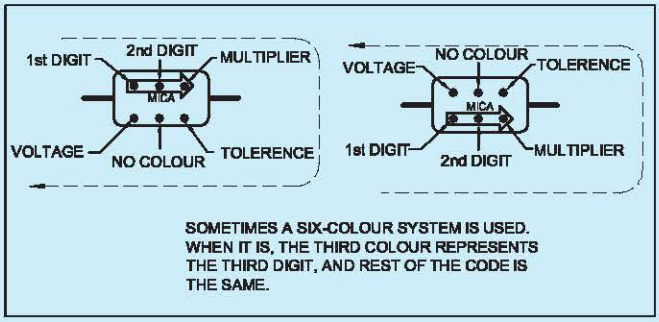


Table - 21/2 (LE: 8.01)

Colour	First Digit	Second Digit	Multiplier	Tole-rance	Voltage Rating (Volts)
Black	0	0	1	±20	100
Brown	1	1	10	±1	200
Red	2	2	100	±2	300
Orange	3	3	1000	±3	400
Yellow	4	4	10,000	±4	500
Green	5	5	1,00,000	±5	600
Blue	6	6	1,000,000	±6	700
Violet	7	7	10,000,000	±7	800
Gray	8	8	100,000,000	±8	900
White	9	9	1,000,000,000	±9	1000
Gold	--	--	0.1	±5	2000
Silver	--	--	0.01	±10	--

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Use voltmeter, Ammeter and multimeter

Objectives At the end of this exercise you shall be able to
- **use voltmeter and check voltage**
- **use Ammeter and check current**
- **operate multimeter**

Refer Ex. No 1.3.13
TASK-1, TASK- 2, TASK - 3

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Practice soldering and de-soldering

Objectives: At the end of this exercise you shall be able to
- **clean and tin lugs**
- **desolder of wires using soldering iron and nose piler**
- **desolder of using desoldering pump.**

Requirements

Tools Equipments/Instruments

- Trainee kit - 1 No
- Cleaning brush ,1/2 inch -1 No.

Materials/Components

- Lug board
- Single strand wire (hook-up wire) - 1 metre.
- Solder - 25 gms.
- Soldering flux - as reqd.
- De-soldering pump - 1No.

PROCEDURE

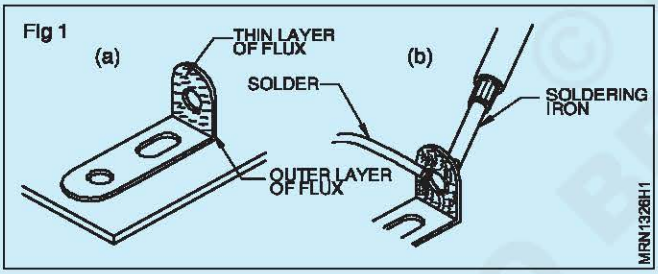
TASK 1: **Clean, tin and solder lugs**

1 Keep ready the soldering iron for soldering.

2 Check if the lugs of the lug board are bright/already tinned. If not, scrap the outer face of the lugs, using knife such that, the oxide layer/varnish is removed. Wipe the lugs with a piece of dry cloth.

3 Apply a thin layer of flux on the outer face of the lug as shown in Fig 1a.

Fig 1



4 To tin the lug, hold the bit of soldering iron at the inner face of lug no.1 and wait a seconds. Hold the tip of solder wire at the outer face of the lug as shown in Fig 1b. As the solder melts and flows on the lug, take out the solder wire and iron from the lug.

Refer Fig 5 for lug numbers.

Allow a very small quantity of solder to flow over the lug.

Do not shake the board till the melted solder dries up by itself.

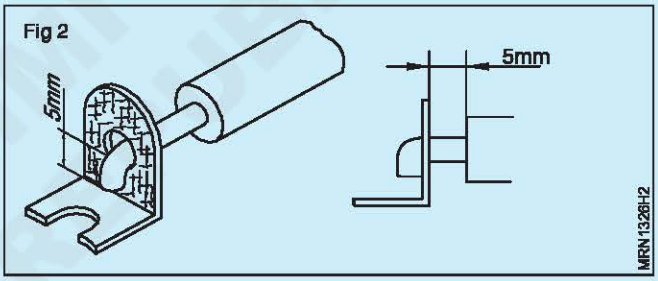
Do not blow air to cool the solder on the lug.

5 Repeat steps 3 and 4 tin all the lugs on the lug board. Get the tinned lugs checked by your instructor.

6 Skin one end of the given single strand wire to a length of 1 cm. Tin the exposed conductor.

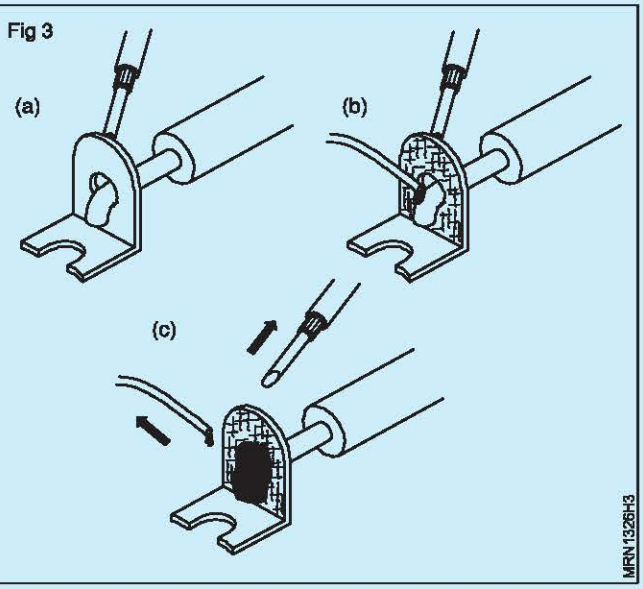
7 Insert and bend the tinned wire in lug 1 hole as shown in Fig 2.(side entry method)

Fig 2



8 As shown in Fig 3a, hold the bit of the soldering iron on the inner face of the lug without touching the wire for 1 to 2 seconds. Apply solder at the outer face of the lug as shown in Fig 3b. Once the solder melts and flows over the tinned wire and lug as in Fig 3c, take away the iron and solder from the lug.

Fig 3



Allow the solder joint to cool normally

If the joint cooled by blowing air, the joint will become a dry solder joint and, hence, will be a weak joint.

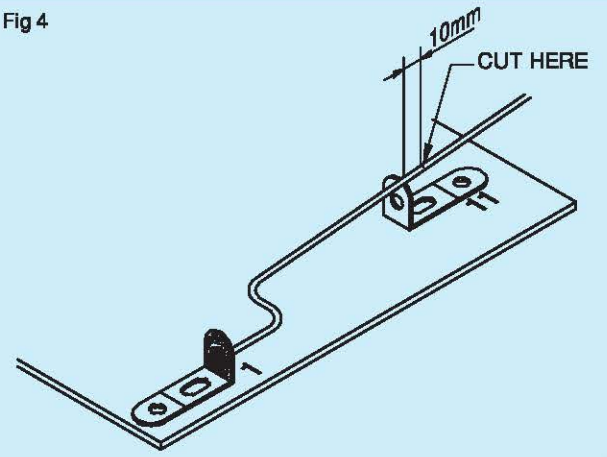
Shaking of wire/lug board before cooling result in dry solder joint.

9 Get the soldered joint checked by your instructor.

10 Take the wire along the path from, lug 1 to lug 11 as shown in Fig 4. Cut the wire at a point 10 mm ahead of lug 11.

Use flat nose piler to lay the wire.

Fig 4

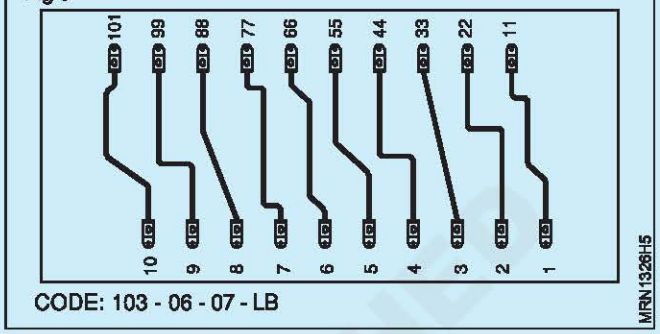


11 Skin the wire for 10 mm using a wire stripper and tin skinned end.

12 Insert the tinned wire end into the hole of lug 11, be the wire as done in step 8. Solder the wire as done step 9.

13 Follow steps 7 to 12 above to solder and bend the wire to obtain a wiring as close as possible to that shown in Fig 5.

Fig 5



14 Clean the soldered points using a brush to remove excess flux.

Excess of flux may corrode the lugs.

15 Get your work checked by your instructor.

Do not desolder/ remove the soldered wires on the lug board. This will be done as a separate exercise.

Observation and Tabulation sheet

Instructors remarks on

[ ] Tinned of lugs on the lug - board

V.Good [ ] Good [ ] Satisfactory [ ] Poor [ ]

[ ] Soldering of wire on the lug

V.Good [ ] Good [ ] Satisfactory [ ] Poor [ ]

[ ] Bending of wires between solder points

V.Good [ ] Good [ ] Satsifactory [ ] Poor [ ]

[ ] Completed board in respect of,

(i) Quality of soldering [ ]

(ii) Wire hamessing [ ]

(iii) Cleaning of solderd points [ ]

TASK 2: **Desoldering using a soldering iron and Nose plier**

1 Keep the soldering iron ready for soldering

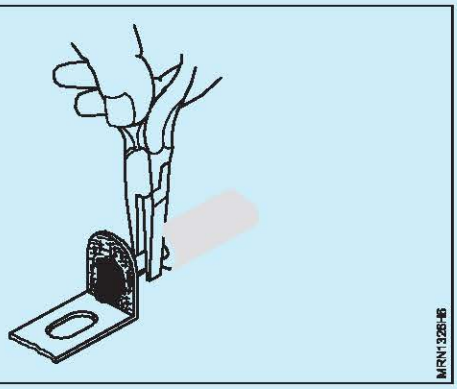
2 Wipe the tip of heated soldering iron on a rag, so as to remove the solder sticking on the tip.

3 Hold the exposed conductors of the wire with a sharp tip flat nose plier or tweezers as shown in Fig 6.

This prevents excessive heat transfer to the wire thus preventing melting of the wire insulation.

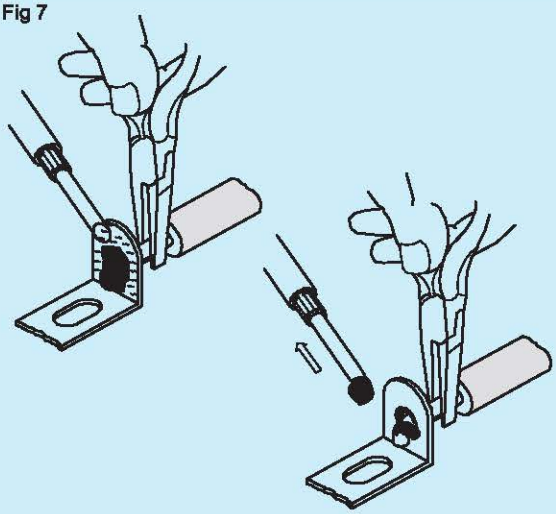
4 Hold the heated soldering iron tip on the soldered joint at lug 1 as shown in fig 7 till the solder at the joint carrying some of the melted solder with it as shown in Fig 7. Remove the solder on the iron tip by wiping the bit on a rag.

Fig 6



5 Repeat step 4, till the joint and the hole are almost free from solder.

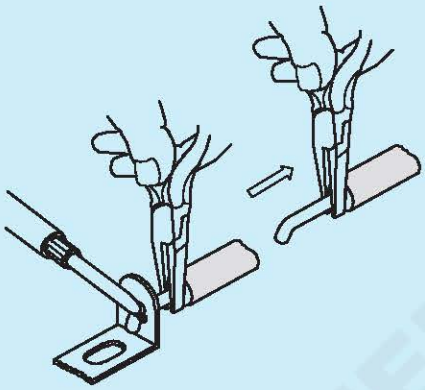
Fig 7



This makes the wire almost free for pulling it out from the lug.

6 Hold the cleaned tip of the iron at the outer face of the lug and pull the wire gently using a nose plier or tweezers as shown in Fig 8.

Fig 8



7 Remove the residual solder sticking to lug 1 using soldering iron such that the lug hole is clear of solder.

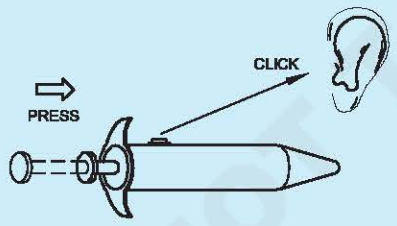
8 Get the desoldered point checked by your instructor.

9 Repeat steps 2 to 7 and desolder the wires at lugs 2 to 10 as in Fig 12

TASK 3: **Desoldering using hand held desoldering pump.**

1 Press the handle of the desoldering pump fully as shown in Fig 9 till it makes a click sound, and release the handle.

Fig 9



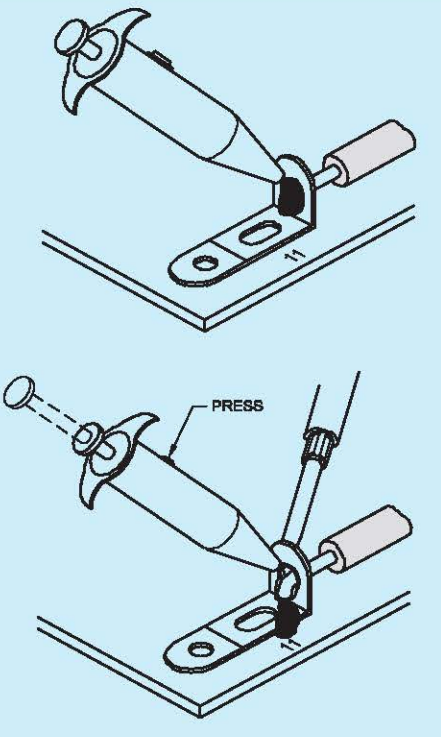
2 Hold the pump nozzle at lug no. 11 of lug board as shown in Fig 10a.

3 Hold the heated tip of the iron at the inner face of lug as shown in fig 10b till the solder melts. With the pump nozzle touching the melting solder at the joint press the pump button.

The pump sucks the molten solder.

4 Take away the iron and pump from the lug. Check if the solder at the joints is sucked off and the lug hole is clear. If not repeat steps 1 to 3 till the hole is almost clear.

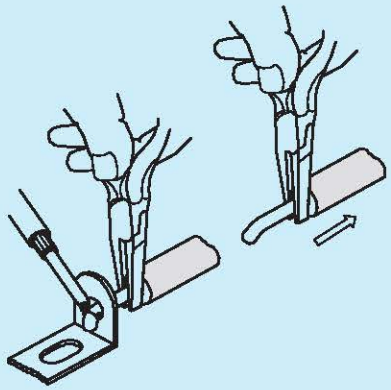
Fig 10



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5 Clean the tip of iron and hold at the outer face of the lug. Pull out the wire from the lug as shown in Fig 11

Fig 11



Do not force the wire out as the wire may get cut. if the wire is not coming out easily, repeat steps 1 to 5

6 Get the desoldered point checked by your instructor.

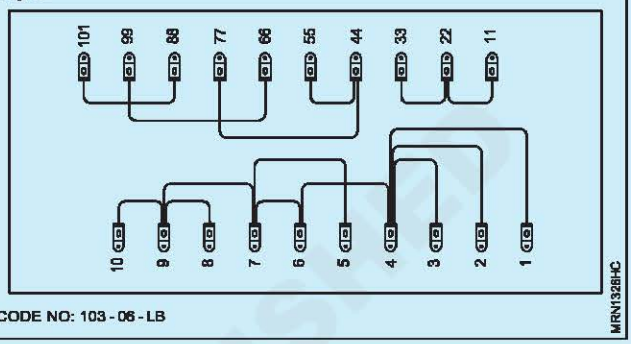
7 Repeat steps 1 to 5 desolder wires at lug no.11 to 101 as in (Fig 12)

8 Get your work checked by your instructor.

ASSIGNMENT :

As a practice of soldering, solder back the desoldered wires on the lug board as shown in Fig 12. After getting it checked, desolder the wires and get it checked.

Fig 12



Observation and Tabulation Sheet

[ ] Instructors remarks on

[ ] Desoldered wire from lug board :

(using soldering iron and nose player)

V,Good	Good	Satisfactory	Poor

[ ] Additional marks for the optional Lab assignment, if done.

[ ] Desoldered wire from lug board

(using soldering iron and desoldering pump)

V.Good	Good	Satisfactory	Poor

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Identify transistors, resistors, capacitors, diodes, SCR, UJT amplifier and IC

Objectives: At the end of this exercise you shall be able to
- **identify the passive components by visual inspection**
- **identify the active components by visual inspection**

Identify transistors, resistors, capacitors, diodes, SCR, UJT, complifier and IC

Refer ex No 1.4.14 TASK -1, and TASK - 2

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Construct and test full-wave rectifiers using diodes

Objectives : At the end of this exercise you shall be able to
- **construct and test a full wave rectifier using two diodes.**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No.
- CRO, 20 MHz, dual trace - 1 No.

Materials/Components

- Tag board code: 109-02-TB (soldered with diode and resistor at - 1 No.
- BASE BOARD (Wooden) - 1 No.
- Step-down transformer, 240V: 12-0-12V, 24VA - 1 No.
- Multi-strand wire, Red, Blue - as reqd.
- Mains cord with 2-pin plug - 1 No.
- Resistors 470 1/2,w - 1 No.
- Nuts, bolts and washers - as reqd.
- Hook-up wires (red and black) - as reqd.
- Semiconductor diode, 1N 4007 or Equivalent - 2 Nos.

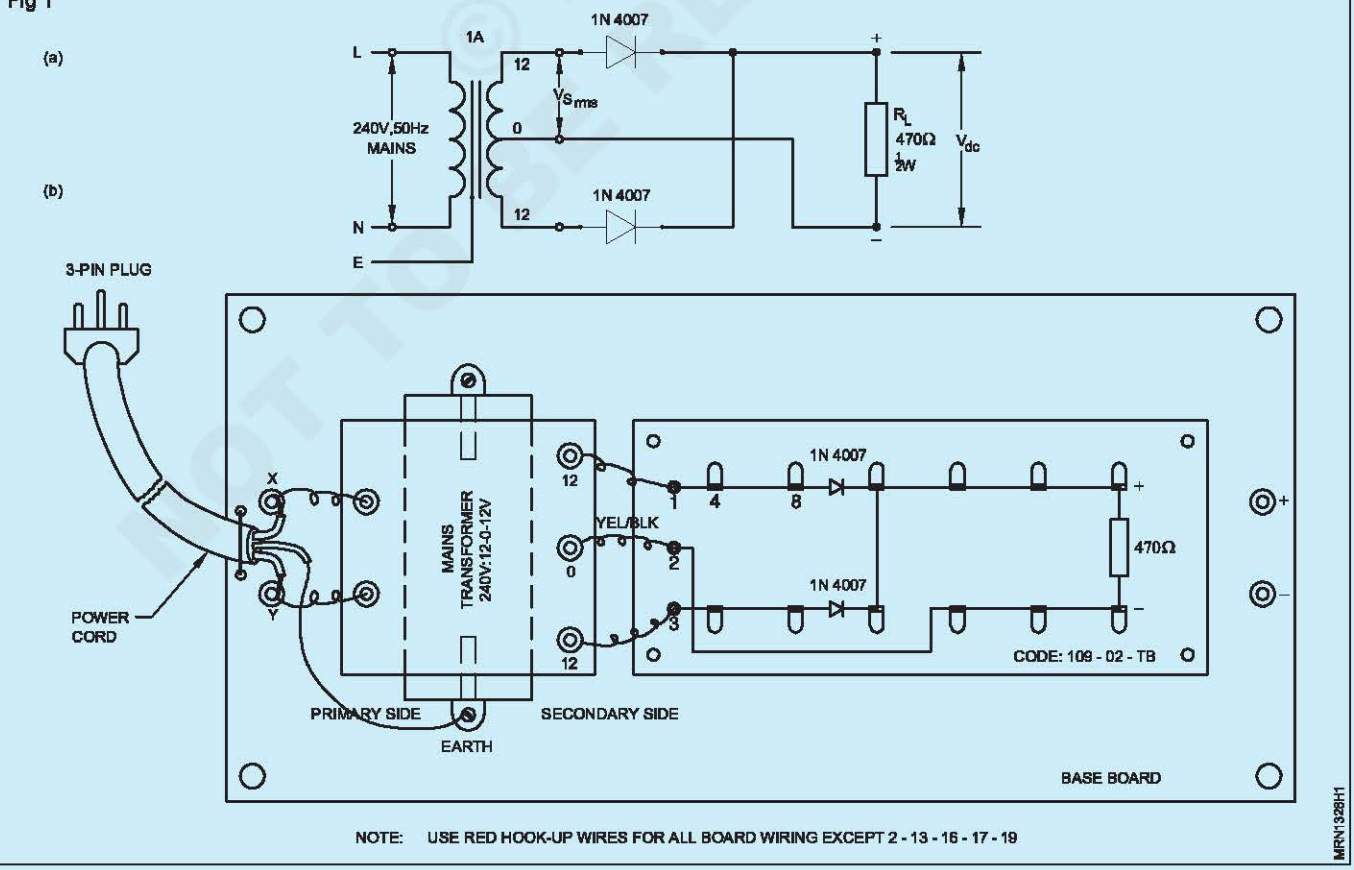
PROCEDURE

TASK 1: **Construct and test a Full wave rectifier using two diodes.**

1 Construct a full wave rectifier as shown in Fig 1. Check the components before soldering in the circuit.

2 Power-on the circuit. Measure and record the AC input $V_{S(rms)}$ to the rectifier across the center-tap and any one end of the transformer.

Fig 1



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3 Calculate and record the expected DC voltage across load R_L using the formula given below;

In a full wave rectifier, $V_{dc} = 0.9 \times V_{S(rms)}$,

where, $V_{S(rms)}$ is the voltage across the centre-tap and any one end terminal of the secondary.

4 Measure and record the rectified output V_{dc} across R_L.

5 Find and record the difference in the calculated and measured values of output DC voltage.

6 Using CRO measure and record the following;

- Peak value of V_S
- Frequency of V_S
- Peak value of pulsating V_{dc}
- Frequency of pulsating V_{dc}

7 Get the waveforms and recorded readings checked by youth instructor. Switch of Mains supply and CRO.

8 Fill the recorded datas in Table 1

Table 1

Transformer specification

1 Rated primary voltage :

2 Rated secondary voltage :

3 Rated secondary current or VA rating transformer :

Readings of two-diode full-wave rectifier

$V_{s(rms)}$	Calculated V_{dc} volts	Measured V_{dc} volts	Difference of (2) & (3)	Peak value of V_s	Frequency of V_s	Peak value of pulsating V_{dc}	Frequency of pulsating V_{dc}
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

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Construct and test a bridge rectifier

Objectives: At the end of this exercise you shall be able to
- **construct the bridge rectifier**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No.
- CRO 20 MHz, dual trace - 1 No./batch.
- Hook-up wires (red and black) - as reqd.
- Semiconductor diode, 1N 4007 or Equv., - 2 Nos.
- Resistor 470 ohms, 1/2 w - 1 No.

Materials/Components

- Tag board mounted with transformer and wired full wave rectifier(2 diode) - 1 No.

PROCEDURE

TASK 1: **Construct and test a Bridge rectifier**

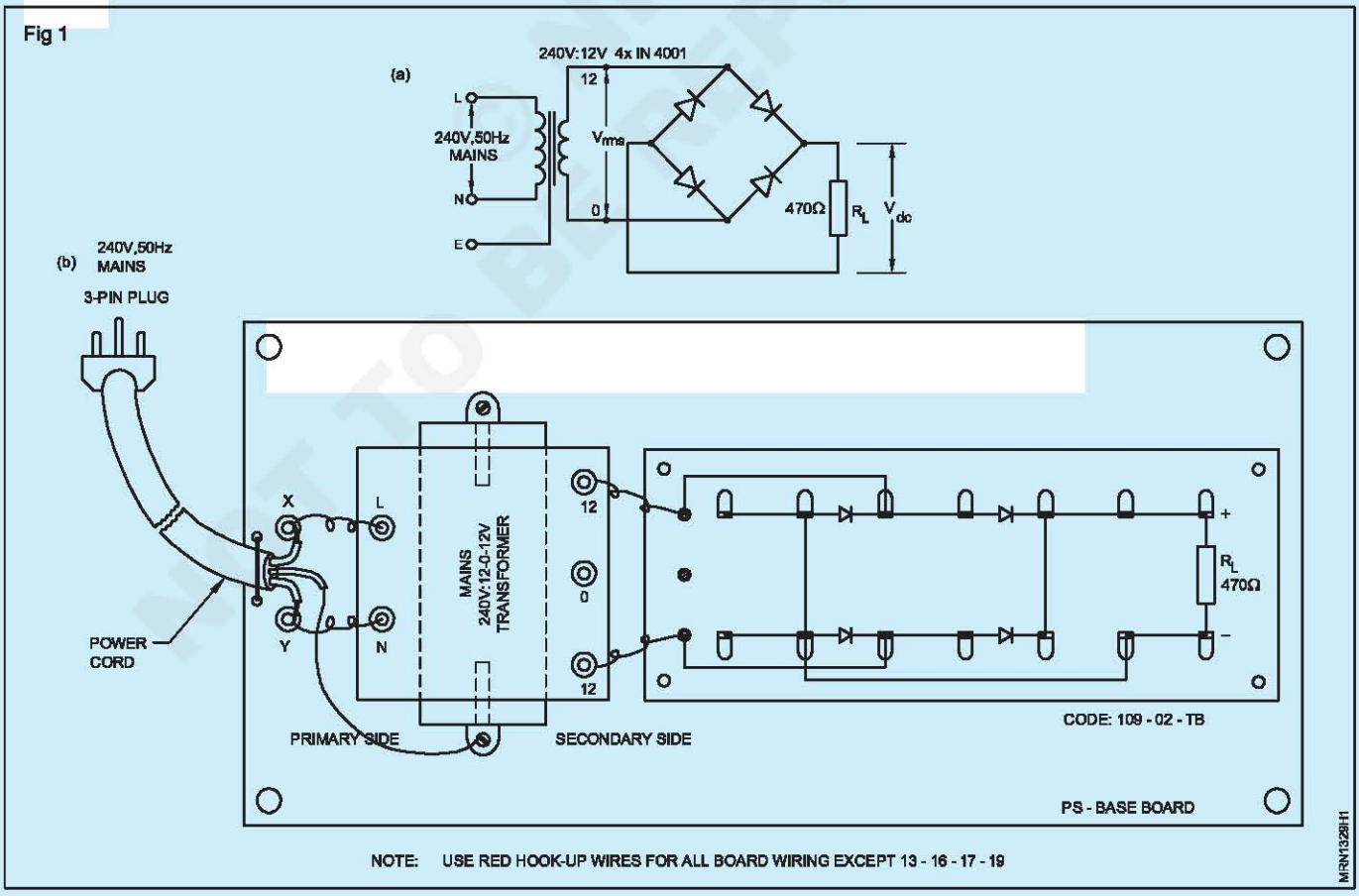
1 Measure the primary and secondary output voltages/ currents of transformer. Record values in record sheet.

2 Modify the two diode full wave rectifier wired in exercise 1.2.27 to construct a bridge rectifier as shown in Fig 1. Test the two new diodes to be used before assembling.

3 Get the wired circuit checked by your instructor.

4 Power-on the wired circuit. Measure and record the AC input $V_{S(rms)}$ to the rectifier in record sheet.

Fig 1



NOT TO BE PUBLISHED

5 Calculate and record the expected output DC voltage V_{dc} 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 rectifier(refer Fig 1)

6 Measure and record the output DC voltage V_{dc} across the load R_L in record sheet.

7 Record the difference in the calculated and measured values.

8 Using a CRO measure and record the peak ac input voltage to the rectifier, peak value of pulsating DC voltage and ripple frequency.

9 Show the waveforms and recorded reading to your instructor.

10 Change the value of the load resistor $R_{L\,9}$ from 470 ohms to 220 ohms and repeat steps 6,8 and 9.

11 Switch- off mains supply and CRO.

12 Get it checked by your instructor

Observation and Tabulation sheet

Transformer specification

1 Rated primary voltage :

2 Rated secondary voltage :

3 Rated secondary current or VA rating transformer :

II Readings of Bridge rectifier with Load resistance of 470 Ohms.

Table 1

$V_{s(rms)}$	Calculated V_{dc} volts	Measured V_{dc} volts of	Difference ②&③	Peak value of V_s	Frequency of V_s	Peak value of pulsating V_{dc}	Frequency of pulsating V_{dc}
①	②	③	④	⑤	⑥	⑦	⑧

III Readings of Bridge rectifier with Load resistance of 220 Ohms.

Table 2

$V_{s(rms)}$	Calculated V_{dc} volts	Measured V_{dc} volts of	Difference ②&③	Peak value of V_s	Frequency of V_s	Peak value of pulsating V_{dc}	Frequency of pulsating V_{dc}
①	②	③	④	⑤	⑥	⑦	⑧

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Identify gas welding equipment and accessories

Objectives: At the end of this exercise you shall be able to
- **identify the gas welding equipments**
- **identify the gas welding accessories**
- **identify the gas welding safety accessories.**

Requirements

Tools/Instruments

- Oxygen gas regulator - 1 set
- Acetylene gas regulator - 1 set
- Cylinder key - 1 No.
- Welding/brazing torch - 1 No.
- Oxygen rubber hose - as reqd length mts.
- Acetylene rubber hose - as reqd length mts.
- Eye goggle - 1 No.
- Spark lighter - 1 No.

Equipment/Machines

- Cylinder trolley - 1 No.

Materials

- Cylinder with oxygen - 1 No.
- Cylinder with acetylene - 1 No.

PROCEDURE

TASK 1: **Identify gas welding equipment**

Fig 1

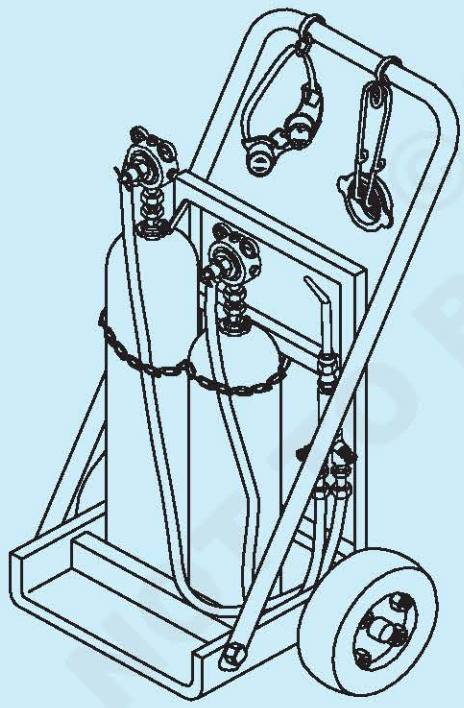
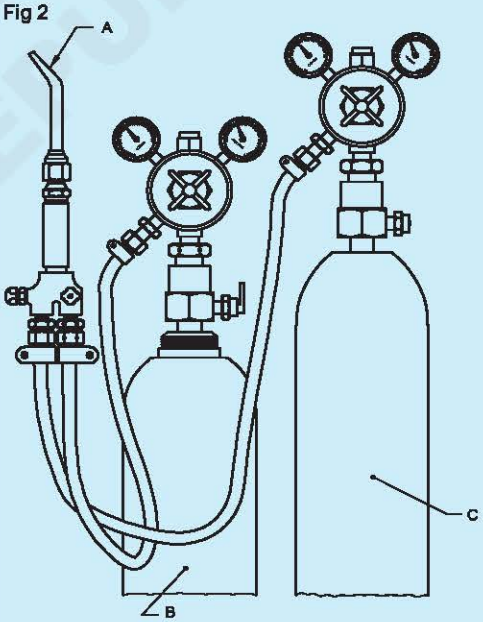


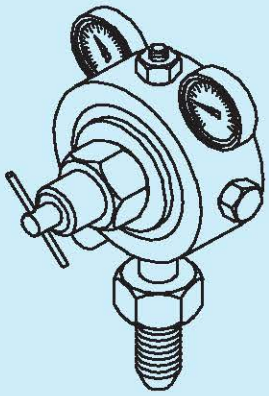
Fig 2



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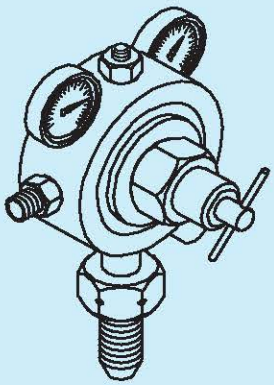
TASK 2: **Identify the gas welding accessories**

Fig 3



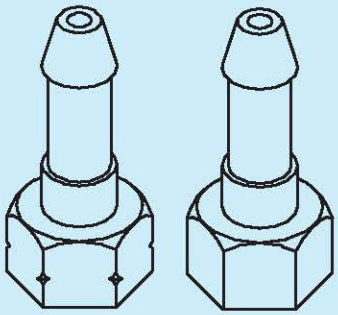
MRN1435H3

Fig 4



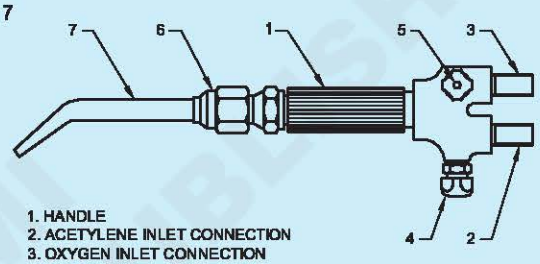
MRN1435H4

Fig 5



MRN1435H5

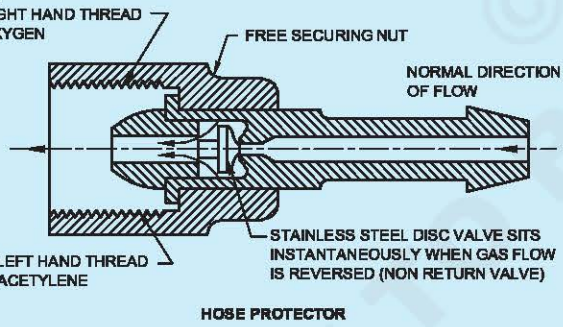
Fig 7



1. HANDLE
2. ACETYLENE INLET CONNECTION
3. OXYGEN INLET CONNECTION
4. ACETYLENE CONTROL VALVE
5. OXYGEN CONTROL VALVE
6. MIXING CHAMBER
7. NECK PIPE WITH NOZZLE

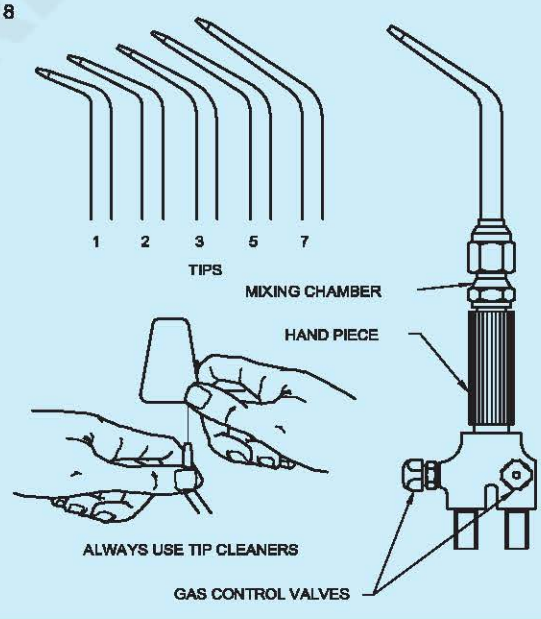
MRN1435H7

Fig 6



MRN1435H6

Fig 8



MRN1435H8

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TASK 3: **Gas welding safety accessories**

Fig 1

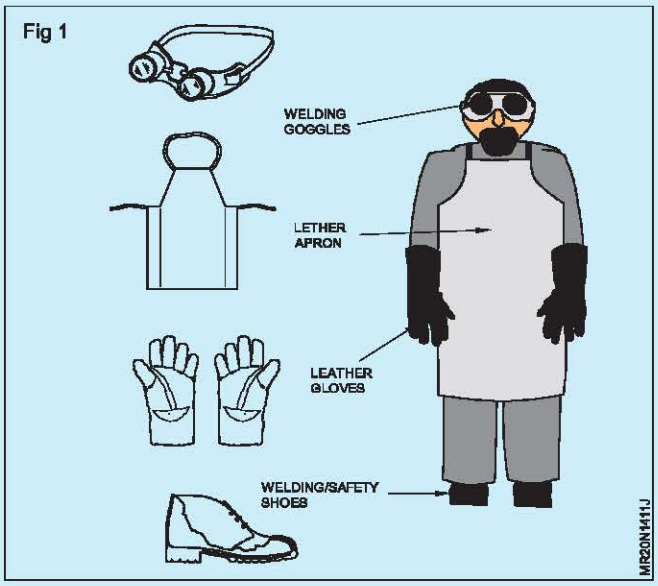


Table 1

Gas welding EQU	Accessories	Safety accessories

Identify complete accessories of gas welding (oxy-Acetylene) & record in a table.

- Check with your instructor.

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Demonstrate safety precaution in handling of Oxy- Acetylene of cylinder, regulators etc

Objectives: At the end of this exercise you shall be able to
- **storage and handle of cylinder**
- **test the gas leakages**
- **wear personnel protective equipments**
- **operate the cylinder, Regulator and light the torch**
- **care and maintain gas welding set.**

Requirements

Tools/Instruments

• Weld man Torch	- 1 No
• Commercial O_2 Cylinder	- 1 No.
• Commercial LPG Cylinder	- 1 No.
• Oxygen Regulator	- 1 No.
• LPG Regulator	- 1 No .
• Hose pipe (Red & Black)	- 2 Nos.
• Torch with Nozzles	- 1 Set.
• Back fire arrestor	- 2 Nos.
• Hose clamps $^1/_2$	- 4 Nos.
• Acetylene gas regulator	- 1 set
• Cylinder key	- 1 No.

Equipment/Machines

• Cylinder trolley	- 1 No.
• Oxy-acetylene welding brazing set	- 1 No.

Materials

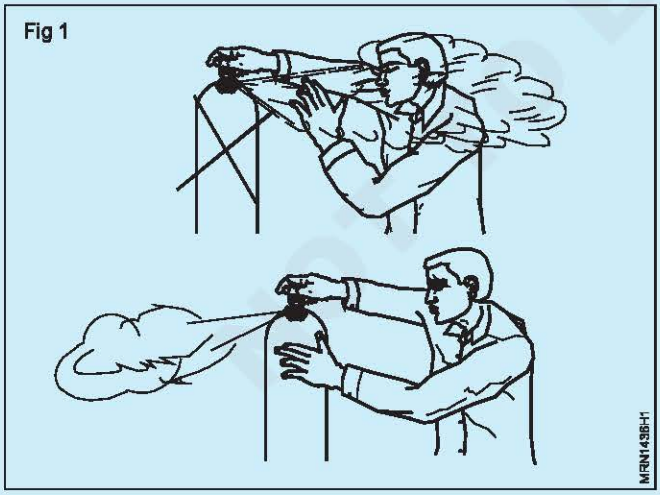
• Weld man gas Tin	- 1 No.
• Oxygen rubber hose length mts.	- asreqd
• Acetylene rubber hose lengthmts.	- as reqd
• Eye goggle	- 1 No.
• Spark lighter	- 1 No.
• Safety apparel	- 1 Set
• Spark lighter	- 1 No.

PROCEDURE

TASK 1: **Storage and Handling of cylinder**

1 Stand opposite side of valve opening while cracking (flushing) the cylinder valve (Fig 1).

Fig 1



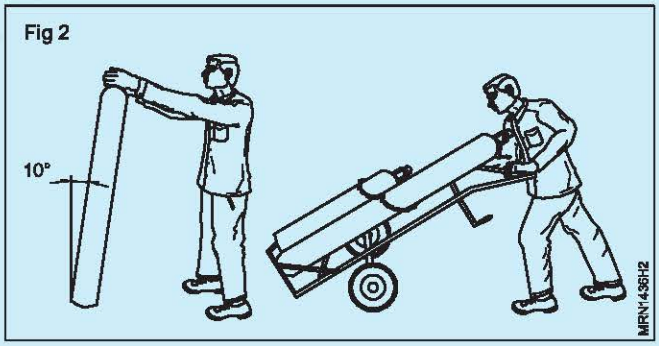
2 Securely chain equipment to prevent falling.

3 Store away from flammable and combustible

4 Store extra gas and oxygen cylinders separately.

5 Roll cylinder on bottom edges to move - Do not drag. (Fig 2)

Fig 2



6 Close cylinder valves before moving.

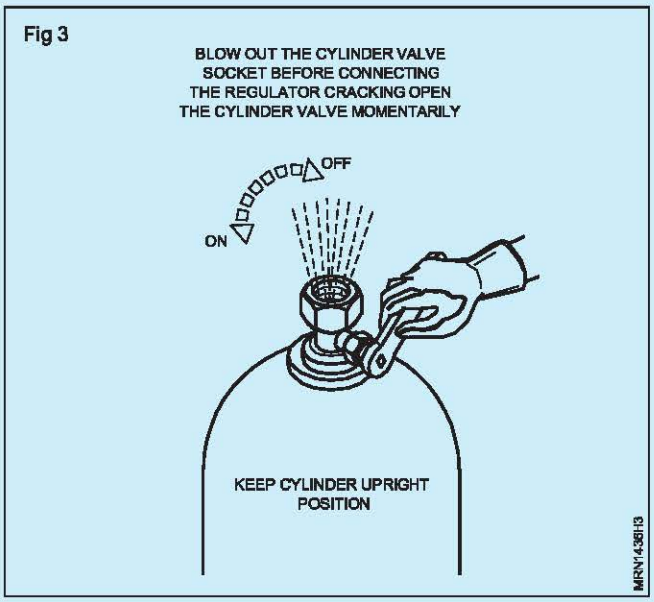
7 Protective caps or regulators should be kept in place.

8 Store in an upright position (Fig 3)

9 Allow very little movement when transporting.

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Fig 3



TASK 2: **Test the gas leakages**

1 Use a spark lighter to ignite the flame. (Fig 4)

2 Inspect hoses for leaks and worn places.

3 Replace bad hoses.

4 Protect hoses and cylinder from sparks, flames and hot metal.

5 Inspect equipment for leaks at all connection using approved leak-test solution. (Fig 5 a & b)

Fig 4

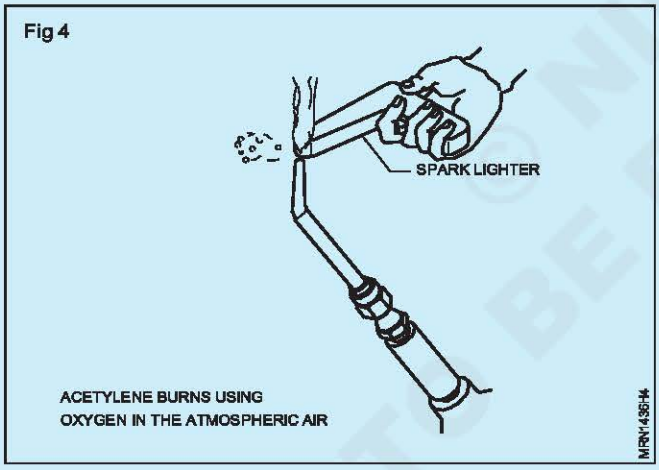
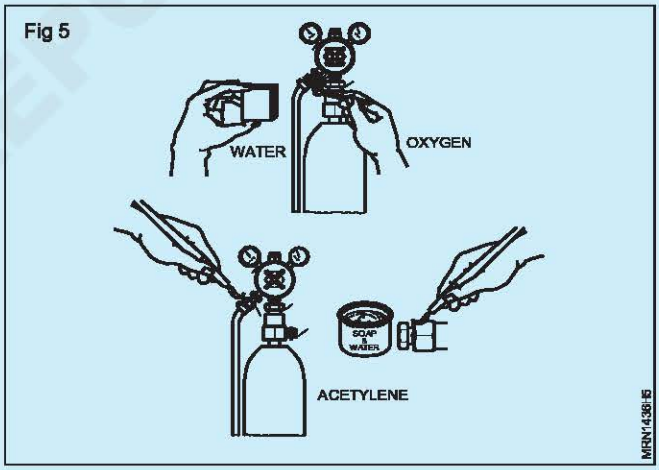


Fig 5



TASK 3: **Wear Personnel Protective Equipment**

1 Infrared radiation is a cause of retinal burning and cataracts. Protect your eyes with safety goggles.

2 Protect your body from welding and arc flash with protective clothing. Such as :

- Woolen clothing
- Flame-proof apron
- Gloves
- Properly fitted clothing that is not frayed or worn
- Shirts should have long sleeves
- Trousers should be straight -legged and covering shoes when arc welding.
- Fire resistance cape or shoulder covers are needed for overhead work.
- Check protective clothing equipment before each use to make sure it is in good condition.
- Keep clothes free of grease and oil.

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TASK 4: **Operate the cylinder, Regulator and light the torch.**

1 Stand to the side (away form the regulators) when opening cylinder valves.

2 Open cylinder valves very slowly to avoid sudden high pressure from exploding the regulators.

3 Only open the acetylene cylinder valve 1/4 - 3/4 turn; leave wrench in place so the cylinder can be quickly closed in an emergency.

4 Open and light acetylene first, then open and adjust oxygen to a flame.

5 Close the acetylene torch valve first when shutting off the torch (a "pop" might occur as the oxygen "blows out" the flame but this eliminate the possibility of the flame burning up the acetylene line).

6 When finished, close cylinder valves, bleed the lines to take pressure off regulators, neatly coil hoses and replace equipment.

7 Have a fire extinguisher easily accessible at the welding site.

— — — — — — — —

TASK 5: **Care and maintenance of Gas welding set**

1 Proper ventilation

- Be sure there is adequate ventilation available when welding in confined areas or where there as barriers to air movement. Natural drafts fans and positioning of the head can help keep fumes away from the welder's face.

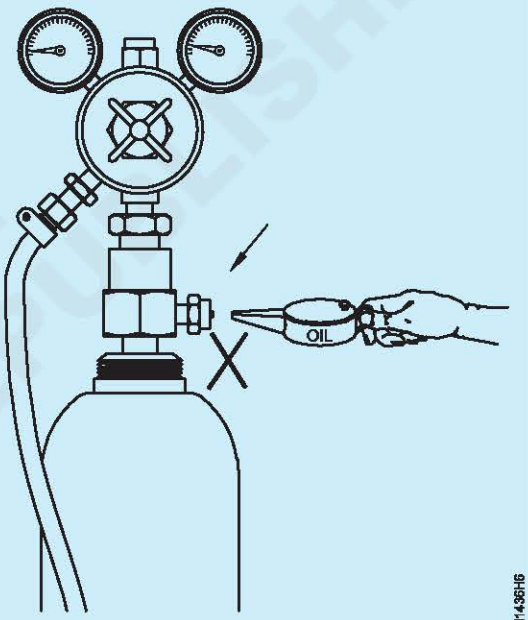
2 Proper infrastructure

- The room or welding area contains at least 1,000 cubic feet for each welder.
- Ceiling height is not less than 16 feet.
- Cross ventilation is not blocked by partitions, equipment or other structural barriers.
- Welding is not done in a confined space.

3 Safety concern

- Proper personal protective equipment is important.
- Acetylene is very flammable.
- Inspect all equipment before welding.
- If ventilation is not sufficient, then the welding area should be equipped with mechanical ventilation equipment.
- Always have a fire extinguisher ready for immediate use.
- Do not put oil or any lubricant in threaded surface. (Fig 6)

Fig 6



— — — — — — — —

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Setting up of Air-LPG and using can type portable flame set O_2-LPG and O_2-C_2-H_2 flame set

Objectives: At the end of this exercise you shall be able to:
- **set up AIR - LPG brazing set (Single torch)**
- **set up OXY- LPG gas welding set**
- **set up an oxy - acetylene welding plant**
- **set gas pressure according to the nozzle size**
- **ignite, adjust and extinguish oxy-acetylene flame**
- **split the oxy-acetylene plant for stopping work.**

Requirements

Tools/Instruments

• Weld man Torch	- 1 No
• Commercial O_2 Cylinder	- 1 No.
• Commercial LPG Cylinder	- 1 No.
• Oxygen Regulator	- 1 No.
• LPG Regulator	- 1 No .
• Hose pipe (Red & Black)	- 2 Nos.
• Torch with Nozzles	- 1 Set.
• Back fire arrestor	- 2 Nos.
• Hose clamps $^1/_2$	- 4 Nos.
• Acetylene gas regulator	- 1 set
• Cylinder key	- 1 No.

Equipment/Machines

• Cylinder trolley	- 1 No.
• Oxy-acetylene welding brazing set	- 1 No.

Materials

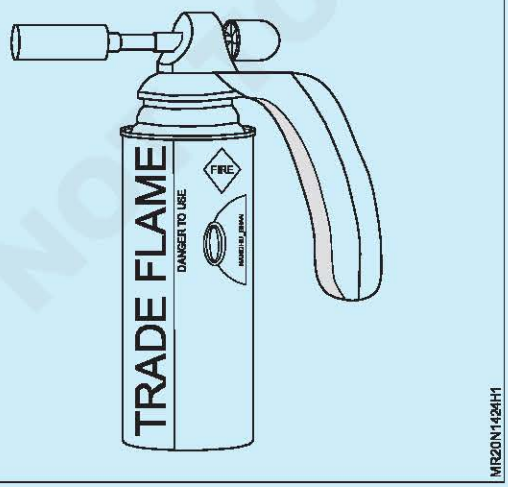
• Weld man gas Tin	- 1 No.
• Oxygen rubber hose length mts.	- asreqd
• Acetylene rubber hose lengthmts.	- as reqd
• Eye goggle	- 1 No.
• Spark lighter	- 1 No.
• Safety apparel	- 1 Set
• Spark lighter	- 1 No.

PROCEDURE

TASK 1: **Setting up AIR - LPG single torch**

1 Take the Butane fuel tin & open the sealed cap. Fig 1.

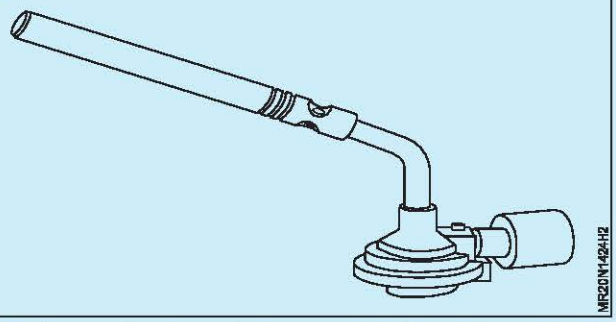
Fig 1



2 Hold the Butane fuel tin vertical position facing the valve up. Fig 2.

3 Place the torch on top of the tin valve.

Fig 2



4 Make sure torch seated properly in the slot provided in the fuel tin.

5 Gently press the torch & rotate the torch clock wise.

6 Check torch seated firmly & there is no leak.

7 Use Soap Solution & Check the leakage

8 Open the Valve & Ignite the flame.

9 Adjust the neutral flame by varying the valve & flow of fuel Quantity (Fig 3)

10 Close the valve & shut the flame after work is over.

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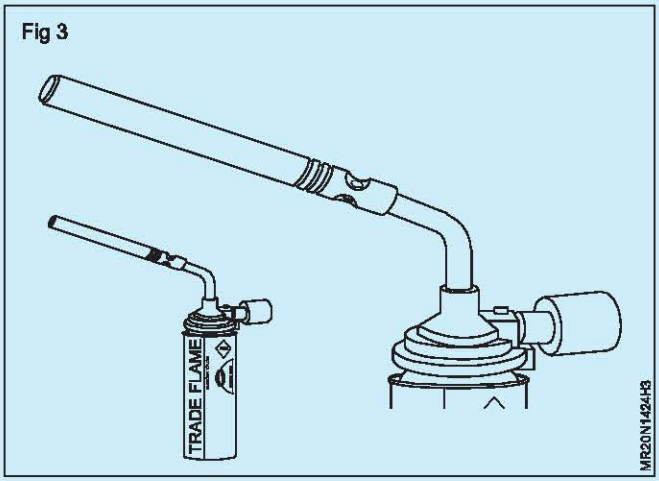
Note : Do not store butane tin above 50°C temp.

Keep flammable materials away from work.

Make sure proper ventilations available.

Do not bend gas tin horizontal during brazing since liquid comes out .

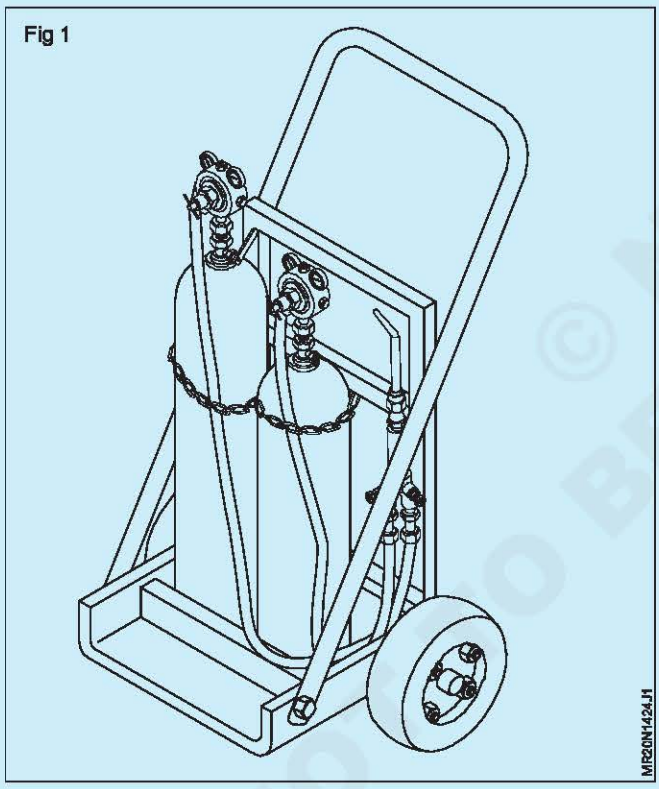
Fig 3



TASK 2: **Set OXY- LPG Gas welding set**

1 Crack the oxygen cylinder valve once.

Fig 1

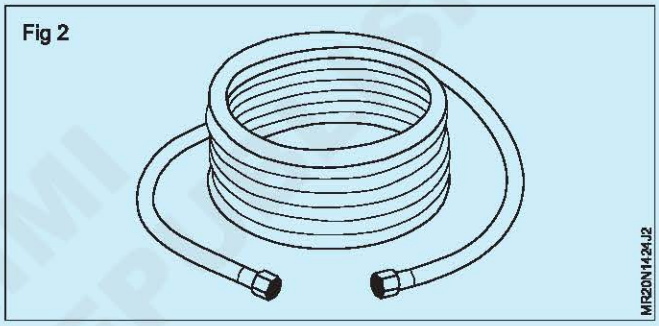


2 Fix the regulator to the Oxygen & LPG Cylinder.

3 Attach rubber hoses to regulators(Fig 2)

- Black colour for oxygen
- Red/Maroon hose for LPG.

Fig 2



4 Fix backfire arrestor / Non return valve before connecting hose pipe. Fig 3.

5 Attach blow pipe to the other end of the hose.

6 Tighten the rubber hose with the clamp

7 Open the cylinder valve and adjust the pressure in the regulators.(Fig 4)

8 Check the leakage in all connections using soap water.(Fig 5)

9 Open the valve of both cylinder slowly.

10 Ignite the flame & adjust neutral flame.

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Fig 3

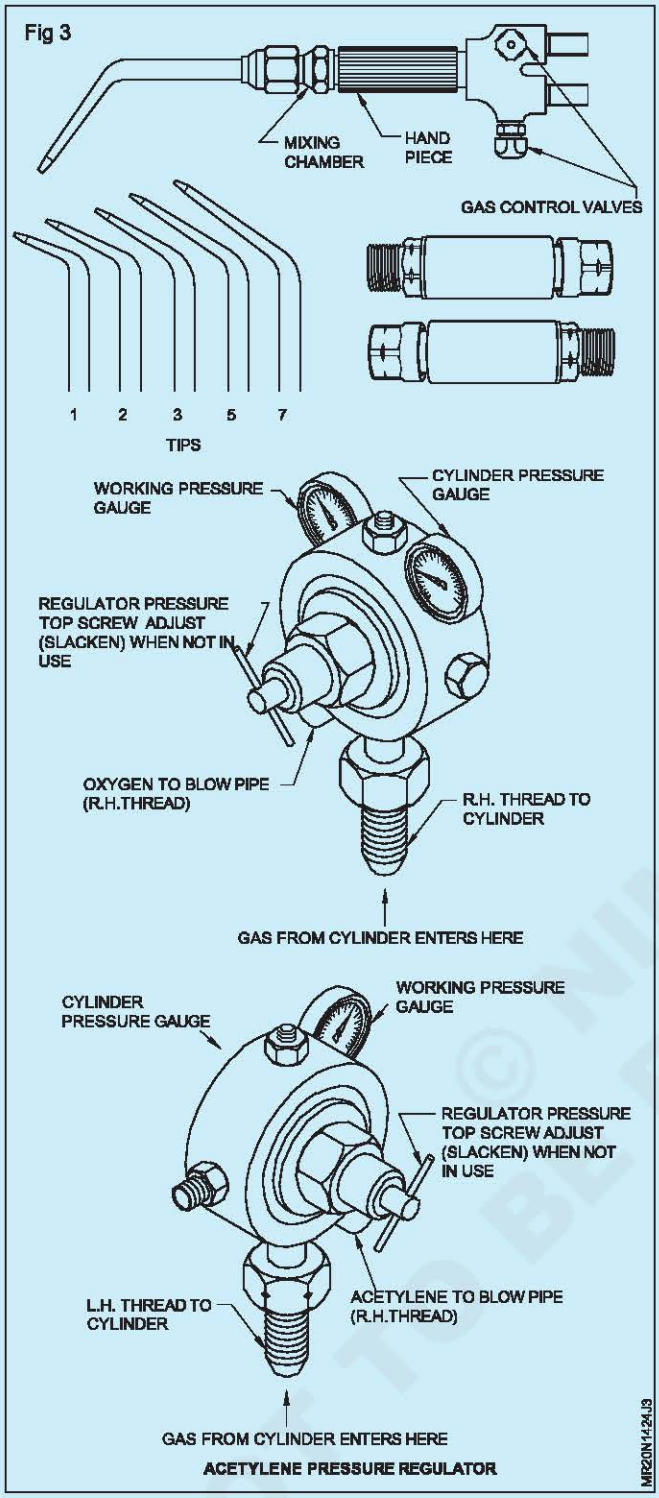


Fig 4

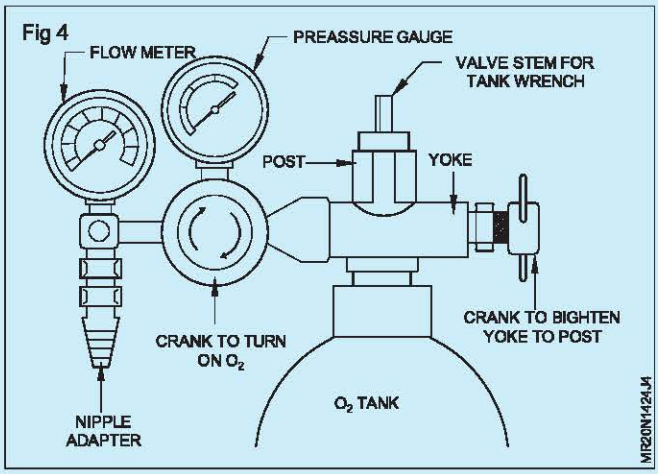
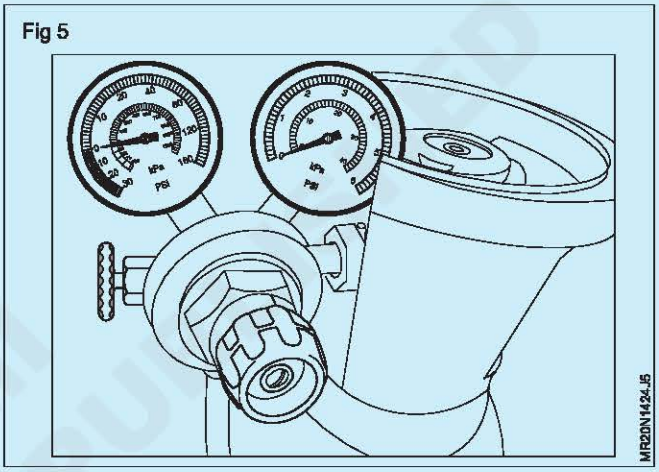


Fig 5



TASK 3: **Set up an oxy-acetylene welding plant**

1 Wear safety apparel.

2 Keep the cylinders in a trolley and secure them in position using a chain.

Crack the cylinder valves before fixing the regulators.

4 Fix the regulators on the cylinders. Ensure the pressure adjusting screws are released.

5 Attach the rubber hoses with gas regulators. Fit the black coloured hoses for oxygen, and the maroon coloured hoses for acetylene lines.

6 Attach the blowpipe with rubber hoses.

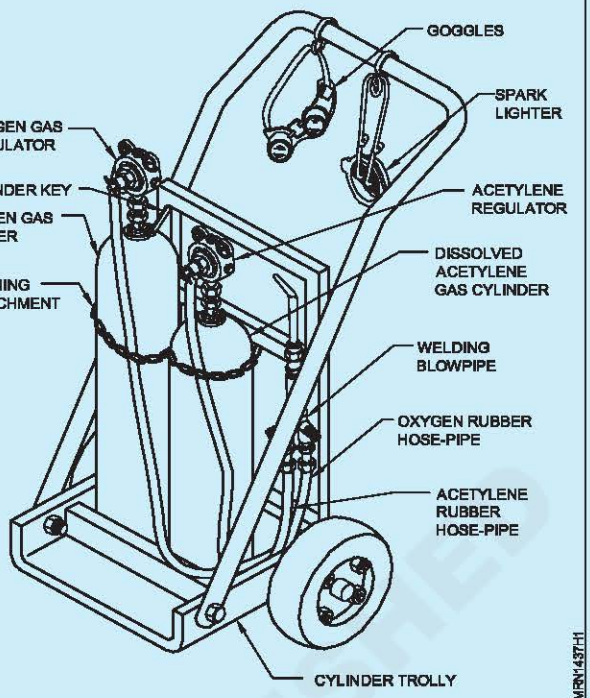
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7 Acetylene connections have left hand threads while the oxygen connections have right hand threads.

8 Open the cylinder and adjust the pressure in the regulators.

9 Check for leaks in all connections (use soap water).

Fig 1



Skill Sequence

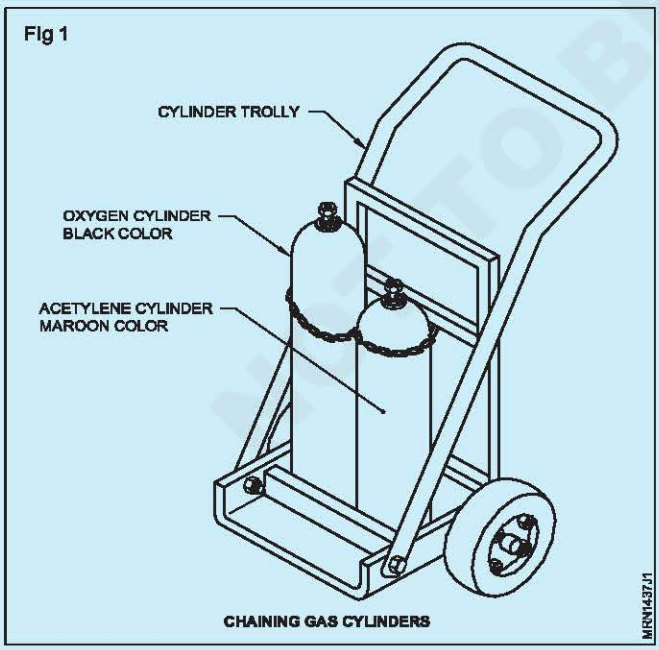
Attaching gas regulators

Objectives: This shall help you to.

- **crack gas cylinder valves**
- **attach gas regulators with cylinder valves.**

Chaining gas cylinders: The cylinder may be chained to a cylinder trolley or to a wall or fixed in cylinder stands to keep in an upright position for safe handling. (Fig 1).

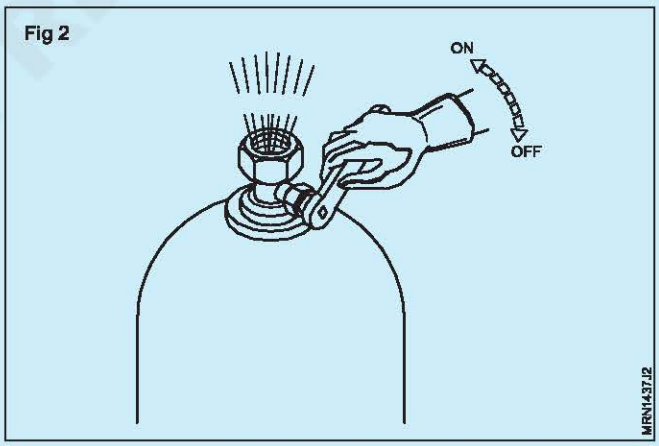
Fig 1



CHAINING GAS CYLINDERS

Cracking the gas cylinder valves: For the safety of gas regulators, the cylinder valve sockets are cleaned by opening and closing the cylinder valves quickly. (Fig 2)

Fig 2



Attaching of gas regulators with cylinder valves: Acetylene regulators should be attached with acetylene cylinders and the oxygen regulators with the oxygen cylinders. (Fig 3)

Acetylene connections have left hand threads while oxygen connections have right hand threads.

All thread connections should be first tightened by hand and then tightened with a spanner.

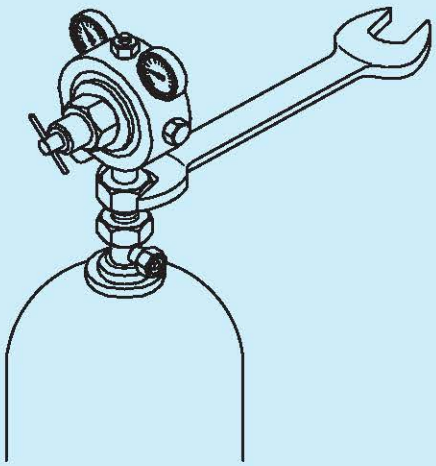
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Use spanners of the correct size.

Never apply any kind of lubricant on the threads.

Before opening the cylinder valves, the pressure-adjusting screws of both the regulators must be released.

Fig 3



ATTACHING REGULATOR

MRN1437J3

Attaching blow pipe

Objectives: This shall help you to

- **Attach blowpipes with regulators of an oxy-acetylene plant.**

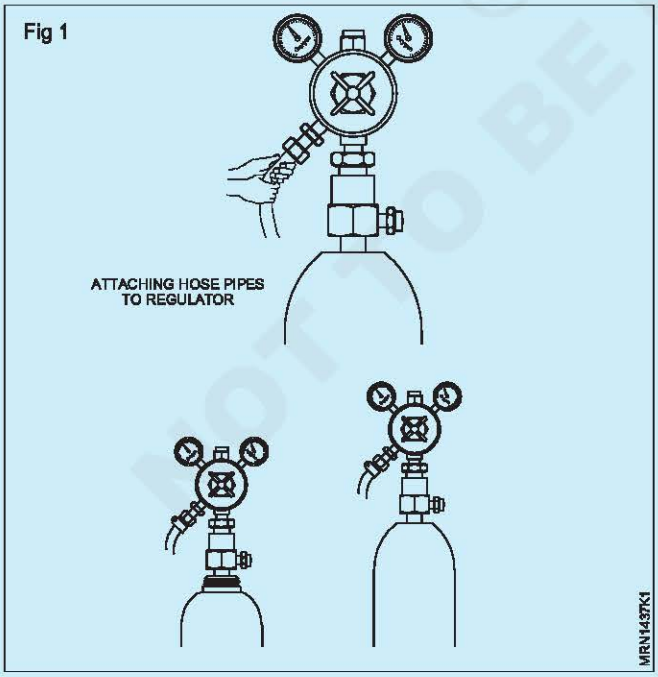
Attaching rubber hose: Acetylene hose connections have left hand threads.

Oxygen hose connections have right hand threads.

Acetylene hose-pipes are of maroon colour. Oxygen hose-pipes are black in colour. The colours are meant to identify the gases easily.

Attach one end of the acetylene hose-pipe with the acetylene regulator outlet, and the oxygen hose-pipe with the oxygen regulator outlet. (Fig 1)

Fig 1



MRN1437K1

Before fitting the holes make sure that the hose-pipes

Connect the threads by hand first and finally tighten with the correct size spanner.

Never apply undue force.

The connections should be dry-tight.

Ensure the hose connection with the non-return valve is attached with the blowpipe.

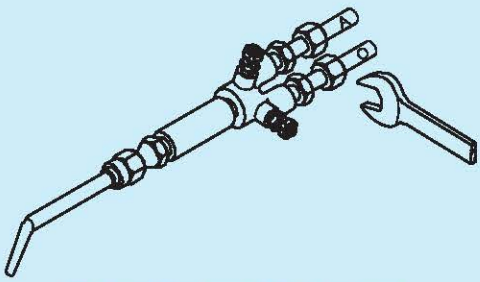
Never use wire to grip the hose-pipe and hose connections.

Always use a proper size hose clip.

Attaching blowpipe: Blowpipes have different threaded inlet connections.

Attach the other end of the acetylene rubber hose having the hose connection with the non-return valve to the blowpipe inlet connection marked 'A'. (Fig 2)

Fig 2



ATTACHING BLOW PIPES TO RUBBER HOSES

MRN1437K2

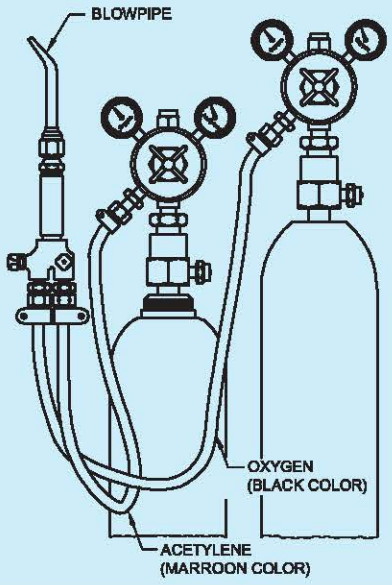
Connect the oxygen rubber hose pipe with the blowpipe connector marked 'O'.

See the complete plant setting. (Fig 3)

Connect the oxygen rubber hose pipe with the blowpipe. Attach the other end of the acetylene rubber hose having the hose connection with the non-return valve to the blowpipe inlet connection marked 'A'. (Fig 2)

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Fig 3



Adjusting gas pressure

Objectives: This shall help you to

- **adjust the gas pressure according to the nozzle size**
- **test leakage in the connections.**

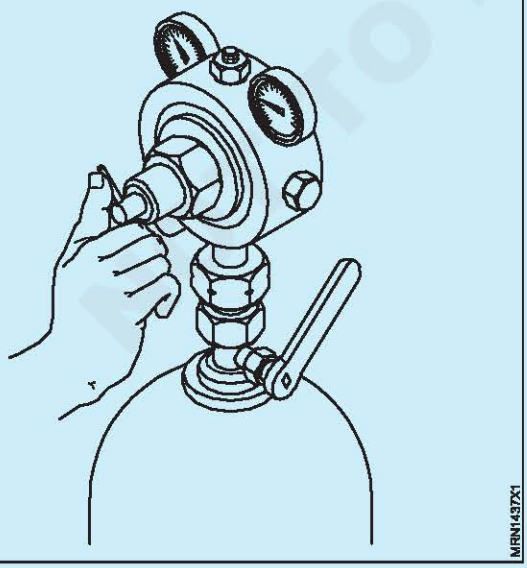
The gas pressure for both oxygen and acetylene has to be adjusted at the regulators according to the nozzle size.

The nozzle size is selected according to the job material and thickness. (SeeTable I for mild steel).

Open the valves of both the cylinders slowly by one turn and set the pressure on both the regulators at 0.2 kg/cm^2 for small size nozzles, by tightening the pressure adjusting screws. (Fig 1)

Read the pressure settings on the working pressure gauge of the gas regulators. (Fig1)

Fig 1



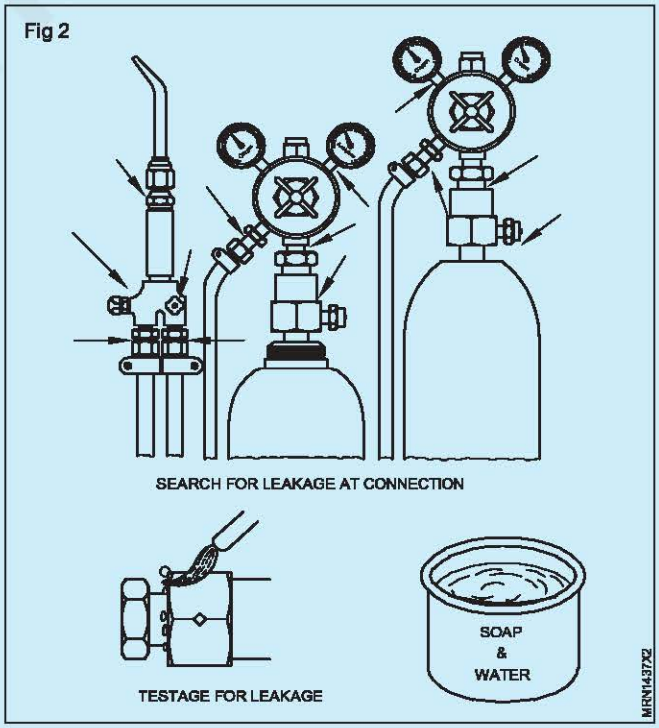
While opening the cylinder valves, always stand aside of the regulators. Do not open the valves suddenly.

Testing leakage

1 The leakage of gas must be tested in all connections.

2 Apply soap water for acetylene connections and fresh water for oxygen connections. (Fig 2)

Fig 2



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3 Never use a match or a flame light while conducting leakage tests.

Table 1

Nozzle sizes for welding mild steel

Plate thickness (mm)	0.8	1.2	1.6	2.4	3.2	4.0	5.0	6.5	10.0	13.0	16.2	19.0	25.0 25	over
Nozzle size	1	2	3	5	7	10	13	18	25	35	45	60	70	80

Flame setting.

1 Wear safety apparel.

2 Open the gas cylinders and adjust the gas pressures on the regulators.

3 Open the control valve of the acetylene gas in the blowpipe.

4 Ignite the flame by using a spark lighter.

Avoid using any other source of fire.

5 Adjust the acetylene flow till the black smoke goes away.

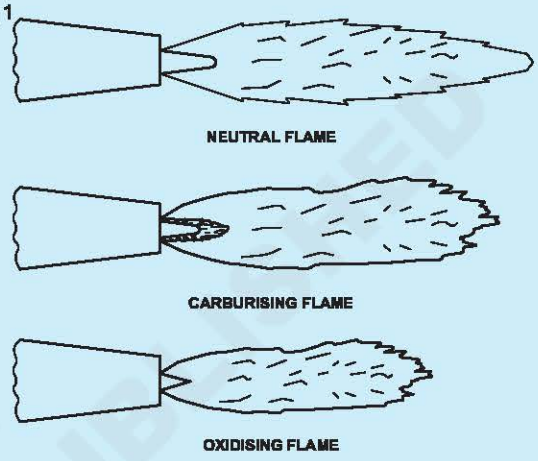
6 Open the oxygen gas till a proper round inner cone is established without any sound in the flame. This is known as a neutral flame.

7 Adjust the oxidizing flame by increasing the oxygen gas. (with sharp inner cone and little hissing sound)

8 Set the neutral flame again and adjust the carburizing flame by increasing the acetylene gas with the soft inner cone covered with an outer feather without any sound.

9 Repeat the setting of the flames till you manage to set the flame without any backfire or flash-back.

Fig 1



Flame extinguishing and stopping work

10 Extinguish the flame by closing the acetylene valve first and then the oxygen valve.

11 Dip the blowpipe nozzle in water to cool down by opening a little oxygen gas.

12 Close the cylinder valves and release all the pressure from the line.

Lighting, setting, extinguishing oxy-acetylene flame and shutting the plant

Objectives: This shall help you to
- **ignite, set and extinguish an oxy-acetylene flame for gas welding correctly**
- **shut the oxy-acetylene plant for stopping work.**

Flame lighting

Ensure that safety apron, gloves and goggles are worn. (Fig 1)

Set the pressure of oxygen and acetylene at 0.2 kgs/cm for a small size nozzle. (No 3)

While setting the pressure on the regulator, keep the blow pipe control valve open the accurate setting.

Open the acetylene control valve 1/4 turn of the blow pipe and ignite with the help of the spark-lighter. Adjust the acetylene flow till the black smoke goes away. (Fig 2)

Avoid back fire or flash-back of blow pipe.

Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. (Fig 3)

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Fig 1

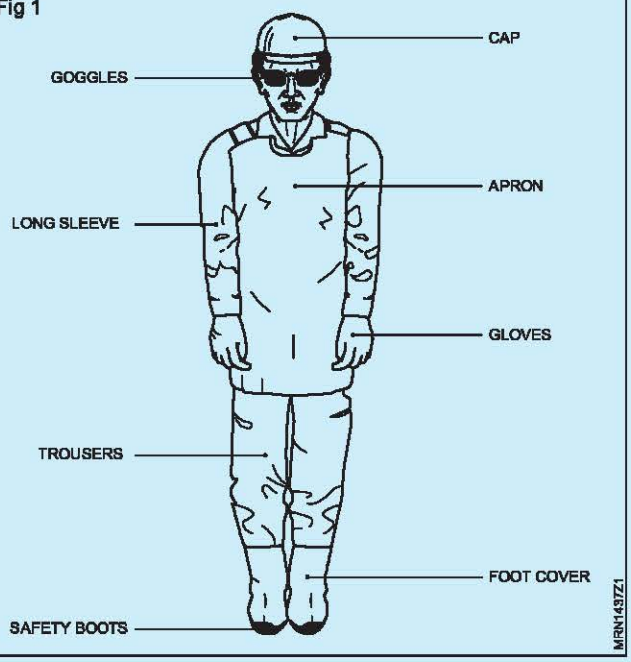


Fig 2

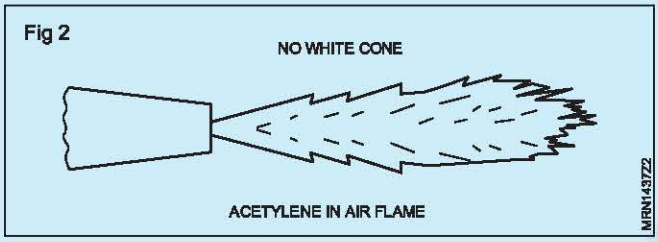
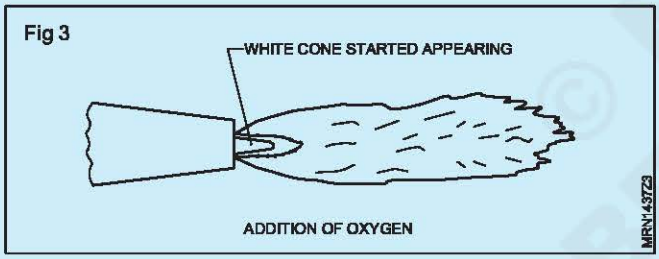


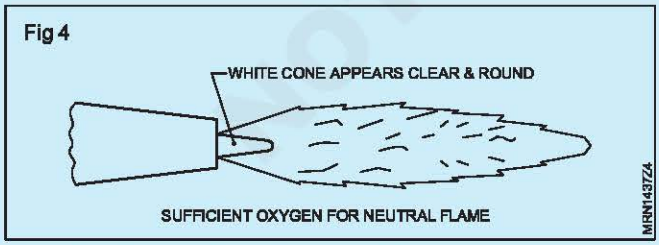
Fig 3



Flame adjustment: To adjust the neutral flame, add sufficient oxygen to make the white cone clear and round. (Fig 4)

The gas mixture from the blowpipe consists of oxygen and acetylene in equal volumes.

Fig 4

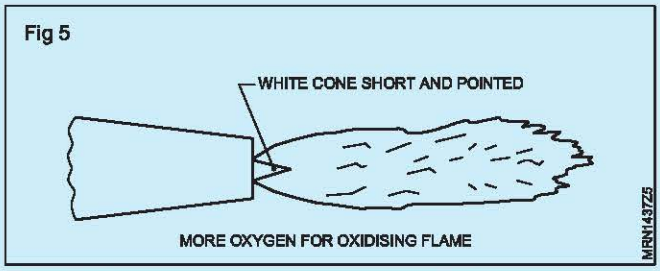


To adjust the oxidising flame, add more oxygen.

The white cone will become short and sharp.

The flame will produce a hissing sound and will have a short length. (Fig 5)

Fig 5

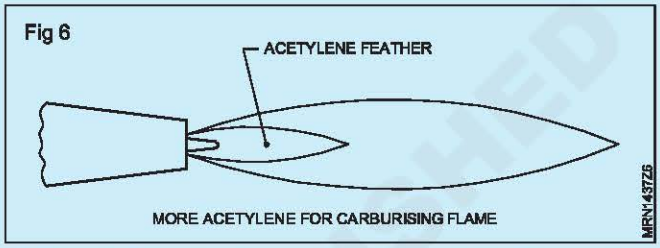


To adjust a carburising flame, adjust the flame to neutral and then add acetylene.

The white cone will become long, surrounded by a feather-like portion.

The flame will burn quietly and have more length. (Fig 6)

Fig 6



Extinguishing the flame: To extinguish the flame, close the acetylene valve (blowpipe) first and then the oxygen valve.

Shutting off the plant: At the end of the work, shut off the plant as stated below.

Close the acetylene cylinder valve.

Open the blowpipe acetylene valve and release all pressure.

Release the acetylene regulator pressure adjusting screw.

Close the blowpipe acetylene valve.

Repeat the above four steps for shutting off oxygen also.

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Oxy- Acetylene gas cutting, brazing & welding on thin sheet metal.

Objectives: At the end of this exercise, you shall be able to
- **straight cutting by hand on thin sheet with cutting torch**
- **brazing of copper tubes**
- **welding of copper sheet.**

Requirements

Tools/Instruments

- Safety apparel - 1 set
- Spark lighter - 1 No.

Equipment/machines

- Oxy-acetylene welding set - 1 set

Materials/Components

- M.S. Plate (work piece) - 1 No.

PROCEDURE

TASK 1: **Straight cutting by hand on thin sheet with cutting torch**

1 Wear complete safety apparel.

2 Set the gas welding with a cutting blow piece.

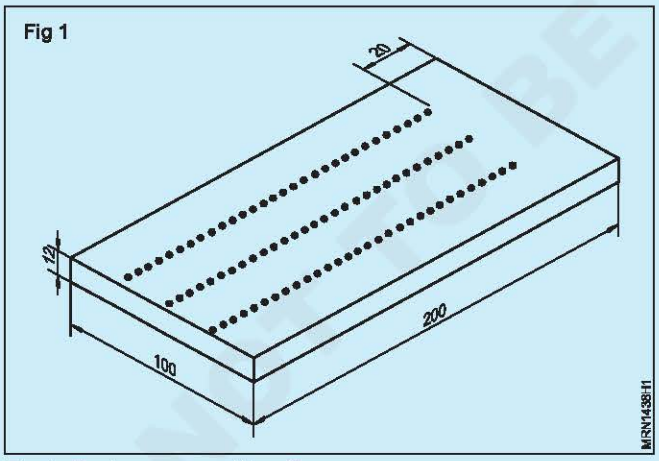
3 Attach the correct cutting nozzle according to the thickness of the metal.

4 Adjust the gas pressure of acetylene and cutting oxygen according to the thickness of the metal and the cutting nozzle.

5 Clean the surface to be cut.

6 Punch a straight line.(Fig 1)

Fig 1



7 Adjust proper cutting flame.

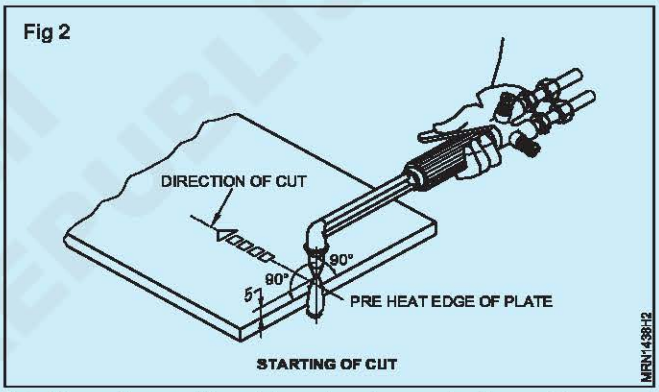
8 Hold the cutting blowpipe at 90° to the cut line and plate surface.(Fig 2)

9 Heat at one end of the plate on the punch line up to cherry red heat.

Keep a distance of about 5mm between the workpiece and the nozzle.

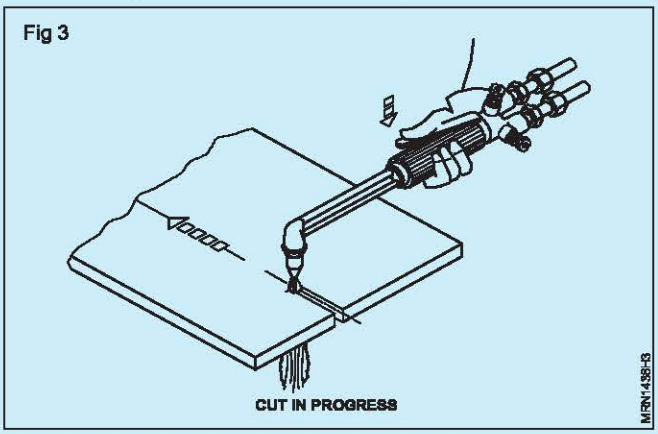
10 Release the cutting oxygen and observe the cutting action.

Fig 2



11 Move the cutting blowpipe towards the other end, following the punched line.(Fig 3)

Fig 3



While gas cutting ensure straight travel of the cutting blowpipe without side-to-side movement and correct nozzle position with the plate surface till the cutting oxygen valve is fully open.

12 Maintain a correct speed and distance of the nozzle.

13 Close the cutting oxygen and shut off the flame on the completion of the cut.

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14 Clean the cut and inspect for its accuracy.

15 Repeat the exercise till a good and smooth cut is achieved.

Fig 4

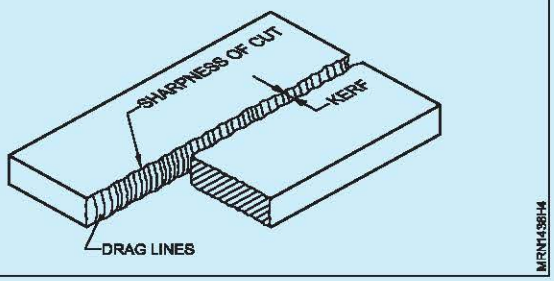
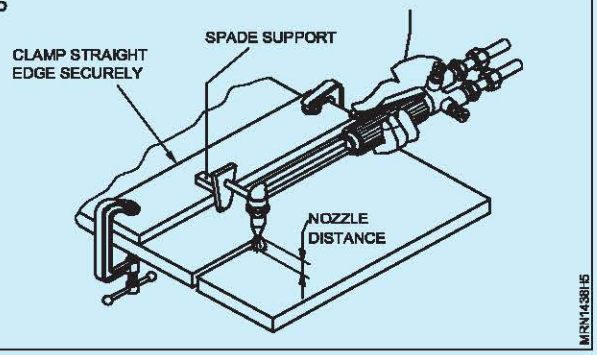


Fig 5



Acetylene pressure should be 0.5 kgf/cm^2

Set the cutting nozzle in the blowpipe correctly.

Adjust the neutral flame for pre-heating.

TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen pressure
(mm)	(mm)	(Kgf/cm^2)
(1)	(2)	(3)
0.8	3-6	1.0-1.4
1.2	6-19	1.4-2.1
1.6	19-100	2.1-4.2
2.0	100-150	4.2-4.6
2.4	150-200	4.6-4.9
2.8	200-250	4.9-5.5
3.2	250-300	5.5-5.6

TASK 2: **Brazing of copper tubes**

1 Make sure that the pipe enters the swage properly. It must be an easy fit.

2 Apply a small amount of flux to the surface to be joined.

3 Heat the joint with blow torch.

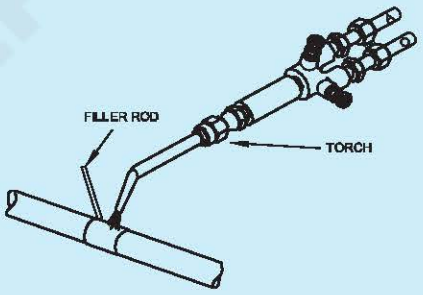
4 Heat the joint up to dull red, put the filler rod (Brazing rod). It will starts to melt

5 The molten filler rod will be drawn in to the joint and fill the space b/w end of the other.

6 When the complete ring a brazing material can be seen at the end of the swage remove the blow torch.

7 Allow the joint to cool.

Fig 1



- **Do not over heat the joint.**
- **Do not leave the brazing rod in the flame.**
- **Do not remove pipe until the brazing material is hardened.**

TASK 3: **Welding of copper sheet**

1 Ensure a de-oxidised copper sheet of correct size since commercial copper will develop cracks during welding.

2 Clean the edges and surfaces free from oil, grease and dirt using pickling/solvent.

3 Ensure the joint surfaces are free from surface oxides. Use emery sheet, wire brush or wire wool for cleaning the surface.

4 Set the sheets as butt joint with correct alignment and a root gap of 2.5mm.

5 Select a phosphor bronze filler rod.

6 Select the bronze flux. (Borax flux)

7 Set a soft oxidising flame, which will help in controlling the evaporation of zinc and tin from the weld metal.

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8 Preheat the plates until the surface oxides just begin to form.

9 Tack weld for every 50mm length of the joint to take care of the higher thermal expansion of copper.

10 Hold the blowpipe over the ends of the joint at an angle of 60° - 70° and the filler rod at 30° - 40° and then tack–weld. 11 The filler rod is coated with flux by heating and dipping into the powder flux.

11 Hold the blowpipe and filler rod at the angles given for tack welding. Slight weaving of the blow pipe ensures proper fusion of both edges.

12 Commence at one end and continue with a slight weaving motion, adding the filler rod at regular intervals until the seam is completed.

13 Ensure uniform root penetration.

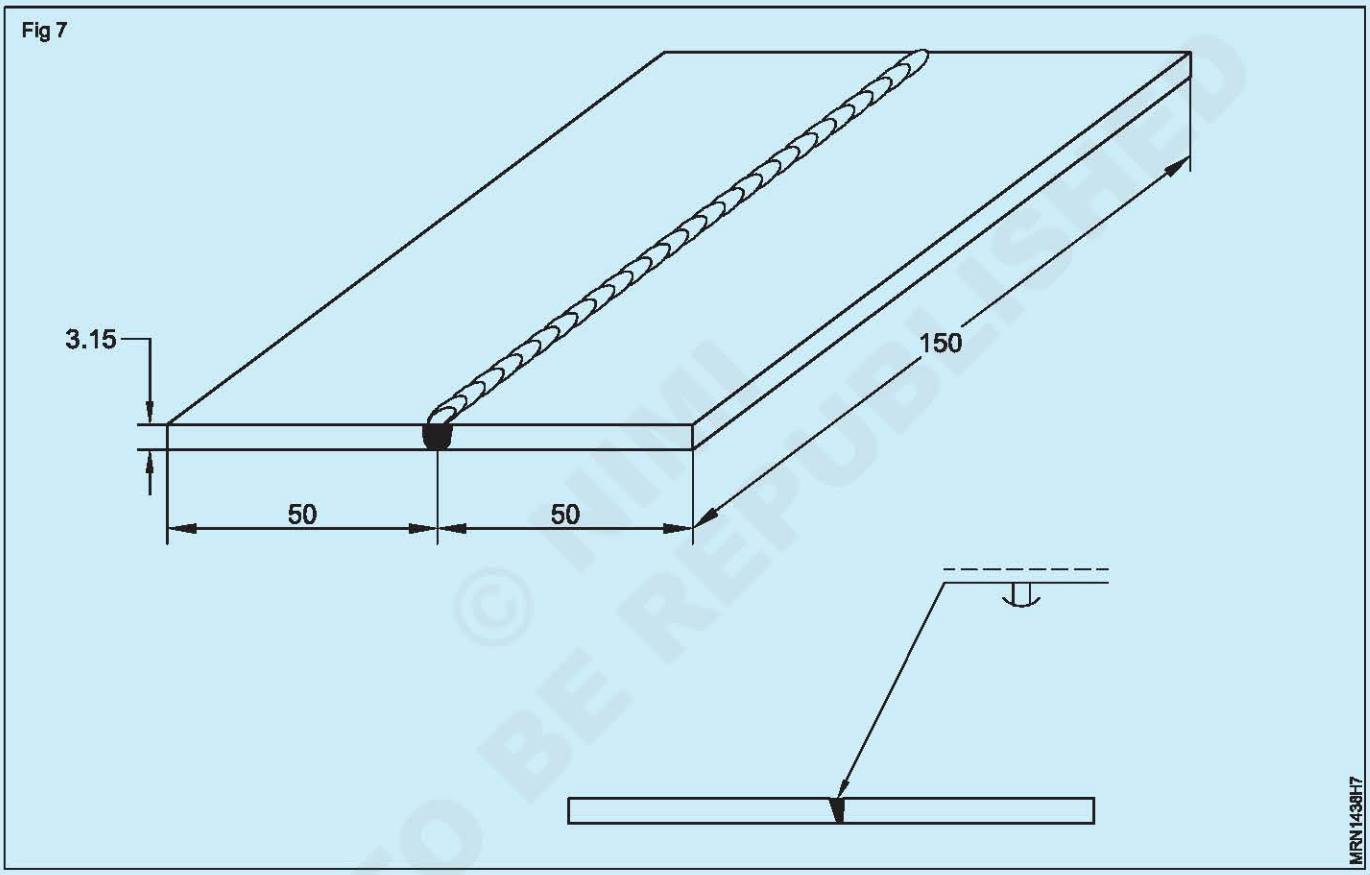
14 Terminate the weld, keeping the reinforcement up to full section and after closing the crater.

15 Remove the flux residue.

The deposit should be of uniform size, bright in appearance and free from porosity.

16 Clean the bead and inspect for weld defects and bead size, profile and appearance.

Fig 7



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Demonstrate care & safety of welding tools and equipments and back fire arrester

Objectives: At the end of this exercise, you shall be able to
- **care and safety of welding tools & equipments**
- **check for back fire.**

Requirements

Tools/Instrtuments

• Oxygen gas regulator	- 1 set
• Acetylene gas regulator	- 1 set
• Cylinder key	- 1 No.
• Welding/brazing torch	- 1 No.
• Oxygen rubber hose	- as reqd length mts.
• Acetylene rubber hose	- as reqd length mts.
• Eye goggle	- 1 No.
• Spark lighter	- 1 No.

Equipment/Machines

• Cylinder trolley	- 1 No.

Materials

• Cylinder with oxygen	- 1 No.
• Cylinder with acetylene	- 1 No.

PROCEDURE

TASK 1: **Care & safety of welding tools and equipment**

Refer (Task 5 of Exercise 1.5.22)

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TASK 2: **Check for back fire**

1 Attach the back fire arrester in the oxygen and acetylene cylinder lines (Fig 1)

2 Fix one back fire arrester in the low pressure side of the regulator near the cylinder.

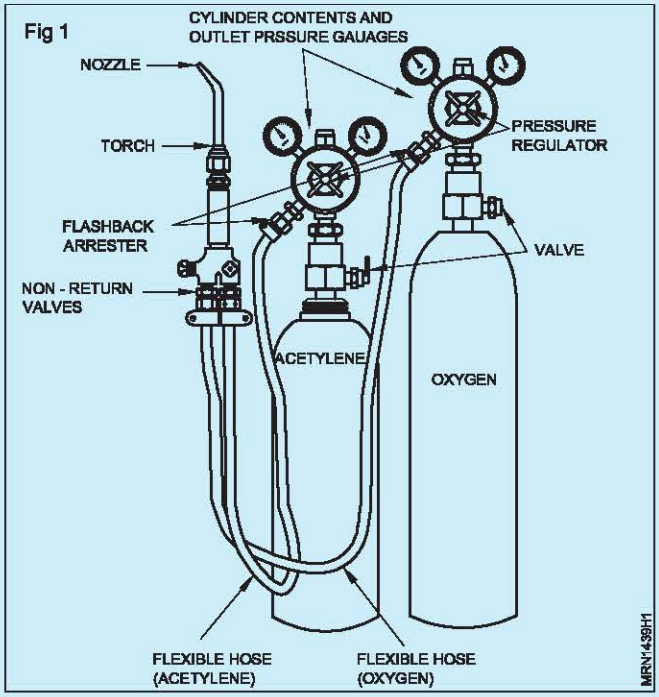
3 Fix another back fire arrester near the torch.

Safety :

1 In case back fire or explosion of the gas pipe immediately close both cylinder valves.

2 Rectify the causes before procedure further to avoid back fire.

Fig 1



— — — — — — —

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Set oxy acetylene plant, use two stage regulator, adjustment of flame gas pressure-O_2 and DA

Objectives: At the end of this exercise, you shall be able to
- **joint cu to cu pipe**
- **joint cu to M.S pipe**
- **joint cu to aluminium pipe.**

Refer exercise Ex No 1.5.23

TASK-3

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Perform brazing between copper to copper and copper and CU to MS, copper to aluminium pipes

Objectives: At the end of this exercise, you shall be able to
- **joint cu to cu pipe**
- **joint cu to M.S pipe**
- **joint cu to aluminium pipe.**

Requirements

Tools/Instruments

- Oxy- acetylene set with Nozzle - 6 Nos

Material

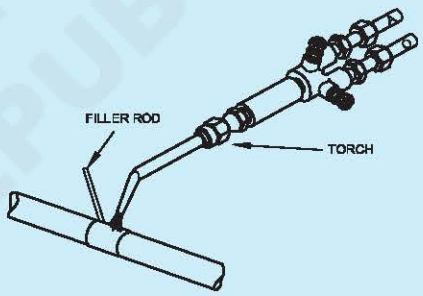
- Welding screen - 1 Set
- Welding mask - 1 No
- Hand gloves - 1 No
- Copper pipe 6mm 200mm each - 10 Nos.
- Copper pros rod - as reqd.
- Steel pipe 6mm 200mm each - 10 Nos.
- Aluminium pipe 6mm 200mm each - 10 Nos.
- Silver braze rod - as reqd.
- Alumina, Borax flux - as reqd.
- Fire brick - as reqd.

PROCEDURE

TASK 1: **Joint cu to cu pipe (fig 1)**

1 Prepare copper surface clean inner and outer diameter.
2 Place the tube on fire brick.
3 Set flame neutral
4 Heat up joint till red colour.
5 Touch copper prosperous filler rod surrounding the joint
6 Molten metal should fill up gape by capillary action

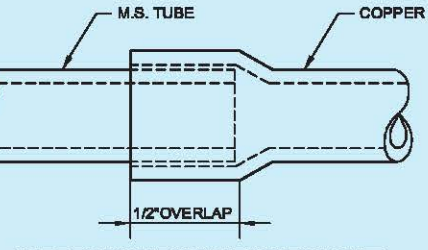
Fig 1



TASK 2 : **Joint cu to M.S pipe (Fig 2)**

1 Prepare copper pipe surface clean inner and M.S outer diameter.
2 Place the tube on fire brick
3 Set neutral flame.
4 Heat up joint till red colour.
5 Apply flux on joint and over filler rod.
6 Touch silver braze filler rod surrounding the joint
7 Molten metal should fill up gap reheated for uniform joint.

Fig 2



TASK 3 : **Joint cu to aluminium pipe**

1 Prepare copper pipe surface clean inner or outer diameter as required
2 Set flame neutral
3 Heat up copper tube
4 Heat up joint till red shining appear
5 Place aluminium pipe on the mouth of pipe and press it
6 Apply flux on joint and over filler rod
7 Touch silver braze filler rod surrounding joint.
8 Molten metal should fill up gap reheated for uniform joint.

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Identify and use of general hand tools instruments and equipment used in refrigeration work

Objectives: At the end of this exercise you shall be able to
- **identify general work shop tools**
- **identify workshop equipments**
- **identify precision instruments**
- **care & maintain of tools, equipments and**

Refer Ex 1.1.05

TASK-1, TASK -2, TASK-3, TASK -4

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Identify special tools , instruments and equipment used in refrigeration work shop

Objectives : At the end of this exercise you shall be able to
- **identify the main parts of refrigeration tools work their function**
- **identify the Instruments used in refrigeration work**
- **identify the Equipment used in refrigeration work.**

Requirements

Tools/Instruments

- Flaring tool with yoke - 1 No.
- Tube cutter with reamer - 1 No.
- Pipe bender lever and soring type - 1 No.
- Swaging tool - 1 No.
- Pinching tool - 1 No.
- Ratchet wrench - 2 Nos.
- Pressure gauge - 2 Nos.
- Thermometer - 1 No.
- Electronic detector - 2 Nos.
- Gauge manifold - 1 No.
- Tong tester - 1 No.
- Vacuum pump - 1 No.
- Pinch off pliver - 1 No.
- Air compressor - 1 No.
- Anemo meter - 1 No.
- Taco meter - 1 No.
- Halide torch' - 1 No.
- Sling psychomotor - 1 No.
- Gauge manifold - 1 No.
- Vacuum pump - 1 No.
- Thermo meter - 1 No.

PROCEDURE

TASK 1: **Identify the main parts of refrigeration tools with their function**

- **Identify the main parts of flaring tool**

1 Refer the diagram and Identify the parts of the label in Fig 1.

2 Record the name of parts and functions in the given Table 1.

Fig 1

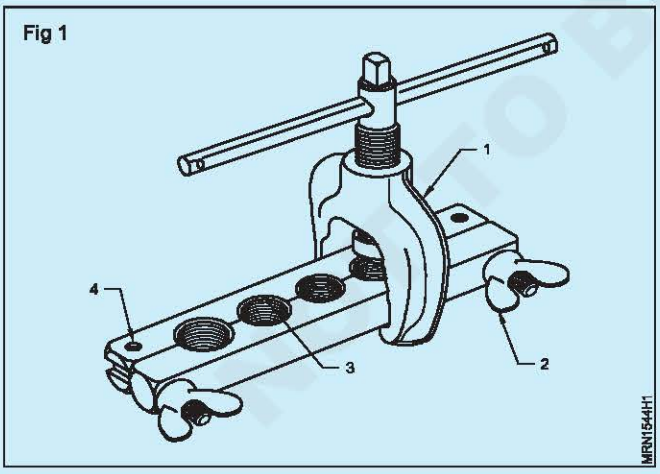


Table 1

Label	Name of the part	Function
1		
2		
3		
4		

- **Identify the main parts of Tube cutter with Reamer**

1 Refer the diagram and Identify the parts of the label in Fig 2.

2 Record the name of parts and functions in the given Table 2.

Fig 2

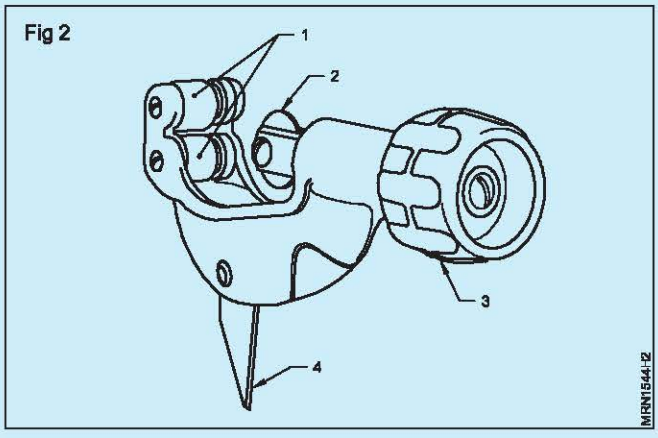


Table 2

Label	Name of the part	Function
1		
2		
3		
4		

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- **Identify the main parts of Pipe bender**

1 Refer the diagram Fig 3 & 4 and Identify the parts of the label.

2 Record the name of parts and functions in the given Table 3.

Fig 3

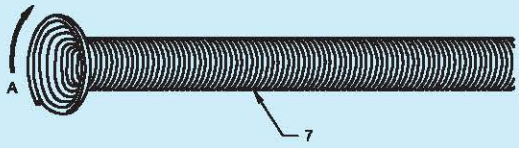


Fig 4

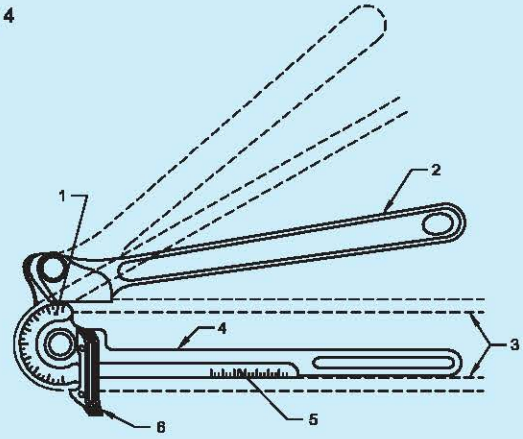


Table 3

Label	Name of the part	Function
1		
2		
3		
4		
5		
6		
7		

- **Identify the main parts of Swaging tool**

1 Refer the diagram and Identify the parts of the label in Fig 5 & 6.

2 Record the name of parts and function in the given table 4.

Fig 5

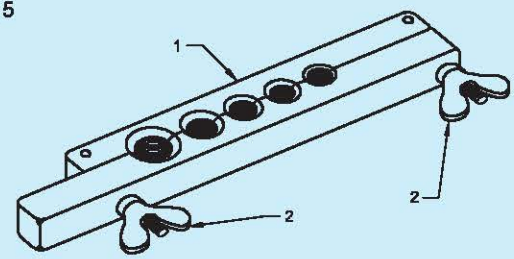


Fig 6

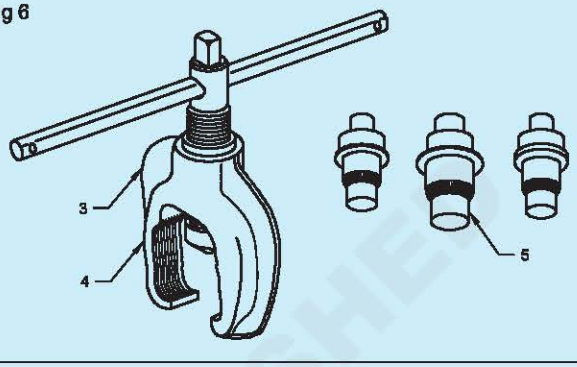


Table 4

Label	Name of the part	Function
1		
2		
3		
4		
5		

- **Identify the main part of Pinching tool**

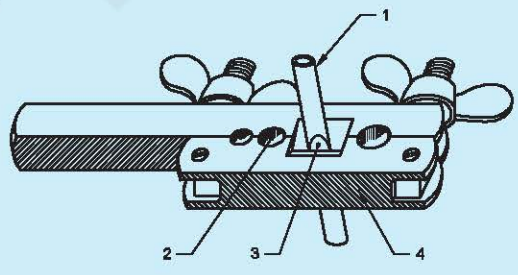
1 Refer the Fig 7 and Identify the parts of the label.

2 Record the name of parts and function in the given table 5.

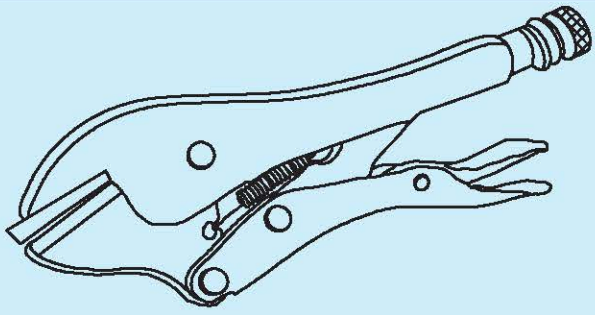
Table 5

Label	Name of the part	Function
1		
2		
3		
4		
5		

Fig 7



PINCHING TOOL



PINCHING PLIER

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- **Identify the main part of Ratchet wrench**

1 Refer the Fig 8 and Identify the parts of the label.

2 Record the name of part in given table.

Fig 8

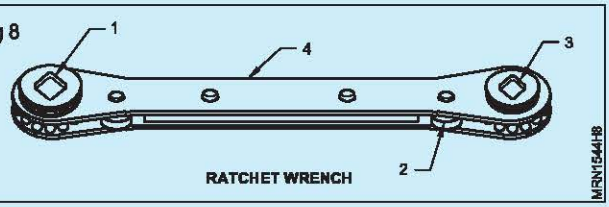


Table 6

Label	Name of the part	Function
1		
2		
3		
4		

TASK 2: **Identify the instruments used in refrigeration work**

- **Identify the main parts of pressure gauge and compound gauge**

1 Refer the diagram 9 & 10 and Identify the parts of the label.

2 Record the name of parts and functions in the given table 7.

Fig 9

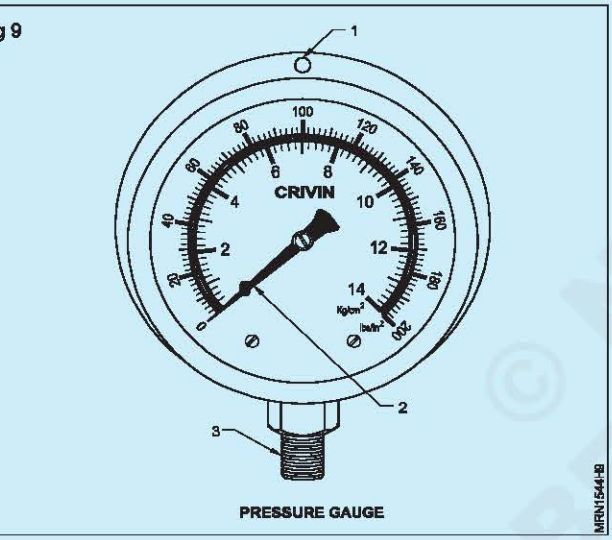


Fig 10

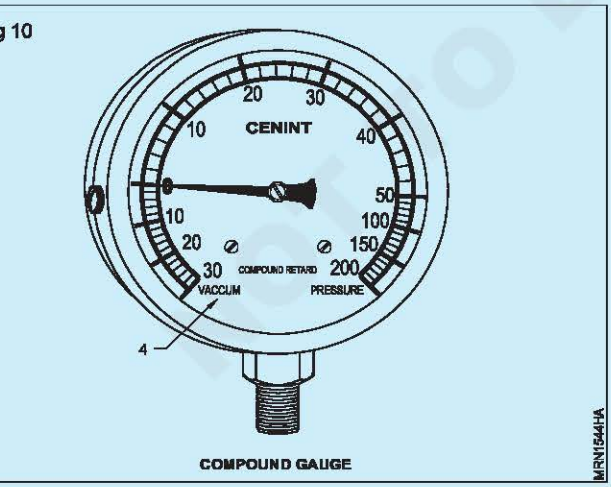


Table 7

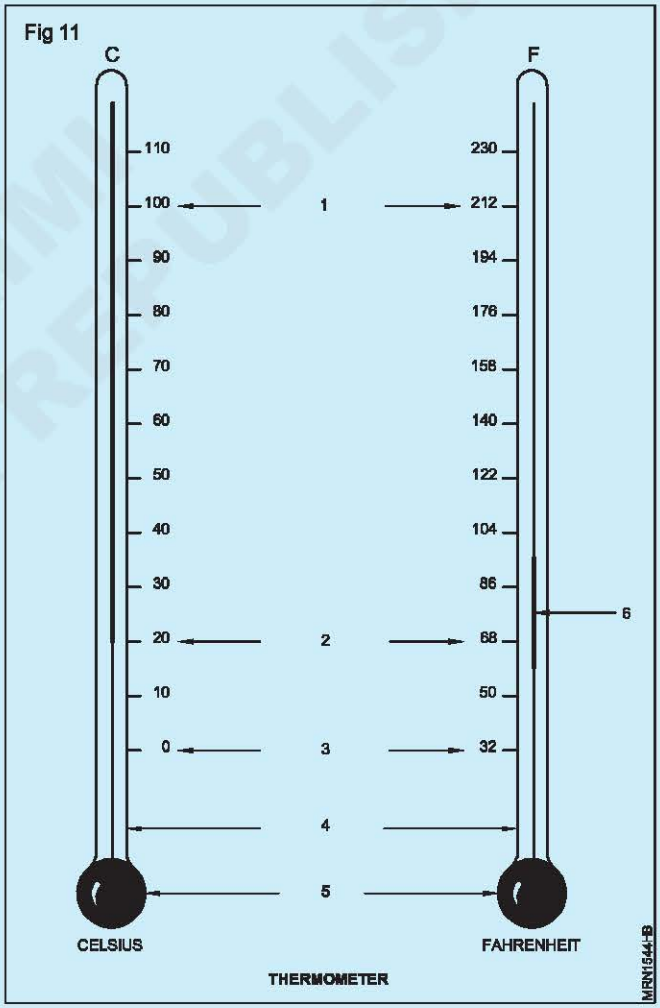
Label	Name of the part	Function
1		
2		
3		

- **Identify the main part of Thermometer**

1 Refer the Fig 11 & 12 and Identify the parts of the label.

2 Record the name of parts and function in the given table 8.

Fig 11



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Fig 12

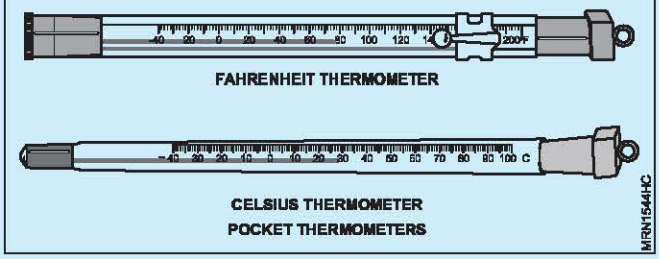


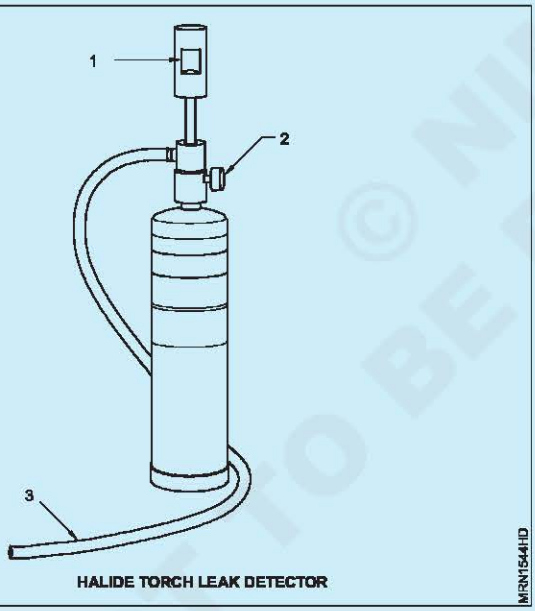
Table 8

Label	Name of the part	Function
1		
2		
3		
4		
5		
6		

- **Identify the main parts of leak defector**

1 Refer the Fig 13 and Identify the parts of the label.

Fig 13



1 Record the name of parts and function in the given table 9.

- **Identify the main parts of electronic leak defector**

1 Refer the Fig 14 and Identify the parts of the label.

2 Record the name of parts and fix the in the given table 10

Table 9

Label	Name of the part	Function
1		
2		
3		

- **Identify the main parts of sling psychomotor**

1 Refer fig 15 and identify the parts of the label

2 Record the name of parts and function of the given table 11.

Fig 14

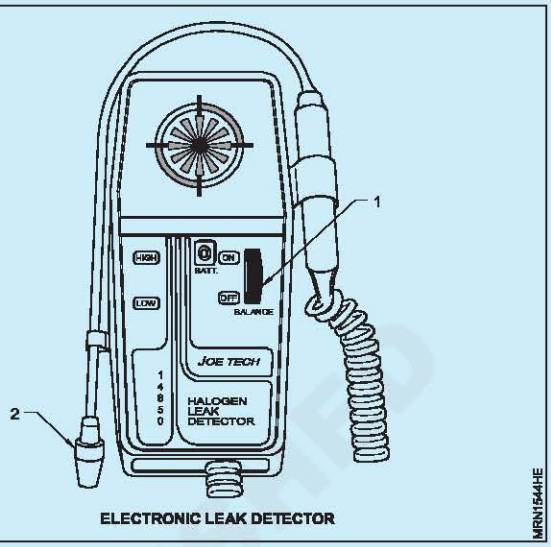


Table 10

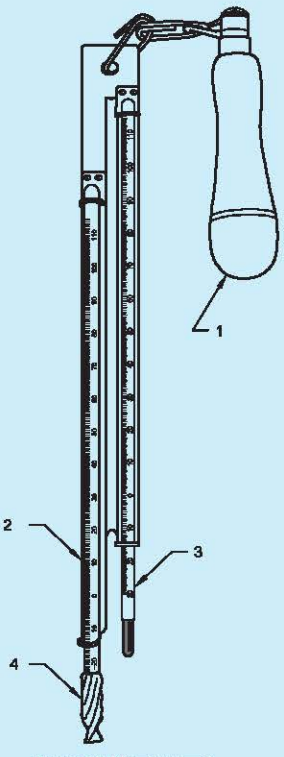
Label	Name of the part	Function
1		
2		

- **Identify the main parts of gauge manifold**

1 Refer the Fig 16 and Identify the parts of the label.

2 Record the name of parts and function in the given table 12

Fig 15



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Table 11

Label	Name of the part	Function
1		
2		
3		
4		

- **Identify the main parts of anemometer**

1 Refer the Fig 17 and Identify the parts of the label.

2 Record the name of parts and function in the given table 13

Table 12

Label	Name of the part	Function of the part
1		
2		
3		
4		
5		
6		
7		
8		
9		

Fig 16

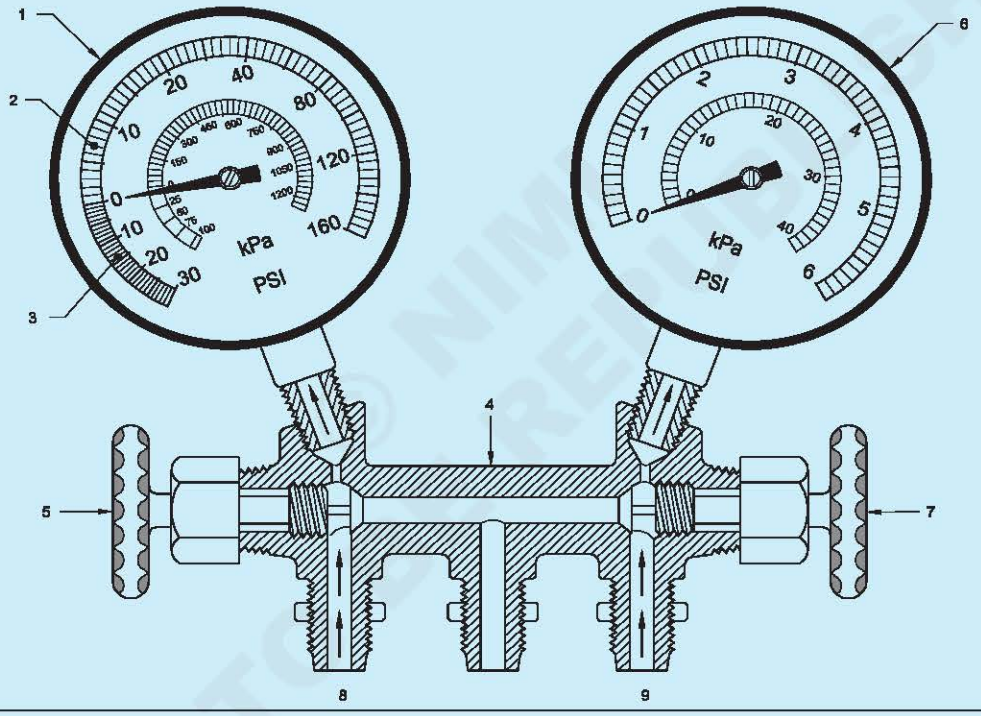


Fig 17

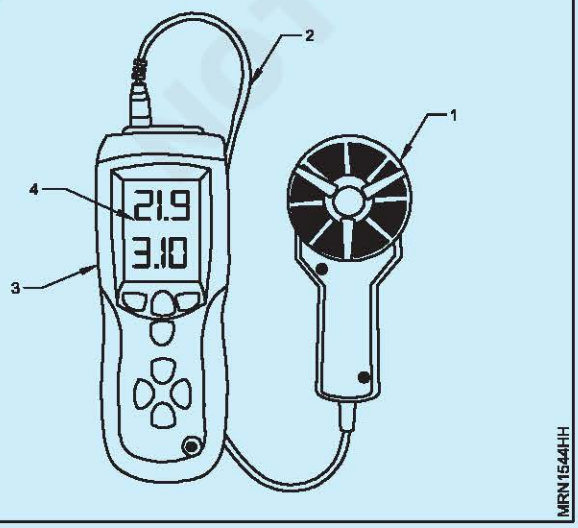


Table 13

Label	Name of the part	Function of the part
1		
2		
3		
4		

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- **Identify the main parts of the tachometer**

2 Refer fig 18 and identify the parts of the tabel

3 Record the name of parts and function in the given table 14.

Fig 18

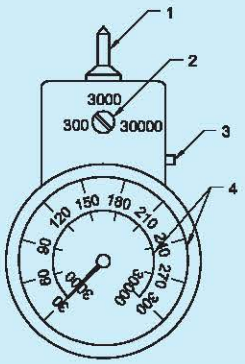


Table 14

Label	Name of the part	Specification Function
1		
2		
3		
4		

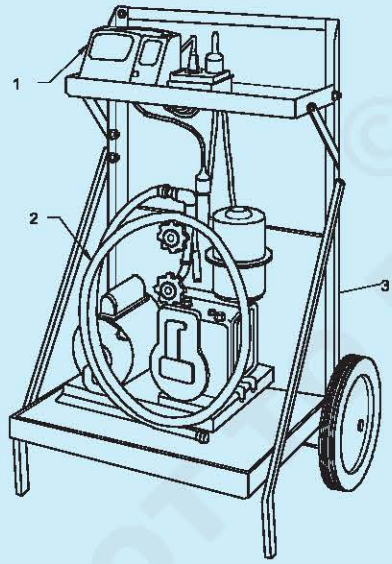
TASK 3: **Identify the equipments in refrigeration work**

- **Identify the main parts of vacuum pump**

1 Refer the diagram and identify the parts of the label shown in Fig 19

2 Record the name of part and function in the given table 15.

Fig 19



PORTABLE HIGH-VACCUM PUMP

Table 15

Label	Name of the part	Specification	Function
1			
2			
3			

- **Identify the admin parts of air compressor**

1 Refer the diagram and identify the parts of label given in Fig 20.

2 Record the name of part in the given in table16.

Fig 20

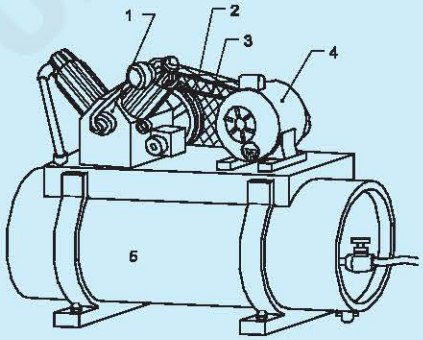


Table 16

Label	Name of the part	Specification	Function
1			
2			
3			
4			
5			

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Identify the various refrigeration equipments compression of vapour compression system and vapour absorption system

Objectives: At the end of this exercise you shall be able to
- **Identify various refrigeration equipment**
- **identify the system and trace out the cycle**
- **identify the components of v.c system**
- **identify the vapour absorption refrigeration cycle.**

Requirement

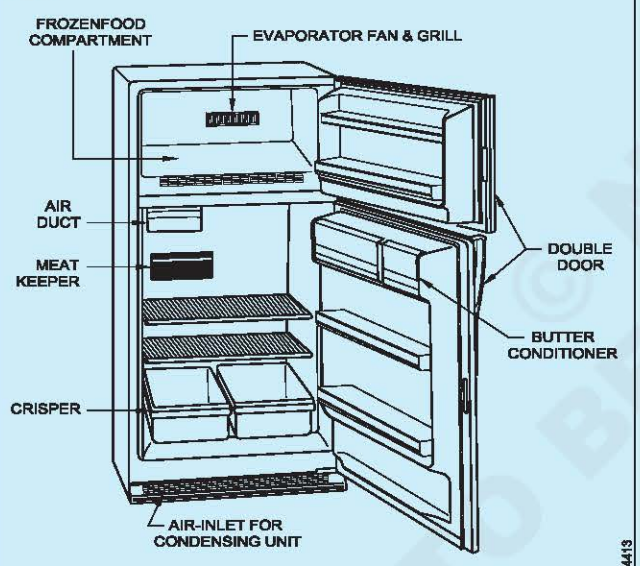
Equipments

- Vapour compression system (Refrigerator) -1 No.
- Vapour absorption system - 1 No.

PROCEDURE

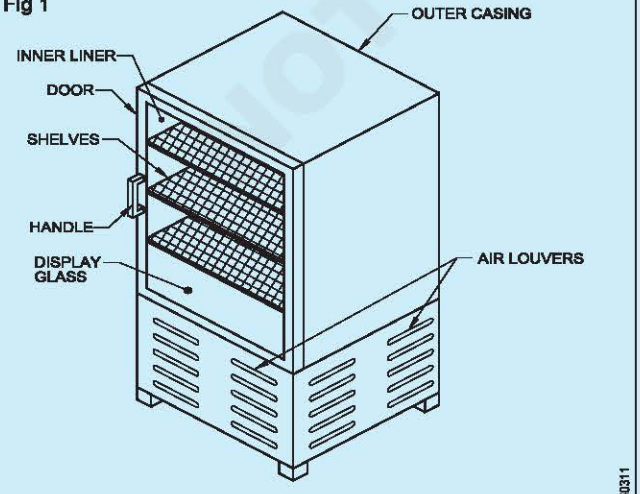
TASK 1: **Identify various refrigeration equipments**

Fig 3



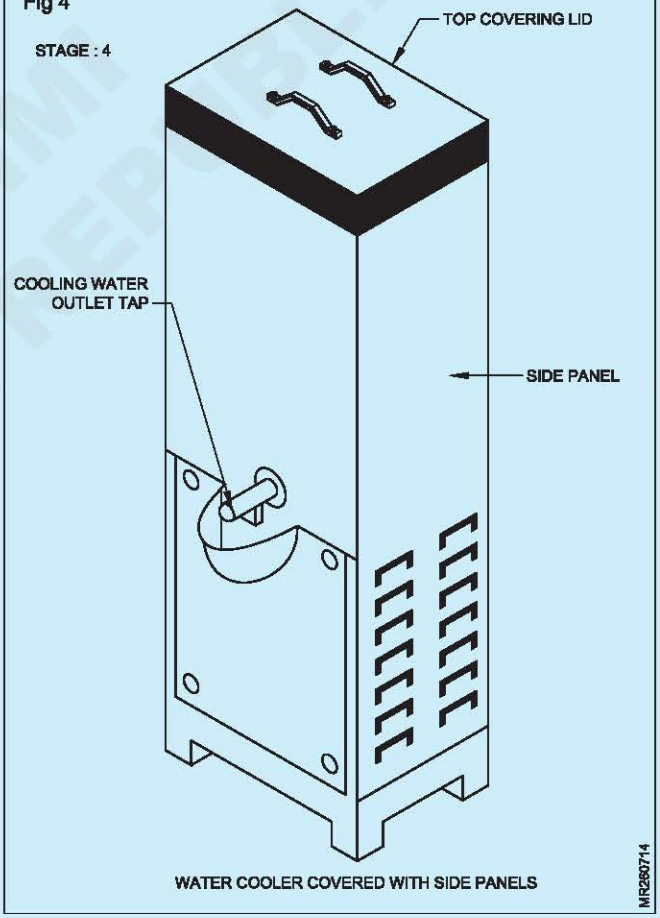
FROST FREE REFRIGERATOR.

Fig 1



PARTS OF VISIBLE COOLER

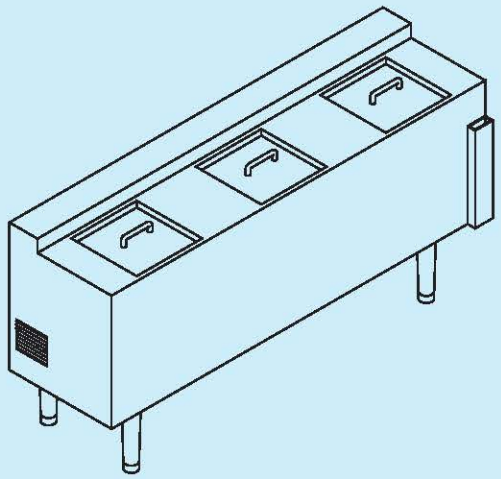
Fig 4



WATER COOLER COVERED WITH SIDE PANELS

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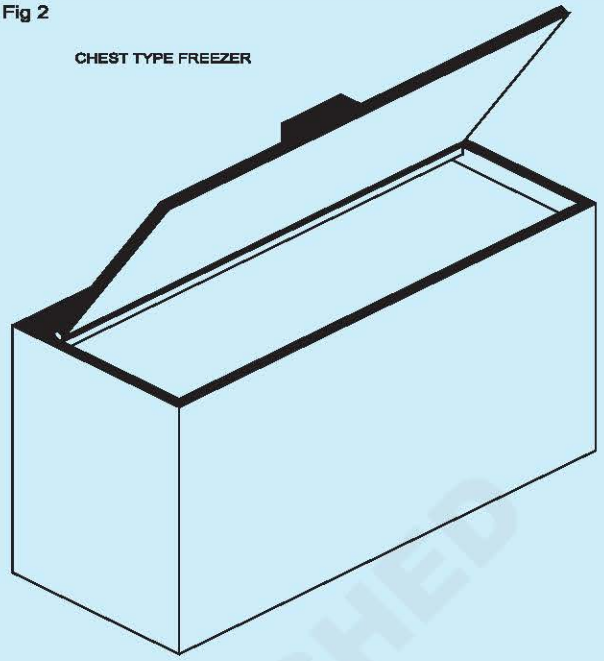
Fig 5



MR2602I5

Fig 2

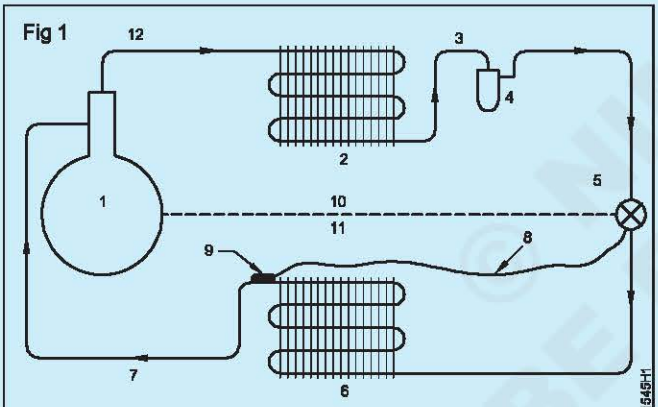
CHEST TYPE FREEZER



MR2602I2

TASK 2: Identify the system of vapour compression and trace out the cycle

Fig 1



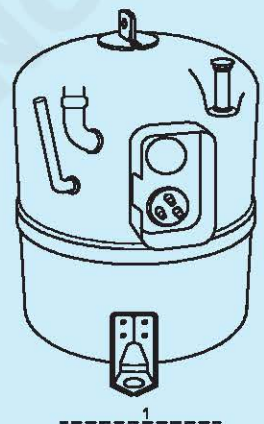
TYPICAL COMPRESSION REFRIGERATION SYSTEM

MRN1545H1

Sl.No.	Identify components in the system
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	

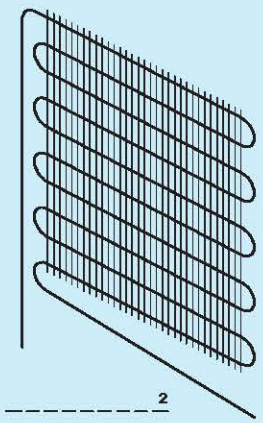
TASK 3: **Identify the components of V.C system.**

Fig 1



MRN1545J1

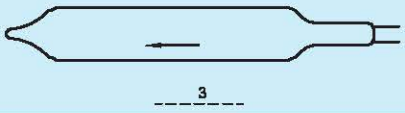
Fig 2



MRN1545J2

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Fig 3



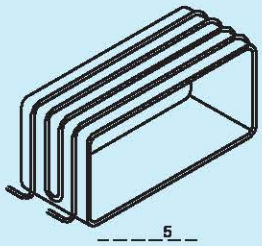
MRN1545J3

Fig 4



MRN1545J4

Fig 5



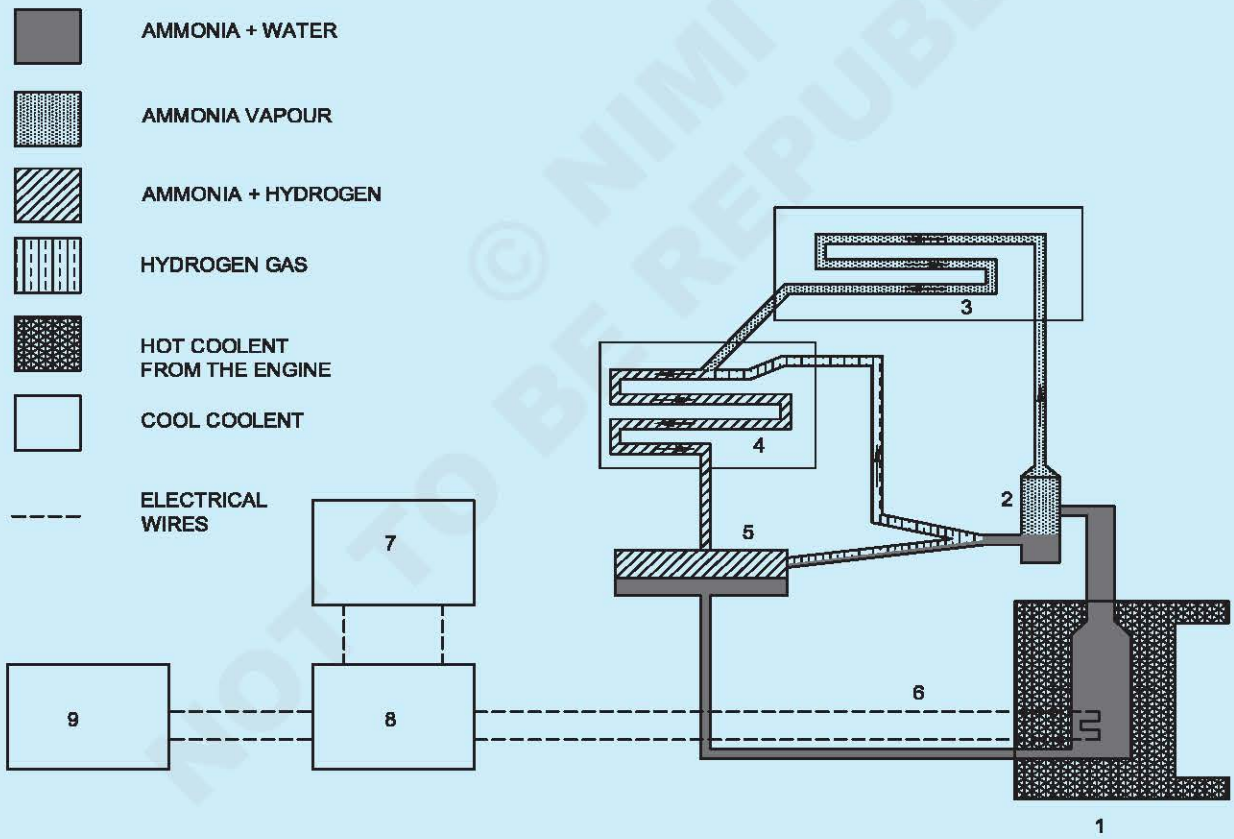
MRN1545J5

Record Sheet

Sl.No.	Components Name	Functions
1		
2		
3		
4		
5		

TASK 4: **Identify the vapour absorption system and the cycle**

Fig 6



MRN1545J6

Record Sheet

Sl.No.	Components Name	Functions
1		
2		
3		
4		
5		
6		
7		
8		
9		

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Unroll, cut and bend on soft copper tubes

Objectives: At the end of this exercise you shall be able to
- **unroll copper tubing from the roll**
- **measure mark and cut the copper tube the given size**
- **bend the copper tube**

Requirement

Tool/Instruments

- Mallet - 1 No
- Tube cutter (0.25mm) - 1 No
- Reaming tool - 1 No
- Spring bender (6mm) - 1 No
- Lever type bender (6mm) - 1 No
- Metal tape or steel rule - 1 No
- Triangular file 150mm - 1 No

Materials

- Copper tube 6mm - 1 coil
- Cotton waste - As reqd.
- A small quantity of oil - As reqd.

PROCEDURE

TASK 1: **Unroll the copper tube**

1 Place the tube on the flat clean surface.

2 Unroll tube to the required length (Fig 1).

Fig 1

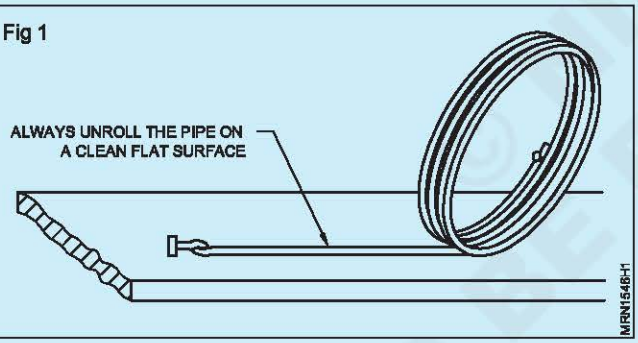
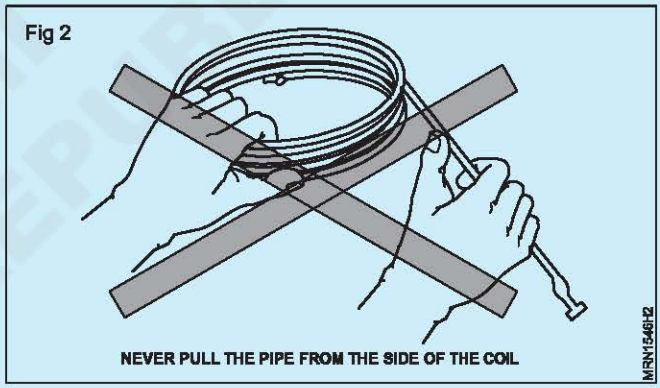


Fig 2



3 If any bend in the tube straighten the tube with light blows from mallet or plastic hammer.

— — — — — — — —

TASK 2: **Measure mark and cut the copper tube the given size**

Observation Table

Sl.No.	Parameter	Remarks
1	Straightness of the tube	Excellent/Very good/ Good/Average
2	Safe handling of the tube	Excellent/Very good/ Good/Average
3	Unrolling other sizes of tube	Excellent/Very good/ Good/Average
Note : Repeat it for various sizes of tubes		

1 Carefully measure the length of pipe needs and mark the outside (where you are going to cut with the edge of a file.

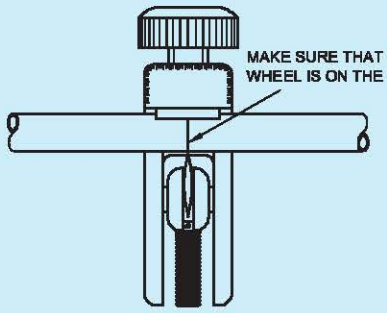
2 Place the pipe between the bottom rollers and the top cutting wheel.

3 Position the pipe so that the cutting wheel is in line with the mark that you made with the file. (Fig 3).

4 Tighten the hand screw until the cutting wheel just touches the outside of the pipe.

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Fig 3



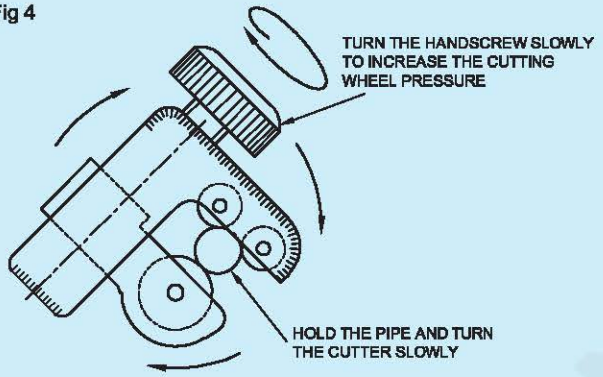
PIPE CUTTER IN POSITION ON THE PIPE

MRN1546I3

5 Turn the pipe cutter slowly around the pipe so that the cutting wheel cuts gradually into the outside.

6 Turn the hand screw to increase the pressure of the cutting wheel and then turn the cutter around the pipe again. (See Fig 4).

Fig 4



USING THE PIPE CUTTER

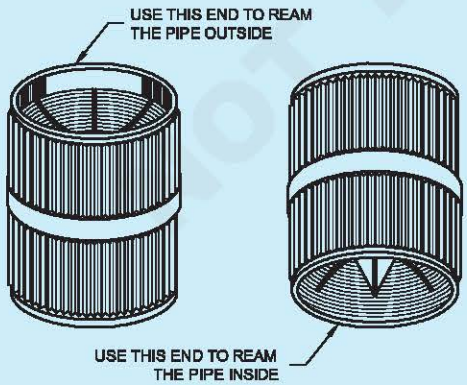
MRN1546H4

7 Continue the cutting by gradually increasing the pressure of the cutting wheel. Work slowly and carefully. Do not use too much pressure or you may damage the pipe.

8 When the cut is complete seal the open end and roll the pipe back into a coil.

9 To remove all rough edges from the end of the pipe, use the reaming tool. (Fig 5)

Fig 5

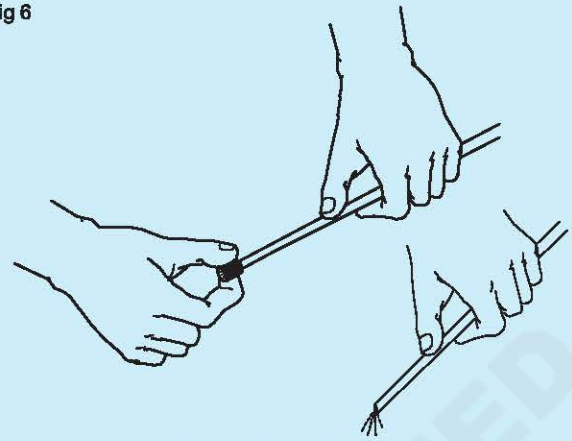


THE PIPE REAMING TOOL

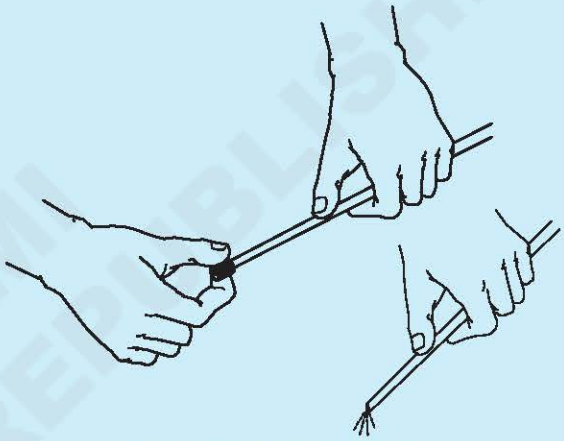
MRN1546H5

10 Hold the open end of the pipe to be reamed down (so that pieces of copper will not get inside the pipe). Turn the reaming tool until all rough edges have been removed from the inside of the pipe. (Fig 6)

Fig 6



REAMING THE INSIDE OF THE PIPE



REAMING THE OUTSIDE OF THE PIPE

MRN1546I18

Observation Table

Sl.No.	Parameter	Remarks
1	Angle of the bend 1	Correct/ not correct
2	Angle of the bend 2	Correct/ not correct
Note : Repeat the same procedure for various sizes of tubes.		

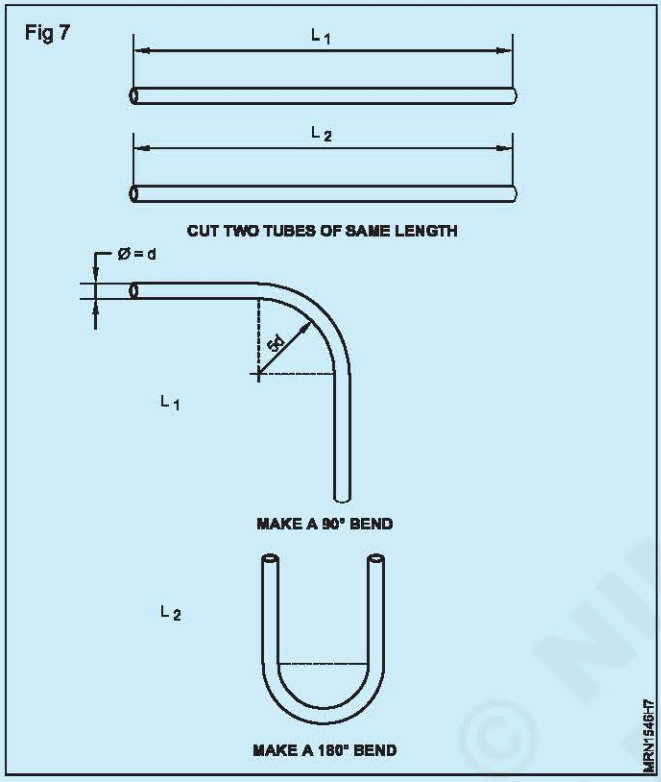
NOT TO BE REPUBLISHED

TASK 3: **Bend the copper tube**

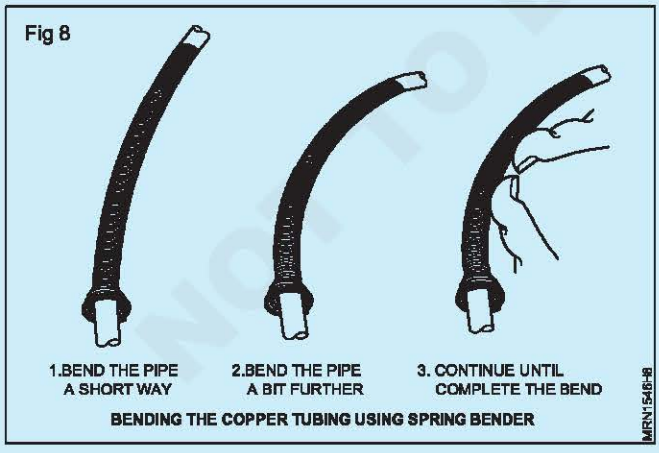
1 Refrigeration pipe is soft and can be bent by hand. Because it is soft it can be easily damaged when bending.

2 If the pipe is hard and will not bend easily, it must be annealed before use.

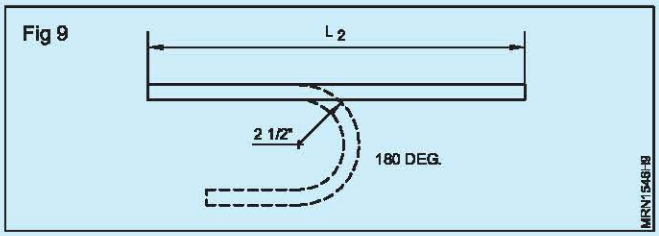
3 Push a bending spring onto the outside of the pipe (see drawing). This helps the pipe to bend evenly.



4 Bend the pipe a little at a time using your thumbs (see drawing).(Fig 8) Do not try to complete the bend with one movement. This will cause the pipe to buckle.

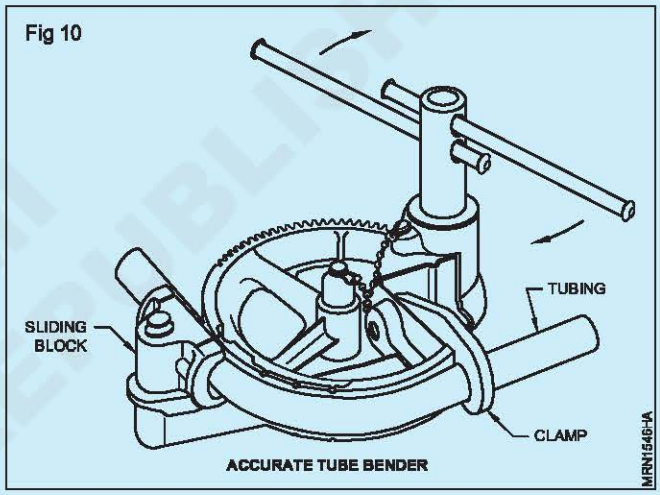


5 Do not make a sharp bend in the pipe. If the pipe diameter is 1/4 inch (6 mm), the sharpest bend that you can make without risk of damaging the pipe is 1 inch (2.5mm) radius (see drawing).(Fig 9) Not less than 5 times of its diameter.



6 Pipe that cracks, splits, wrinkles or flattens during bending must not be used.

7 Bend the pipe so that it fits onto the connection easily (see drawing).



Observation Table

Sl.No.	Parameter	Remarks
1	Length of the tube cut	Excellent/good/ average
2	Cleaned edges of the tubes	Excellent/god/ average
Note : Repeat the exercises for various sizes of tubes.		

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Swage and make a brazed joint on copper tubing

Objectives: At the end of this exercise you shall be able to
- **swage a copper tube (6mm)**
- **make a brazed joint.**

Requirement

Tools/Instruments

• Metal tape or steel rule	- 1 No.
• Triangular file 150mm	- 1 No.
• Flaring block	- 1 No.
• Swaging tool set	- 1 No.
• Ball pane hammer 225 gms	- 1 No.
• Blow lamp or Gas welding set	- 1 No.
• Handy braking torch	- 1 No.

Materials

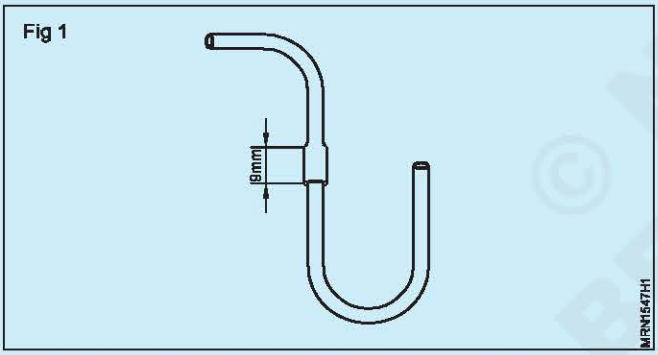
• Brazing rod	- As reqd.
• Brazing flux	- As reqd.
• Butane ean	- 1 No.

PROCEDURE

TASK 1: **Swage the end of the tube**

1 To join two pieces of tube of the same size together one must be made larger so that the other fits inside (Fig 1)

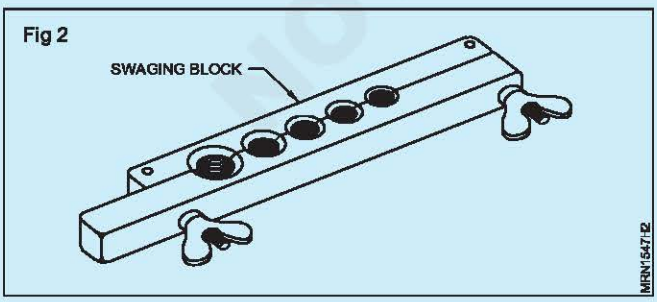
Fig 1



2 Making the end of a tube larger is called swaging

3 The tool used for swaging is shown in the drawings (Fig 2) & (Fig 3). Examine the pipe swaging tool and compare it with the drawings. Make sure that you understand how it works before starting to swage the end of a pipe

Fig 2



4 Place the tube in the tool. Make sure that you have chosen the correct size hole to fit the tube.

5 Position the tube so that the end is "the outside diameter of the tube plus 1/8 inch (3 mm) above the top of the swaging block. For 1/4 inch (6 mm) pipe this will be 1/4 inch (6mm) + 1/8 inch (3 mm) = 3/8 inch (9 mm), as shown (Fig 4).

Fig 3

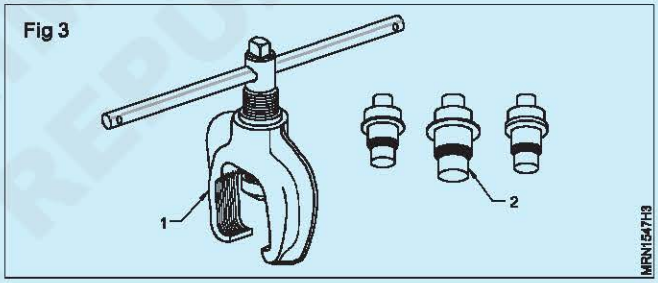
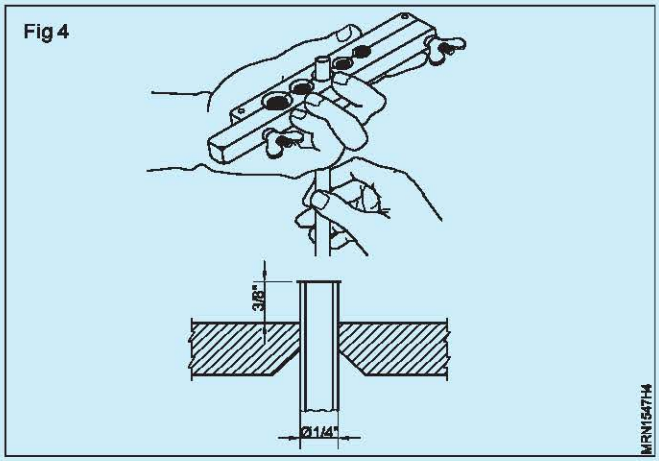


Fig 4



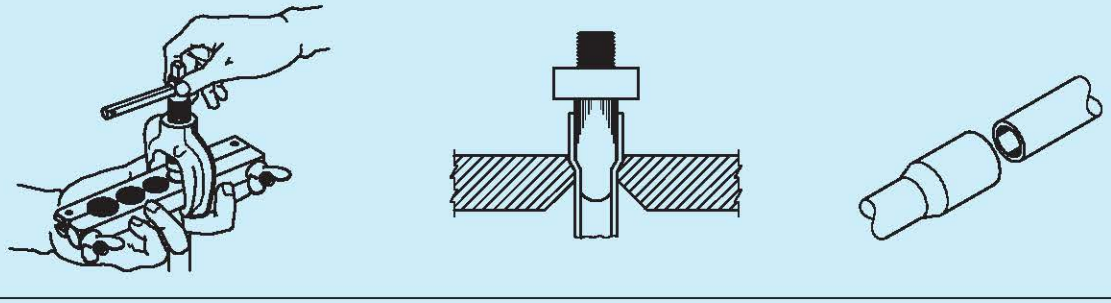
6 Tighten the nuts at each end of the swaging block.

7 Choose a punch of the right size to swage out the end of the tube so that another piece fits inside. Oil the punch. Fit the clamp and punch onto the swaging block. Twist the handle and Force the punch into the tube.

8 The punch will open out the end of the tube. (Fig 5)

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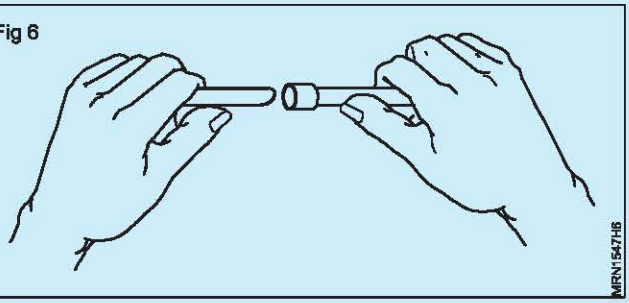
Fig 5



TASK 2: **Braze a swaged joint**

1 Make sure that the tube enters the swage properly. It must be an "easy" fit. If it is a tight fit there will not be sufficient space for the brazing material. If it is a loose fit the joint will be weak. (Fig 6)

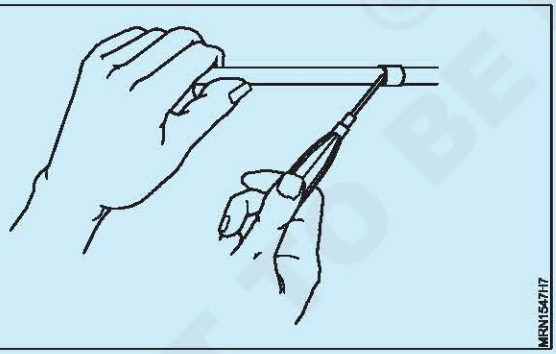
Fig 6



2 Mix a little flux powder with spirit (or water) to make a stiff paste.

3 Apply a small amount of flux to the surfaces to be joined. Only a small quantity is necessary. Too much will contaminate the system.(Fig 7)

Fig 7

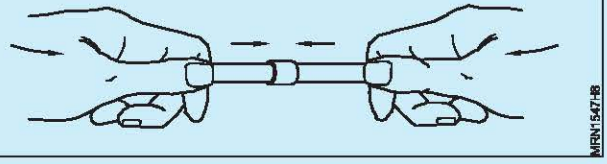


Note : If "self-fluxing" brazing rods are being used this stage of the work is not necessary

4 Push the end of one pipe into the swage of the other as far as possible. Turn the pipes to spread the flux. (Fig 8)

5 Heat the joint with the blow torch. Use a flame of the right size.

Fig 8



6 Wait until the joint is dull red. When the brazing rod starts to melt the joint is at the right temperature. This temperature is found by touching the brazing rod onto the joint from time to time while heating. Do not overheat the joint. Do not leave the brazing rod in the flame. The brazing rod must be melted by the heat of the joint and not by the flame. (Fig 9)

7 When the right temperature has been reached touch the joint with the brazing rod at several points

8 Molten brazing rod will be drawn into the joint and fill the space between the outside of one pipe and the swaged end of the other. When a complete ring of brazing material can be seen at the end of the swage remove the blow torch.

9 Allow the joint to cool. Do not move either pipe until the brazing material has hardened.

Observation Table

Sl.No.	Parameter	Remarks
1	Testing the swaging	Excellent/Good/ Average
2	Testing the brazed joint	Firm/ Blow holes
3	Time taken	Slow/Medium/ Fast
4	Materials waste	Less/Very less/ No waste

Note : Repeat the same exercise for various sizes of tube and test the improvement.

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Make flare joints and test them with flare fittings

Objectives: At the end of this exercise you shall be able to
- **make flare on copper tubes**
- **join with flare fittings**
- **test the leak in fittings**

Requirement

Tool/Instruments

- Flaring block with yoke - 1 Set
- Adjustable wrench 200mm - 1 No
- Valve key 6mm (cylinder valve opener) - 1 No
- Pressure gauge with adapter - 1 No
- Flat file smooth 200mm - 1 No
- N^2 Cylinder with gas - 1 No

Materials

- Copper tubes 6mm - As reqd.
- Flare nut 6mm size - As reqd.
- Union 6mm - As reqd.
- Soap solution with stirrer - As reqd.
- A small quantity of oil - As reqd.

PROCEDURE

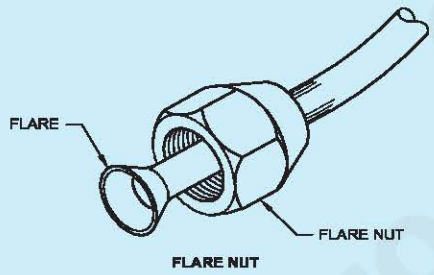
TASK 1: **Make flare on copper tubes**

1 Refrigerator pipes are sometimes jointed to fittings by making a flared connection

2 The end of the pipe is opened out to form a cone (Fig1).

3 Always place the special flare nut on the pipe first before flaring.

Fig 1



4 Examine the tube flaring tool. Make sure that you understand how it works before starting to flare the end of a pipe.

5 Make sure that the end of the tube is free of rough edges before flaring

6 Place the tube in the tool (Fig 2). Make sure that you have:

a Place the flare nut in to the tube.

b Chose the correct size hole in the flaring tool to fit the pipe; (there are 5 holes to fit different sizes of pipe.)

7 If the pipe is 1/4 inch (6 mm) in diameter, position the tube so that the end is at least 2 mm above the top of the flaring block (Fig 3). (This distance is calculated as "pipe diameter divided by 3"; in this case, 6 mm divided by 3 = 2mm).

Fig 2

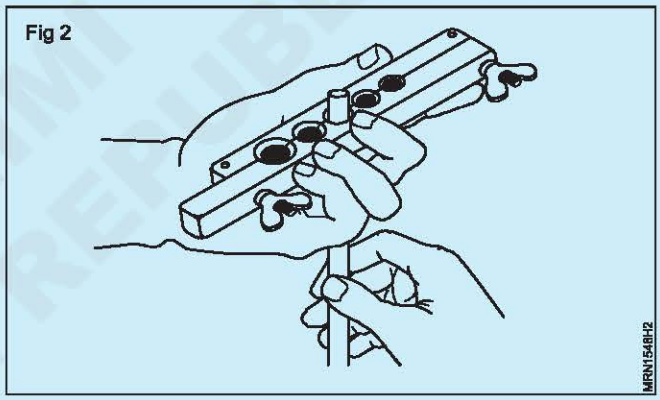
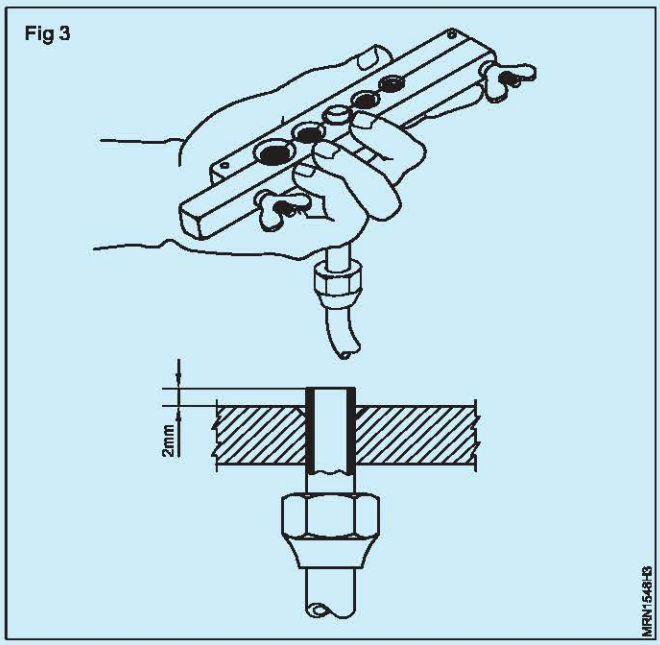


Fig 3



8 Tighten the nuts at each end of the flaring block (see drawing).

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9 Fit the yoke to the flaring block (Fig 4)

10 Oil the cone and slowly screw it into the end of the pipe

11 The end of the tube will be formed into a flare.

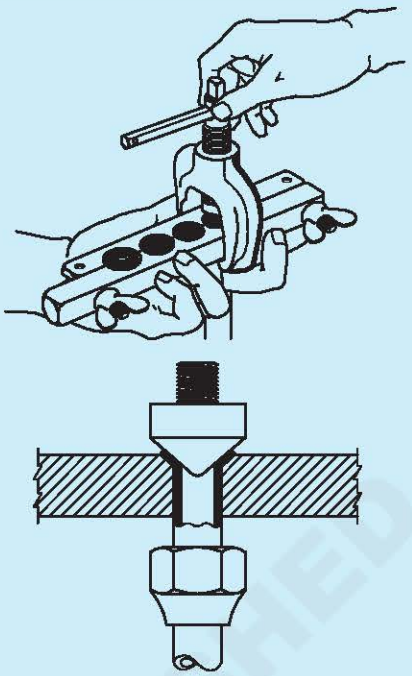
12 Remove the flared tube from the block.

13 Examine the flare. If it has cracked, the cone was screwed down too quickly.

14 Make sure that the flare is the correct size. It should just fit inside the flare nut. If it is too loose, cut off the flare and start again at instruction 5.

At instruction 7, use 3 mm instead of 2 mm. Repeat until the flare is the correct size for the flare nut - not too loose and not too tight.

Fig 4



Observation Table - 1

Sl.No.	Skills	Remarks
1	Checking Flaring	Cracked/uneven/too small/too long/ correct
2	Number of attempts	One/two/three
Note : Repeat the steps to the various sizes of copper tube		

TASK 2: **Join with flare fittings**

1 Push back the flare nut and place the flared tube on the fitting, then tighten the nut using adjustable wrench or suitable double end spanner.

2 Tighten the one end of the tube to the dry nitrogen cylinder with the flare nut. Always use safety valve with double stage pressure regulator while wring dry nitrogen.

3 Connect a pressure gauge at the other end of the tube with flare nut.

Note :

- **Do not give more pressure while tightening since this will spoil flare.**
- **Make sure that they should not be loose in the tube.**

Observation Table - 2

Sl.No.	Skills	Remarks
1	Selection of correct fittings	Correct/ notcorrect
2	Joining method	Excellent/ good/fair
3	Time taken	Less/very less/more

TASK 3: **Test the leak in fittings**

1 After joined the tube firmly, open the cylinder valve with help of valve key or ratchet.

2 The pressure will be shown in the pressure gauge.

3 Then close the cylinder valve. Major leaks will make noise and that needs the nut to be tightened.

4 If there is no leak, the pressure in the pressure gauge will remain constant.

5 If it decreases, check the joints with soap solution foam. Leak will bubble, then tight the joints. If it stands still then there is no leak.

Observation Table - 3

Sl.No.	Skills	Remarks
1	Selection of tools	excellent/ good/average
2	Detecting leak and arresting	excellent/ good/average

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Pinch off copper tubing

Objectives: At the end of this exercise you shall be able to
- **pinch off the copper tube using pinching tool.**

Requirement

Tool/Instruments

- Tube cutter with reamer - 1 No.
- Small triangular file - 1 No.
- Pinch off tool - 1 No.
- Steel rule - 1 No.

Materials

- Soft tubing 1/4",3/8",1/2" - 1 Roll each
- Clean cloth - As reqd.

PROCEDURE

TASK 1: **Pinch Off the copper tube using pinching tool**

1 Unroll 1/4" soft copper tubing so that a 3" piece may be cut.

2 Measure 3" piece long tube using the steel ruler and mark it by nicking the face with a triangular file.

3 Cut the copper tube by placing the tubing in 'V-guide' of the cutter.

4 Tighten the thumb screw until considerable pressure is applied.

5 Revolve cutter slowly around the tubing.

6 Seal the end of the tubing coil after cutting off the required piece.

7 Ream and file the edges of the tubing.

8 Repeat with other sizes using 3/8" and 1/2" tubes (steps 1 to 7).

9 Place copper tube in the pinch off section of the tool apply even pressure by turning screws equally by hand. (Figs 1 & 2)

10 Take a part turn on one screw and then an equal amount on the other.

11 The tightening process must carry on until the two blocks are evenly seated.

12 The tube is then pinched shut.

13 Seal the end of the tubing coil after cutting off the required piece.

14 Ream and file the edges of the tubing.

15 Repeat with other sizes using 3/8" and 1/2" tubes (steps 1 to 7)

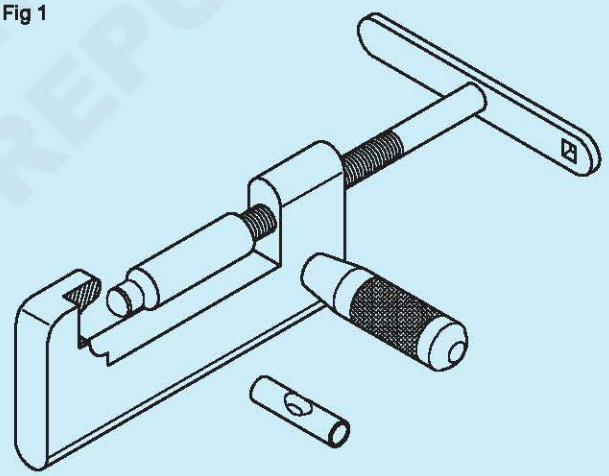
16 Place copper tube in the pinch off section of the tool apply even pressure by turning screws equally by hand. (Figs 1 & 2)

17 Take a part turn on one screw and then an equal amount on the other.

18 The tightening process must carry on until the two blocks are evenly seated.

19 The tube is then pinched shut.

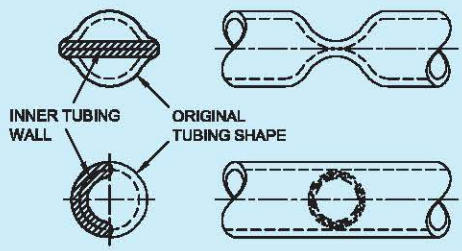
Fig 1



PINCH-OFF TOOL

MRN1549H1

Fig 2



ACTION OF PINCH-OFF TOOL

MRN1549H2

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Use lock ring tools various fittings of lockring for servicing of appliances

Objectives: At the end of this exercise you shall be able to
- **connect two copper tubes with lokring**
- **connect capillary tube by lokring fitting.**

Requirement

Tool/Instruments

• Tube cutter	- 1 No.
• Tube caliper	- 1 No.
• Digital micrometer caliper	- 1 No.
• Lokring tool kit	- 1 No.

Materials

• Sand paper	- As reqd.
• Lock prep (adhesive)	- 1 No.
• Lokring various sizes	- 1 Set.
• Copper tubes	- As reqd.

PROCEDURE

TASK 1: **Connect two copper tubes with lokring.**

1 Select the correct lokring size and materials(size are available range from 1.6mm to 35mm.)

2 Check the size of the tubing with tube calipers(for accurate measuring use digital micrometer caliper if available)

3 Set the tube & lokring fitting in horizontal line(see Fig1)

Fig 1



4 Use the lokring hand tool compress the fitting over the joint (for hand lokring see Fig 2)

5 Apply the sealant lokprep on the tube outer space and rotate the tubes.

6 Now compress fully till the lokring have tight close.(see Fig 3)

7 After completing lokring fitting clean the lokring and joints with a dry cloth.

Fig 2

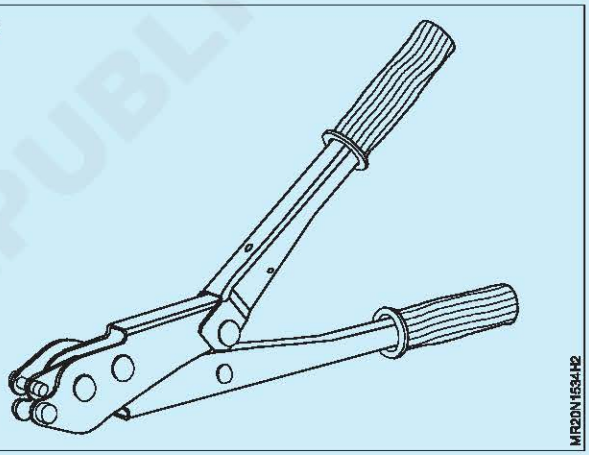
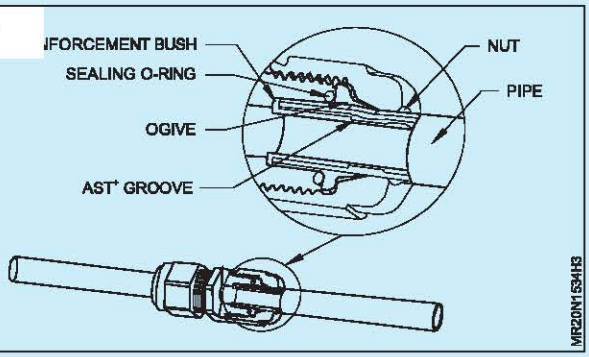


Fig 3



TASK 2: **Connect capillary tube by lokring fitting**

1 Use the tube cutter to separate the tubing if necessary

2 Clean the capillary tube end with sand paper.

3 Pass the capillary tube all the way in till it reaches the other end of lokring connector.

4 Apply a single drop of lokprep while partially inserted in the lokring .

5 Rotate the fitting 360° to spread the sealant evenly around the tubing.

6 Place a slight bend into the capillary tube

7 Insert other end with copper tube and refer steps in task 1 to complete the lokring connection.

8 After completion of joint wipe the joints with dry cloth.

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Brazing of cu to cu, cu to steel cu to brass using Air - LPG

Objectives: At the end of this exercise you shall be able to
- **set the gas pressure according to the nozzle size**
- **ignite, adjust and extinguish LPG air flame**
- **braze the swaged copper tube joint.**

Requirements

Tools/Instruments

- Spark lighter - 1 No.
- LPG cane attached with nozzle and control valve - 1 set

Materials

- Filler rod (Silver, brass, copper alloy) - as reqd.
- Flux suitable - as reqd.
- Copper tubes length size - as reqd.
- Safety apparel - 1 set

PROCEDURE

TASK 1: **Set the gas pressure according to the nozzle size.**

Remove the oxides and other impurities from the surface to be joined.

1 Wear safety goggles grouses and apron.

2 Keep the copper tube swaged connection in position easy to braze.

3 Select 1.6mm die silver brazing filler rod and suitable flux in the form of paste.

4 Take the LPG cane open the valve slightly.

Air will be sucked through the side of nozzle (for oxygen)

TASK 2: **Ignite, adjust and extinguish LPG-air flame**

1 Ignite the flame by using a spark lighter.

2 Adjust the control valve of the LPG cane and set a soft flame.

TASK 3: **Braze the swaged copper tube joint**

The flux should be applied after cleaning of the tube swaged joint and kept ready before brazing.

1 Heat both the tube by the joint area evenly.

2 Dip the silver brazing rod in the flux (paste) and apply the filler rod to the joint area as you pointing the flame on the connection. (Fig 1)

3 Carefully watch for proper melting and flow of the filler metal into the minute gap (capillary action) of the joint (i.e. wetting of the joint)

4 Move the LPG cane flame (oxy-air) and filler rod along the joint to complete the brazing operation. Finally close the control valve (put off flame) of LPG cane.

Note : If the joint is not properly wetted it indicates that the metals (tube) have not been heated to the required brazing temperature.

5 Cool the job (by natural air) and clean the flux residue thoroughly from the joint.

6 Inspect for any surface defects.

7 Get it checked by your instructor.

Fig 1

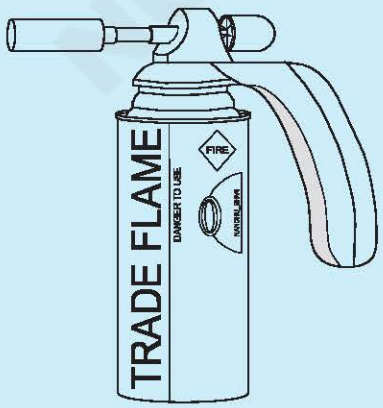
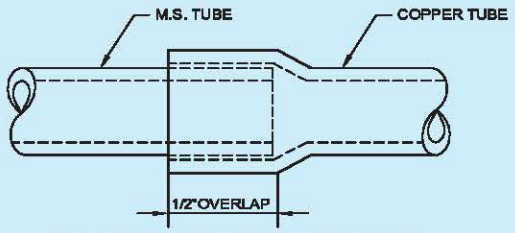


Fig 2



SILVER BRAZING TO MAKE CONNECTING JOINTS

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Brazing of cu to cu, cu to steel and cu to brass using Oxy LPG set

Objectives: At the end of this exercise you shall be able to
- **set oxy - LPG gas welding set**
- **braze copper to copper**
- **braze copper to steel**
- **braze copper to brass.**

Requirement

Tool/Instruments

• Gas welding set	- 1 no.
• Tube cutter	- 1 no.
• Wire brush	- 1 no.
• Cylinder key	- 1 no.

Equipments

• oxy-acetylene welding set	- 1 set.

Materials

• Sand paper materials	- as reqd.
• Brazing flux	- as reqd.
• Brazing rods (silver & copper)	- as reqd.
• Ms tube & Brass tube	- as reqd.
• Clean cloth	- as reqd.
• 6 mm copper tube (as required)	- as reqd.

PROCEDURE

TASK 1 & 2: Refer Exercise 1.5.27

TASK 3: **Braze the copper to brass tube**

1 Soften the end of copper tube to be bell-mouthed by heating

2 Dip the heated end in water and remove the oxides

3 Use a mandrel to form the bell mouth

4 Insert the mandrel and drive into the softened end of the tube by hammering

5 Remove any unevenness of the bell mouth

6 Insert the brass tube into the bell mouth and tack it at 3 points

7 keep the tack welded pipe assembly vertically and heat it until the colour of the tube starts changing.

8 Make a thin run on the line formed by the outer circumference at the bottom end of the brass tube and the inner circumference at the bottom of the bell mouth of copper tube (i.e tip of the bell mouth).

9 Make the first deposit starting from the tack weld 1 and ending at the midpoint of the tack welds 2 and 3 covering half the circumference of the bell mouth

10 Clean the deposit.

11 Make the second deposit starting from the commence mint point of deposit 1 and ending at the finishing point of the deposit 1 which will cover the remaining half circumference of the bell mouth.

12 Ensure the deposit 2 merges with the deposit 1 at both ends (i.e. terminal points) properly by withdrawing the filler rod and manipulating the flame over these merging points.

13 Ensure that the weld deposit is of the correct profile and it completely covers and bonds (without over spilling the outer edge of the bell contour.

14 Clean the bead and the joint and remove the flux residue thoroughly.

15 Inspect the weld deposit for uniform size and weld defects like porosity, etc.

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Brazing of cu to cu, cu to steel, cu to brass using Oxy- acetylene

Objectives: At the end of this exercise you shall be able to
- **braze a swaged copper tube joint**
- **braze copper with MS tube**
- **braze copper to brass tube.**

Requirement

Tool/Instruments

• Spark lighter	- 1 No.
• Tube cutter	- 1 No.
• Wire brush	- 1 No.
• Cylinder key	- 1 No.

Equipments

• oxy-acetylene welding set	- 1 set.

Materials

• Sand paper materials	- As reqd.
• Brazing flux	- As reqd.
• Brazing rods (silver & copper)	- As reqd.
• Ms tube & Brass tube	- As reqd.
• Clean cloth	- As reqd.
• 6 mm copper tube (as required)	- As reqd.

PROCEDURE

TASK 1: **Braze a swaged copper tube joint (Refer Ex: 1.6.32 - Task 2)**

TASK 2: **Braze copper with Ms tube cut the copper tube**

1 Place the tube in V-guide of cutter.

2 Tighten the thumb screw until considerable pressure is applied

3 Revolve the cutter slowly around the tube so that the sharp cutting wheel feeds gradually on the tubings to apply pressure thumb screw till tube is completely cut

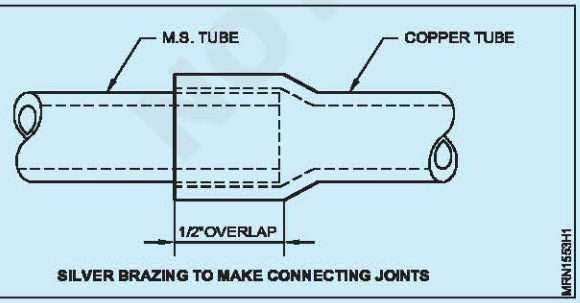
4 Ream and file the edges of the tubing

5 Use sand paper to clean the outer surface of the tube and clean inside by wire brush

6 Make a paste of silver brazing flux by mixing it with little bit of water and apply a thin coat of flux to outside of the fitting

7 Insert the pipe into MS pipe and see that the fit is not too easy (Fig 1)

Fig 1

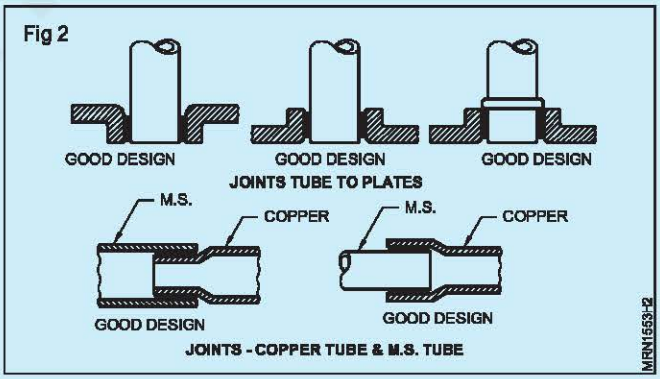


8 Clamp the pipe in the flaring block and mount the block in the vice

9 Light the oxy-acetylene torch using the spark lighter

10 Heat the connection at safe distance from the joint until the water vaporizes

Fig 2



11 Continue heating until the flux turns milky and finally turns clean (Fig 2)

12 Apply the silver solder to both edges of the MS tube until the solder flows on both pipes

13 Remove silver solder rod and allow the joint to cool

NOT TO BE REPUBLISHED

Identify the electrical and mechanical components of refrigerator direct cool and frost free

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.**

Requirement

Tool/Instruments

• Screw driver	- 1 No.
• Line tester	- 1 No.
• Combination insulated handle plier	- 1 No.
• Series test lamp	- 1 No.
• Multimeter	- 1 No.

Materials

• Cotton waste/ cloth	- 1 No.
• Loose wire	- as reqd.

Equipments

• Refrigerator direct cool and frost free fill accessories	- 1 No

PROCEDURE

TASK 1: **Identify the Electrical parts**

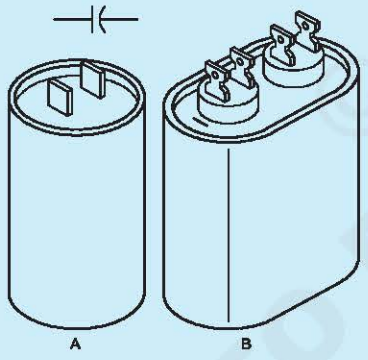
1 Disconnect the connection & identify the electrical components (Fig 1 to 7)

2 Keep it on work bench.

3 Clean all the spare parts.

4 Record the name of electrical parts of the given table 1

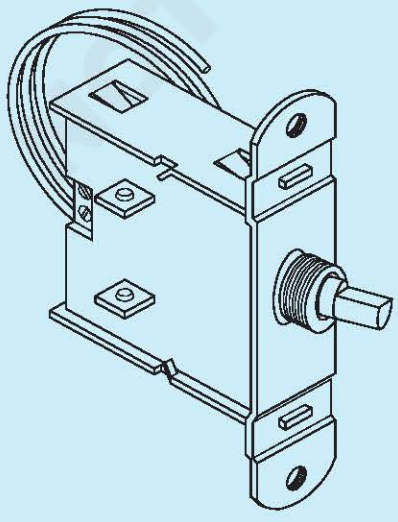
Fig 1



TYPES OF CAPACITORS

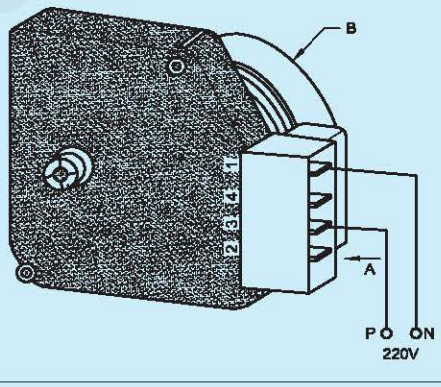
MRN1654H1

Fig 2



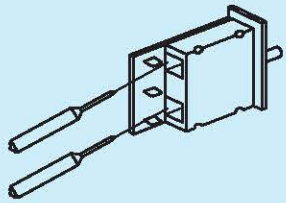
MR20N1654H2

Fig 3



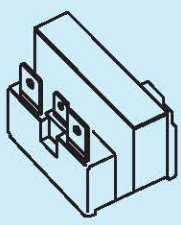
MRN1775H8

Fig 4



MRN1454H5

Fig 5



PTC RELAY

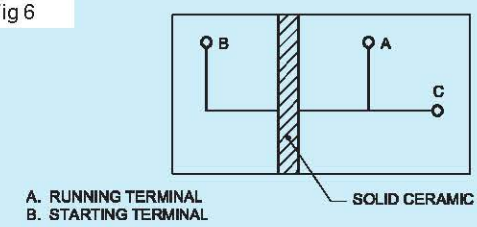
MRN1654H7

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Table 1

Figure No	Name of the part
1	
2	
3	
4	
5	
6	
7	

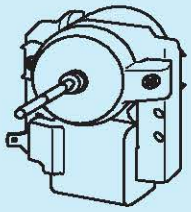
Fig 6



INTERNAL CONSTRUCTION

MRN1775HB

Fig 7



EVAPORATOR FAN MOTOR

MRN1776HD

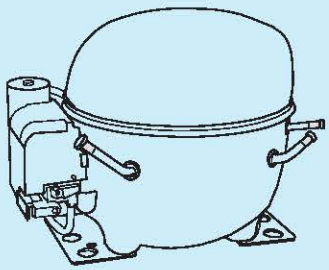
TASK 2: **Identify the Mechanical parts**

1 Disconnect the electrical connection and identify this mechanical components (Fig 1 to 5)

2 Clean all this parts

3 Record the name of mechanical parts in the given table 2.

Fig 1



MR20N1637J1

Fig 2

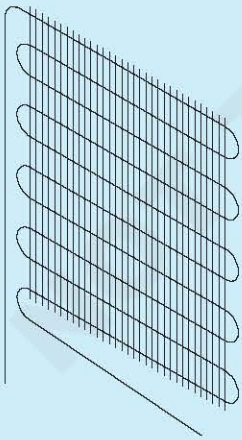
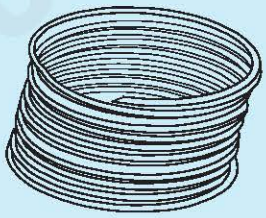


Fig 3



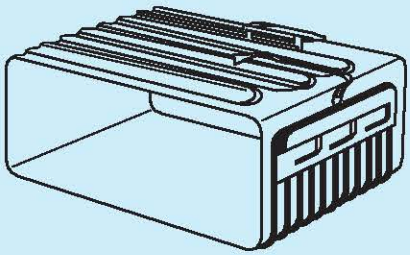
MR20N1637J3

Fig 4



MR20N1637J4

Fig 5



MRN1654J5

Table 2

Figure No	Name of the part
1	
2	
3	
4	
5	

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Check and replace electrical components of refrigerator

Objectives: At the end of this unit you shall be able to
- **check and test current coil relay**
- **check and test overload protector**
- **identification of compressor winding**
- **check short circuit in compressor**
- **check the condition of a door switch**
- **check Thermostat & check capacitor.**

Requirement

Tool/Instruments

- Screw driver 10mm tip 200mm length - 1 No.
- Cutting plier 200mm length (Insulated) - 1 No.
- Phillips screw driver set - 1 No.
- Ohmmeter - 1 No.
- Test board fitted with voltmeter & ammeter - 1 No.

Equipments

- Refrigeration (all electrical components direct and indirect - 1 No

Materials

- Current coil relay - 1 No.
- OLP - 1 No.
- 2 m 1 sq.mm lead wire as reqd.
- 2 m wire with crocodile clip as reqd.
- Thermostat - 1 No.
- Capacitor - 1 No.

PROCEDURE

TASK 1: **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.

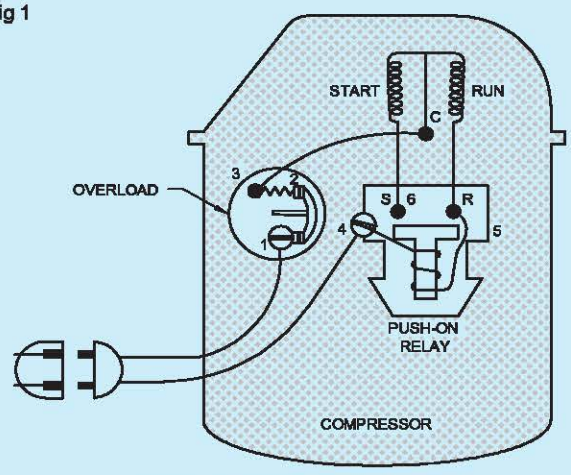
3 Check continuity between 5 & 6. Normal condition (when not in use) 5 & 6 open. If there is no continuity between 5 & 6 relay is OK.

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 2: **Check and the overload protector**

Refer TASK 1: 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)

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TASK 3: **Identification of compressor winding**

Terminal pins with Ohmmeter of fraction horse power hematic 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 2)

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

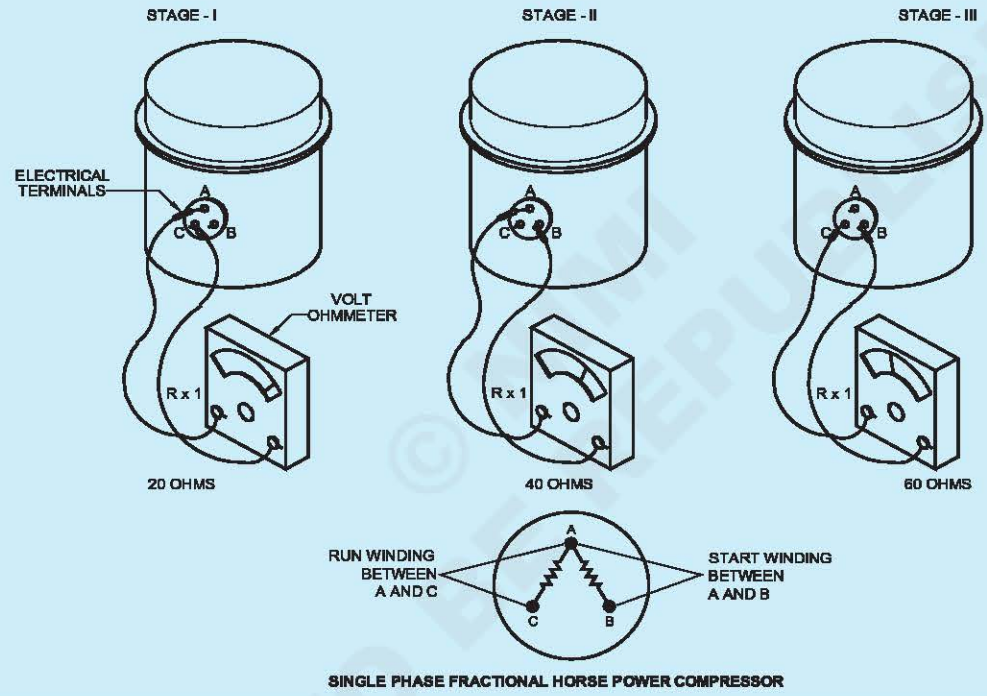
8 Identified 'A' terminal pin become common terminal

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 2



Sl No	Terminal connection	value of reading
1	A to B	
2	B to C	
3	C to A	

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TASK 4: **Check short circuit in compressor.**

1 Select ohmmeter scale (R x 10000) (Fig 3)

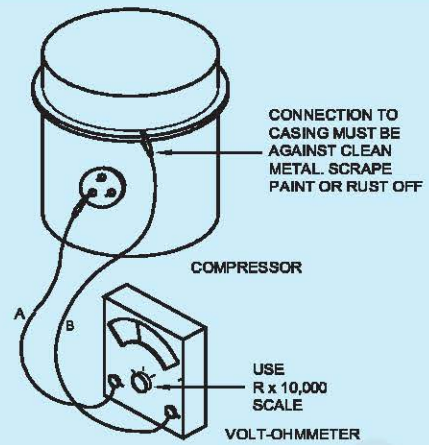
2 Place 'A' probe to compressor terminal

3 Place 'B' probe to metal casing of compressor

4 Check continuity. If continuity is there compressor grounded. (Fig 3)

5 If there is no continuity compressor not grounded.

Fig 3



CHECKING THE COMPRESSOR FOR A GROUND TO CASING

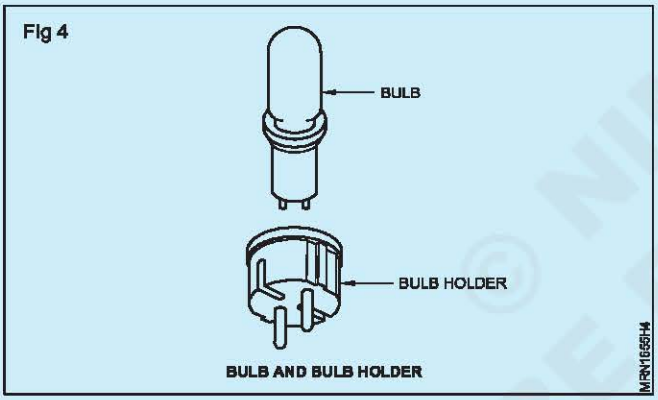
TASK 5: **Check the condition of a door switch**

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 4)

Fig 4



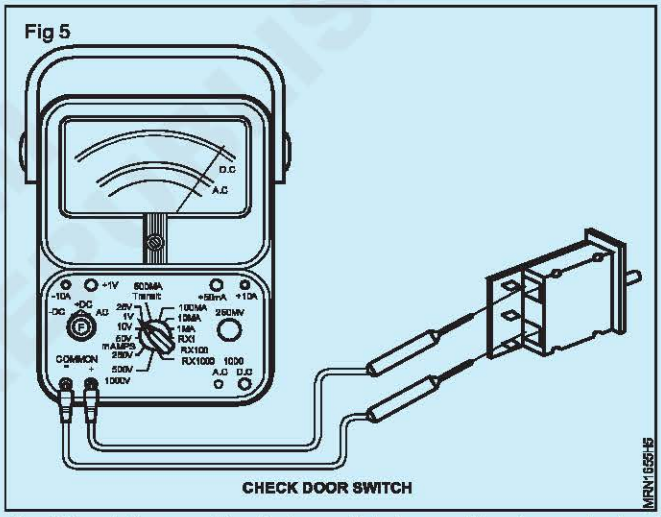
BULB AND BULB HOLDER

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.

Fig 5



CHECK DOOR SWITCH

6 Check the continuity in switch by multimeter or by test lamp is ON and OFF position. (Fig 5)

7 Check bulb holder wires.

8 If switch found defective, replace it and connect wires.

TASK 6: **Check the condition of a thermostat.**

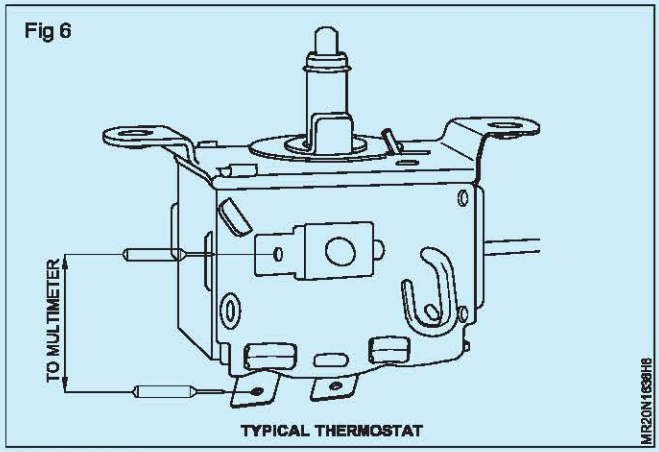
1 Switch ON the Refrigerator.

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 6)

Fig 6



TYPICAL THERMOSTAT

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TASK 7: **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 7A)

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 7B)

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 7C)

8 If it does not spark in the first time, try it two or three times before replacing the capacitor to the unit.

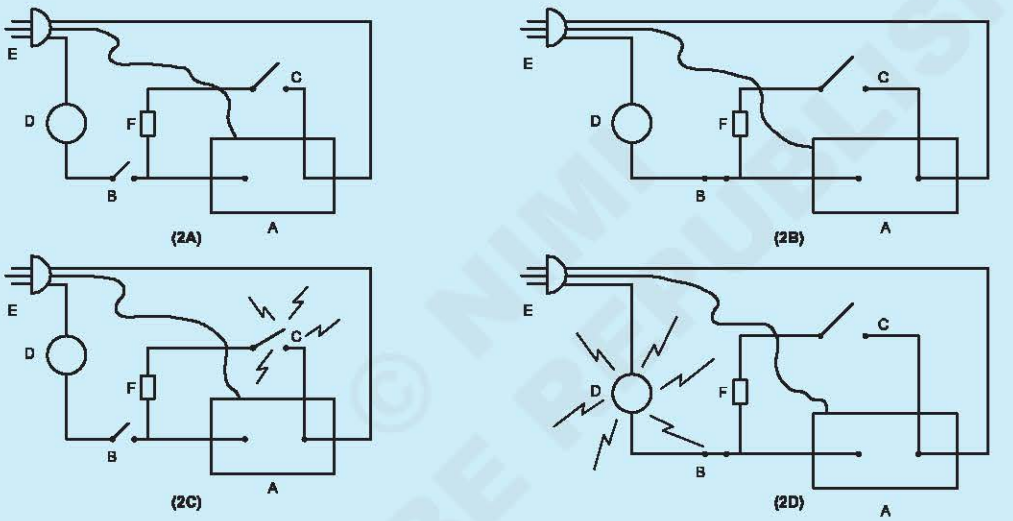
Note : If the capacitor is good it will spark as in (Fig 7C).

If the capacitor is shorted or grounded the fuse (D) will blow as in view. (Fig 7D).

If the capacitor does not take a charge, it will not spark. This indicates an open circuit. (Fig 7A). 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 7



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

MRN1855H7

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Leak, test evacuation and gas charging in a refrigerators

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

- **flare and make additional charging tube in compressor**
- **braze compressor charging tube with additional flared copper tube**
- **connect compressor charging tube with gauge manifold and nitrogen cylinder**
- **charge nitrogen gas into the system**
- **test leak with soap solution**
- **braze the leak spots.**
- **connect the system with vacuum pump**
- **handle and operate vacuum pump**
- **dehydrate the system**
- **evacuate the system by low side and both high & low sides.**
- **Gas changes of the system**
- **Porch the system**

Requirements

Tools/Instruments

- Combination plier - 1 No.
- Cylinder key - 1 No.
- Digital thermometer - 1 No.
- Gauge manifold with LP/HP gauges - 1 Set
- Double ended spanner Nos. 6/7 to 20/22 - 1 Set
- Adjustable spanner 10" (25 cm) - 1 No.
- Flaring block with yoke - 1 Set
- Brazing torch with hoses and oxygen and LPG cylinders - 1 Set
- Heating kit - Infrared lamp type or hot air gun - 1 set
- Online tester 230V - 16A - 1 No.

Equipments

- Conventional Refrigerator - 1 No.
- Frost free refrigerator - 1 No.
- Vacuum pump 2 stage - 1 No.

Materials

- Soap solution concentrate - 1 bottle/ 100ml
- Clean and pure water - 500ml.
- Fine emery sheet - 2 nos
- Copper tube soft annealed type - 1/4" OD (6 mm) - 15 cm
- Flare nut brass 1/4" (6 mm) - 1 No.
- Flare union brass 1/4" (6 mm) - 1 No.
- Brazing rod copper to copper 30 cm - 2 Nos.
- Flare dummy nut brass (6 mm) 1/4" - 1 No.
- Plastic/ metal mug. 1 ltr water volume - 1 No.
- Painting brush 1" (25 mm) - 1 No.
- Charging hose - 2 No.
- Nitrogen cylinder and 2 stage pressure regulator - 1 Set
- Dry nitrogen gas - 1 No.

PROCEDURE

TASK 1: **Flare and make additional charging tube in compressor**

Conventional refrigerator (Fig 1)

1 Make sure that there is no gas in the system through the charging tube of compressor (it should be open)

2 Take the copper tube 6 mm (soft) 1/4 " OD : Flare one end with flaring block and yoke.

3 Insert the flare nut (6 mm) through the copper tube (6 mm) at non flared end

4 Insert (15 mm) the non flared end of copper tube (6 mm) into the compressor process tube.

Note : This practical exercise to be done after leak testing of the unit /appliance. Ensure that the unit/appliance is already leak tested.

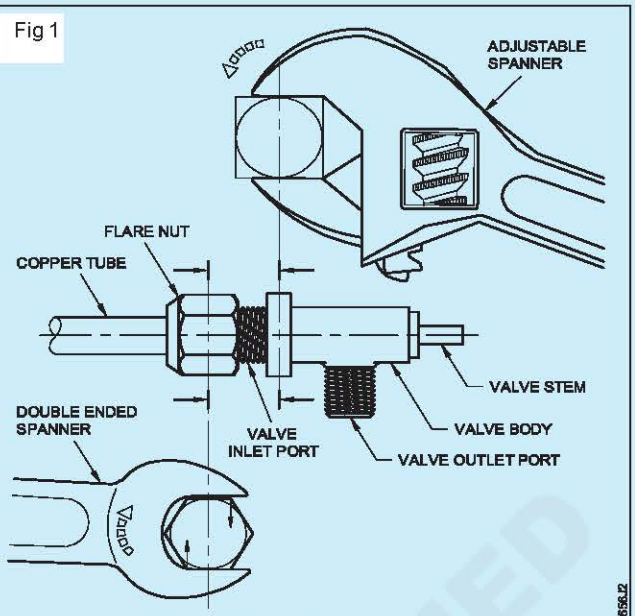
5 Fix the angle valve inlet port to the compressor process (additional) tube flare nut.

6 Tighten the joint 'angle valve - flare nut' by using a suitable double ended spanner and adjustable spanner

7 Make sure that the angle valve is closed.

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Fig 1



FIXING ANGLE VALVE WITH FLARE NUT

TASK 2: **Braze compressor charging tube with additional flared copper tube**

1 Take the gas welding brazing set
2 Open the valve of oxygen cylinder and regulate pressure
3 Open the valve of LPG cylinder and regulate pressure
4 Light up the brazing torch and set the flame (neutral type)
5 Take the flame to the point of compressor charging tube with additional copper tube (6 mm)
6 Braze the point with brazing rod (copper - copper)
7 Allow the point to cool down.

TASK 3: **Connect compressor charging tube with gauge manifold and dry nitrogen gas cylinder**

1 Connect flare nut of additional charging tube with flare union 6mm.
2 Connect the other end of flare union with charging hose.
3 Connect the other end of charging hose with HP(High pressure) port of gauge manifold.
4 Connect the intermediate port of gauge manifold with another charging hose.
5 Connect the other end of charging hose with outlet part of nitrogen cylinder/

TASK 4: **Charge dry nitrogen gas into the system**

1 Make sure that all thread/ screw points are in tight fit position
2 If not, make the joints tighten by using cutting plier (to tighten charging hose), double ended spanner and adjustable spanner (to tighten flare nuts, flare unions)
3 Open the nitrogen cylinder valve using valve key
4 Regulate the pressure to 50 psig. in the pressure regulator
5 Open the knob of HP(High Pressure) port of gauge manifold by turning the knob gently in anti clockwise direction
6 Observe the nitrogen gas flowing into the system through, notice the reading in the HP gauge of manifold
7 Allow the nitrogen flow for 15 - 20 seconds
8 Close the knob of gauge manifold by turning it gently clockwise direction
9 Observe the reading in the pressure gauge (HP) manifold
10 If the pressure not reached 150 psig, again allow nitrogen flow into the system through reopening the knob of manifold.
11 When the pressure reaches 150 psig, close the valve of nitrogen cylinder; close the regulator knob
12 Close the knob of gauge manifold
13 Take the dry bulb thermometer and find the temperature of ambient air

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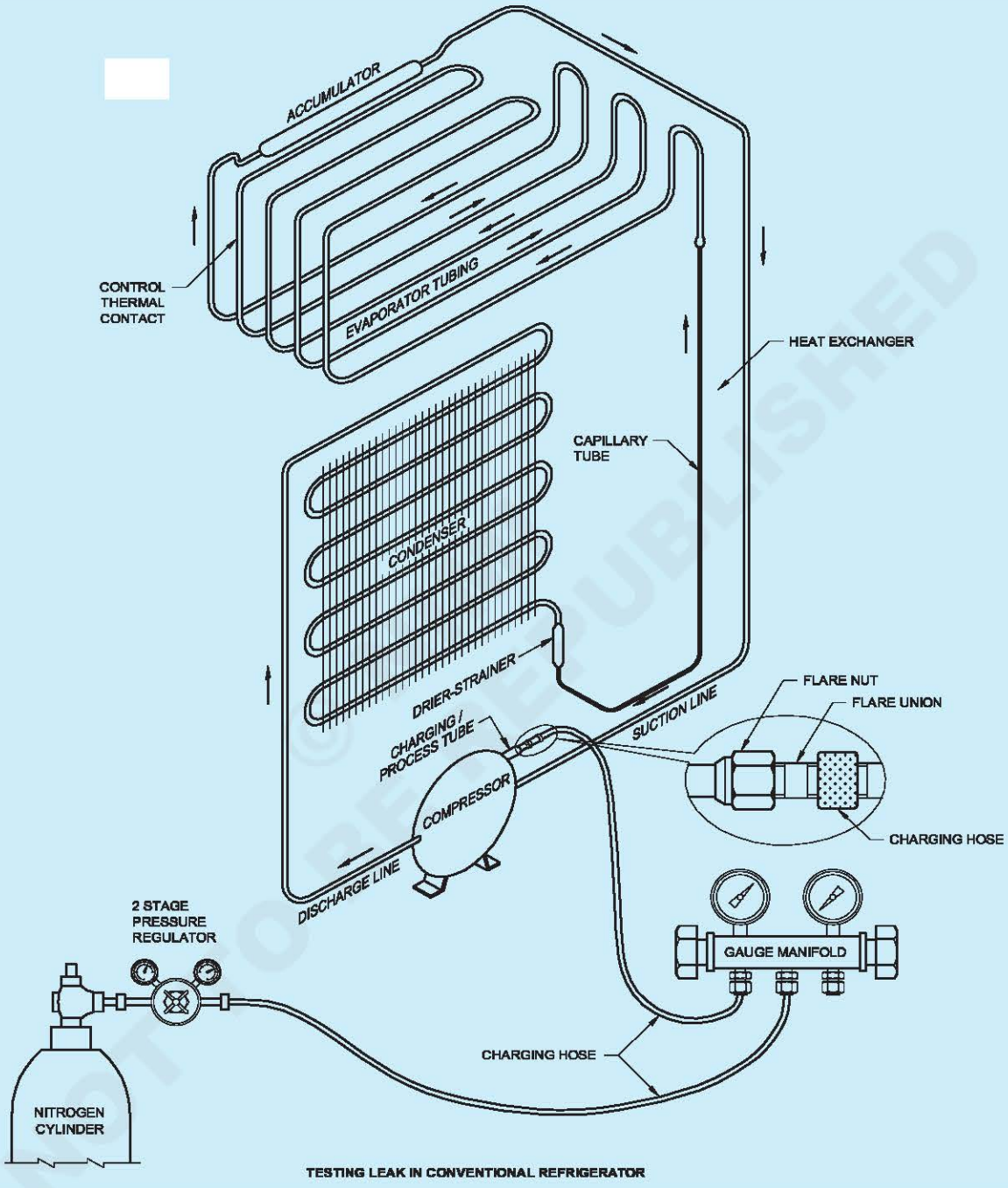
14 Note down the time

15 Tabulate the readings in the tabular column which is given at the end of this exercise

16 Remove the charging hose II which inter connects gauge manifold and nitrogen cylinder

17 Close the intermediate port of manifold by dummy nut brass 6 mm.

Fig 2



TESTING LEAK IN CONVENTIONAL REFRIGERATOR

NOT TO BE REPUBLISHED

TASK 5: **Test leak with soap solution**

1 Take a plastic / metal mug filled with pure water 500 ml.

2 Add 25 ml of soap solution concentrate into the water

3 Stir mixture well and make lather by a paint brush.

4 If the lather is not sufficient, add some more soap solution into the mixture.

5 Soak the sponge into the soap solution mixture

6 Take few quantity of soap solution mixture by the brush and apply the solution on the points.

Swaged joints charging hose adapters, flare nuts etc., brazed joints. Places where copper tubes are joined together.

7 Take the sponge with solution and lather; place it under the joints.

8 Carefully watch any nitrogen bubbles are coming from the system through the soap solution mixture

9 If no bubbles present, it indicates there is no leak

10 If any bubbles present in the joint, add more soap solution on the joint and find where it is coming from exactly

11 If the leak at screwed/threaded joints (flare nuts, charging hose adapters) make it tight fit and arrest the leak by using double ended spanner or adjustable spanner or cutting plier.

12 If the leak at brazed joints (copper tube), confirm the leak and note down to carryout repairs

13 If there is no leak in screwed/brazed joints leave the system as it is to hold the pressure for next 24 hrs.

14 After 24 hours note down the reading - pressure, ambient - temperature and time

15 Compare the reading of pressure with previous days reading

16 If there is no difference between two readings or there is 5 to 10 psig difference between two reading - The system has no leak.

Record sheet

S.No.	Date	Time	Ambient temp	Test pressure	Remarks
	D.M.Year	Hrs.min	°C	psig/bar	Joints leak tested

TASK 6: **Braze the leak spots**

1 Leaks if any in brazed joints mark the spots.

2 Let out nitrogen pressure from the system.

3 Clean the leak spots with emery papers.

4 Light the brazing torch, use goggles.

5 Heat top and bottom joints of leakage pipes when it get red hot apply flux and apply copper rod.

6 Stop the welding torch, let the brazing joint cool.

7 Pressure rise the system with dry nitrogen.

8 Check leak with soap water on all brazed joints.

9 If there is no leak, vent the nitrogen pressure.

TASK 7: **Connect the system with vacuum pump**

1 Connect one end of charging hose (I) to the outlet of angle valve. Tighten the joint with a cutting plier

2 Connect the other end of charging hose (I) to LP(low pressure) port of gauge manifold

3 Connect one end of charging hose (II) to intermediate port of gauge manifold.

4 Connect the other end of charging hose (II) to inlet port of the vacuum pump

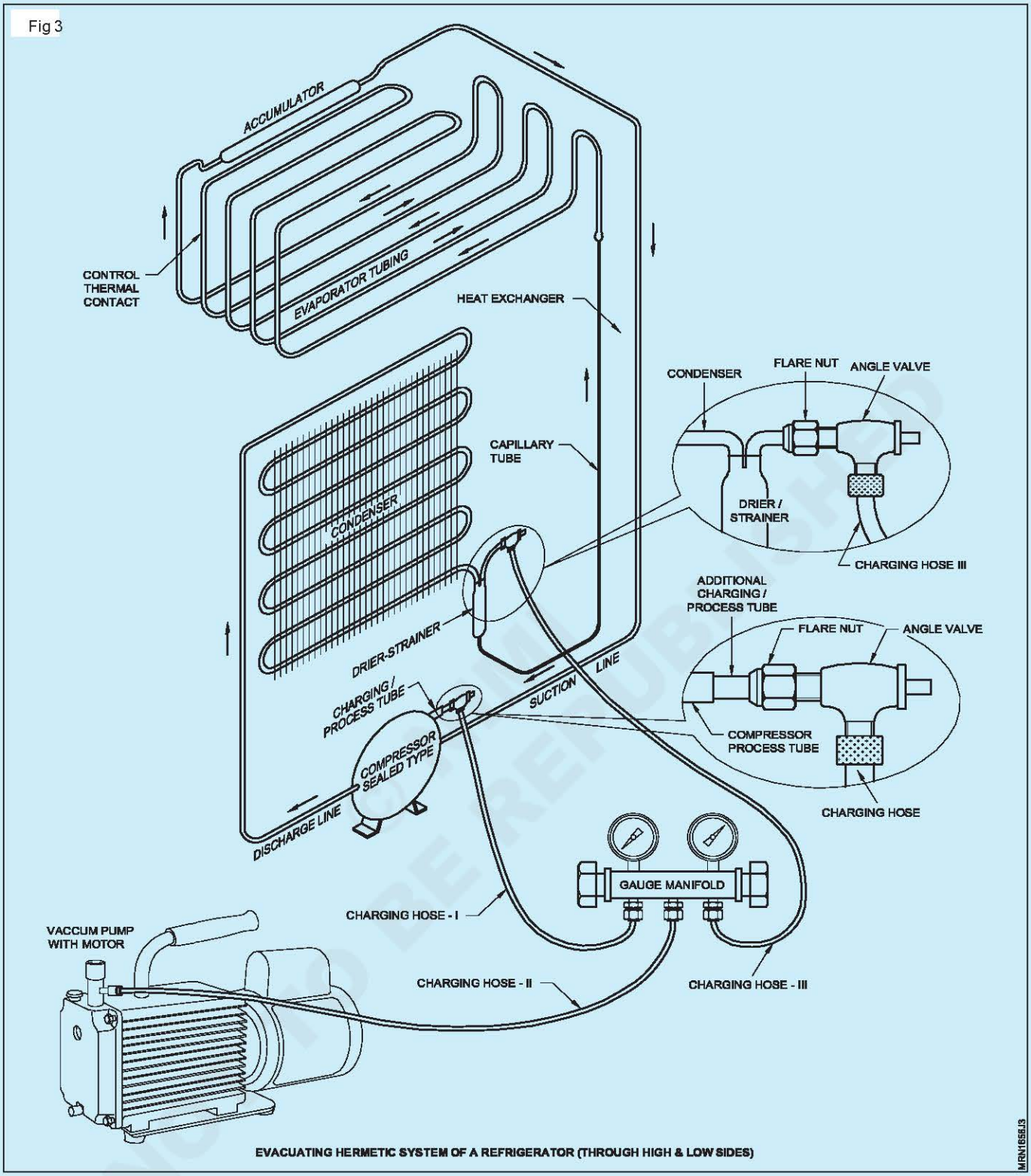
5 Close the HP (High pressure) port of gauge manifold with a brass flare dummy nut (6 mm)

6 Tighten the screwed/threaded joints by using cutting plier (for charging hoses), suitable double ended spanners (for flare nuts, dummy nuts etc).

7 Make sure that the HP/LP knobs of gauge manifold are closed.

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Fig 3



TASK 8: **Handle and operate vacuum pump**

1 Ensure that the power(electrical) supply available to the vacuum pump by using a online tester.

2 Connect the electrical power line of the vacuum pump to the power source (test board/switch board)

3 Switch on the vacuum pump

4 Open the valve knob (LP port) of gauge manifold

5 Open the angle valve by turning the stem to anticlockwise direction with ratchet key/wrench.

6 Observe the pressure reading available on the LP gauge of manifold. The pressure gets reducing.

7 Leave the system as it is for 2 hours without any interruption.

TASK 9: **Dehydrate the system**

1 Take the heating kit (Infrared lamp) and switch it ON.

2 Make sure that the system is getting vacuum and the pump is functioning

3 Heat all over areas of the system with infrared lamp

4 Apply heat uniformly to all areas - Refrigerant tubes, condenser coil, evaporator coil (if it is exposed), liquid line drier/filter.

5 Keep and maintain the distance between the heating kit and surface of system (15cm) always.

6 Continue the process for 15-30 minutes.

— — — — — — — —

TASK 10: **Evacuate the system**

1 Notice and observe the pressure reading on the LP gauge of the manifold, it should be 100 microns or below (equivalent 30 in of Hg)

2 Close the angle valve by turning its stem to clockwise direction with ratchet key/wrench after 3 hours from the time of vacuum pump started.

Caution:

Whenever operating (opening /closing) angle valves fixed on pipe lines, needs extra care. (Fig3).

Over tightening (closing) over loosening (opening) of valve stems strictly to be avoided as it damages the valve internally.

3 Close the LP knob of gauge manifold

4 Switch off vacuum pump and disconnect the power supply

5 Disconnect charging hose (I) from angle valve

6 Close the outlet of angle valve with dummy nut (6 mm) tighten the nut with a suitable size double ended spanner

7 Disconnect charging hoses (I & II) from gauge manifold and vacuum pump.

Hand shut off valve can also be used instead of angle valve at compressor process tube.

— — — — — — — —

TASK 11: **Gas charging the system**

- charge refrigerant in hermetic (refrigeration) system of a conventional refrigerator
- charge refrigerant in hermetic (refrigeration) system of a frost free refrigerator.

Note:

1 This practical exercise to be started immediately (within 2 hours) after evacuating the unit/appliance.

2 Before starting the exercise make sure that the unit appliance is already vacuum to the required (30 in Hg) level.

3 It is assumed that the unit/appliance which is going to get charged is under/holding vacuum.

Method 1 : Using charging cylinder

Note:

1 Wear eye goggles and hand gloves

2 Get charging cylinder filled with correct refrigerant and not less than required quantity (pre determined)

3 This method is mostly followed in charging refrigerant in new/fresh system/appliance. (See Fig 4)

— — — — — — — —

TASK 12: **Connect system to charging cylinder (Fig 4)**

1 Connect one end of charging hose (1) to the valve of charging cylinder and connect other end to intermediate port of gauge manifold.

2 Connect an end of charging hose (II) to the angle valve of compressor and connect other end to low pressure (LP) port of gauge manifold.

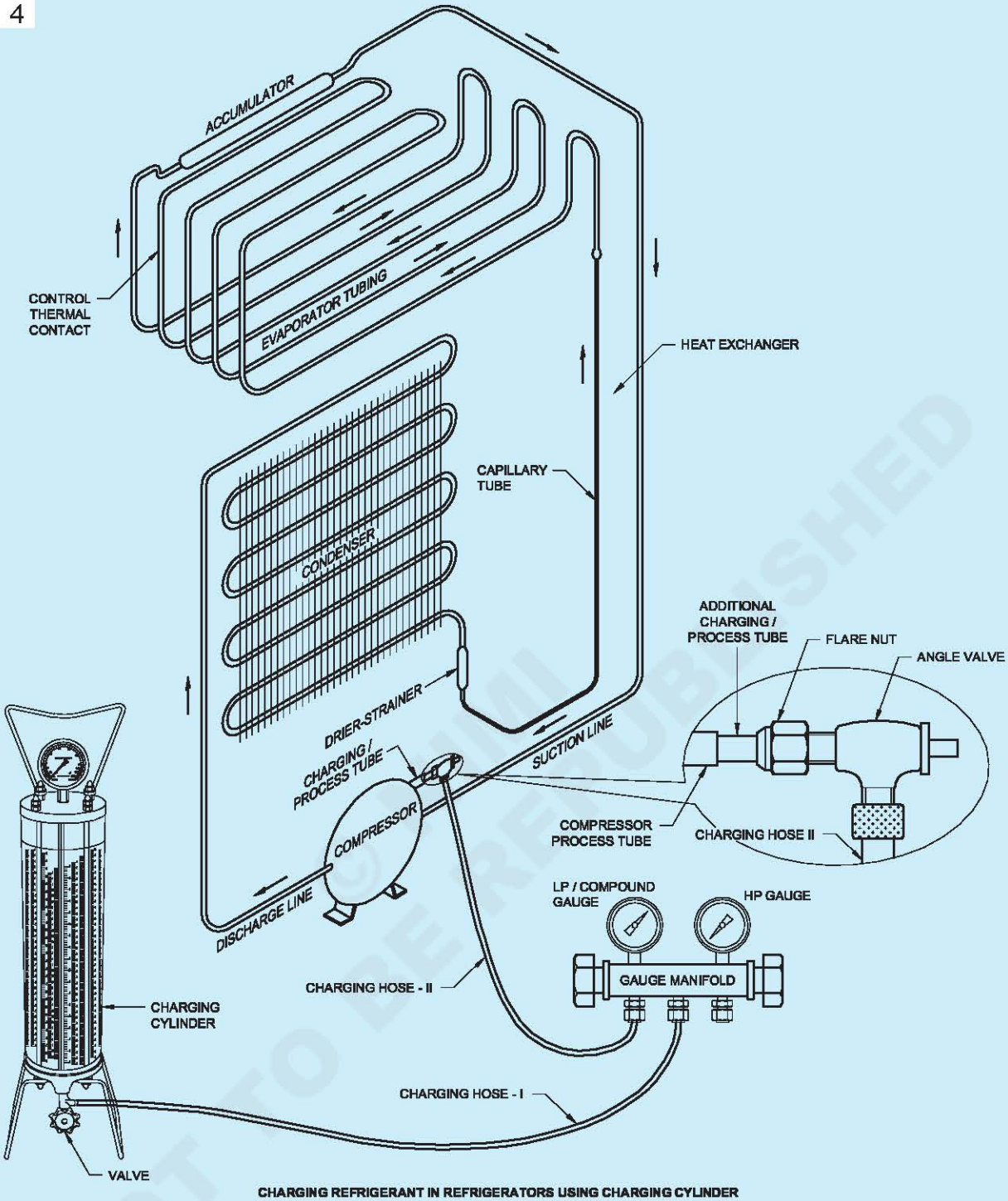
3 Close the high pressure (HP) port of gauge manifold with a flare dummy nut (6 mm) and tighten it using a suitable double ended spanner.

4 Ensure that the charging cylinder valve, LP and HP valve knobs of gauge manifold and compressor angle valves are closed.

5 Tighten the ends of charging hoses using a cutting plier.

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Fig 4



CHARGING REFRIGERANT IN REFRIGERATORS USING CHARGING CYLINDER

TASK 13: **Purge air in the charging hoses**

1 Open the charging cylinder valve gently/slowly by turning the knob 1/2 to1 turn to anticlockwise direction

2 Purge the charging hose (I) by loosening its end at the intermediate port of gauge manifold using a cutting plier.

3 Observe the refrigerant is escaping out at intermediate port of manifold in form of snow, then immediately tighten the end of charging hose I and ensure that the escape/release of refrigerant is arrested. Construction MRAC - Refrigeration System -Ex- 1.4.56A

4 Open (2-3 turns) the LP knob of gauge manifold and observe the reading on the LP gauge.

5 Purge the charging hose (II) by loosening its end at the angle valve using a cutting plier.

6 Observe the refrigerant escape then immediately tighten the end of charging hose II to arrest the refrigerant flowing out.

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TASK 14: **Charge refrigerant into the system.**

1 Note down the level of refrigerant in the charging cylinder and record it in the tab column.

2 Open the stem of angle valve (at compressor process line) by slowly turning the stem to anti clockwise direction using ratchet key / wrench.

3 Observe the refrigerant flow in the charging tube of the compressor by touching it with hand/finger. ensure the refrigerant flow by feeling the charging line is cold.

4 Observe the refrigerant flow/ transfer by watching the level in the charging cylinder.

5 Leave the system as it is for 3-5 min or till all refrigerant /required quantity of refrigerant to settle into the system.

6 Close the valve of charging cylinder after ensuring the refrigerant is transferred into the system.

7 Close the LP knob of gauge manifold by turning the knob to clockwise direction using hand.

8 Close the angle valve by turning its stem carefully to clockwise direction using ratchet key and adjustable spanner.

9 Observe and record the reading on the charging cylinder to calculate the amount of refrigerant is charged.

10 Disconnect charging hose-II from the angel valve.

Note:

To increase the flow of refrigerant into the system or to fasten the charging process, keep the level of charging cylinder above than the compressor.

To improve the charging process, heat the refrigerant cylinder by wiping it with warm water cloth.

Method II

Using refrigerant service cylinder

Note : Wear goggles and hand gloves

Get the service cylinder filled with correct refrigerant and not less than the required quantity.

This method is most commonly followed in the trade.

This method is useful for spot charging.

TASK 15: **Connect system to service cylinder (Fig 5)**

1 Connect an end of charging hose I to the valve of service cylinder and connect the other end to the intermediate port of gauge manifold.

2 Connect one end of charging hose II to the angle valve of the compressor and connect other end of the low pressure (LP) port of gauge manifold.

3 Close the high pressure (HP) port of gauge manifold with a flare dummy nut (6mm) and tighten it using a suitable double ended spanner.

4 Ensure that the service cylinder valve, LP and HP valve knobs of manifold and compressor angle valve are closed.

5 Tighten the ends of charging hoses using a cutting plier.

TASK 16: **Purge air in the charging hoses**

1 Open the service cylinder valve by slowly turning its stem 1/2 to 1 turn to antic lock wise direction using a ratchet key/wrench.

2 Purge the charging hose (I) by loosening its end at the intermediate port of gauge manifold using a cutting plier.

3 Observe the refrigerant is escaping out at the intermediate port of manifold in the form of snow, then immediately tighten the end of charging hose I and ensure that the escape/release of refrigerant is averted.

4 Open (2-3 turns) the LP knob of gauge manifold and observe the reading on the LP gauge.

5 Purge the charging hose (II) by lessening its end the angle valve using a cutting pillar.

6 Observe the refrigerant escape then immediately tighten the end of charging hose II to arrest the refrigerant flowing out.

TASK 17: **Charge refrigerant into the system**

1 Open the angle valve stem (a compressor process line) by slowly turning it to anti clockwise direction using a ratchet key/wrench.

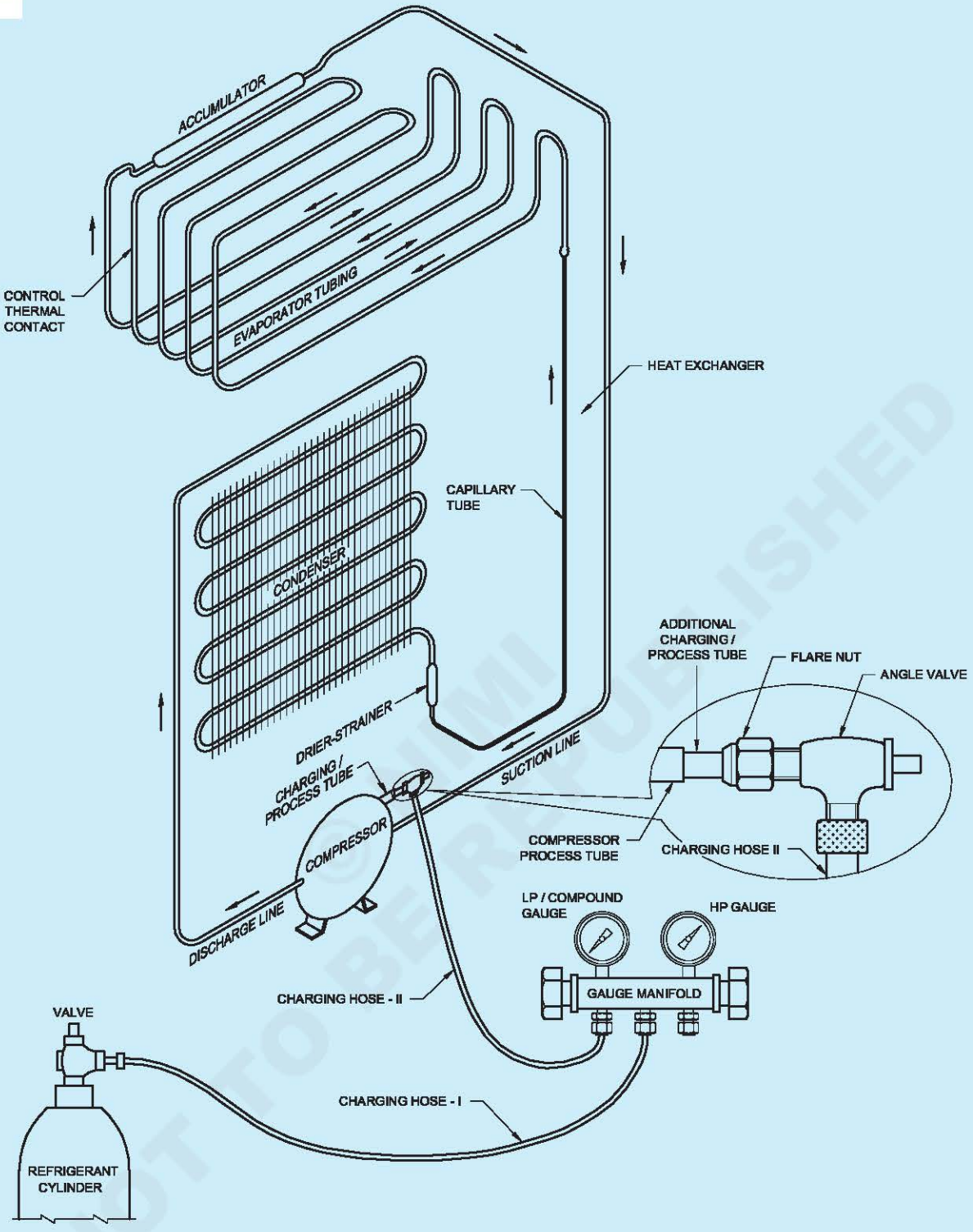
2 Observe the refrigerant flow in the charging tube of the compressor by touching it with hand/finger. Ensure the refrigerant flow by feeling charging line is cold.

3 Observe the refrigerant flow also in LP gauge of manifold, the pressure is increasing from vacuum level -30 in Hg to above 0 psig onwards.

4 Observe the hissing noise into the compressor during the pressure increasing from vacuum to above 0 level. It indicates the vacuum is braked.

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Fig 5



CHARGING REFRIGERANT IN REFRIGERATORS USING REFRIGERANT SERVICE CYLINDER

5 Allow the refrigerant flow till it reaches 30 to 50 psig in the LP gauge of manifold. Then immediately close the angle valve.

6 Ensure that the wiring of the system/appliance is ready for switch ON using wiring diagram.

7 Test the electrical power supply available to the appliance is in operating limits (180-230 volts) using a multimeter.

Note :

1 It is always advisable using a suitable capacity voltage stabilizer (0.5 KVA/500 W) with time delay (3 min.) and high and low voltage cut off for any home/commercial appliance to save the life of compressor.

2 Switch ON the appliance and ensure that the compressor is working by touching the dome by hand, feel mild vibration and sound.

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3 Set the thermostat knob to maximum position by turning the knob to clockwise direction by hand.

4 Observe the reading on the LP gauge and ensure it is '0' or above '0' psig.

Note :

1 After switching ON the compressor/ appliance the low pressure must be positive level or it should be more than atmospheric level to avoid atmospheric air sucked by the compressor through minute leak joints/spots if any.

2 If the pressure on the LP gauge shows below '0' level then immediately switch OFF the appliances.

3 Pre-charge additional quantity of refrigerant then switch ON the appliance.

4 The appliance being charged is to be kept in normal temperature (32°C ± 2°C) and it should be away from any heating/cooling appliances like gas welding flame, blow lamp flame, sun rays/light, any other heaters, ceiling/table/pedestal fans.

5 Open more the angle valve to allow the refrigerant sucked by the compressor.

6 Open the refrigerator/appliance door and observe the hissing noise in the evaporator/freezer which indicates the refrigerant flow.

7 Observe the cooling effect in the evaporator by touching its surface by hand and feel the cold then close the door.

8 Observe the chillness (moisture formation) on the suction line and hotness (above atmospheric temp.) on the liquid line, feeling by the hand

9 Allow the refrigerant flow till it gets saturation by watching the suction tube of compressor gets frost formation.

10 Stop the refrigerant flow to the appliance by closing the angle valve.

11 Observe the reading on the LP gauge it may be 5 to 7 psig.

12 Charge additional quantity of refrigerant if frost formation disappears on the suction line by opening the angle valve again.

13 Measure current drawn by the compressor using a clamp/tong tester and record the reading.

14 Complete the charging if the low pressure reached to its boiling point (5 - 8 psig) by closing the angle valve.

15 Close the cylinder valve using valve key/ratchet key.

16 Disconnect the charging hose from the angle valve.

17 Disconnect the charging hoses I and II from service cylinder and gauge manifold.

18 Close the cylinder valve with a dummy nut with a suitable double ended spanner.

19 Test the cylinder (at valve seating, gland, dummy nut) for any leaks with soap solution.

20 Measure the weight of cylinder with a weighing scale/ platform and record the value.

21 Let the appliance to work for 1 hour.

Note:

1 It is advisable to keep the evaporator of the appliance with constant load during charging process.

2 The load should not be very HIGH or LOW to its cooling capacity otherwise there will be a problem when setting the suction pressure.

3 If the appliance / system newly made it is better to measure 'discharge Pressure (HP)' of the system by having proper provision (at filter/drier) at liquid line.

4 Confirm the values in the pressure temperature chart of a particular refrigerant (eg. R134a or other refrigerant).

5 Common task for both methods.

— — — — — — — —

TASK 18**: Pinch the system**

Note:

1 Pinching may require either on low side or high side. Some times it requires at both sides suction/process line and liquid line.

2 System to be in working condition when pinching at low side and system to be kept 'off' position when pinching at high side.

3 Use of proper tools like pinching block or pinch off tool hand held type must be compulsory to carry out 'pinching process' using cutting/nose pliers as pinching tools to be strictly avoided as it may not serve the purpose

4 Wear eye goggles and hand gloves whenever necessary.

5 Ensure that the compressor is working.

6 Pinch the line between compressor process tube and flare nut of angle valve using a pinching tool.

7 Hold the pinching tool tightly on the process line.

8 Remove the angle valve by loosening it from the flare nut using a adjustable spanner and a suitable size double ended spanner.

9 Cut the copper tube between the flare nut and pinching point using a tube cutter.

10 Test leak (refrigerant) at open end of copper tube-beyond the pinching point by applying thin film of soap solution into the open end.

11 Arrest leak if found by extra tightening of pinching block or double crimping the hand held pinching tool.

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12 Light up the brazing torch and heat the open end of copper tube (charging tube) till it becomes dark orange colour then fill the open end with a silver brazing rod immediately.

Note:

1 Silver rod must be put on the brazing spot only after the material reaching its melting point.

2 The partial part of flame will turn to green colour due to presence of refrigerant gas in the brazing spot.

3 When the pinching spot is completely filled the green flame will disappear.

4 At any cause the pinching tool should not be disturbed/ shacked before the process gets over.

5 Light off the torch when the brazing spot is completely filled with silver rod.

6 Ensure that there is no any blow holes in the brazed spot.

7 Test leak at the brazed spot/pinched spot by applying a thin layer of soap solution on to it.

8 Re-braze the spot if found any leak.

9 Remove the pinching tool from the charging/process tube very carefully.

Record sheet

Name of appliance :

Capacity :

Date :

Sl. No.	Time Hrs/min	Pressure psig kg/cm^2		Temp. °C	Voltage	Current	Cylinder Weight(Kg)		Net Refg. charge (Kg)	Rem
		Low side	High side	Ambient	Volts	Amps	Before charge	After charge		

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Circuit of refrigerator

Objective: At the end of this exercise you shall be able to
- **check all the electrical components**
- **check electrical wiring circuit**

Requirements

Tools/Instruments

• Trainees kit	- 1 No.
• Line tester	- 1 No.
• Test cords	- 5 m
• Test lamp with holder	- 1 No.
• Soldering iron	- 1 No.
• Multimeter	- 1 No.

Equipments

• A complete system of RSIR circuit, CSIR circuite	- 1 No each.

Materials

• Soldering wire and flux	- as reqd.
• Clips	- 5 Nos.
• Wire each colour R,B,G	- 5 mts
• Insulation tape	- 1 Roll

PROCEDURE

TASK 1: **Check all the electrical components**

Refer Ex No 1.7.40 TASK 1 to 7

TASK 2: **Check electrical wiring (RSIR operation)**

1 Check wiring as per diagram in Fig (1,2,3,4).

Fig 1

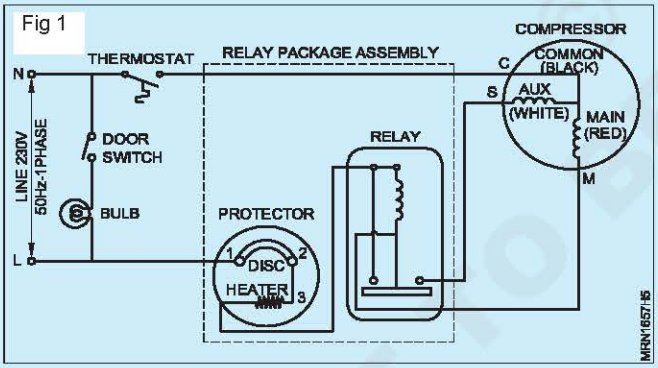
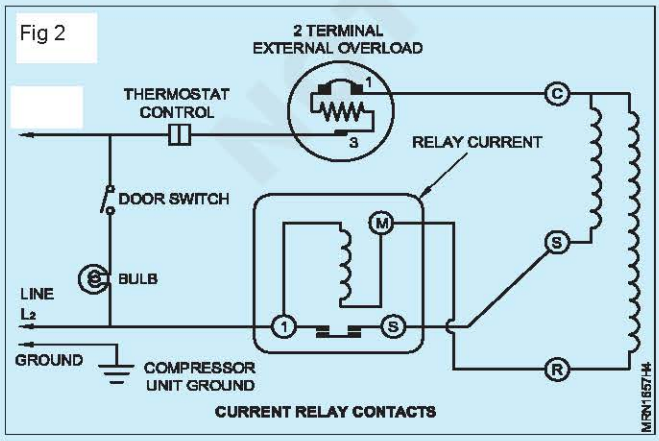


Fig 2



Caution: Do not fail to put insulation tape on connections where it is found necessary.

1 Switch 'ON the UNIT.

2 If it does not start, check the electrical circuit as per (Fig 1,2,3) circuit diagram.

3 If the wiring circuit is good, check the other parts of electrical circuit.

Fig 3

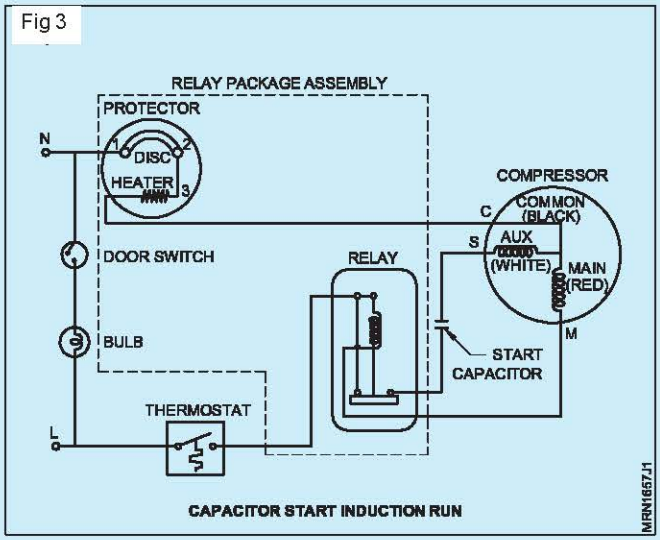
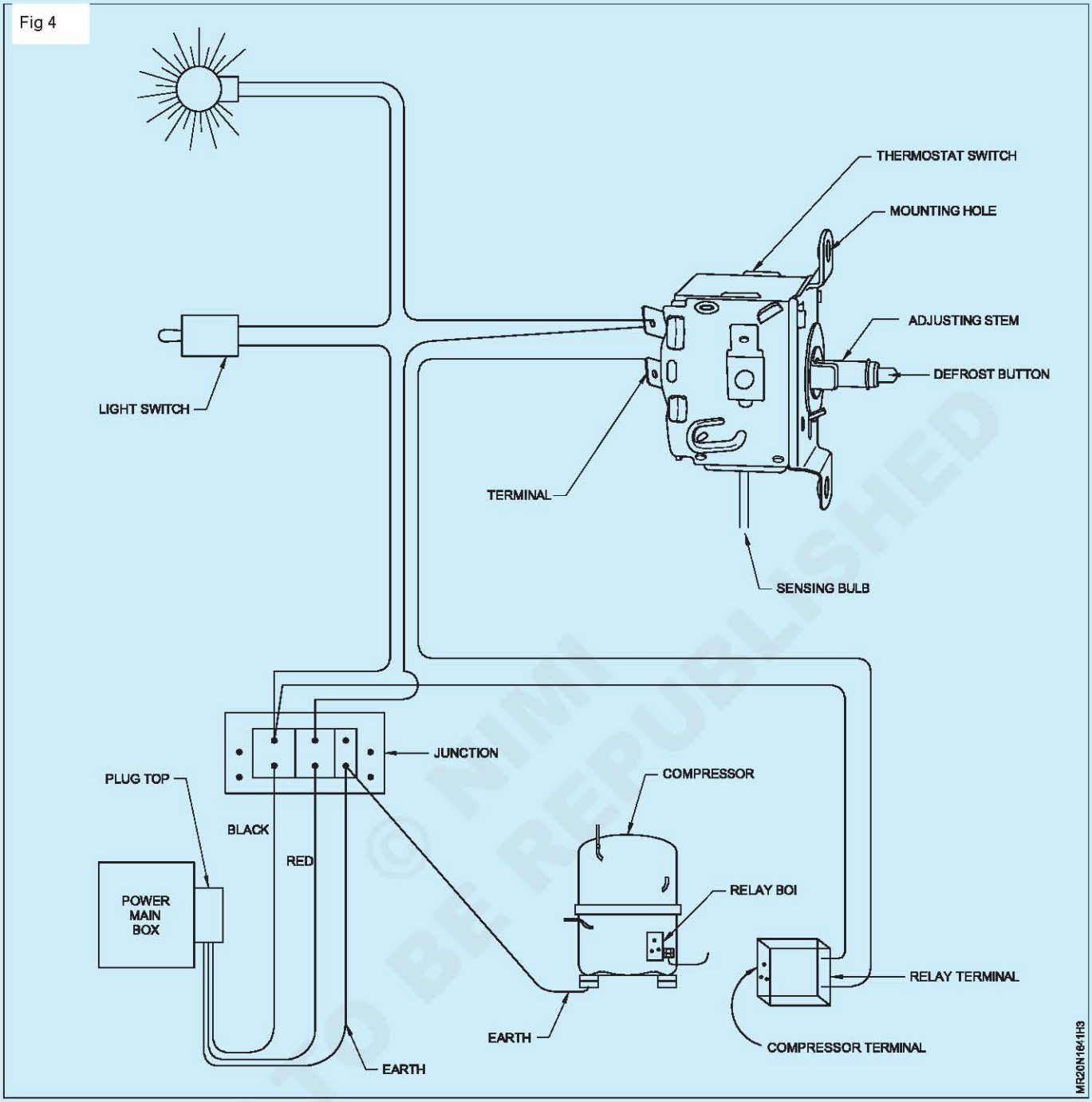


Fig 4



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Installation of refrigerator

Objectives: At the end of this exercise you shall be able to
- **uncrate/unpack the refrigerator unit**
- **select the location of the unit**
- **position the unit**
- **test the electrical power supply**
- **connect the voltage stabilizer to the unit**
- **start the refrigerator unit**
- **test the performance of the unit.**

Requirements

Tools/Instruments

- Spirit level meter - 1 No.
- Multimeter - 1 No.
- Online tester - 1 No.
- Combination plier - 1 No.
- Wire stripper - 1 No.
- Screw driver 6" 150mm - 1 No.
- Adjustable spanner 150mm - 1 No.
- Thermometer (stem/digital type) –5 to +50°C - 1 No.
- Clamp meter -0- 10 amps -1 No.

Equipments

- Domestic refrigerator -1 No.

Materials

- Soap solution - 50 ml
- Clean water - 2 lit.
- PVC insulation tape 12 mm width - 1 Roll
- Voltage stabilizer 0.5 KVA - 1 No.
- Clean cloth/sponge - 1 piece

PROCEDURE

TASK 1: **Uncrate/unpack the refrigerator unit.**

1 Place the unit in upright position on a flat even surface carefully.

2 Cut the packing tape/rope using wire stripper/small knife.

3 Remove the outer cover/crate by lifting it from bottom to top very carefully.

Caution; Beware of condenser coil, if it is backside. If any damage occurred on it may leads to gas leak.

4 Remove extra packing materials, if it is there.

5 Watch carefully the outer surface of unit. The outer body should be clean and glossy and without any scratches, dents etc.

6 Remove the base packing (wood) by unscrewing the bolts and nuts using a suitable double ended spanner/ adjustable spanner.

Note: Keep safe the unit inclined position while removing the base bolts

7 Keep the unit away from packing materials

TASK 2: **Select the location.**

Note: Normally 'unit location' will be decided before the unit is arrived to the place. So that proper wiring and plug point will be made accordingly.

1 Ensure that the location has sufficient air ventilation.

2 Ensure that electrical power point available near the unit.

3 Ensure that there is no any heat emitting/radiating units (gas stoves, heaters, sunlight etc.) nearby the location.

4 Ensure that the floor level should be strong and flat even surface using spirit level.

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TASK 3: **Position the refrigerator unit.**

1 Place the unit on the selected location.

2 Keep one foot or more space between the wall surface and rear side of the unit, if condenser is in back side (external type).

3 Keep one foot or more space between the wall surface and both sides of the unit, if the condenser is built in (Internal type)

4 Keep sufficient space in front side for opening the door fully.

— — — — — — — —

TASK 4: **Test the electrical power supply.**

1 Test the availability of electrical power using online tester by inserting its tips into the socket

2 Measure the voltage rate using a multimeter/ tong tester/voltmeter by inserting the probes (phase and neutral) into the socket.

3 Ensure the rated/measured voltage is in operating range of compressor of the unit (180-260 volts).

4 Use voltage stabilizer if the voltage is out of range or fluctuating.

5 Ensure proper earthing is made in the socket.

— — — — — — — —

TASK 5: **Connect voltage stabilizer.**

Note : It is always advisable use voltage stabilizer (correct capacity) not only in the places of low voltage or fluctuating. Use it everywhere with every units to save the compressor from sudden voltage fluctuations and maintain constant voltage to the compressor.

1 Unpack the voltage stabilizer

2 Notice the outer surface of stabilizer for any defects like sheet metal bulge, scratches etc.

3 Make sure that the pointer of the voltmeter of stabilizer at '0' reading only or make sure the voltmeter has no error.

4 Insert the 3 pin plug of the stabiliser into the socket.

5 Switch 'ON' the socket

6 Ensure the LED bulb (for MAIN ON) glows (If provided)

7 Observe the voltage limits of input and output by pressing the selector switch.

Note: Normally the voltage stabilizers for refrigerators/air conditioners are available with time delay (3 min) start. So the output voltage may come after 3 minutes from the time it is switched 'ON'.

— — — — — — — —

TASK 6: **Start the refrigerator unit.**

1. Open the door(s) of the unit and see the internal conditions. It must be clean and dry.

2 Keep the door open for 2 minutes for replacing existing cabinet air with ambient air. Then close the door (S).

3 Make sure that the stabilizer is 'OFF' position

4 Insert the 3 pin plug of refrigerator unit into the output socket.

5 Switch ON the stabilizer.

6 Wait for 3 min to start the unit, if the stabilizer has time delay facility.

7 Observe the refrigerator gets ON by hearing mild noise (30-35 db) due to compressor is started.

— — — — — — — —

TASK 7: **Test the performance of the unit.**

1 Ensure that the door(s) of the unit closing well

2 Make shelves in the cabinet with the materials which are given separately or along inside of the unit.

3 Fill water (at normal room temperature) in the ice tray which will be in freezer section.

4 Observe the 'bulb/light in the cabinet glows during the door kept open.

5 Set the thermostat knob to Normal position (between low cool and high cool position) by turning it clockwise/ anticlockwise direction as required.

6 For Conventional (ordinary) Refrigerator feel the chillness by keeping the hands over inner surface of the freezer.

For Frost Free Refrigerators feel the chillness by keeping the hands before the air breeze at the fan motor which is in the freezer.

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7 Put the sensing probe (of digital thermostat) inside the freezer and start watching the reading in the display (outside).

8 Keep the freezer door and cabinet door(s) closed for some time (2 hours). Let the unit to run without any interruption for 2 hours.

9 Open the refrigerator door and observe the cooling in the cabinet by feeling.

10 Open the freezer door and ensure that the water which is filled earlier (2 hours before) is became ice.

11 Set the thermostat knob to 'low ' position.

12 Keep the door closed and wait for some more time (30 min).

13 Observe the unit(compressor) trips.

14 Fill up the check list as per the contents.

Installation - Check list

Date :

Type of refrigerator : Direct cooled / Frost free

Capacity : Lts

Brand name :

1 Unit found in good physical condition OK

2 Unit location OK

3 Unit standing floor level OK

4 Electrical plug point OK

5 Current consumption .....Amps

6 Unit input voltage OK ..... volts

7 Stabiliser output OK ..... volts

8 Cooling satisfactory ..... degree Centigrade (Temperature at evaporator)

9 Thermostat functioning OK

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Check find fault and test the electrical and other system components of refrigerator

Objectives: At the end of this unit you shall be able to
- **check and test current coil relay**
- **check and test overload protector**
- **identification of compressor winding terminal pins with ohmmeter**
- **check short circuit in compressor**
- **check the condition of a door switch**
- **check Thermostat**
- **Check capacitor.**

Requirement

Tool/Instruments

- Screw driver 10mm tip 200mm length - 1 No.
- Cutting plier 200mm length (Insulated) - 1 No.
- Phillips screw driver set - 1 No.
- Ohmmeter - 1 No.

Materials

- Current coil relay - 1 No.
- OLP - 1 No.
- FHP compressor - 1 No.
- 2 m 1 sq.mm lead wire as reqd.
- 2 m wire with crocodile clip as reqd.
- Test board fitted with voltmeter & ammeter - 1 No.
- Thermostat - 1 No.
- Capacitor - 1 No.

PROCEDURE

TASK 1: **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.

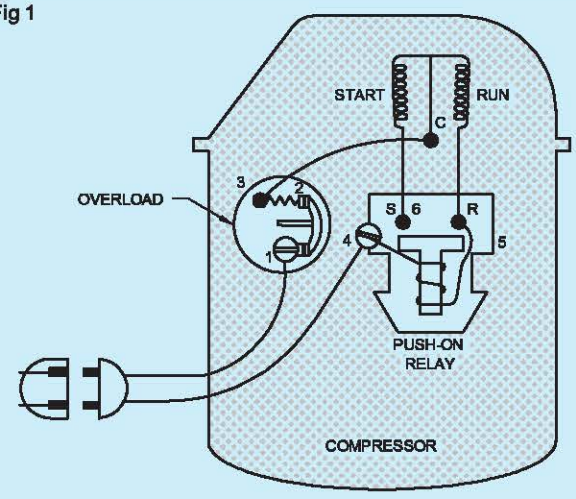
3 Check continuity between 5 & 6. Normal condition (when not in use) 5 & 6 open. If there is no continuity between 5 & 6 relay is OK.

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

MRN1855H1

TASK 2: **Check and the overload protector**

Refer TASK 1: 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)

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TASK 3: **Identification of compressor winding**

Terminal pins with Ohmmeter of fraction horse power hematic 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 2)

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

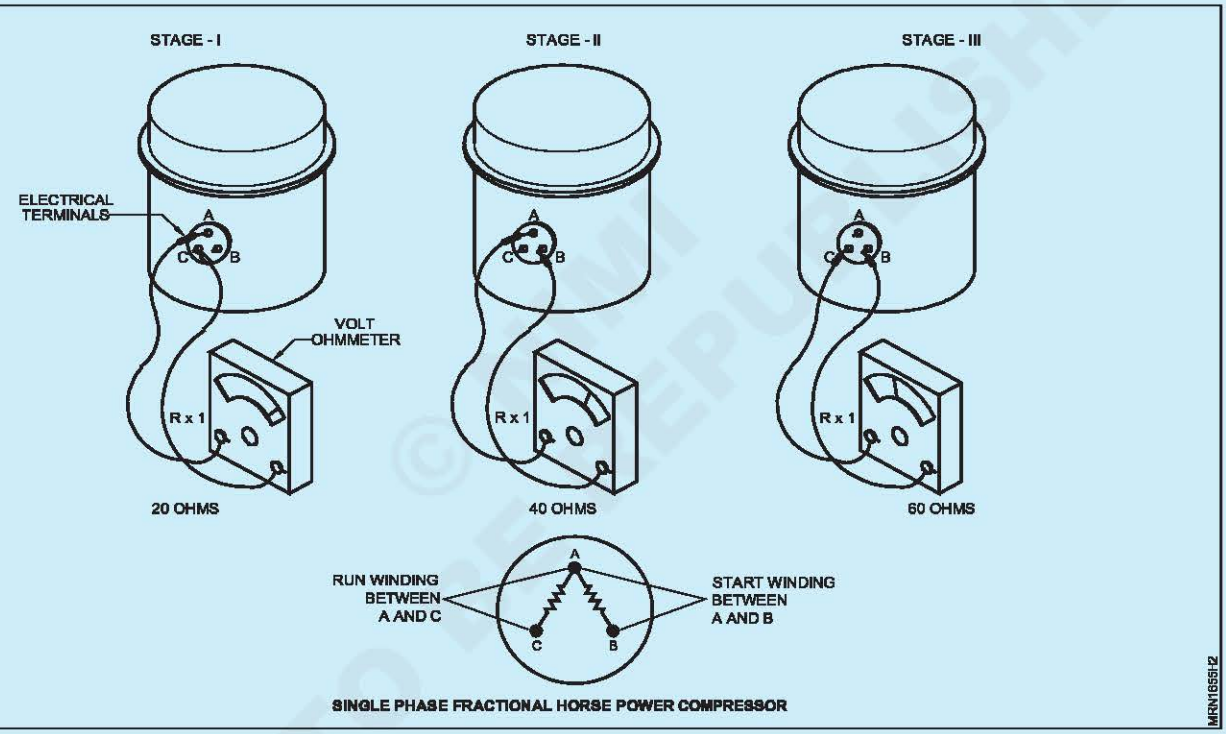
8 Identified 'A' terminal pin become common terminal

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 2



TASK 4: **Check short circuit in compressor.**

1 Select ohmmeter scale (R x 10000) (Fig 3)

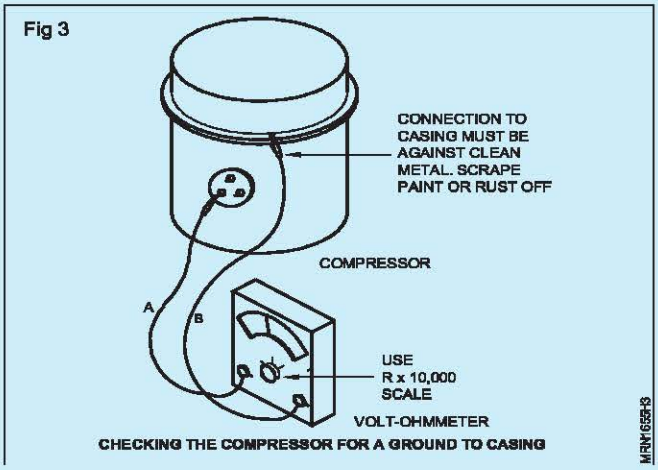
2 Place 'A' probe to compressor terminal

3 Place 'B' probe to metal casing of compressor

4 Check continuity. If continuity is there compressor grounded.(Fig 3)

5 If there is no continuity compressor not grounded.

Fig 3



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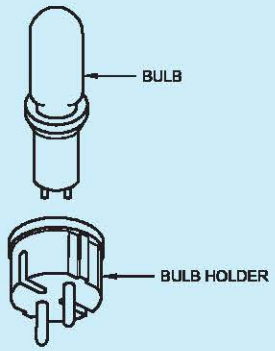
TASK 5: **Check the condition of a door switch**

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 4)

Fig 4



BULB AND BULB HOLDER

MRN1655H4

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.

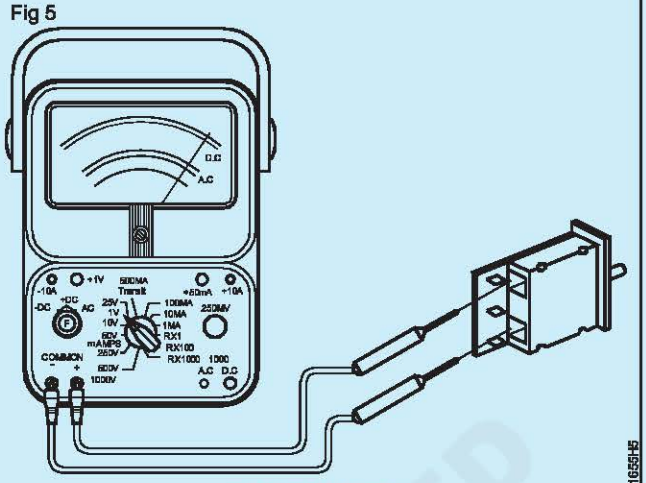
Note : Mark all connections which are being disconnected.

6 Check the continuity in switch by multimeter or by test lamp is ON and OFF position. (Fig 5)

7 Check bulb holder wires.

8 If switch found defective, replace it and connect wires.

Fig 5



CHECK DOOR SWITCH

MRN1655H5

If found necessary add salt and ice cubes from time to time.

Take out salt water from the insulated container from time to time to obtain correct temperature.

Precaution: While handling the thermal bulb do not bend the capillary to sharp as it may break.

Table 1

Sl. NO	Cutout temperature ° C

TASK 6: **Carry out a test on thermostat**

1 Crush ice cubes and place it in an insulated container.

2 Mix some salt to the crushed ice cubes.

3 Insert a thermometer inside the container.

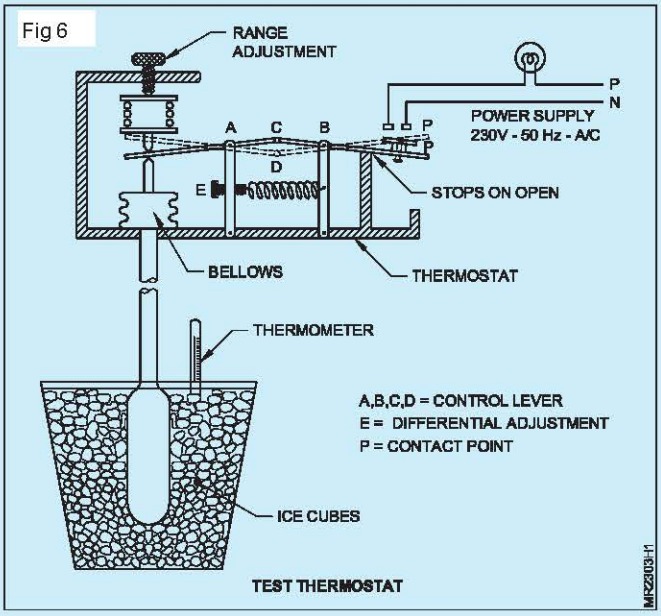
4 Take a thermostat and check electrical contact points. If necessary clean the contact points with fine sand paper.

5 Connect two wire leads to the thermostat.

6 Connect a bulb in series with thermostat.

7 Connect the other end wire leads with 2 pin plug and plug it in test board and switch ON.

Fig 6



TEST THERMOSTAT

MR22003-H1

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8 Check that the light glows when the knob of the thermostat is not in stop position.

9 If the light is not glowing when the knob of the thermostat is in stop position.

10 Adjust the knob to ON position.

11 Watch the reading of the thermometer.

12 See that the 100 watts bulb glows all the time.

13 Wait till thermostat goes to cut off which will be indicated by off position of the light quickly take the reading of the thermometer. (Fig 6)

14 Remove the thermal bulb from the ice cubes.

15 Hold the thermal bulb by hand and warm it when the thermostat goes to cut in position which will be indicated by the glowing of the 100 watts bulb.

16 Repeat steps from 10 to 15 for 3 readings and note the temperatures carefully and record in Table 1.

TASK 7: **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 7A)

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 7B)

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 7C)

8 If it does not spark in the first time, try it two or three times before replacing the capacitor to the unit.

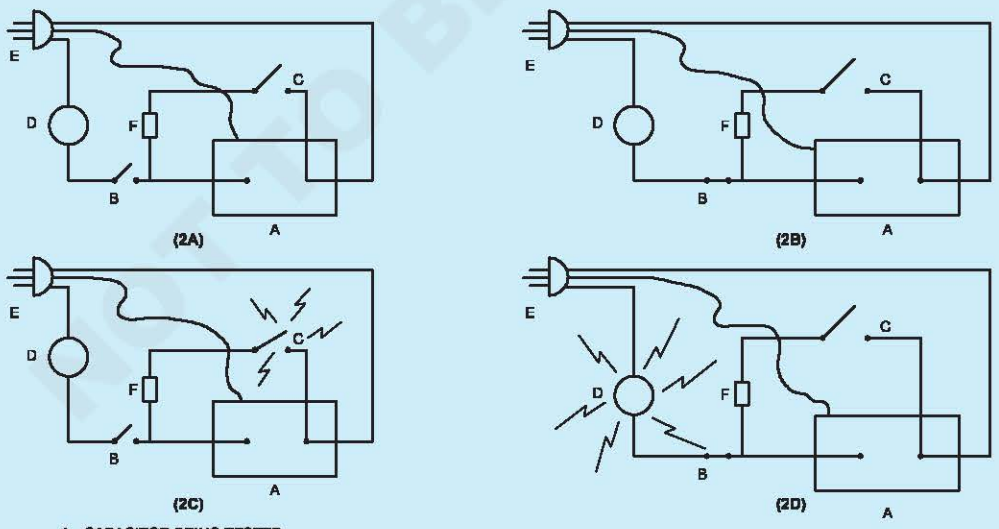
Note : If the capacitor is good it will spark as in (Fig 7C).

If the capacitor is shorted or grounded the fuse (D) will blow as in view. (Fig 7D).

If the capacitor does not take a charge, it will not spark. This indicates an open circuit. (Fig 7A). 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 7



ONE METHOD OF TESTING A CAPACITOR

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Testing of compressor

Objectives: At the end of this exercise you shall be able to
- **check compressor (Hermetic) pumping efficiency**
- **check compressor winding.**
- **Check short circuit grounded in compressor**

Requirements

Tools/Instruments

• Gauge manifold	- 1 No.
• Charging line	- 1 No.
• Ratchet wrench	- 1 No.
• Adjustment wrench	- 1 No.
• Multimeter	- 1 No.
• Insulated plier	- 1 No.
• Line tester	- 1 No.

Equipments

• Refrigerant cylinder	- 1 No.
• Hermetic compressor	- 1 No.

Materials/components

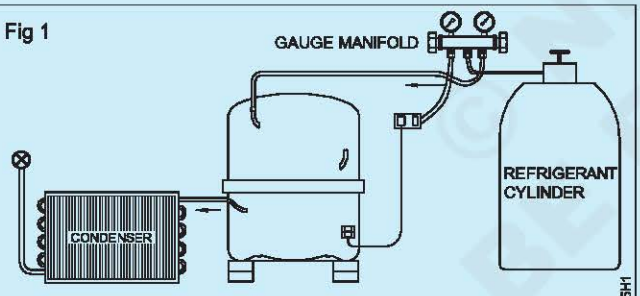
• Soap solution and brush	- 1 No.
• Clean cloth	- 1 No.
• Test board	- 1 No.
• Condenser unit	- 1 No.

PROCEDURE

TASK 1: **Check compressor (Hermetic) pumping efficiency.**

1 Connect the refrigerant cylinder to the process tube of hermetic compressor using a pressure regulator as per (Fig 1).

Fig 1



CHECK COMPRESSOR (HERMATIC) PUMPING EFFICIENCY

2 Connect the discharge side of the compressor to a condenser coil having appropriate capacity. Now connect the other end of the condenser coil to a pressure gauge having a range of 0 to 20.5 kg/cm^2.

3 Check for leakages at all joints using soap solution

4 Supply refrigerant vapour gas at a constant pressure of 150 PSI in the process tube of the compressor.

5 Start the compressor and run for few seconds to build a head pressure of valve as given below. On attaining the specified discharge pressure, stop the compressor as table column given below.

6 Check for drop in pressure for a period of one minute and verify whether it falls within specified limit in the Table 1.

7 In case the drop exceeds the specified limit, the compressor has a pumping defect otherwise the compressor is perfectly okay.

Table 1

S.No.	Leak rate in 1st minute per min.kg/cm^2	Head pressure kg/cm^2
1	2.0 kg/cm^2	8.5 kg/cm^2
2	2.5 kg/cm^2	10.0 kg/cm^2
3	4.0 kg/cm^2	13.5 kg/cm^2

TASK 2 : **Check hermetic compressor winding by multimeter. (Fig 2&3)**

Task 2 refer **Exercise 1.7.40 Task 3 (Fig 2)**

TASK 3: **Check short circuit grounded in compressor**

Task 3 refer: **Exercise 1.7.40 - Task 4 - (Fig 3)**

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Identification of motor terminals

Objectives: At the end of this exercise you shall be able to
- **identify compressor terminals by using test lamps**
- **identification of compressor winding using ohmmeter**

Requirements

Tools/Instruments

- Screw driver 200mm - 1 No.
- Line tester 0-500 volts - 1 No.
- Multi meter/ohm meter 0-250 ohms - 1 No.
- Series holders with 200 watts lamps - 1 No.
- Soldering iron 65 watts - 1 No.
- Combination plier (insulated handle) - 1 No.

Equipments

- Sealed compressor

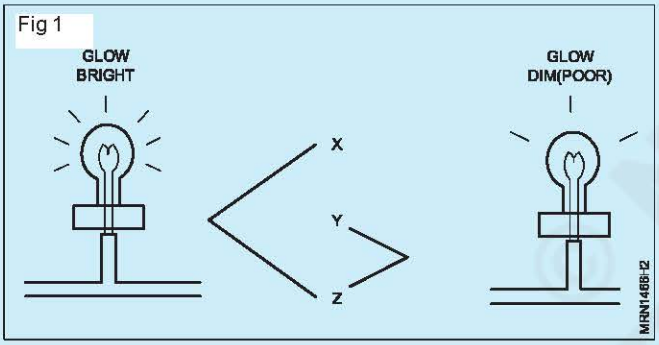
Materials/components

- Cotton waste/ cloth
- Soft solder paste
- Loose wire

PROCEDURE

TASK 1: **Identify compressor motor terminals using test lamps.**

Fig 1



1 By testing 200 watts series lamp in between pair of terminals.

2 Mark the terminal XYZ.

Running & starting minimum brightness

Identified remaining terminals is common

Running & common maximum brightness

Identified remaining terminals is starting

XY+ XZ = YZ Ω

Good winding resistance shows the above results.

1 Test & measure the pair of terminals.(x,y,xz abd yz)

2 They indicates different Ω

TASK 2: **Identification of compressor winding using ohmmeter**

Task 2 refer **exercise no 1.7.40 Task 3**

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Start compressor with and without relay

Objectives: At the end of this exercise you shall be able to
- **start the compressor with relay**
- **start the compressor without relay.**

Requirements

Tools/Instruments

• Cutting plier 200mm	- 1 No.
• Nose plier 150mm	- 1 No.
• Wire stripper	- 1 No.
• Screw driver set	- 1 No.
• Line tester 500V	- 1 No.
• Clamp meter, 0-500V AC	- 1 No.
• Multimeter -0-500V	- 1 No.

Materials/components

• Terminals clips	- 2 Dozen.
• Copper wire 1.5mm^2	- 4 meter.
• Relay PTCR with OLP	- 1 No.
• Push button switch	- 1 No.

Equipments

• Compressor(Hermetic) FHP	- 1 No.

PROCEDURE

TASK 1: **Start the Compressor with relay**

1 Take the 1/6 or 1/8 HP sealed compressor.

2 Fix the PTCR relay & OLP to the compressor terminals.

3 Provide power supply to the relay (230V AC).

4 Switch on the supply & start the compressor.

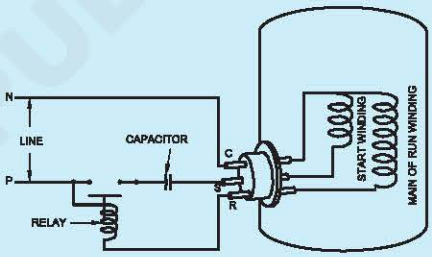
5 Check the current drawn by compressor

6 Check the suction & discharge pressure by manual sensing.

7 Measure the current drown by the compressor.

8 Switch off the power supply after testing over.

Fig 1



TASK 2: **Start Compressor without relay**

1 Take the 04 Nos of 1 meter length different colour wire pieces

2 Skin the wire at one ends fix the clips.

3 Connect the Red wire into compressor 'R' terminals series with the Ammeter.

4 Connect the Black wire into 'C' terminals.

5 Connect Blue wire to 'S' terminal through push bottom switch.

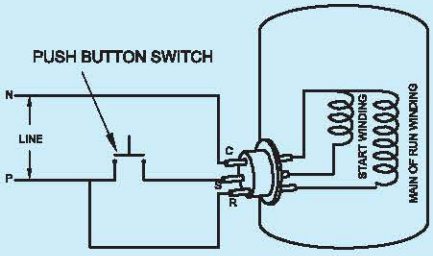
6 Provide earthling for the compressor with green wire

7 Fix spin plug to Red, Black & Green wire

8 Press the push bottom switch

9 Switch on the power supply and

Fig 2



10 Release the push bottom switch and see the running of compressor.

11 Check the compressor working suction & Discharge.

12 Measure the current drawn by the compressor.

13 Switch off & remove wire after test is over.

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Test performance of Direct cool refrigerator

Objectives: At the end of this exercise you shall be able to
- **installiation of new refrigerator**
- **start the refrigerator unit**
- **test the performance**

Requirement

Tools/Equipment

- Thermometer (stem/digital type) - 5 to +50°C - 1 No.
- Sprit level - 1 No
- Clamp meter 0 to 30A - 1 No

Equipment

- Domestic refrigerator - 1 No.

Materials

- Clean cloth/ sponge - 1 piece.

PROCEDURE

TASK 1: **Installation of new refrigerator**

1. Place the unit in upright position on a flat even surface carefully.
2. Cut the packing tape and remove the outer cover
3. Remove extra packing materials.
4. Check the physical damage if any in refrigerator
5. Ensure that the installing location has sufficient air ventilation.
6. Ensure that electrical power point available near the unit and measure the voltage.
7. Ensure that the floor level should be strong and flat even surface using spirit level.
8. Keep one foot or more space between the wall surface and rear side of the unit of external condenser type.
9. Connect the power supply throught voltage stablizer.

— — — — — — — —

TASK 2: **Start the refrigerator unit**

1 Open the door(s) of the unit and see the internal conditions. It must be clean and dry.

2 Keep the door open for 2 minutes for replacing existing cabinet air with ambient air. Then close the door(S)

3 Make sure that the stabilizer is 'OFF' position.

4 Insert the 3 pin plug of refrigerator unit into the output socket.

5 Switch ON the stabilizer.

6 Wait for 3 min to start the unit, if the stabilizer has time delay facility.

7 Observe the refrigerator gets ON by hearing mild noise (30-35 db) due to compressor is started.

8 Check the voltage & current drawn by the compressor.

9 Check the suction & Discharge temp by physical sensation.

— — — — — — — — —

TASK 2 : **Test the performance of the unit.**

1 Ensure that the door(s) of the unit closing well.

2 Fill water (at normal room temperature) in the ice tray which will be in freezer section.

3 Allow the Refrigerator to run.

4 Insert the thermometer in the Cabinet & freezer compartment.

5 Check the temperature decreasing rate.

6 Check and record the Ice formation time.

7 Check and note the Compressor 'Cut off' time & temperature.

8 Check the compressor 'Cut in' temperature & time.

9 Refrigerator cabinet temperature should between 2 to 4°C

10 Check the Ice formation in the tray.

— — — — — — — — —

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Cleaning and flushing of evaporator and condenser with dry nitrogen

Objectives: At the end of this exercise you shall be able to
- **strip out the components from conventional refrigerator**
- **clean and flush condenser coil with dry nitrogen**
- **dry the condenser and evaporator coil with hot air gun.**

Requirements

Tools/Instruments

- Flaring block & yoke 4.7mm to 16mm - 1 set
- Flaring block and swage punch - 1 No.
  4.7mm to 16mm OD - 1 No.
- Hammer ball peen 220gms - 1 No.
- Measuring tape - 2 mts - 1 No.
- Tube cutter 3mm to 16mm dia - 1 No.
- Spanner double end 4.7 to 16mm - 1 No.
  cutting plier 200mm - 1 set
- Nose plier 150mm - 1 No.
- Screw driver 10mm tip 200 mm length - 1 No.
- Screw driver 3mm tip 150mm - 1 No.
- Hot air gun - 1 No.
- Line tester 500V heavy duty - 1 No.

Equipments

- Gas welding set - 1 No.
- Nitrogen regulator 2 stage
  with hand shut off valve - 1 No.

Materials

- Charging hose - 1 No.
- Goggles, spark lighter - 1 set
- Power cord wire extension box - 1 No.
- 6.0 mm flare nut - 2 Nos.
- 6.0 mm straight union - 2 Nos.
- Dry nitrogen cylinder - 1 No.
- Hose clamp - 2 Nos.
- Silver rod - 1 No.
- Copper rod - 1 No.
- 6.0 mm copper tube - 2"
- Silver flux - 1 pocket (50 gms)
- Static evaporator coil - 1 No.
- Static condenser coil - 1 No.
- Small mirror - 1 No.
- 6.0 mm PVC hose (transparent) - 2 mts

PROCEDURE

TASK 1: **Strip out evaporator coil and condenser coil from the Refrigeration system for Internal cleaning in conventional refrigerator**

1 Disconnect the electrical power supply to the refrigerator

2 Remove the relay cover clip.

3 Gently pull the relay from the compressor terminal.

4 Keep away wire harness assembly from the torch flame reach.

5 Recover the refrigerant in service cylinder.

6 Allow 5 minutes to escape all the refrigerant gas from the surrounding if any.

7 Flame the torch and adjust to neutral flame.

8 De-braze suction line, capillary tube from the outlet drier.

9 Unscrew the condenser coil mounting bracket.

10 Separate the condenser coil from the refrigerator.

11 Remove the door by unscrewing top hinge to enable to pull the evaporator coil from inside.

12 Check the evaporator coil mounting arrangement (normally front portion mounted on two bolts, back portion lock arrangements)

13 Remove the mounting bolt, unlock the evaporator.

14 Remove the thermostat bolts from the evaporator.

15 Gently pull the evaporator from the refrigerator.

16 De-braze the suction line from the evaporator outlet, and debraze capillary tube from the inlet of the evaporator coil.

17 Before debraze suction line and capillary tube from the evaporator, keep wet cloth on evaporator copper aluminium joints.

18 Now the evaporator coil, condenser coil is ready for internal cleaning.

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TASK 2: **Clean and flush condenser and evaporator coil with nitrogen.**

1 Clean the condenser external surface with wire brush

2 Cut 150mm length 6.0 mm tube for the coil.

3 Insert 6.0mm flare nut at one end of the 150 mm copper tube and make 6.0 mm flare with help of flaring block and yoke

4 Swage other end to suit 6.0 mm Bundy tube with help of flaring block and swage punch.

5 Insert swaged tube to Bundy tube of condenser coil/ evaporator coil (Fig 1,2)

6 Braze the joints (Bundy tube & copper tube) with silver rod use suitable flux.

7 Ensure the joint properly fitted with silver rod

8 Check with small mirror, opposite side are also covered properly

9 Connect 6 mm straight union in the flare nut

10 Check charging hose, ensure rubber bushes are there in both end.

11 Connect one end of charging line to dry nitrogen cylinder and hand shutoff by tightening clockwise

12 Connect the other end of charging hose to the straight union in the condenser coil/evaporator coil

13 Unscrew the dry nitrogen cylinder regulator valve stem and keep the hand shut off valve open

14 Crack the nitrogen cylinder valve (anti clock wise) stem with the help of cylinder key

15 Check the cylinder pressure in the cylinder pressure

16 Slowly turn clockwise regulator spindle and maintain 7.0 kg/cm^2 outflow with the help of testing pressure gauge

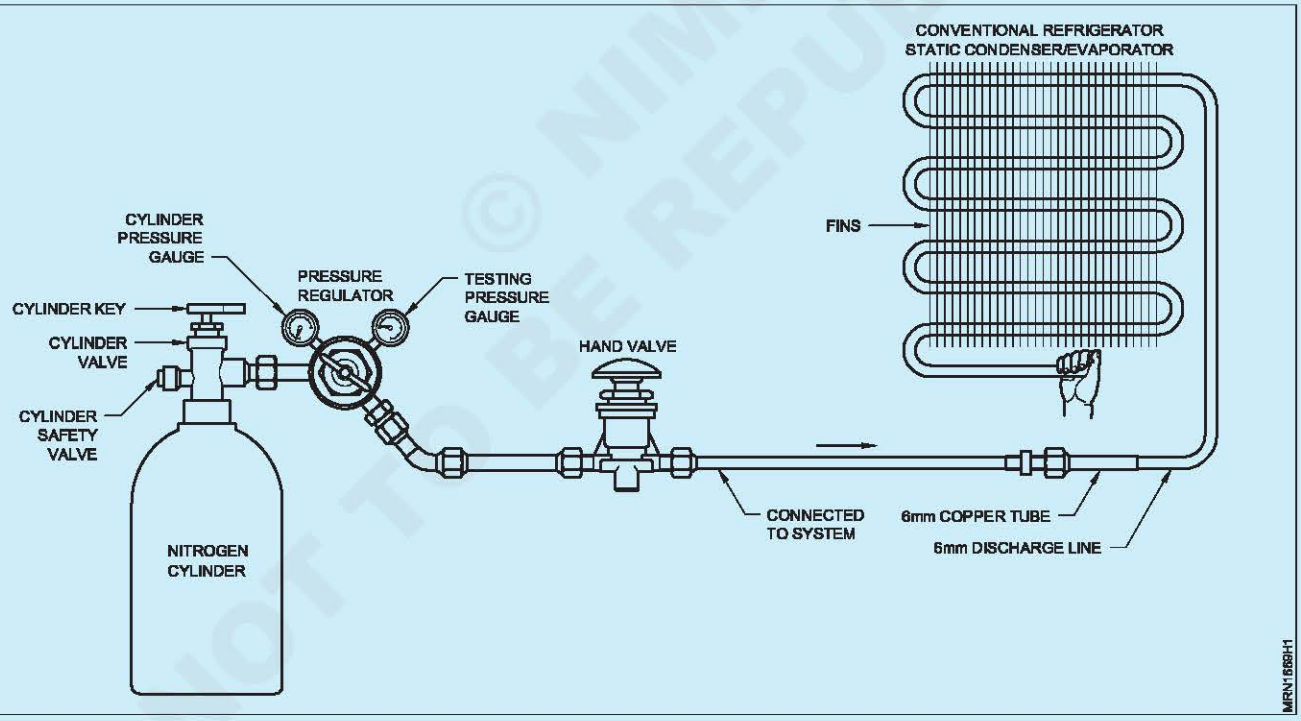
17 Hold your hand on condenser outlet as shown in (Fig1,2).

18 Close the outlet mouth for few seconds with your finger than leave your finger

19 Repeat the above procedure till (Max.5 min) all the contamination come out.

After flushing cap the end of the condenser evaporator coil. Now the coils is ready for assembling.

Fig 1

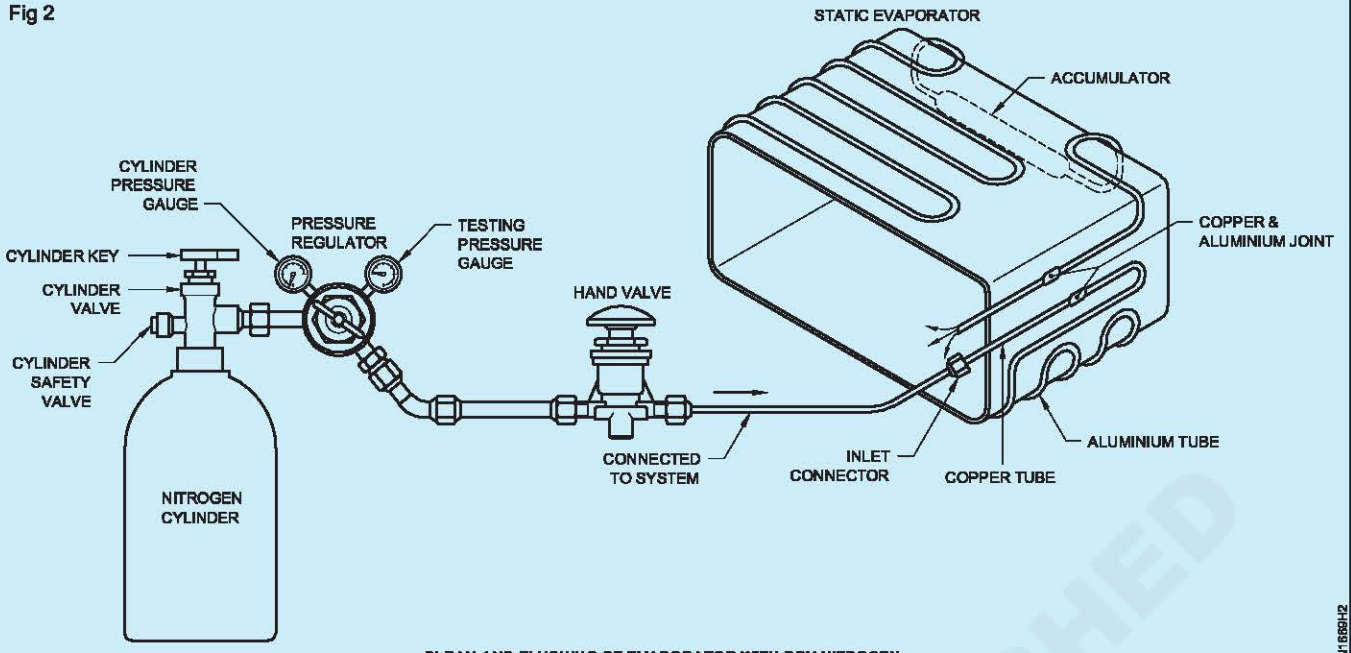


Note : In conventional refrigerator we are using (0.031") small bore capillary tube of single feeding contamination in capillary tube. Cleaning is very difficult. So it is not advisable to clean the capillary.

Advised to replace the capillary tube. In refrigerator capillary tube soldered along with the suction line. So capillary tube alone cannot be replaced. Advised to replace capillary tube along with suction line.

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Fig 2



CLEAN AND FLUSHING OF EVAPORATOR WITH DRY NITROGEN

TASK 3: **Dry the condenser and evaporator coil with hot air gun**

1 Connect the nitrogen cylinder as per the (Fig 4)

2 Regulate to 0.5 kg/cm^2 on the regulator to pass the nitrogen during drying operation to avoid air entry.

3 Switch On the hot air gun.

4 Hold the gun and warm the condenser coil. Right to lef from top to bottom for 15 minutes. (Check continues rating of hot air gun)

5 Switch OFF hot air gun.

6 Remove the charging hose, straight union plug the inlet outlet mouth with suitable cap.

Fig 1

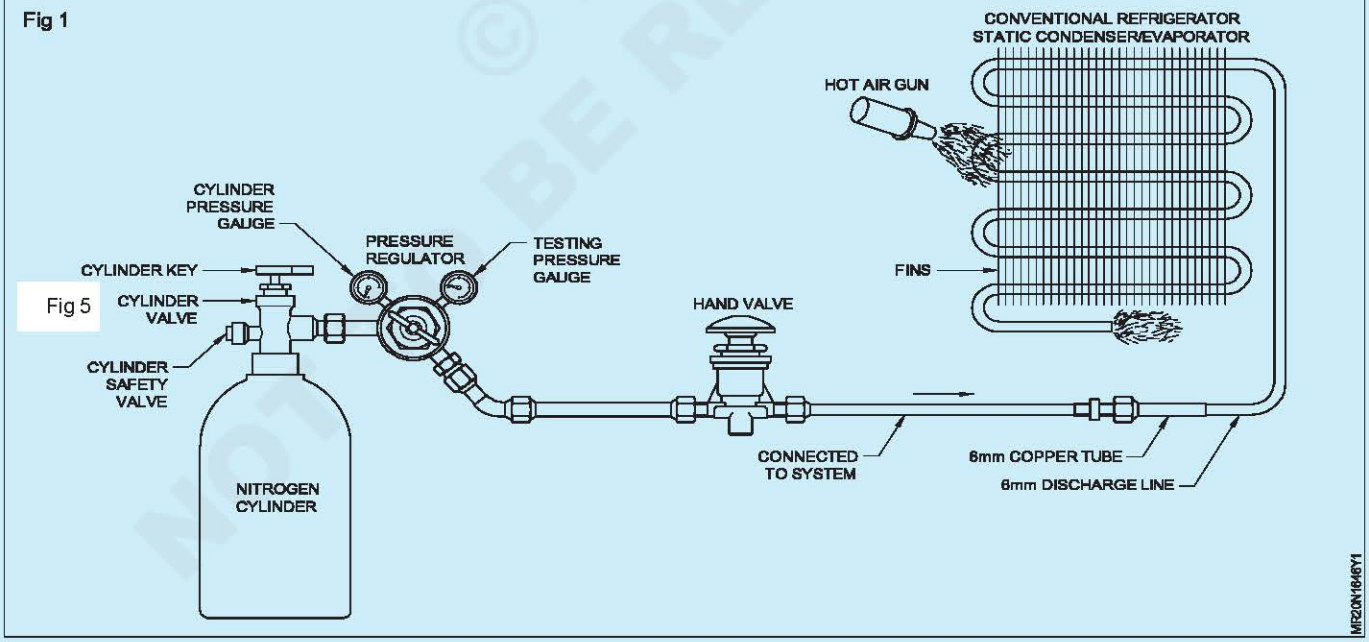


Fig 5

1 Connect the nitrogen cylinder as per (Fig 5)

2 Regulate to 5 kg/cm^2 on the regular to pass the nitrogen during drying operation to avoid air entry in.

3 Flame the blow lamp.

4 Hold the blow lamp warm the condenser coil move right to left from top to bottom for 15 minutes.

5 Put off the flame of blow lamp.

6 Remove charging hose, strainer union, cut the flare end of copper tube remove the flare nut.

7 Plug both ends with suitable caps.

8 Now the condenser coil ready for assembling.

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Replacement of capillary tube and drier

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

- **find out the filter-drier is clogged.**
- **flush the evaporator and condenser**
- **braze the capillary tubes assembly in position**
- **replacement of dehydrator**

Requirements

Tools/Instruments

- Cylinder valve key - 1 No.
- Double end spanner - 1 set.
- Needle file set - 1 No.
- Tube cutter - 1 No.
- 6" sharp knife - 1 No.

Equipment

- Gas welding set - 1 No.
- Fridge - 1 No.
- Filter drier - 1 No.
- Capillary tube - 1 No.

Materials

- Banian cloth
- Leather gloves - 1 No.
- Goggles - 1 No.
- Safety shoes - 1 Set.

PROCEDURE

TASK 1: **Find out if the dehydrator (filter drier) is clogged**

1 Start the refrigerator. Run for one hour

2 Check the evaporator for cooling. There should be snow formation in the evaporator.

3 If there is sweating in the evaporator then check the filter drier by hand

4 If the filter drier is cool then indicate that the dehydrator (filter drier) is clogged

— — — — — — —

TASK 2 : **Flush the evaporator and condenser**

Task 2 refer **exercise no 1.7.49**

— — — — — — — —

TASK 3: **Braze the capillary tube assembly in position.**

1 Place a metal sheet between the cabinet and liquid line as shown in (Fig 1).

2 Braze the filter entry to the condenser outlet from the area where the old filter was removed. Note the arrow mark on the filter drier.

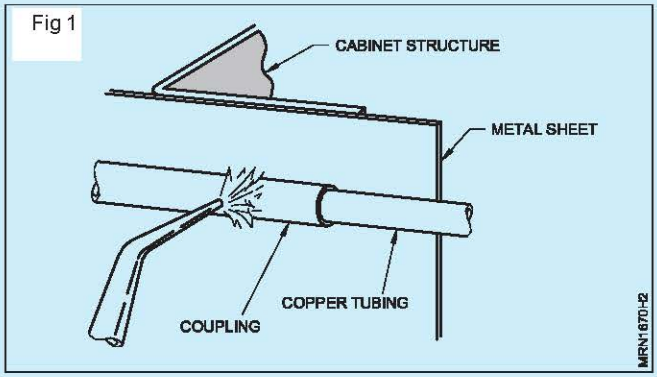
3 Install the capillary tube carefully touch it to the suction pipe use brazing torch with low flame and solder the capillary to the suction pipe.

4 Then braze the other end of the capillary.

5 Ensure that the cloth pieces of the pipes are removed.

6 Fig 2a. A shows the correct position of the capillary in the strainer. However positioning as shown in Fig 3b may bring about various problems during operation. Small circulating particles will be guided directly towards the capillary tube and the probability of observation is thus increased.

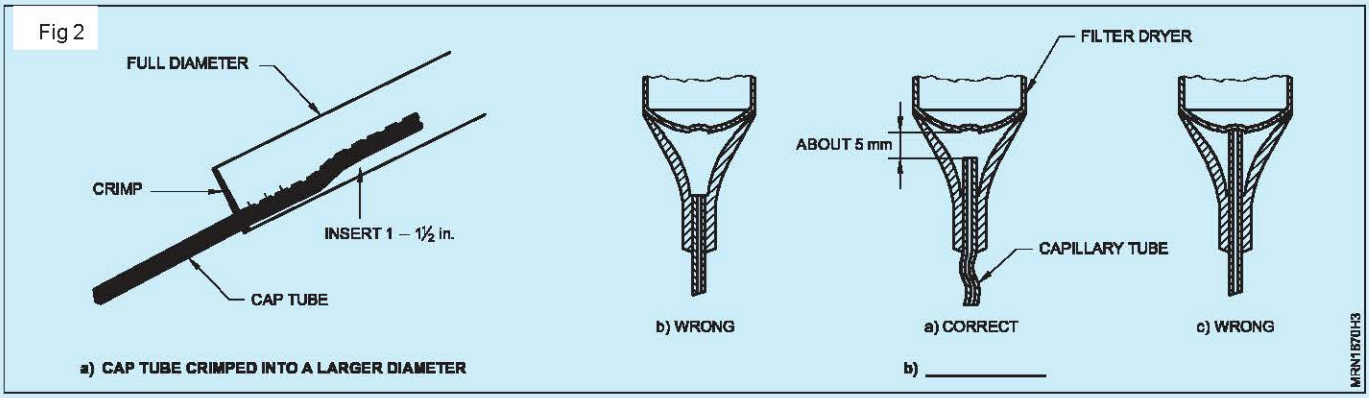
Fig 1



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Fig 2



TASK 4: **Replacement of dehydrator (filter drier).**

1 Cut charging line release gas wear goggles and ensure proper ventilation around working place.

2 Carry out debasing procedure as explained in previous exercises.

3 Select the new dehydrator (filter drier) to correct size compare with removed one.

4 Select new capillary size of old cut capillary.

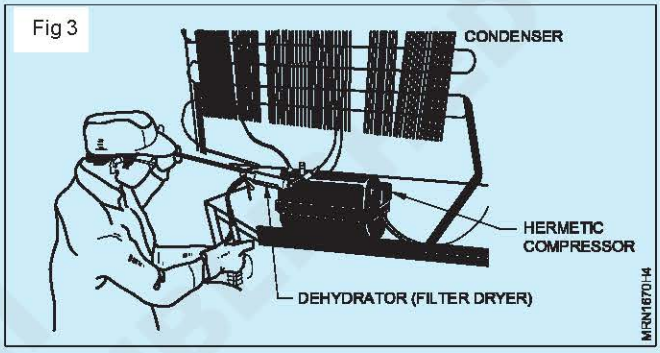
5 Braze the capillary to filter drier (dehydrator).

6 Flush the dehydrator (filter drier) and capillary.

7 Flush evaporator and condenser.

8 Braze the dehydrator (filter drier) inlet to condenser outlet and capillary outlet to evaporator inlet as shown in (Fig 3).

Fig 3



9 Carry out leak test as explained in next exercise.

10 Evacuate the system.

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Trace the electrical circuit of frost free refrigerator

Objectives: At the end of this exercise you shall be able to
- **trace the electrical circuit**
- **dismantling of all parts (electrical) in frost free**
- **checking all electrical parts removed from fast free refrigerator by multimeter**

Requirement

Tools / Instrument

• Trainee's kit	- 1 No.
• Multimeter	- 1 No.
• Cutting player	- 1 No.
• Screw driver	- 1 No.
• Test lamp	- 1 No.
• Volt and amp meter	- 1 No.
• Knife	- 1 No.

Equipment

• Defective frost free refrigerator	- 1 No.

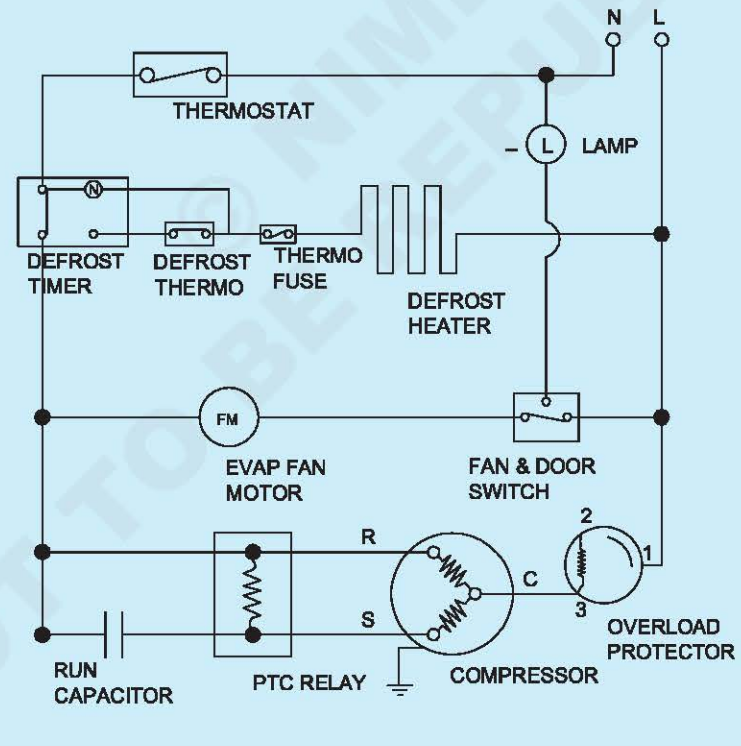
Materials and components:

• Insulation tape	- 1 roll.
• Multicore wire	- 3 mtr
• Wire clip	- 12 Nos.
• Cotton waste	- as reqd.

PROCEDURE:

TASK 1 : **Trace the electrical circuit**

Fig 1



TASK 2: **Dismantling of all parts (electrical) in frost free refrigerator**

1 Switch off refrigerator power and remove 3 pin top from switch board.

2 Remove compressor relay clip and relay.

3 Note down the colour of the wire while removing.

4 Remove relay wire and junction wire.

5 Remove thermostat switch by unscrewing.

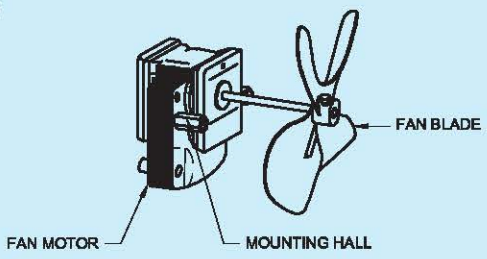
6 Remove freezer fan motor by unscrewing the fan blade.

7 Remove light switch and light holder and bulbs.

8 Remove timer switch and strip heater wire only.

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Fig 2



FAN MOTOR AND ASSEMBLY COMPONENTS.

TASK 3: **Checking all electrical parts removed from frost free refrigerator by multimeter.**

1 Connect the multimeter to the compressor terminal and check for the continuity.

2 Connect black lead to compressor top terminal (c), and red lead of meter unit to compressor (R) terminal the meter shows ohms. Then without removing black lead touch red wire to compressor (S) terminal, now you will get starting winding ohms. Without removing black lead, touch red wire to compressor body, if you get ohms, then compressor motor get burnt out otherwise winding OK in normal condition.

3 Check relay.

4 Check light holders and light switch.

5 Check thermostat switch.

6 Check the cooling coil fan motor (Fig 2)

7 Check the timer.

8 Check the bimetal heater.

Check fan motor bush bearing by shaking up and down.

Check fan motor winding with multimeter if get ohms (continuity) motor winding is normal, otherwise winding burnt out.

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Checking fault finding and testing of electrical components in frost free refrigerator

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

- **check and test timer**
- **check and test bimetal thermo**
- **check and test defrost heater**
- **check and test PTC relay**
- **check and test overload protector**
- **check and test evaporator fan motor.**

Requirement

Tools/Instrument

- Multimeter analog type - 1 No.
- Line tester 500V - 1 No.
- Cutting plier length 200mm - 1 No.
- Nose plier length 150mm - 1 No.
- Phillips Screw driver set - 1 No.

Materials

- 5 mts./1 sq.mm multistring wire
- Bulb holder - 1 No.
- Electrical test board - 1 No.
- Dry ice - as required.

Equipments

- Frost free Refrigerator - 1 No.

PROCEDURE

TASK 1 : **Check and test timer in Frost free refrigerator with test lamp, multimeter and power source**

1 Prepare table for manufacturer specification on Table1.

RECORD SHEET

Table 1

S.No.	Timer	Specification
1.	Model No.	
2.	Serial No.	
3.	Operating voltage	
4.	Current	
5.	Power consumption	
6.	NC points	
7.	NO points	

2 Prepare Test lamp as per diagram. Ref. (Figs 1 & 2).

Fig 1

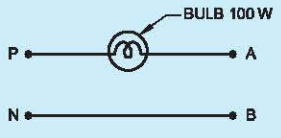
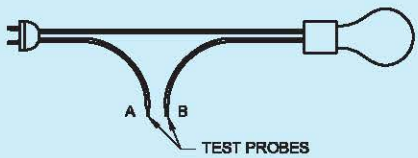


Fig 2



3 Check the test lamp by touching Probe 'A' with Probe 'B'. Bulb is glowing. Prepared test lamp is OK.

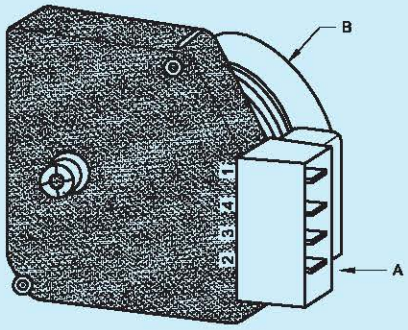
4 Check timer motor winder continuity between timer terminal 3 & 1. Touch 'A' probe in Timer Terminal 3, B probe is Timer Terminal 1. If the bulb is glowing timer motor continuity is OK. If the bulb is not glowing timer motor is faulty. Refer Figs (3 & 4).

5 Check the continuity of NC (Normally closed) point. Touch Probe A at point 3 in Timer. Touch Probe 'B' at point 4 in Timer. If the bulb is glowing NC point is OK. Refer Figs (3 & 4).

6 Check the continuity of NO points (normally open). Place the Probe A at Timer Terminal point 3. Place Probe B at Timer terminal point 2. If the bulb is not glowing NO point is OK. Refer Fig (3 & 4).

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Fig 3



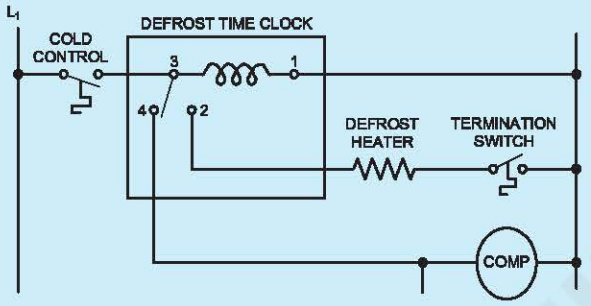
A - TIMER IS CONNECTED INTO MOTOR COMPRESSOR CIRCUIT AND PROVIDES BOTH A CLOCK MECHANISM AND SWITCHING MECHANISM. CLOCK ENEREGIZES SWITCH MECHANISM IN SUCH A WAY THAT, AFTER EIGHT HOURS OF COMPRESSOR OPERATION, FAN MOTOR IS TURNED OFF AND DEFROST HEATER IS ENERGIZED.

B - TIMER MOTOR

A DEFROST TIMER

MRN1775H3

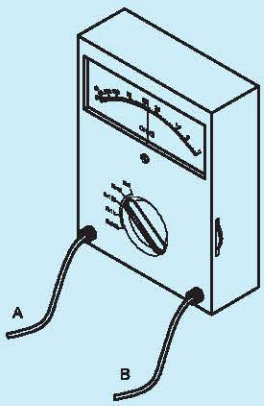
Fig 4



MRN1775H4

7 Check Timer with multimeter. Set the knob at Ohms measuring position. Place Probe A in Timer Point 3 and Probe B in Timer Point 1. If the needle of the Multimeter deflected, Timer motor winding continuity is OK. Check NC points for continuity. Check N.O. points for no continuity. Refer Figs (3, 4 and 5).

Fig 5

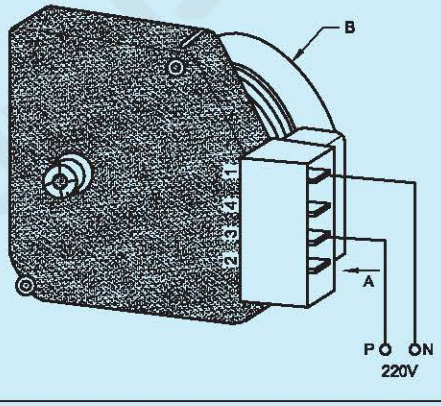


MULTIMETER

MRN1775H5

8 Connect Timer to the power source as shown in the (Fig 6). Mark the shaft position. Touch and feel whether the motor is working. Allow 15 minutes time to run the motor. After 15 minutes check the shaft position. If shaft is moved from the Mark the timer is OK.

Fig 6



MRN1775H6

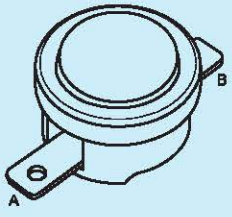
TASK 2: **Check and test bimetal thermo.**

1 Prepare test lamp. (Refer Fig 1 & 2 in TASK 1)

2 Check continuity between A & B of bimetal. If the bulb is not glowing bimetal thermo OK.

3 Keep the bimetal thermo in dry ice of 5 minutes. After 5 minutes check continuity between A & B. If bulb is glowing bimetal thermo is OK.

Fig 7



BIMETAL THERMO

MRN1775H7

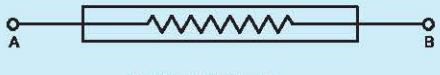
TASK 3: **Check and test Defrost heater**

1 Prepare table for manufacturer specification

2 Check continuity with Multimeter point A and B. If the needle is defected continuity of heater is OK. Check the resistance of the heater and register in the Table.

3 If the operating voltage is 220 V AC power supply connect the power source as per diagram for 2 minutes and disconnect the power source. Touch your finger on the heater and observe heat. If heat is developed, heater is OK.

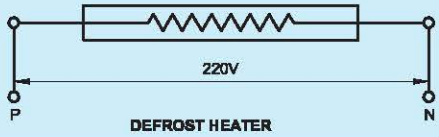
Fig 8



DEFROST HEATER

MRN1775H8

Fig 9



DEFROST HEATER

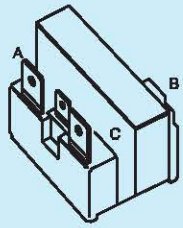
MRN1775H9

TASK 4: **Check and test PTC relay**

1 Check continuity between C and A with multimeter. If the needle deflected continuity is OK. A terminal connected with Main winding. B terminal connected with starting winding. Check resistance between C and B. Resistance approximately 30Ω.

2 Connect the relay in the FHP compressor. Allow the compressor to run for 5 minutes. Disconnect the power supply. Measure the resistance between C & B. Resistance approximately 30,000Ω.

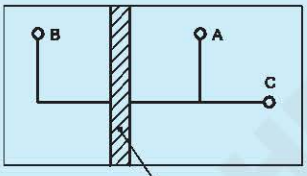
Fig 10



PTC RELAY

MRN1775HA

Fig 11

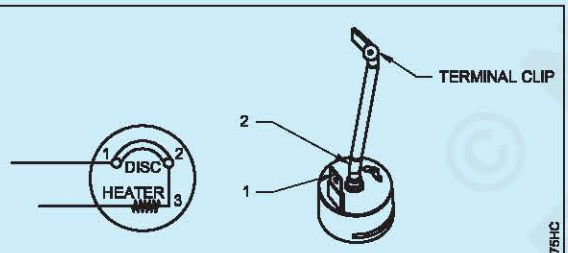


INTERNAL CONSTRUCTION

MRN1775HB

TASK 5: **Check and test Overload protector**

Fig 12



OVER LOAD PROTECTOR

MRN1775HC

Check continuity with test lamp between 1 and 2 and 3 also. If the bulb glow OLP is OK.

TASK 6: **Check and test Evaporator Fan motor**

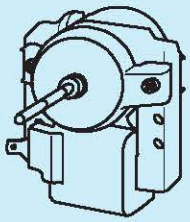
Check continuity of motor winding with test lamp. If the bulb glows continuity is OK. Connect to the power supply. Run the motor. If motor shaft run smoothly the fan motor is working OK.

RECORD SHEET

TABLE 2

S.No.	Defrost heater	Specification
1.	Make	
2.	Operating voltage	
3.	Watts	

Fig 13



EVAPORATOR FAN MOTOR

MRN1775HD

Very narrow winding wire used in timer and evaporator fan. So that use low wattage bulb test lamp

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Check air distribution system in frost free refrigerator

Objectives: On completion of this exercise you shall be able to

- **check air flow in freezer compartment, fresh food compartment, meat keeper compartment (if provided)**
- **check the temperature (by remote sensing bulb thermometer) in freezer compartment, fresh food compartment and meat-keeper compartment.**
- **check frost accumulation in freezer compartments and meat-keeper department besides high humid air flowing in frost food compartment**

Requirements

Instruments and tools

- Thermometer with remote bulb sensor - 1 No.
- Screw drivers (set) - 1 No.
- Allen key (set) (if necessary) - 1 No.

Equipments

- Domestic frost-free refrigerator double door - 1 No.

Materials

- 5 amps fuse wire and insulation tape - 1 No.
- Cotton waste - 1 No

PROCEDURE

TASK 1: **Check air flow in Freezer compartment, fresh food compartment, meat-keeper compartment (if provided)**

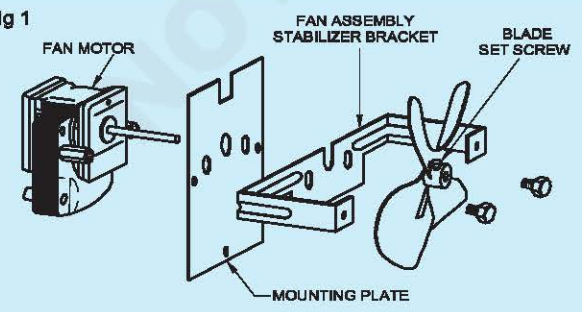
1 Start the refrigerator and ensure that the refrigerator fully loaded with commodities both in fresh food compartment and frozen food compartment.

2 Allow the refrigerator to run for at least for 2 hours before carrying out the subsequent tasks.

3 By opening the door of the refrigerator, remove the door switch and short the terminal with 5 amps fuse wire and insulate the open terminals of the door switch with insulation tape and install back door switch in its original place from where it is removed. Now the evaporator fan will run continuously even if the refrigerator kept open.

4 Now reach out your hand to evaporator fan outlet to feel air flow in the freezer compartment of fresh food compartment and make sure if evaporator fan is in running condition (Refer Figs 1 & 2)

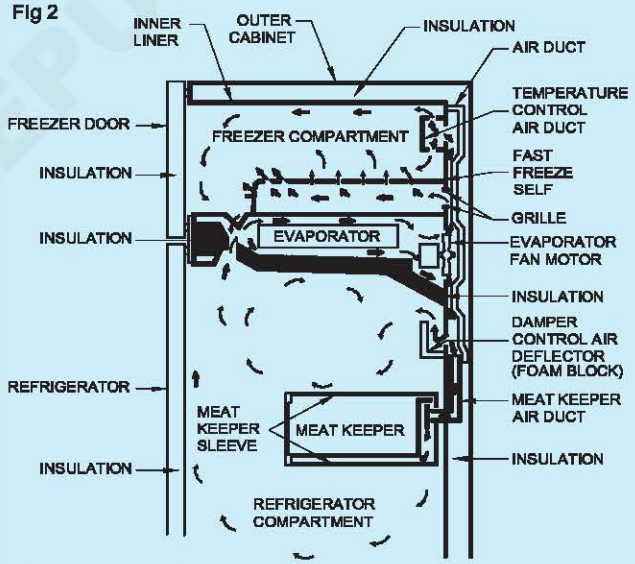
Fig 1



FAN MOTOR AND ASSEMBLY COMPONENTS.

5 While the refrigerator is still running but cannot able to obtain required temperatures. Stop the unit and open the cover of evaporator fan compartment by using short screw drivers.

Fig 2



AIR CIRCULATION IN REFRIGERATOR WITH FROZEN FOOD COMPARTMENT. EVAPORATOR FAN FORCES CIRCULATION OF COOLED AIR THROUGH VARIOUS COMPARTMENTS. DAMPERS CONTROL AIR DUCT OPENINGS. THEREFORE, THEY CONTROL VARIOUS CABINET TEMPERATURE.

TOP MOUNT AIRFLOW PATTERN

6 Examine whether the fan blade is fitted well with blade set screws. If not tighten blade set screws and put back the cover of Evaporator Fan Compartment using short Screw-Drivers (Refer Fig 1)

Note: Refrigerator door switch terminals short with 5 amps fuse wire be removed after pulling out insulating tape and door switch to be fitted back in its original place to avoid continuous running of fan blade even if the refrigerator door is open.

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TASK 2: **Check the temperature (by remote sensing bulb thermometer) in freezer compartment, fresh food compartment and meat-keeper compartment.**

1 By taking the remote sensor bulb of thermometer to the freezer compartment check the temperature and list the temperature in the Record Table I. Record temperature from fresh food compartment and meat-keeper compartment also in the Record sheet.

2 Also examine the dampers control air deflector to fresh food and compartment temperature control air duct to meat keeper and freezer compartment working properly.

— — — — — — — —

TASK 3: **Check if frost accumulated in freezer compartment and meat-keeper compartment, besides high humid air flowing in fresh food compartment.**

1 By inserting thin paper in between door gasket and gasket sealing area on the body of the refrigerator, while the refrigerator door still kept in closed position, pull out papers to ascertain the sealing of gasket is normal and if the paper inserted in between comes out easily. Moisture from ambient enters the refrigerator to get deposited as frost inside freezer cabinet.

2 Change the door gasket to avoid leakage of moisture from ambient air to refrigerator compartments.

3 Reset thermostat to normal cooler position from low temperature setting and allow the refrigerator to run further.

4 Observe the thermostat setting. It should trips to normal cool position. If not remove thermostat and replace it.

5 Check the condition of heaters time-delay switch. In case of any defect in time-delay switch due to long run, it stops heaters to run thereby allowing the frost to accumulate.

6 Remove defective time delay switch and replace it with new one.

RECORD SHEET - I

Particulars	Temperature Required	Temperature Noted
Freezer compartment Temperature	-10°C (14°F)	
Fresh food compartment temperature	4°C (40°F)	
Meat - Keeper compartment (if provided)	-10°C (14°F)	

— — — — — — — —

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Service components of frost free refrigerator

Objectives: At the end of this exercise you shall be able to
- **service the condensing unit of the refrigerator**
- **service the evaporator cabin of the refrigerator**
- **service the inner and outer cabinet of the refrigerator**
- **test the operation of the refrigerator**

Requirements

Tools/Instruments

• Thermometer	- 1 No.
• Tong tester	- 1 No.
• Voltmeter	- 1 No.
• Screw driver	- 1 No.
• Cutting plier	- 1 No.

Equipments

• Frost free refrigerator	- 1 No.
• Air blower (small)	- 1 No.

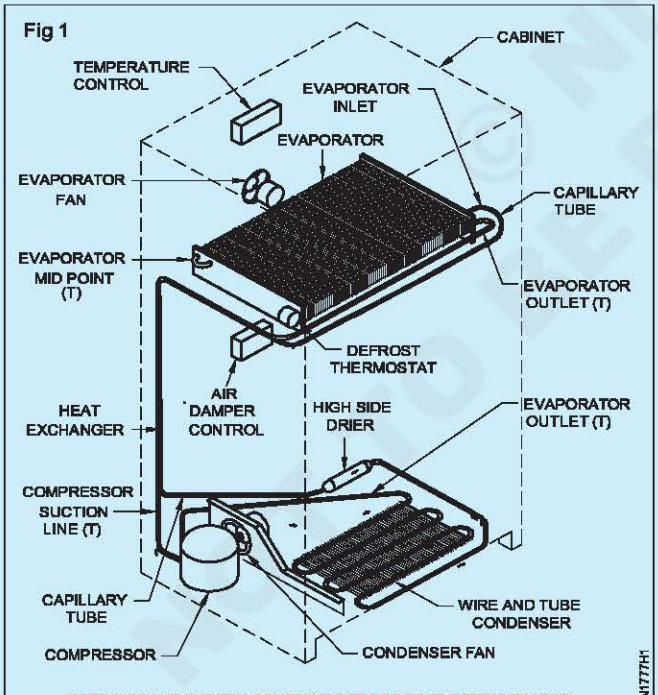
Materials/components

• Nylon brush	- 1 No.
• Clean cloth	- as reqd.
• Mild detergent powder	- as reqd.
• Bucket water	- as reqd.
• Oil can	- 1 No.

PROCEDURE

TASK 1: **Service the condensing unit of the refrigerator.**

Fig 1



REFRIGERANT SYSTEM SCHEMATIC FROST FREE REFRIGERATOR.

1 Stop the refrigerator, remove the plug from the socket

2 Remove the items kept inside the refrigerator and pull the unit little forward

3 Unscrew the back cover and make the condensing unit visible (Ref. Fig 1) for location of condensing unit)

4 Connect the air blower to the socket and blow the air to the condenser fins. Clean the fins with nylon brush, clean the compressor and remove the dust. Keep off the blower

5 Wipe the compressor and condenser with dry cloth

6 Lubricate the fan motor and wipe, fan , motor and the base of the condensing unit, then cover the back and tighten the screws.

TASK 2 : **Service the evaporator cabin of the refrigerator.**

1 Open the top door of the cabin and wipe the freezer cabin with mild detergent solution wet cloth

2 Again wipe it with clean water wet cloth, finally wipe it with dry cloth

3 Remove the evaporator fan grill. Wipe the fan and the grill with dry cloth then fix the grill.

4 Keep the top door open till the evaporator cabin become dry then close it

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TASK 3: **Service the outer inner cabinet and door of the refrigerator.**

1 Close the door slowly and check the door is pulled by the magnetic arrangement when the door reaches to the nearest closing point

2 Take 4 cm (breadth) x 10 cm (length) newspaper place it as half portion is visible outside on the edge of the door and close it.

3 Now pull the paper and check if the paper is holed by the gasket tight. Check all the surrounding of the door gasket by this method.

4 If certain place the gasket is not holding tight assume there is a chance of cool air leak from inside

5 Fold the newspaper neatly and insert in between the gasket and the door inner wall. (Paper should not be visible).

6 Close and see if the door is shut firmly. When slowly closing the door, if door is leaving gap, not in the magnetic reach means the fridge level as to be balanced for automatic closing.

7 Adjust the bottom level screws and make the door to close by balances automatically while you close the door slowly even.

8 Lubricate the door hinges and latches by oil can. Then settle the shelves to the proper place.

9 Clean the handle, lock, hinges, name plate with soft wet cloth, then wipe it with dry cloth.

10 Check the thermostat temperature control knob and set it for normal or centre range for usual operation.

11 Finally after wiping the external area of the fridge apply little fridge wax polish and polish it till all the sides shine with soft cloth

12 Connect the plug and on the refrigerator switch. Open the door and check inner cabinet light is glowing and check for off-on by pushing the door switch and leaving.

13 After 10 minutes check by touching the evaporator plate and feel the chillness.

14 Now the refrigerator is ready and can load the food stuffs and cool drinks etc. in proper racks.

— — — — — — — —

TASK 4: **Test the operation of the refrigerator.**

1 After checking of electrical and mechanical components, reassemble then test the performance of the unit.

2 Ensure that the door(s) of the unit is closed well, then start the refrigerator.

3 Fill water in the ice tray and keep it in the freezer components.

4 Set the thermostat knob to normal position (medium cool)

5 Keep the sensing probe of digital thermometer inside the cabinet

6 Let the unit to run 2 hours without any interruption

7 After 2 hours open the freezer door and check the water kept in the ice tray become solid ice.

8 Find the temperature shown in digital thermometer and compare with initial temperature.

9 Check if the unit is running with normal

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Testing performance of frost free refrigerator

Refer Exercise 1.7.48 TASK : 1, TASK : 2, TASK : 3

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Identify three and four door no frost refrigerator

Objectives: At the end of this exercise you shall be able to
- **identify three door refrigerator**
- **identify four door refrigerator**
- **distinguish between normal refrigerator and 3/4 door refrigerator.**

Requirements

Tools/Instruments

- Line tester - 1 No.
- Three door refrigerator - 1 No.
- Four door refrigerator - 1 No.

Materials/components

- Clean cloth -1 piece.

PROCEDURE

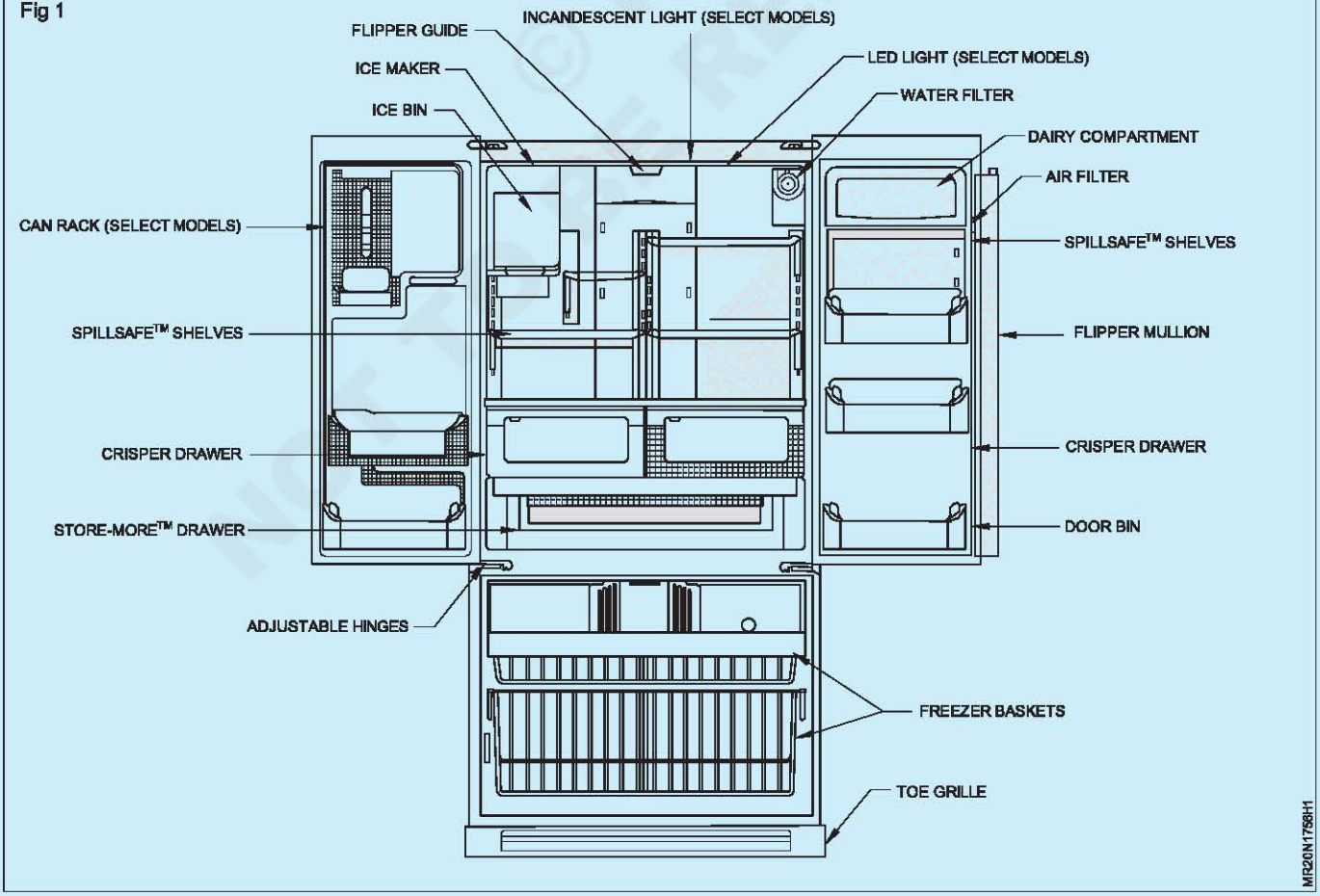
TASK 1: **Identify three door refrigerator:**

1 Identify three door refrigerator and check its construction and parts.

2 Lable the parts in Figure 1.

Sl No	Name of parts

Fig 1



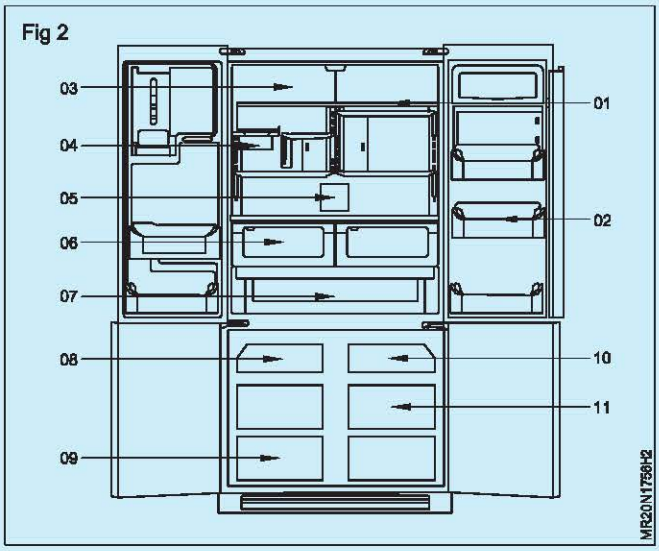
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TASK 2: **Identify four door refrigerator.**

1 Identify four door refrigerator and check its construction and parts.

2 Lable the parts in Figure 2.

Fig 2



Sl No	Name of parts

— — — — — — — —

TASK 3: **Distinguish between normal refrigerator and 3/4 door refrigerator.**

1 Check the construction and design of the both refrigerators.

2 Distinguish between the refrigerator and make a note of it.

Note : Do not start the refrigerator without permission

Do not use cotton waste for cleaning.

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Testing the components of three/four refrigerator

Objectives: At the end of this exercise you shall be able to
- **use of diagnostic aid kit**
- **check the and test inverter compressor testing**
- **check and test electronic board testing.**

Requirement

Tool Instruments

• Screw driver 100mm 6mm tip	- 1 No.
• Cutting plier 200mm	
• (Insulated handle	- 1 No.
• Philips screw driver set	- 1 Set.
• Double end spanner	- 1 Set.
• Multimeter	- 1 No.
• Test cord	- 1 No.

Material

• Insulation tape	- 1 No.
• Cotton waste	- as reqd.
• 2M 1.5 sqmm Wire	- as reqd.
• Test board fitted with voltmeter & ammeter	- 1 No.

Equipment

• Inverter Refrigerator 3/4 door	- 1 No.

Refer EX No 1.8.52

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Identify different types of compressor

Objectives: At the end of this exercise you shall be able to
• identify compressor used for refrigerator and window A/C.

Requirement

Tools/ Equipments

- Work bench - 1 No
- Trainees tool kit - 1 No

Material

- Cotton Waste - as reqd

Equipment

- Different capacity and type of sealed compressor - as reqd

PROCEDURE

TASK 1: **Identify compressor for refrigerator and window A/C (Fig 1)**

1 Keep the refrigerator and window air condenser on the work bench

2 Identify the compressor of refrigerator and window A/C

3 Note the speciation of refrigerator and window A/C and entered into Table - 1

Table 1

Sl No.	Manufacturer name	Model no	H.P/watts	Other details
1				
2				
3				
4				

Fig 1



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Dismantle assembling - reciprocating - rotary compressor

Objectives: At the end of this exercise you shall be able to
- **cut the reciprocating compressor dome**
- **dismantle the reciprocating compressor**
- **assemble hermetic reciprocating compressor**
- **cut the compressor dome of rotary compressor**
- **dismantle rotary compressor**
- **assemble the rotary compressor.**

Requirements

Tools/Instruments

- Bench vice 100 mm - 1 No.
- Hand hacksaw 300 mm - 1 No.
- Flat file 200 mm - 1 No.
- Power hand cutting tool - 1 No.
- marking punch - 1 No.
- Box spanner - 1 set.
- Plier 200 mm - 1 No.
- Mallet - 1 No.
- Oil can - 1 No.
- AG4 cutting machine - 1 No.
- Adjustable wrench 200 mm - 1 No.
- Screw driver 250 mm - 1 No.
- Hacksaw /Hand grinder - 1 No.
- Ball peen Hammer 400 Gm - 1 No.
- Screw driver set - 1 No.
- Measuring jar - 1 No.
- Ratchet Wrench - 1 No
- Nose plier 100mm. - 1 No
- Metal tray 450X450mm - 1 No
- D.E. spanner set - 1 Set

Equipments

- Rotary compressor, wobble plate compressor
- Swash plate compressor, scroll compressor.
- Hermatic compressor reciprocating - 1 No

Materials / components

- Cotton waste - as reqd.
- Kerosene oil - as reqd.
- Compressor oil - as reqd.
- TCE - as reqd.
- AG4 cutting machine - as reqd.
- 150 x 3mm Cutting Wheel - 1 No.

PROCEDURE

TASK 1: **Cut the hermetic reciprocating compressor**

1 Remove the compressor and tilt the compressor and take out oil in measuring Jar.

2 Clean the compressor by cotton waste.

3 Mark the dome to cut.

4 Hold the Compressor in bench vice.

5 Mark the place to into the dome

6 Wear gloves and goggles.

7 Cut by hacksaw or power cutter through the marking.

8 Takeout the dome by two hand and keep separately on tray space.

9 Loose the bolts of suspension springs.

10 Twist and remove the crankcase along with motor from the done

11 Loosen the four bolt with the help of ratchet spanner and keep it in the tray.

TASK 2: **Dismantle the hermetic reciprocating compressor**

1 Disconnect stator electrical clips from terminal. of dome.

2 Take out stator from the housing.

3 Cut the discharge connection inside the dome.

4 Unlock suspension springs.

5 Take out complete assembly.

6 Remove bolt of Compressor head.

7 Take out valve plate, Piston, Connecting rod all the component.

8 Keep all the components carefully in Tray.

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TASK 3: **Assemble hermetic reciprocating compressor.**

1 Check CSR point of the motor terminal and connect it to terminal adapter.

2 Clean rotor with fine emery sheet and compressor body with rough emery sheet.

3 Clean and check mounting springs.

4 Smoothen surfaces of both bottom and top compressor dome by using flat file.

5 Check compressor bearing and assemble a hermetic compressor.

6 Put piston in bore with connecting rod. Fix crankshaft and rotor by wheel press.

7 Put gasket on compressor head.

8 Put oil on gasket and assemble valve on valve plate

9 Put gasket on head plate, put head bolt tight all bolt evenly.

10 Turn rotor and check if piston head knocking on valve plate if knock the suction and discharge gasket to be changed 1/32 mm.

11 Fix motor stator (winding) with help of wooden hammer or with wheel press.

12 The clearance between stator and rotor 0.1 or 0.125 mm this to be checked with feeler gauge.

13 Fix winding put full compressor in a good tray fill new oil up to compressor main bearing to be immersed.

14 Put wire connection check with multimeter compressor winding to compressor body if meter show reading winding grounded rectify the problem.

15 Start compressor check discharge pressure with HP gauge. Discharge pressure should be 20.5 kg/cm^2 otherwise the valve reeds not seated in plate or some leak will be in the head gasket put oil and check if any leak in head gasket that to change and tight fully. After this head pressure will come 20.5 kg/cm^2.

16 Check rotor direction. Recommended direction to be run for pull oil from crank housing to main bearing.

17 Check oil will travel up to piston and main bearing through crankshaft bearing and oil groove.

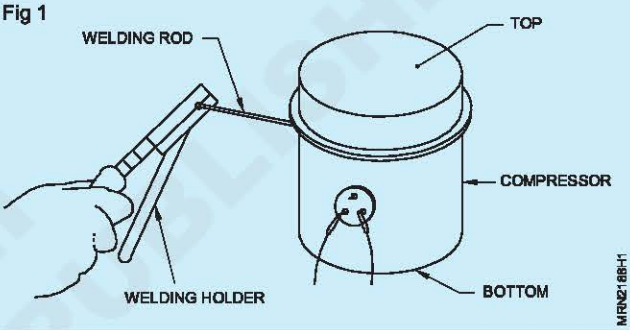
18 Braze discharge line with dome.

19 Put winding terminal in compressor body terminal.

20 Fix and test if any noise after cover top.

21 Weld the top lid with done (Fig 1)

Fig 1



TASK 4: **Cut the compressor dome of rotary compressor (Fig 2)**

1 Drain the oil from compressor through process line by tilting the compressor.

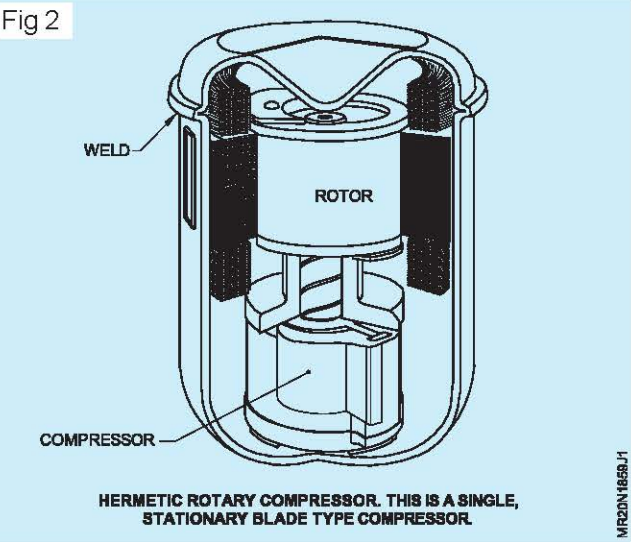
2 Clean the compressor externally

3 Mark the dome for cutting

4 Keep the hermetic rotary compressor on the bench vice.

5 Cut the dome on the marked portion by using hand hacksaw or power hand cutter.

Fig 2



HERMETIC ROTARY COMPRESSOR. THIS IS A SINGLE, STATIONARY BLADE TYPE COMPRESSOR.

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TASK 5: **Dismantle rotary compressor.**

1 Remove compressor from the dome.
2 Keep the compressor on the table
3 Dry the compressor externally
4 Lessen the nuts and bolts in the tray.
5 Keep the nuts and bolts in the tray.
6 Remove the compressor cylinder, roller, dividing blade and spring.
7 Clean each compressor parts by using kerosene oil and then by TCE
8 Dry the compressor parts.
9 Apply a thin coat of compressor oil on the parts to avoid rust.

— — — — — — — —

TASK 6: **Assemble the rotary compressor.**

1 Fix spring and dividing blade on the cylinder block.
2 Keep the roller inside the cylinder block.
3 Place the end plat eat both sides of the cylinder and tight the bolts
4 Fix shaft to the motor
5 Fix discharge valve assembly
6 Connect motor windings to the terminal point of the internal dome.
7 Check compressor and motor position in the dome.
8 Fill oil in to the dome
9 Keep the oil level below the discharge tube
10 Fix suction line to the compressor
11 Keep top portion dome for welding
12 Weld the dome.

— — — — — — — —

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Identify different parts of dismantled compressor .

Objectives: At the end of this exercise you shall be able to
- **identify the different parts of reciprocating compressor**
- **identify the different parts of the rotary compressor.**

Requirements

Tools/Instruments

- Box spanner set with ratchet handle - 1Set.
- Ball peen hammer - 1No.
- Screw driver set - 1Set.
- Measuring jar - 1No.
- Ratchet wrench - 1No.
- Nose plier 100mm - 1No.
- Nylon mallet hammer 200gms - 1No.
- Wooden steel work table - 1 No.
- Mallet/hammer - 1 No.
- Bench vice - 1 No.

Material/Equipments

- Cotton waste - as reqd.
- Lubricating oil can - 1No.
- All the parts - as reqd.
- Hermetic reciprocating compressor - 1No.
- Dismantled Compressor parts - as reqd.
- Cotton waste - as reqd.
- Oil - as reqd.

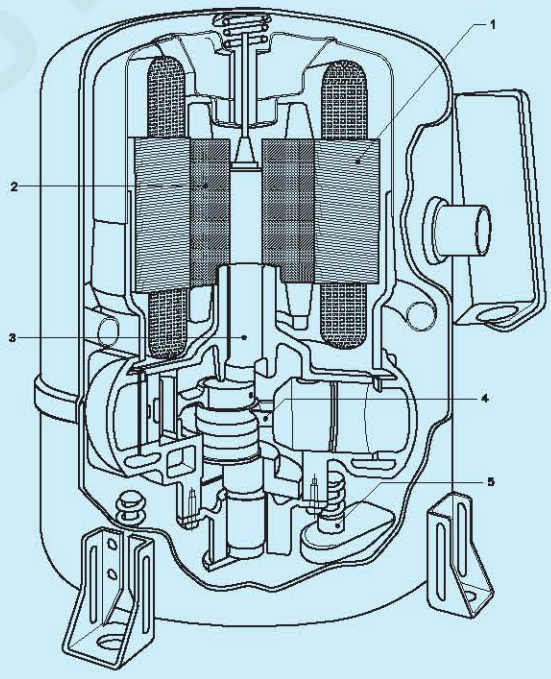
PROCEDURE

TASK 1: **Identify the different parts of reciprocating compressor.**

1 Check all the individual compressor parts
2 Identify parts record it table number 1
3 Clean all components
4 Check for wear and tear.
5 Replace damaged parts by new one
6 Apply a thin film of oil

Part No.	Type of compressor
1	
2	
3	
4	
5	

Fig 1



SECTIONAL VIEW OF A VERTICAL HERMETIC COMPRESSOR

MRN2188H1

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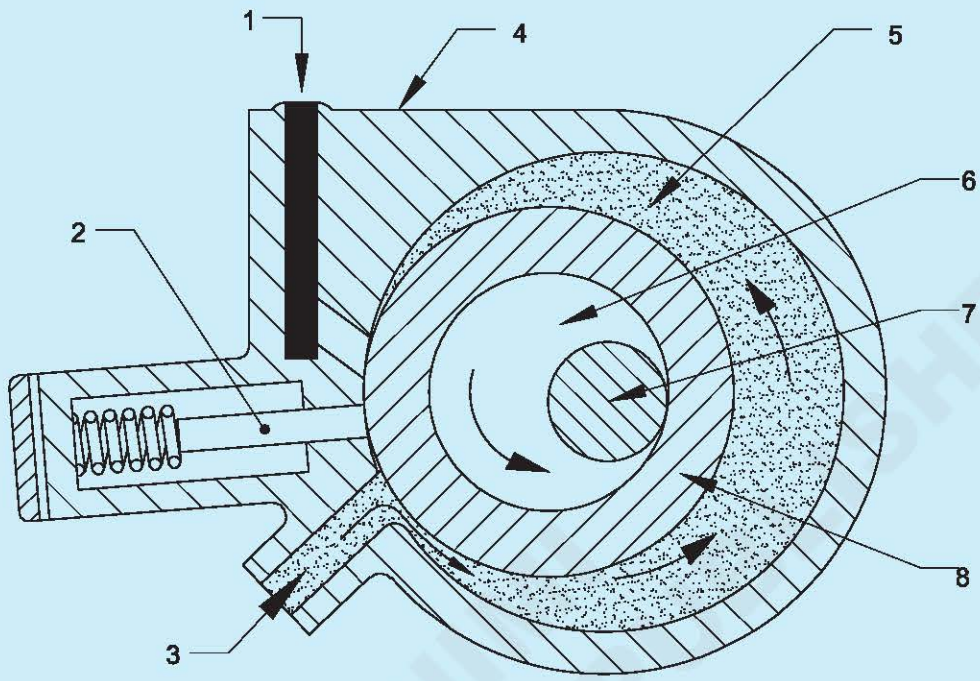
1 Display each components of rotary blade type stationery compressor on the work table.

2 Identify the parts of rotary compressor and enter into tabular column.

3 study the function of rotary compressor.

TASK 2 : **Identify the different parts of rotary compressor parts (stationary blade)**

Fig 2



IDENTIFICATION OF PARTS

MRN2190H1

Part No.	Name of the parts	Function	Part No.	Name of the parts	Function
1			5		
2			6		
3			7		
4			8		

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Identity terminal sequence of hermetic compressor motor by using digital multimeter and measure starting current and running current by using ammeter and Odometer

Objectives: At the end of this exercise you shall be able to
- **identify terminals of measure resistance**
- **start the unit and measure starting and running current.**

Requirements

Tools/Instruments

- Ammeter 0 to 10A - 1 No
- Volt meter - 0 to 250V - 1 No
- Screw driver set - 1 No
- Combination plier - 1 No
- Electrician knife 100mm - 1 No

Equipments

- Single phase induction motor 0.5 HP. 230V/240V - 1 No
- DOL starter 10A, 240V - 1 No

Materials

- 2.5 sq.mm PVC multi stand cable - 5m
- 1C DP Switch 240V 16A - 1 No

PROCEDURE

TASK 1: **Identify terminals and measure resistance**

Refer Ex : 1.7.40

TASK 2 : **Measure the current**

1 Plug the unit and "ON" the power
2 Clamp the long tester on phase wire
3 Fun the unit and hole the current
4 Wait for 5 minutes
5 Take another reading and record it
6 Stop the unit and remove the ling tester

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Identity terminal sequence of CSIR motor by using digital multimeter and measure starting current and running current by using ammeter and Odometer

Objectives: At the end of this exercise you shall be able to
- **test and identify the terminals of an A/C single phase, capacitor - start, induction - run motor**
- **start and run the A/C single phase, capacitor - start, induction - run motor and measure current and voltage**

Requirements

Tools/Instruments

- Screwdriver 200 mm - 1 Set.
- Combination pliers 200mm - 1 No.
- Spanner set 6mm to 20mm - 1 Set.
- Flat nose pliers 150mm - 1 No.
- Electrician's knife - 1 No.
- AC voltmeter 0 - 300V - 1 No.
- M.I. ammeter 0 - 10A - 1 No.

Equipment/Machines

- 240V 50 HZ 1HP single phase, capacitor - start, induction - run motor - 1 No.

Materials

- 2.5 sq. mm. PVC multi - strand cable 250v grade - 10 mts.
- 23/0.2 flexible cable - 5 mts.
- Fuse wire 10 amperes - 10 grs.
- I.C.D.P switch 250V 16A - 1 No.

PROCEDURE

TASK : **Test and identify the terminals of an A/C single phase, capacitor - start, induction - run motor**

1 Disconnect the AC single phase, capacitor - start, induction - motor if it is connected to the supply.

2 Identify the pairs of terminals and measure the resistance of each winding. Note the values in Table 1.

Table 1
Resistance value

1	Main winding	(low)
2	Starting winding	(high)

Comparatively the winding which has high resistance is the starting winding, and the other is the running winding.

3 Test the insulation value between the windings and the body and note the value in Table 2.

Table 2
Insulation value

1 Between main winding and starting winding	
2 Between the main winding and body	
3 Between the starting winding and body	

4 Check the condition of the capacitor and the centrifugal switch and enter the details in Table 3.

Table 3

Condition of capacitor	Condition of centrifugal switch

5 Give the connection as per the circuit diagram shown in Fig 1. Earthling the I.C.D.P. switch, and motor is most essential.

6 Provide fuse - wire, according to the rating of the motor, in the I.C.D.P.

7 Switch `ON' the I.C.D.P.

8 Start the motor with the help of the starter and note the starting current, normal running current and the direction of rotation, and enter the details in Table 4.

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Fig 1

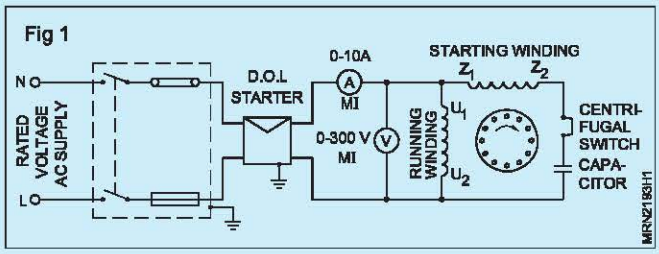


Table 4

Sl.No.	Reference circuit diagram	Starting current	Running current	Direction of rotation
1				
2				
3				

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Start CSR motor and measure starting current and running current

Objectives: At the end of this exercise you shall be able to
- **test and identify the terminals of an A/C single phase, capacitor - start, capacitor - run motor**
- **connect, start and run an A/C single phase, capacitor - start, capacitor - run motor**
- **measure current and voltage.**

Requirements

Tools/Instruments

- Insulated cutting pliers 200mm - 1 No.
- Screwdriver 250 mm - 1 No.
- Electrician's knife - 1 No.
- Megger/insulation tester 500 V - 1 No.
- Ohmmeter - 1 No.

Equipment/Machines

- A/C single phase, capacitor - start, capacitor - run motor 240V, 0.5HP 50 cycles - 1 No.

Materials

- P.V.C insulated stranded copper cable (3/20) 3/0.914 mm - 6 mtr.
- Fused I.C.D.P switch, 250V, 16A - 1 No.

PROCEDURE

TASK 1: **Connect, start and run an A/C single phase, capacitor - start, capacitor - run motor.**

1 Stop the motor if connected to the supply, switch off the I.C.D.P, remove the fuse - carriers and disconnect it from supply.

2 Open the terminal box and identify the terminal markings.

3 Using a Megger/insulation tester, find out the continuity between the winding terminals.

4 Measure the resistance between the terminals of the same winding with the help of an ohmmeter, and identify the starting and running windings. Enter the value of resistance in Table 1.

Table 1

Sl.No.	Terminal pairs	Resistance	Remarks
1	Running/Starting		
2	Running/Starting		

5 Measure the insulation resistance between the starting and running windings and also between the winding and body with the help of a Megger, and enter the values in Table 2.

6 Select suitable sizes of switch, starter, cables, fuse etc. according to the motor rating.

7 Identify the starting and running capacitors and check their condition and enter the data in Table 3. Also compare and analyse the data relating to the starting and running capacitors.

8 Show the readings to your instructor and get his approval.

9 Check the condition of the centrifugal switch, and ensure it is working.

10 Connect the motor to the 230V AC supply through the switch and starter as per the circuit diagram. (Fig 1)

11 Insert a suitable size of fuse in the I.C.D.P. switch, and set the overload relay according to the rating of the motor.

12 Start the motor and observe the direction of rotation and record the D.O.R below.

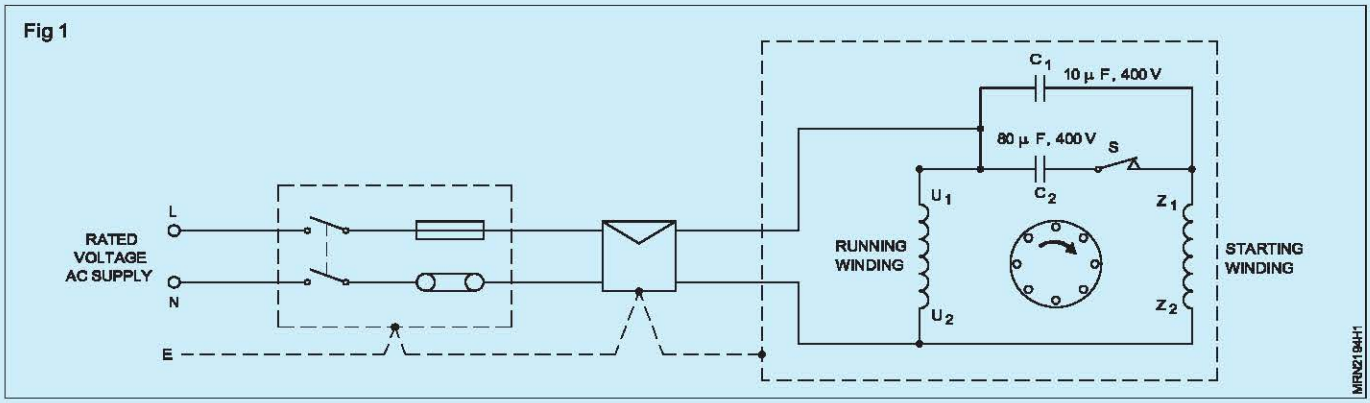
13 Direction of rotation - clockwise/anticlockwise.

Table 2

Sl.No.	Terminals	Insulation resistance	Remarks
1	Body to starting winding		Good/bad
2	Body to running winding		Good/bad
3	Between windings		Good/bad

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Fig 1



TASK 2:

Refer Ex No : 1.8.61 Task 2

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Start shaded pole motor and measure starting current

Objectives : At the end of this exercise you shall be able to
- **read and interpret the name-plate details of a shaded pole motor**
- **identify the parts of the shaded pole motor**
- **connect the shaded pole motor to the supply line and start the motor**

Requirements

Tools/Instruments

- Hand tool kit - 1 Set.
- DE spanner set 6 mm to 20 mm - 1 Set.
- Test lamp - 1 No.
- Megger 500 V - 1 No.
- Ohmmeter/Multimeter - 1 No.
- Tachometer 150 to 3000 rpm. - 1 No.

Equipment/Machines

- Shaded pole motor 1/8 HP, AC 240 V 50 Hz - 1 No.
- Special type shaded pole motor with double set of shaded winding 1/2 HP 240 V - 1 No.

Materials

- 2.5 sq. mm. PVC copper multi-strand cable 660 V grade - 6 Mts.
- Bare copper wire 14 SWG - 4 Mts.
- ICDP switch 250 V, 16 A - 1 No.
- SPDT switch 250 V 16 A - 1 No.

PROCEDURE

TASK 1:- **Interpret the name plate details of shaded pole motor.**

1 Read and interpret the name-plate details of the given shaded pole motor and enter them in your practical note book.

2 Switch off the mains and remove the fuse carriers from the ICDP switch of the given shaded-pole motor.

3 Identify the parts and terminals of the shaded pole motor. Test the winding for continuity and insulation resistance value.

As it has the squirrel cage type rotor, only two terminals of the stator are brought out.

TASK 2: **Identify the parts at shaded pole motor.**

1 keep the shaded pole motor on the work table.

2 Identify the parts of shaded pole motor.

TASK 3: **Connect, start and run the shaded pole motor**

1 Select and arrange proper rating of ICDP switch, cables, fuse wire and DOL starter according to the rating of the given shaded pole motor.

2 Connect the motor as per circuit diagram given in Fig 1.

3 Provide suitable earth connection to the ICDP switch, and motor.

4 Provide fuses of suitable rating according to the motor rating in the ICDP switch and also set the starter overload relay to the motor rating.

5 Starts the motor observe the direction of rotation and record it in Table 1.

6 Measure the speed by a tachometer and record in Table 1.

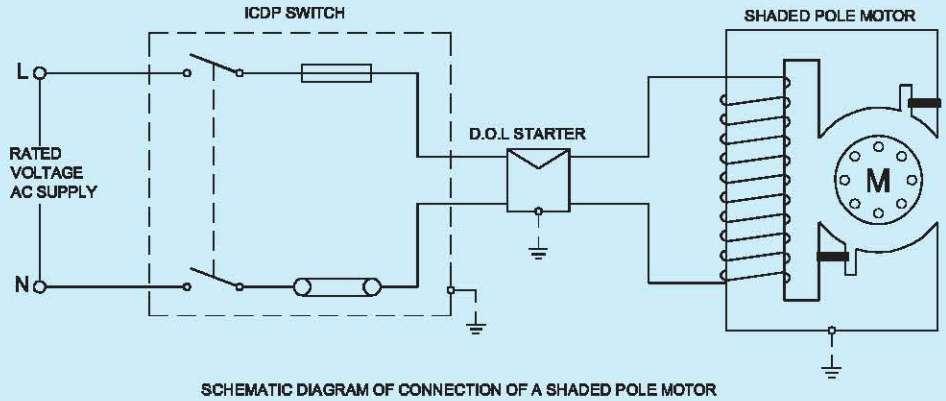
8 Stop the motor by switch 'off' the ICDP and remove the fuse.

Table 1

Sl. No.	DOR	Speed in rpm.	Position of SPDT Switch
TASK 2			
TASK 3			

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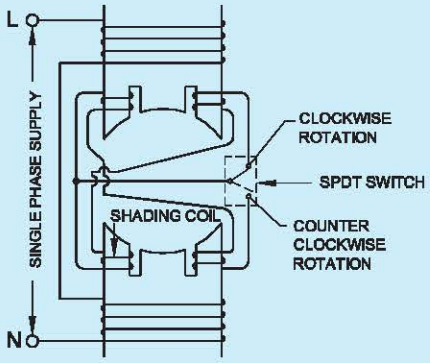
Fig 1



SCHEMATIC DIAGRAM OF CONNECTION OF A SHADED POLE MOTOR

MRN2195H1

Fig 2



DOUBLE SET OF SHADING-COILS METHOD

MRN2195H2

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Test open, short, continuity and earth of a hermatric compressor

Objectives : At the end of this exercise you shall be able to
- **test open, short, continuity using multimeter**
- **test open, short, continuity using test lamp**
- **test earth, circuit using multimeter.**

Requirements

Tools/Instruments

- Multimeter - 1 No.
- Insulator plier - 1 No.
- Line tester - 1 No.
- Test lamp 200w - 1 No.

Equipments

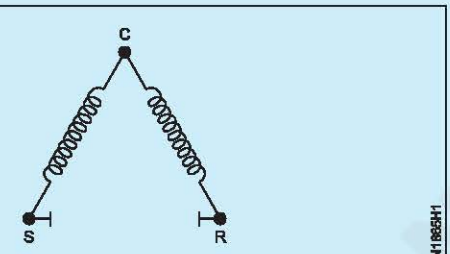
- Hermetic compressor - 1 No.

Materials/components

- Soap and brush - 1 No.
- Clean cloth - 1 No.
- Test board - 1 No.

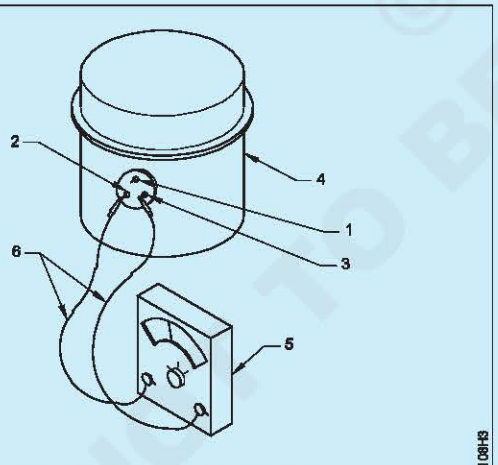
TASK 1: **Test open, short, continuity using multimeter.**

Fig 1



COMPRESSOR WINDING TERMINALS

Fig 2



CHECKING COMPRESSOR WINDING

1 Remove the terminal cover from the compressor terminal box

2 Remove the wire clips from the terminal

3 Use multimeter and set knob to resistance

4 Two leads from the multimeter touch it in the 'C' other lead to be touched into 'R'.

5 Take a meter lead from 'R' and touch into 'S'

6 Remove the meter lead from the 'C' and touch it in the 'R' and take reading in meter.

7 Like that resistance and continuity of the winding can be checked.

8 Check continuity, if continuity (there is resistive continuity) the compressor is food.

TASK 2**: Test open, short, continuity using test lamp.**

1 Remove the unit from the outer cover.

2 Remove the terminal cover from the compressor terminal.

3 Remove the wire clips from the compressor and lable it.

4 Take a test lamp with 200 watts bulb.

5 Plug the test lamp in test board.

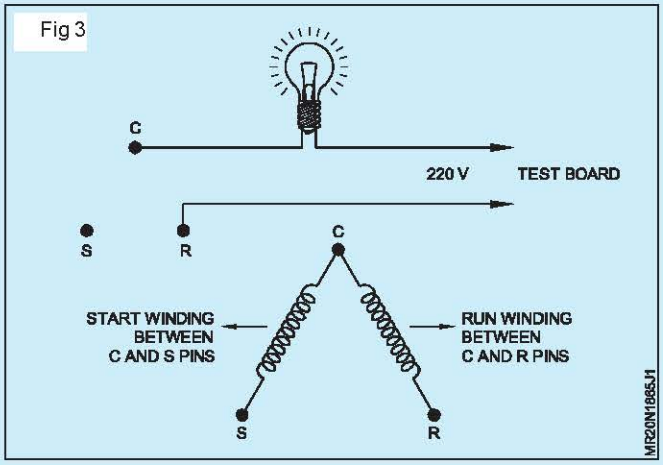
6 Switch ON the test lamp and touch the wire with 'c' and other wire with 'R' (centre and right pin). The bulb will be glowing bright. The running winding continuity is good.

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7 Then remove the wire from (R right side pin) and touch into S (left side pin) terminal. Bulb glow is dull. The starting winding continuity is good.

8 Remove the wire from 'C' (centre) and touch into 'R' terminal (right) the bulb will glow very dull. So that running and starting winding good.

Fig 3



TASK 3**: Test earth circuit using multimeter**

1 Select ohmmeter scale(R x 10000) as given for.

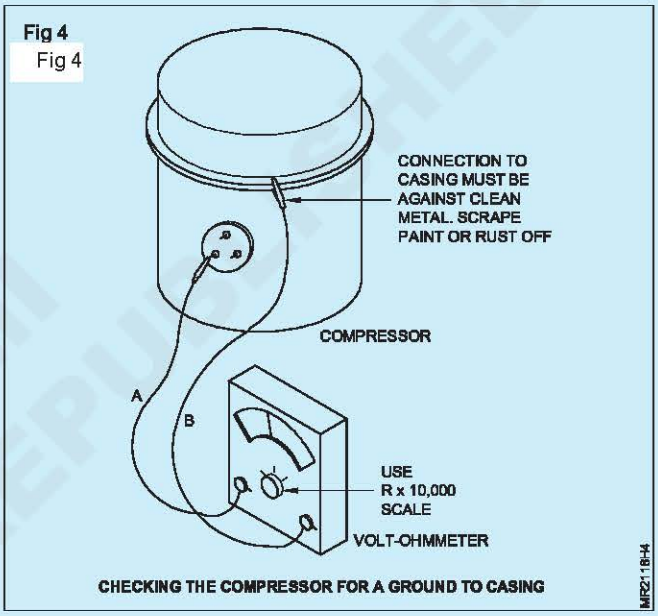
2 Place 'A' probe to compressor terminal.

3 Place 'B' probe to metal casing (must be against clean metal).

4 Check continuity. If continuity is (there is no resistive continuity) there compressor grounded.

5 If insulation resistance is zero in between the terminal "A" and body "B" the compressor is grounded .

Fig 4



CHECKING THE COMPRESSOR FOR A GROUND TO CASING

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Start the compressor motor by RSIR, CSIR, PSC and CSR method by using different type relay, capacitors OLP'S etc,

Objectives: At the end of this exercise you shall be able to
- **start compressor by RSIR method**
- **start compressor by CSIR method**
- **start compressor by PSC method**
- **start compressor by CSR method.**

Requirements

Tool/Instruments

- Trainees kit - 1 No
- Line tester - 1 No
- Test lamp - 1 No
- Test board - 1 No
- 3/20 wires each colour - 1 No
- Multi meter/Ohmmeter - 1 No
- Capacitor test circuit with protective case

Equipments

- RSIR,CSIR,PSC & CSR circuit refrigeration unit - 1 No

Materials

- Insulation tape - 1 No
- 3/20 wires each colour - 1 No

PROCEDURE

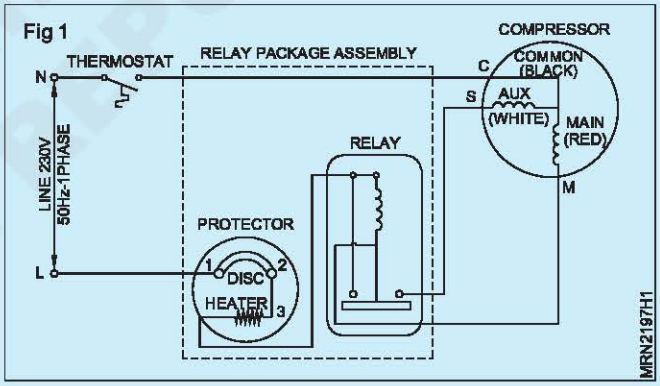
TASK 1: **Start compressor by RSIR method**

1 Connect the parts are per circuit diagram.

2 Check wiring connection

3 Start the compressor and check starting & running current.

Fig 1

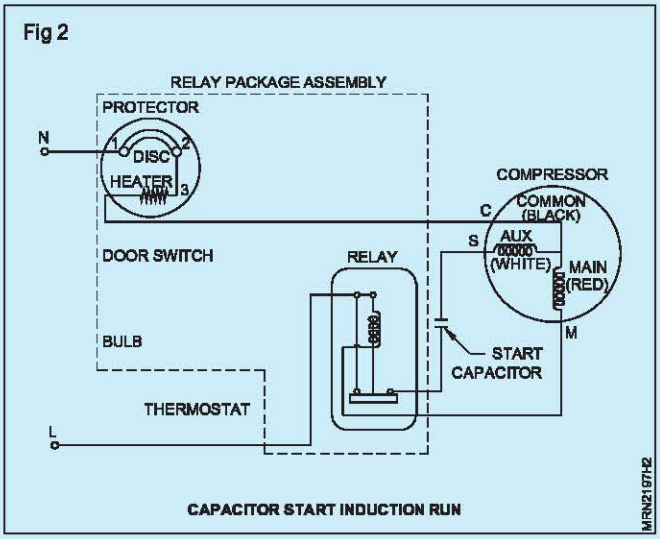


TASK 2: **Start compressor by CSIR method**

1 Check wiring connection

2 Start the compressor and check starting & running current.

Fig 2



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TASK 3: **Start compressor by PSC method**

- Connect the parts as per circuit diagram.
- Check wiring connection.
- Start the compressor and check starting & running current.

Fig 3

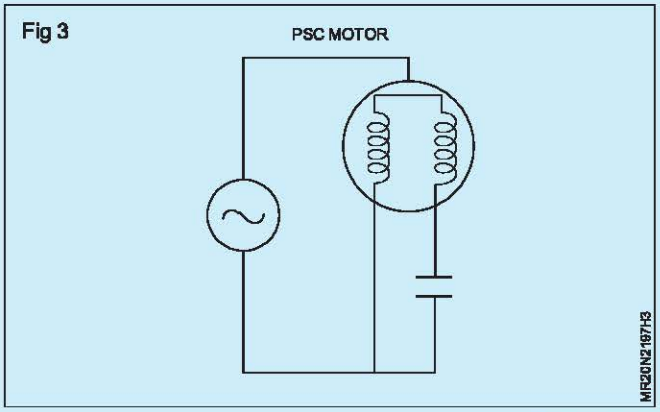
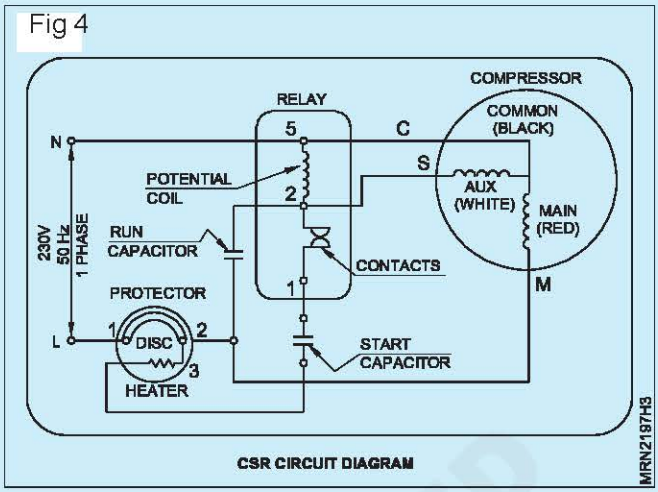


Fig 4



TASK 4: **Start compressor by CSR method**

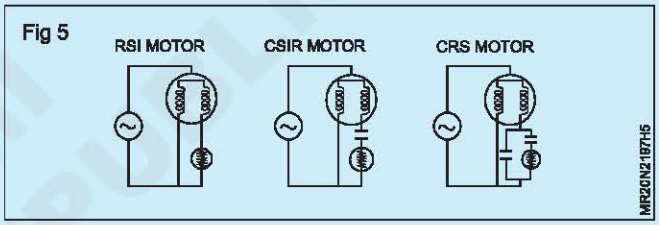
1 Connect the part as per circuit diagram.

2 Check wiring connection.

3 Start the compressor and check starting & running current.

Note: Following circuit shows different wiring circuit of hermetic and compressor motor.

Fig 5



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Check and test different type, relay, capacitor OLP's find out faults and rectification

Objectives: At the end of this unit you shall be able to
- **check and test capacitor by physical check method**
- **check and test capacitor by spark test method**
- **check and test capacitor with ohmmeter**
- **check and test overload protector**
- **check and test relay**

Requirement

Tool/Instruments

- Screw driver 10 mm tip 200 mm length - 1 No.
- Cutting plier 200 mm length (Insulated handle)
- Phillips screw driver set - 1 No.
- Ohmmeter Analogue type - 1 No.

Materials

- Run capacitor 6 mfd - 1 No.
- Current coil relay - 1 No.
- OLP - 1 No.
- 2 m 1 sq.mm lead wire
- 2 m wire with crocodile clip
- Test board fitted with voltmeter & ammeter - 1 No

Equipments

- FHP compressor - 1 No.

PROCEDURE

TASK 1: **Check and test run capacitor - Physical check method.**

1 Check the capacitor physically whether the capacitor is bulged or not.

2 Check the capacitor case for bulged it is sure that the capacitor is short circuited

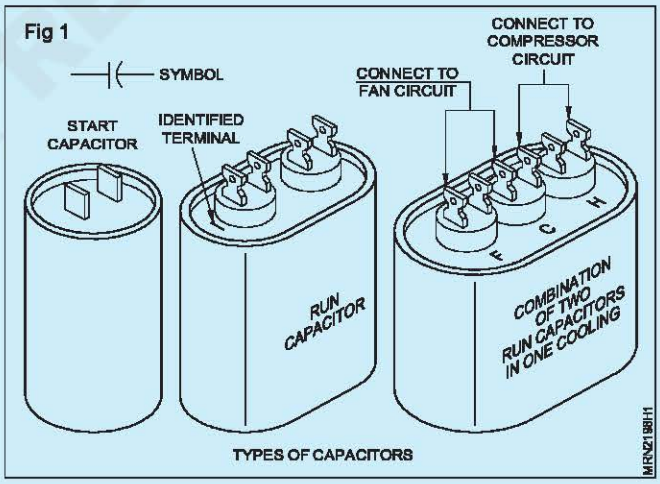
3 Check the capacitor terminal whether it is shaking or not.

4 Check the terminals for shaking it is not advisable to use the capacitor

5 Check any oil leak in the capacitor. Leak in the capacitor not advisable to use the capacitors

6 Ref. (Fig 1) for types of capacitor construction.

Fig 1



TASK 2: **Check and Test run capacitor by spark test method**

1 Prepare the test board as per the (Fig 2).

2 Connect A probe in capacitor one terminal.

3 Connect 'B' probe in capacitor another terminal.

4 Connect the cord wire to the power source.

5 Switch ON the test board for few seconds and switch OFF.

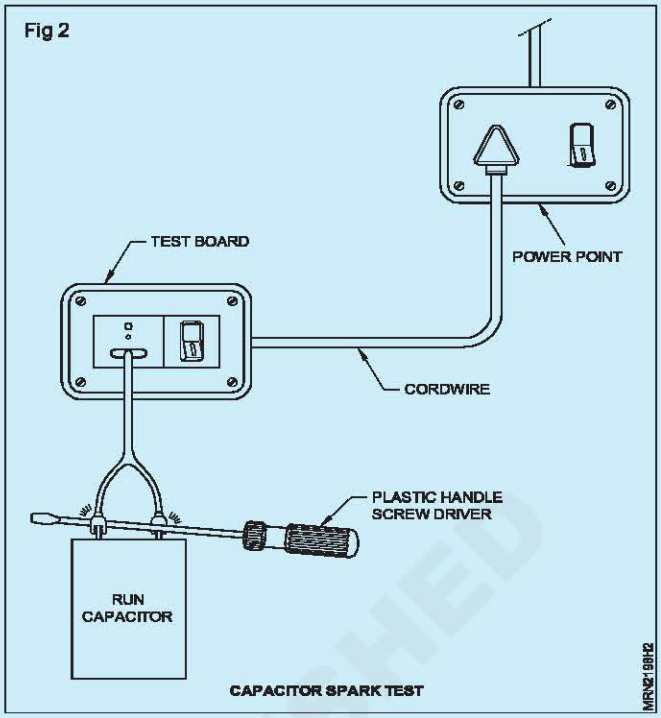
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6 Hold the plastic handle to the screw driver at short the terminals of capacitor.

7 Occurring satisfactory capacitor an intense spark.

8 Occurring indicate a weak spark indicate a defective capacitor

Fig 2



CAPACITOR SPARK TEST

TASK 3: **Check and test capacitor with Ohmmeter**

1 Touch the capacitor leads or terminals momentarily with the test cord of an ohmmeter

2 Watch a slight instantaneous deflection of the ohmmeter pointer will indicate a satisfactory capacitor.

3 See the pointer of the ohmmeter, it indicates a continuous low resistance it means the capacitor is short. In that case the pointer will move to the 'O' end of the scale after certain time.

4 If the capacitor is open there will not be any movement of the ohmmeter pointer

5 Touch the ohmmeter leads to the capacitor terminal and note the deflection of pointer in the ohmmeter. Change the leads and touch it again. The deflection of the pointer will be approximately twice that of the first check if the capacitor is satisfactory.

TASK 4: **Check OLP by using test lamp protector**

1 Take an overload protector.

2 Take a test lamp plug it in test board and switch ON.

3 Touch one lead to OLP no. 1 and other to 2nd and 3rd terminals.

4 If the bulb glows, the OLP is good.

Use multimeter and check OLP

– Take multimeter and set knob to resistance.

– Touch one probe to OLP terminal 1 and other probe to 2 watch meter indication and take the probe from 2 and touch it in 3 watch meter indication.

Multimeter shows continuity, the OLP is good.

TASK 5: **Check and test a relay.**

1 Disconnect the relay from the unit.

2 Remove the wires from relay.

3 Set multimeter knob to resistance.

4 Connect one probe to relay contact 1 and other to S.

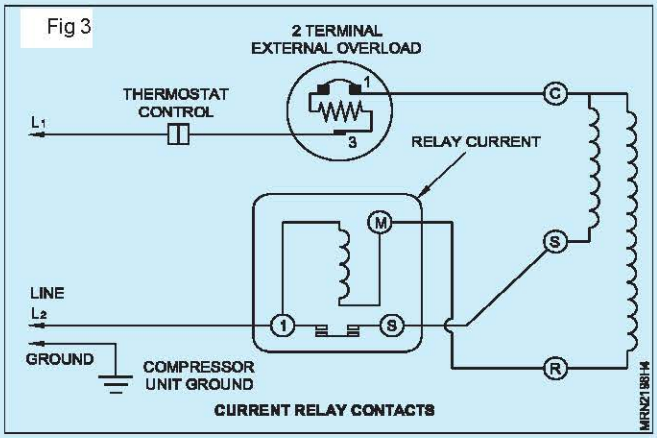
5 Check continuity between them it this continuity the contacts have stuck or been welded together. (Fig 4)

6 Replace the relay.

7 Test the continuity of the current relay coil between I and M.

8 Replace the relay. If there is no continuity means, the coil is open circuit.

Fig 3



CURRENT RELAY CONTACTS

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TASK 6: **Testing current coil relay**

1 Check continuity between the 1 & 2 with help of ohmmeter. (Fig 5)

2 If the continuity is OK between 1 and 2. Coil continuity of current coil relay is OK. Normal condition 1 & 2 continuing will be there.

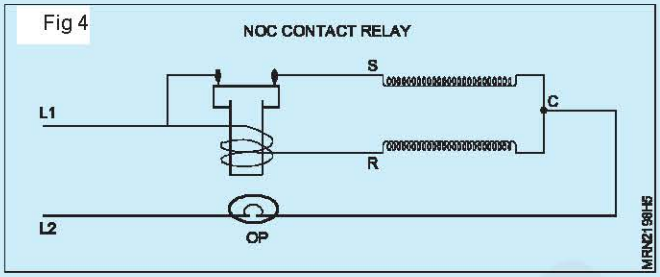
3 Check continuity between 2 & 3. Normal condition (when not in use) 2 & 3 open. If there is no continuity between 2 & 3 relay is OK.

4 Keep the relay upside down. Check continuity between 2 & 3. 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 4



TASK 7: **Testing voltage relay by series test lamp**

1 Voltage or Potential type relay have NCC (Normally closed contacts)

2 Normally closed contact points (NCC) in between 1 &2 relay (pressure)coil in between 2&5

3 Fig 1 / point 1 & 2 normally closed contacts point

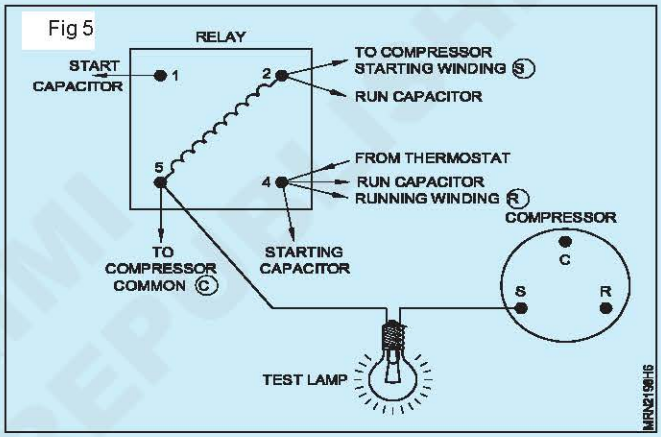
4 Check by normally series lamp respond lighting

5 Point : 1 & 5 make & break contact points sound like calling bell, it tested by series lamp

6 2&5 potentials or pressure coil if connect series lamp only one tick sound come for energised & break the contact point.

7 If the above result come for test so that relay coil & functioning is ok.

Fig 5



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Check control circuit of variable speed air conditioner invertor A/C

Objectives: At the end of this exercise you shall be able to
- **check control circuit of inverter air conditions.**

Requirements

Equipment/Machines

- Inverter A/C 1.5 ton - 1 No
- Philips screw diver set

PROCEDURE

TASK : **Check control circuit of inverter A/C**

- Put the inverter A/C in work table
- Remove the outer cover of the outdoor unit.
- Explain the parts and function
- Remove the cover of the indoor unit
- Explain the control circuit as per diagram (inverter A/C manual required as per model)
- Differ the control circuit in different company inverter A/C.

Fig 1

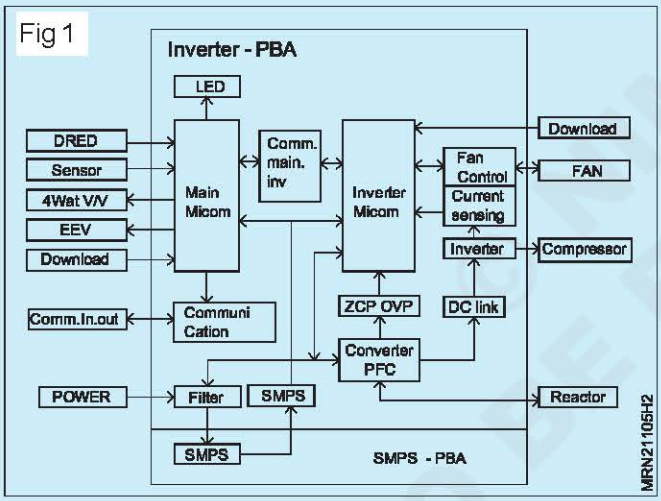
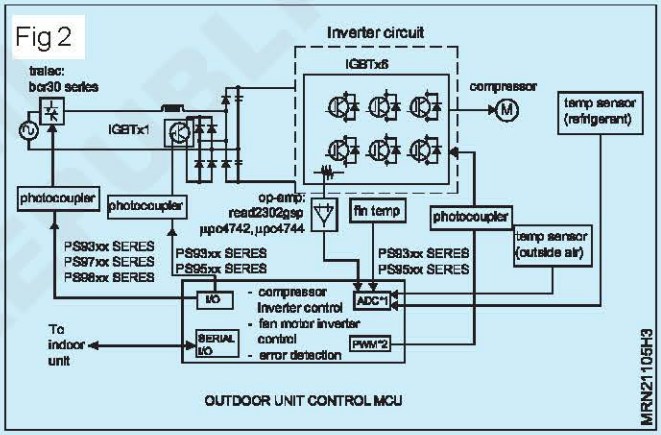
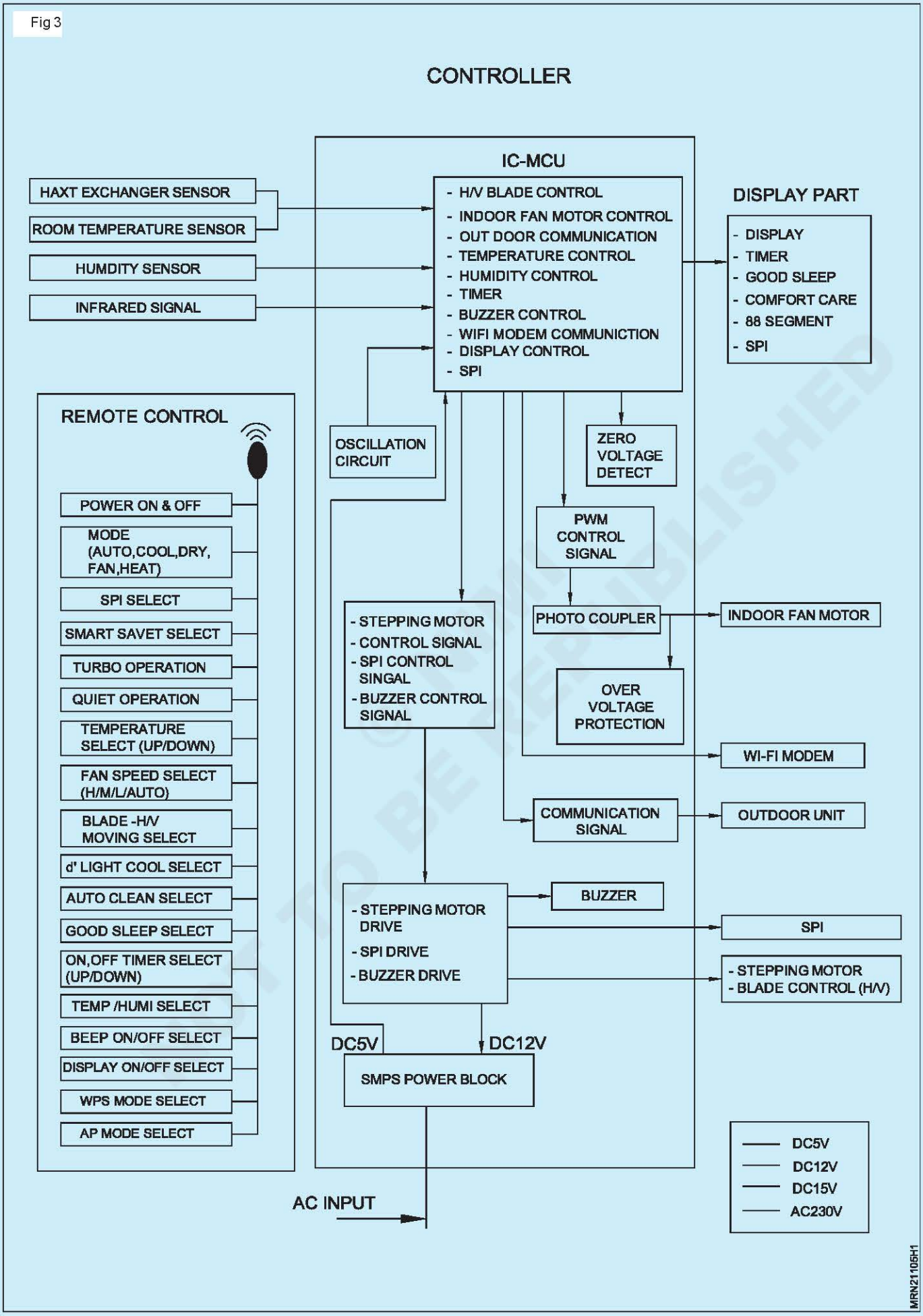


Fig 2



NOT TO BE REPUBLISHED

Fig 3



© NOT TO BE REPUBLISHED

Identify components of control system of inverter - ACS - PCB, NTC, PTC

Objectives: At the end of this exercise you shall be able to
- **identify a PCB**
- **identify NTC and PTC**

Requirements

Tools/Instruments

- Combination Pliers 200mm - 1No.
- Screw driver 150mm - 1No.
- Connector screw driver 100mm - 1No.
- Election knife - 1No.
- Round nose pliers 150mm - 1No.
- Multimeter - 1No.
- Digital Thermometer - 1No.
- Soldering Trim with flux - 1No.

Materials

- PVC flexible cable as per required.
- Insulation Tape -1 No.
- Soft solder - As reqd.

Equipment/Machines

- Inverter A/C 1.5 Ton -1 No.

PROCEDURE:

TASK 1: **Identify a PCB**

1 Collect the PCB along with the instruction booklet

2 Deter mine by inspection the terminal connection of the PCB

3 Measure the capacitor valve and record it.

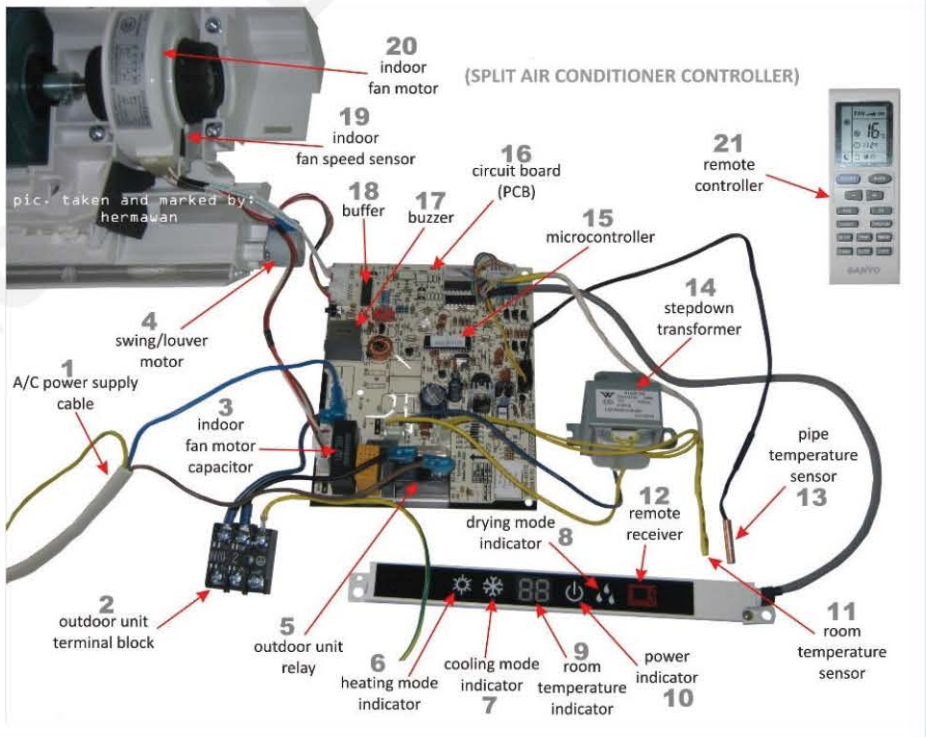
4 Identify the various parts in PCB and record in Table 1 and Table 2

Table 1

Data of the PCB

Type of PCB	
Out door unit relay	
Step down transformer	
Indoor fan motor capacitor	
Pipe temperature Sensor	

Fig 1



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Table 2

Part No.	Name of the part
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Part No.	Name of the part
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	

TASK 2: **Identify NTC and PTC**

1 Collect the NTC and PTC of inverter ACS

2 Determine and inspect the NTC x PTC

3 NTC [Negative Temp Coefficient type) used as resistive temperature Sensors and current - limiting devices. e.g:

(i) Room thermistor has 10 kilo ohms at 25° C

(ii) at room temp is 30°C the valve will be. Check the temp of NTC, if around 8k. ohms.

4 Temp increases then ohm valve decrease in NTCS. Check the PTC, valve, NTCS.

5 If PTC [positive Temp. Co efficient]. Resistance valves increases as the temp is increased.

6 Check the thermistor if the valves are 0 ohm (or) infinity Replace the thermistor.

Fig 3

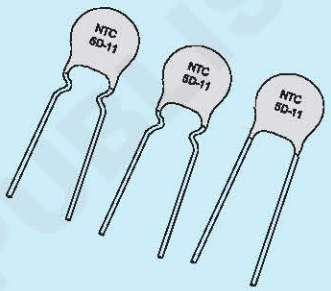


Fig 4

Teamperature ambien (°C)	valor resistivo sonda (Ω)
40	1439
35	1765
30	2176
25	2700
20	3371
15	4237
10	5362



Características dos sensores NTC & PTC

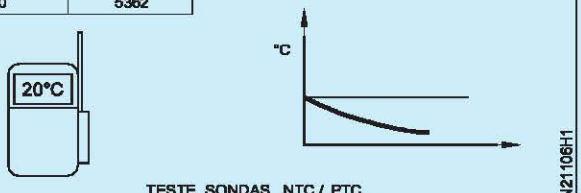
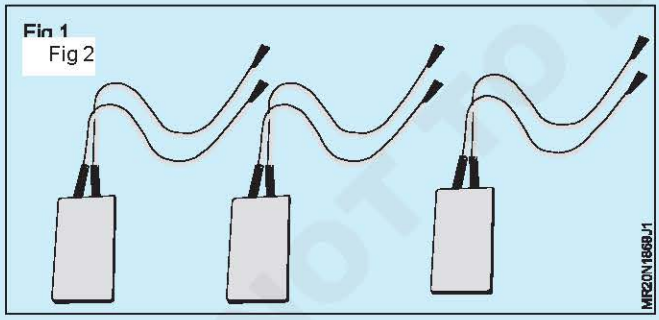


Fig 1
Fig 2



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Familiarise with different type of condensers used in refrigerators, bottle coolers, visible coolers, deep freezers, window and split A/C

Objective: At the end of this exercise you shall be able to
- **identify different types of condenser and their uses.**

Requirements

Tools and Instruments

- Trainees took kit - 1 set.
- Oil can - 1 No.
- Condenser of refrigerator - 1 No.
- Condenser of bottle cooler - 1 No.
- Condenser of visible cooler - 1 No.
- Condenser of deep freezer - 1 No.
- Condenser of window AC and split AC - 1 No.

Machines

- Cotton cloth - as reqd.
- Oil - 250gm.

PROCEDURE

TASK 1: **Identify different type of condensers.**

- Identify condenser from section and place on work table.
- Inspect visually.
- Record in Table.

Fig 1

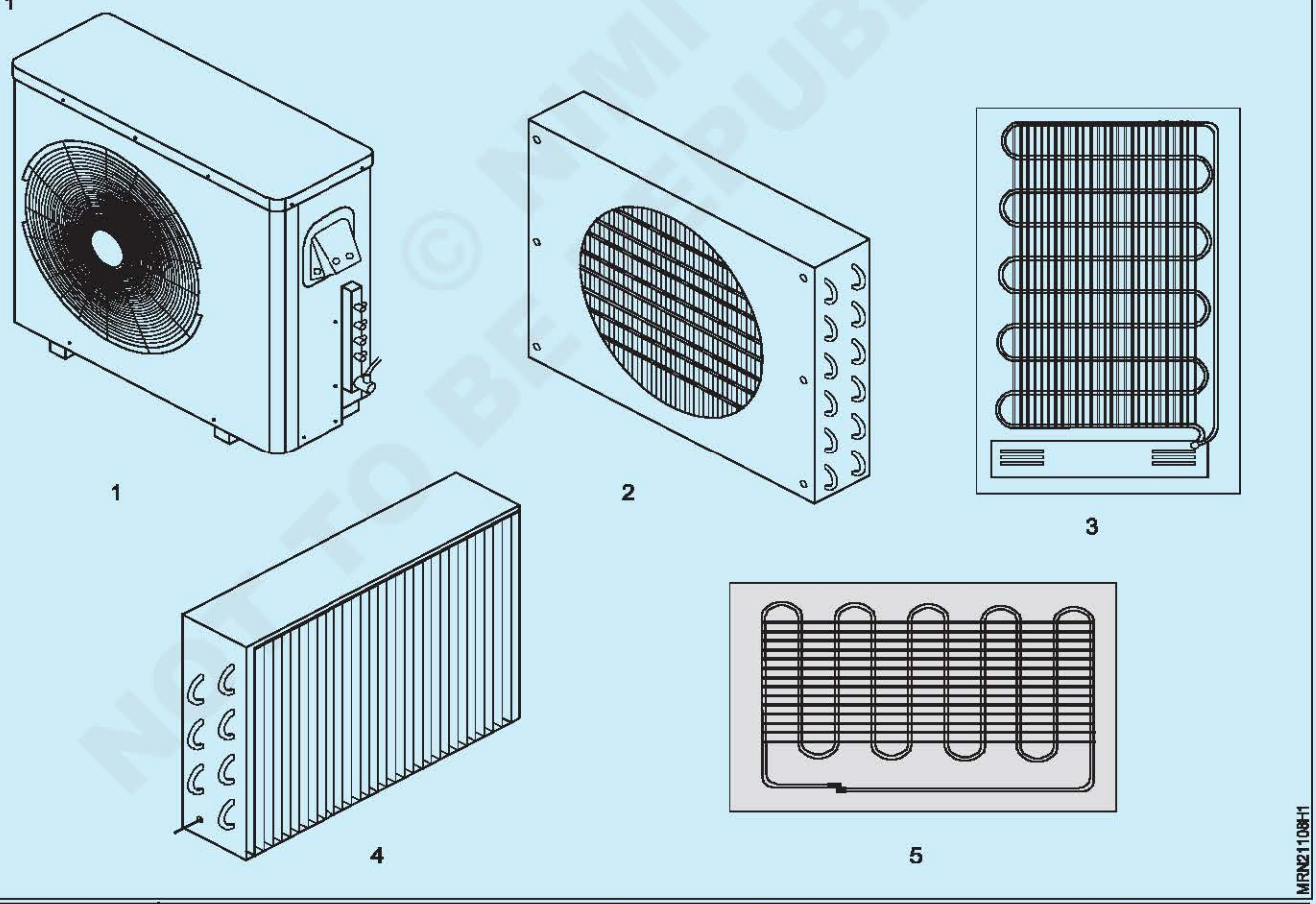


Fig No.	Types of condenser	Application	Material
1			
2			
3			
4			
5			

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Clean, flush, service and leak test in different types of Air cooled condenser

Objectives: At the end of this exercise you shall be able to
- **service and clean wire mesh type condenser**
- **service and clean plate type air cooled condenser**
- **straightening fins**
- **flush and clean air cooled condenser**
- **leak test in condenser.**

Requirements

Tools / Instruments / equipments

- Screw driver 6 mm tip 100 mm length - 1 No.
- Screw driver 6 mm tip length 150 mm - 1 No.
- Wrench adjustable 150 mm length - 1 No.
- Nitrogen cylinder with double stage
- pressure regulator - 1 Set
- Tube cutter - 1 No.
- Flaring tool - 1 No.
- Compound gauge - 1 No.

Equipment

- Domestic fridge with
- Wire mesh type condenser - 1 No.
- Domestic fridge with
- Plate type condenser (back cleaned) - 1 No.
- Fins type air cooled condenser [window AC]
- Air blower
- Water tank [required size] - 1 No.
- Vacuum pump [two stage]

Materials/components

- Oxy - acetylene with brazing torch - 1 No.
- Goggles - 1 No.
- Spark lighter - 1 No.
- Fin comb (required size) - 1 No.
- Flexible charging hose - 1 No.
- Brazing copper rod and flux - 1 No.
- Painting brush - 1 No.
- Enamel paint (black 50 ml) - 1 No.
- Liquid soap solution 50 ml - 1 No.
- Bucket with clean water
- Wooden supporting block - 1 No.
- 6 mm dummy nut - 1 No.
- 6 mm copper tube - 300mm
- Clean cloth - as read
- Relief valve 300 psig - set - 1 No.

PROCEDURE

TASK 1: **Service and clean wire mesh type condenser.**

1 Off the refrigerator main switch and remove the plug

2 Push the refrigerator gently and turn the back side (along with the stand) facing you

3 Take the cloth and wipe the fins of the condenser

4 With the painting brush, brush each line of the fins thoroughly. (Fig 1)

5 Again wipe the back side of the fridge body and the fins of the condenser with clean cloth

6 If the compressor is visible wipe it as far as you can reach with the cloth

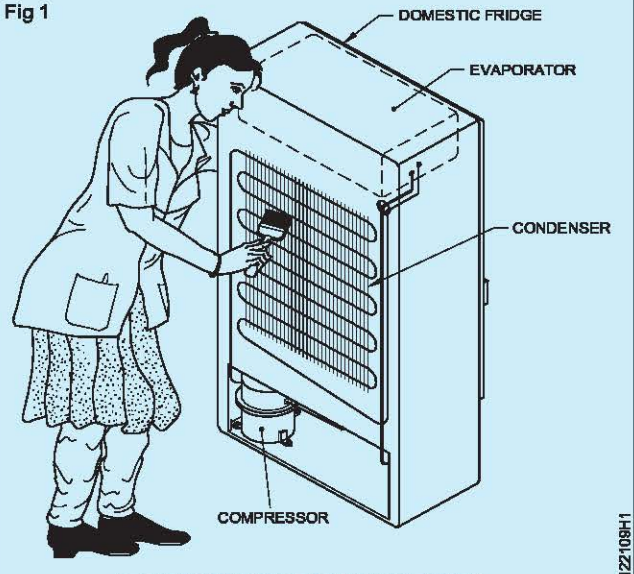
7 Turn the fridge backside facing the wall and wipe the total body of the fridge with clean cloth.

8 Straightening the dented wire .

9 Flush & clean the condenser by dry nitrogen.

10 Re-brazed the condenser & pressure test for leak.

Fig 1



AIR-COOLED CONDENSER CLEANING AT FRIDGE.

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TASK 2: **Service and clean the plate type condenser (Fig 2)**

1 Off the refrigerators main switch and remove the plug from the socket.

2 Pull the fridge towards you and make around 50 cm gap between the wall and the fridge.

3 Remove four corners screws of the plate type condenser and carefully slant the plate on the wall without stretching the gas tubes.

4 Keep a wooden block at the bottom of the plate for support.

5 Mix the soap solution in the water and make it weak solution.

6 Dip the cloth in the soap water after squeezing it wipe the inner side of the condenser plate where the coils are fixed and wipe the back side of the fridge.

7 Wipe it with dry cloth and fix the corner screws tighten the condenser plate.

8 Again with the wet cloth wipe and clean the outer side of the plate thoroughly, wipe it with the dry cloth and let it dry.

9 Wipe the compressor body as fast as you can reach, should not touch the terminals

10 Touch up the plate with black paint and leave it to dry.

Fig 2

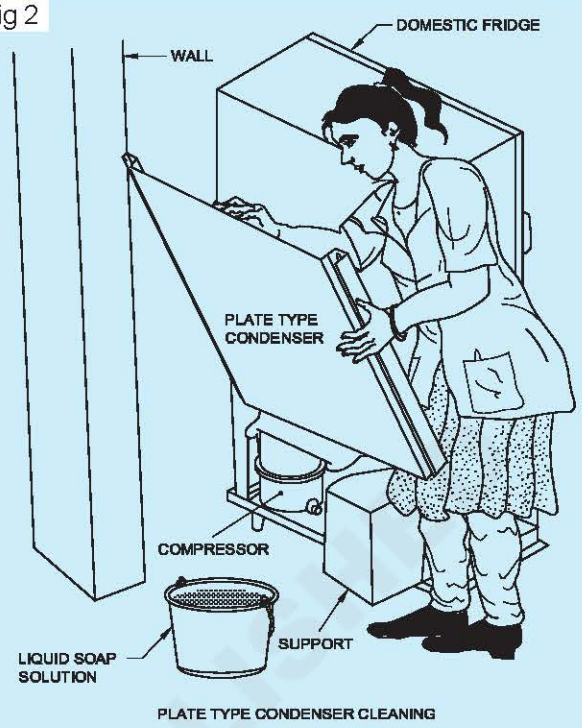


PLATE TYPE CONDENSER CLEANING

11 Back cleaned leaky/condenser choked may be replaced by wire mesh condenser & fit it backside.

TASK 3: **Service fin and tube condenser**

1 Check the evaporator grill and room temperature and record it

2 Stop the unit and remove the plug from the socket

3 Pull the unit from the outer shell and keep it on the work bench.

4 Take the cloth and wipe the outer of the entire unit.

5 Strip of the covering plate on top of the condenser by removing the screws.

6 Loosen the allen screw on the fan motor shaft and release the fan blade.

7 Unscrew the condensers shroud screws and lift it with fan blade and keep it by the work table.

8 Put on mouth mask (cloth) and wear goggles.

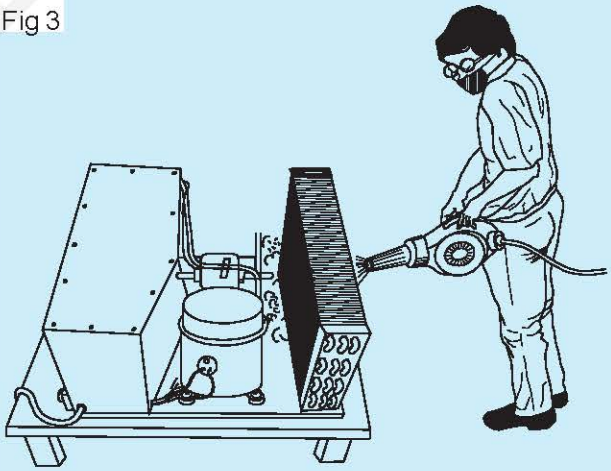
9 Connect the air blowers plug to socket and start it. Carry carefully and point it towards facing the condenser fins.

10 Move it near the fins left to right and top to down till all the dusts clear from the fins. (Fig 3)

11 Change the blower's position on the other side of the condenser and do the same process till the exhaust air through condenser fins comes dust free.

12 Stop the air blower remove the plug and keep it

Fig 3



CLEANING THE FINS BY AIR-BLOWER

13 Check in between the fins any foreign materials got in struck, try and remove it with the help of tension wire or hacksaw blade.

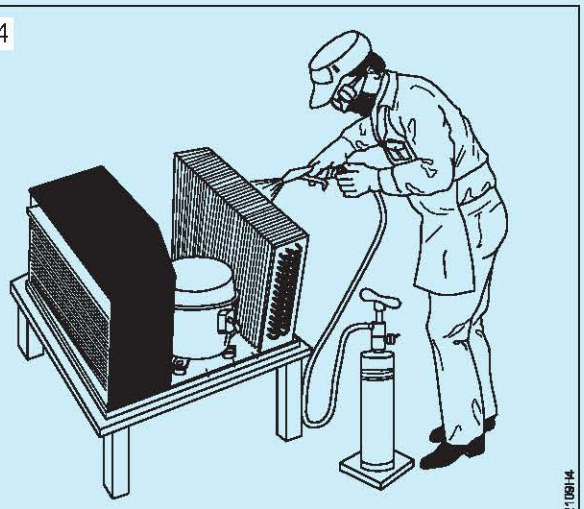
14 Wipe the dust in between spaces on the base and the condenser fins outer with clean cloth, compressor, fan motor, on top of evaporator etc.

15 Flush & clean the condenser internals.

16 Rebrazed the condenser & pressure test for leak.

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Fig 4



CLEANING THE FINS BY CHEMICAL SPRAY

MRNZ2109H4

TASK 4: **Correct the bended fins by combing method**

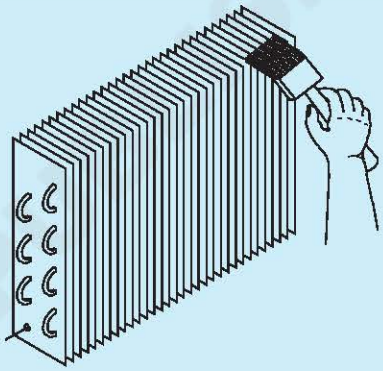
1 Take the fin comb and place it at the left end of the condenser fins

2 From top to down, uniformly run the comb and check the bends in the fins are getting straight.

3 Change the position of the comb to the next remaining fins, alternately and do the same process, till all the fins covered in combing. (Fig 5)

4 If the comb is getting struck is serious jamming of the fins together take the small screw driver or hacksaw blade and split the fins in between and make way for comb to run freely.

Fig 5



COMBING FINS WITH FIN COMB

MRN22109H5

TASK 5: **Flush and clean air cooled condenser.**

1 Stop the unit and remove the plug from the socket.

2 Place the unit on the work bench.

3 Take the cloth and wipe the outer of the enter unit.

4 Recover are the refrigerant from the system.

5 Cut the condenser from discharge line using tube cutter.

6 Cut the other end of condenser line using tube cutter.

7 Separate the condenser from the system.

8 Fix the hand shut off valve in one end using flare and brazing the tube.

9 Now connect the hand shut off with flexible hose.

10 One end is fix with nitrogen cylinder fill up oxygen free dry nitrogen (OFDN) with two stage regulator up to 300 PSI.

11 Now open the cylinder valve, one end of condenser tube is free nitrogen air is flush out.

12 All the contamination of the inner tube is flush and clear it.

13 Close the dummy nut or cap on both side of the condenser.

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TASK 6: **Pressure test for leak (water immersion method)**

1 Remove the cap on both side of the condenser.

2 Close out let of condenser with dummy nut.

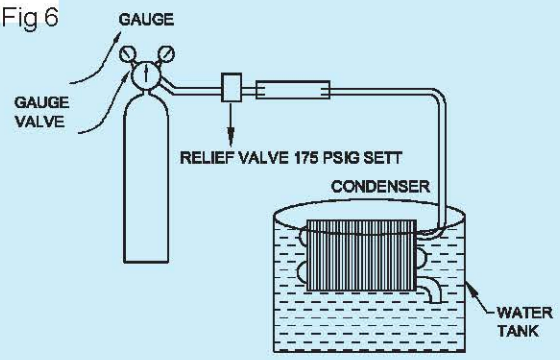
3 Fit with nitrogen cylinder fill up oxygen free dry nitrogen (OFDN) with two stage regulator up to 300 PSI. (Fig 6)

[Two stage regulator must use neither accident may occur nitrogen pressure is 3500 to 4000 PSI. If not controlled more than tolerating power of condenser, nitrogen will enter and it will burst].

4 Now complete condensing unit immerse in water and looking for bubble.

5 If bubbles appear repair or replace it.

Fig 6



TASK 7: **Vacuum test by evacuating the condenser**

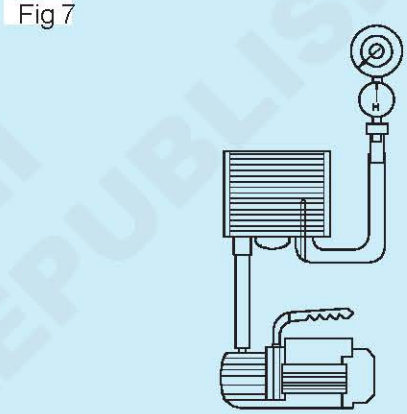
1 Connect condenser with vacuum pump another end fit with compound gauge (Fig 7)

2 Start evacuation close vacuum pump valve and leave it for 2 hrs.

3 If needle of vacuum gauge rise towards the atmospheric side leakage is there repair or replace it.

Note: Same procedure as followed clear, flush, service and leak test by different air cooled condenser.

Fig 7



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Identify different items necessary for de-scaling condenser

Objective: At the ends of this exercise you shall be able to
- **identify de-scaling unit.**

Requirements

Tools/Equipments

• Trainees tool kit	- 1 Set
• Descaling unit	- 1 Set

Materials

• Brass tube cleaning brushes	- 1 No
• Rubber houses & clamps	- 1 Set
• Hydrochloric acid	- as reqd

PROCEDURE

TASK 1: **Identify de-scaling unit**

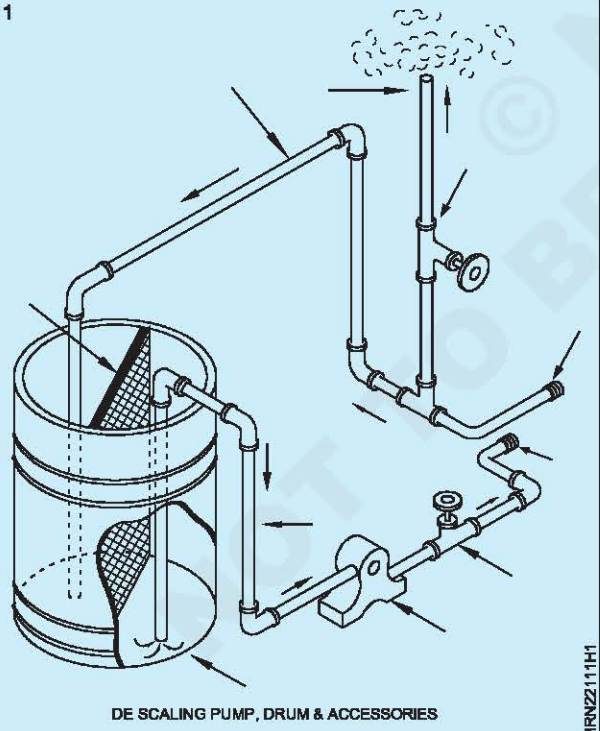
1 Identify acid resistance centrifugal pump barrel.

2 Connect 200 lts nylon barrel with valve at bottom.

3 Connect rubber hose between pump suction and valve of barell bottom using clamps.

4 Connect rubber hose between pump delivery and condenser water inlet.

Fig 1



DE SCALING PUMP, DRUM & ACCESSORIES

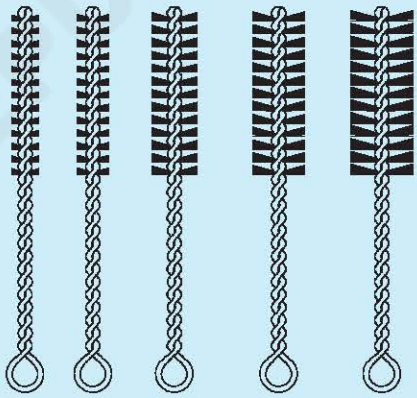
MRN22111H1

5 Connect rubber hose between condenser water out let and nylon barrel top.

6 Prepare nylon or brass tube cleaning brushes according to the length of condenser with "T" handle.

7 Make electric connection to pump motor.

Fig 2



MRN22111H2

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Identify drier and capillary tube used in different cooling machines

Objectives: At the end of this exercise you shall be able to
- **identify drier in different cooling machines**
- **identity capillary tube in different cooling machines.**

Requirements

Tools

- Trainees tools kit - 1 Set

Equipments

- Refrigerator - 1 No Each
- (Direct cool, Frost free)
- Bottle cooler - 1 No
- Water cooler - 1 No
- Window AC 1.5 Ton - 1 No.
- Split AC 1.5 Ton - 1 No.

Materials

- Cotton cloth - as reqd
- Oil - as reqd
- Gloves - 1 Set.

PROCEDURE

TASK 1: **Identify drier in different cooling machines**

- Identify the location of drier
- Check the type of drier

TASK 2: **identity capillary tube in different cooling machines.**

- Identify the location of capillary tube.
- Check specifications of capillary tube.

Sl.No	Name of the equipment	Caliper tube		Drier type
		Dia inch	length in inch	
1	DC Refrigerator			
2	FF Refrigerator			
3	Bottle cooler			
4	Water cooler			
5	Window AC			
6	Split Ac			

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Replace drier and capillary tube at the line of gas charging

Objective: At the end of this exercise you shall be able to
- **check and replace faulty dehydrator and capillary tube.**

Requirements

Tools/Instruments

- Trainees kit - 1 No
- Gauge manifold - 1 No
- Tube cutter - 1 No
- Flaring tool - 1 No

Equipments

- Window AC - 1 No
- Oxy acetylene with brazing torch - 1 set
- Nitrogen cylinder with regulator - 1 No
- Vacuum pump - 1 No

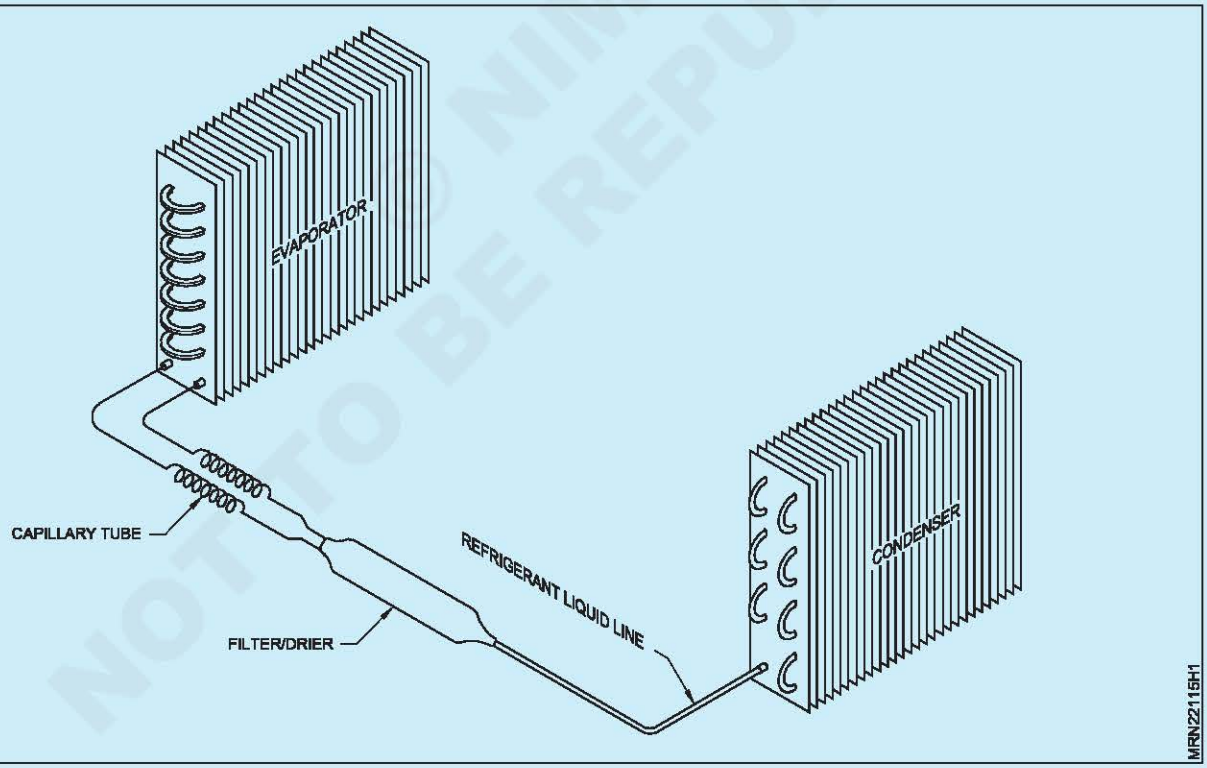
Materials

- Dehydrator (new) - 1 No
- Capillary tube - 1 No
- Cotton waste - as reqd
- Oil - as reqd
- Service cylinder with refrigerant - 1 No
- 6 mm dummy nut - 1 No
- 6 mm copper tube - 50 cm
- Brazing copper rod with flux - 2 Nos
- Goggles - 1 set
- Spark lighter - 1 No

PROCEDURE

TASK 1: **Check and replace faulty dehydrator & capillary (Fig 1)**

Fig 1



1 Start and run the machine for 10 min

2 Observe the cooling effect in the evaporator and grill

3 Check the drier physically and should be warm. If it is found partially cold and sweating in drier, it is sure that the drier is faulty. Stop the machine.

4 Cut off the charging line in compressor for vent refrigerant from the system.

5 Attach a hand shut off valve to the charging line.

6 Connect a gauge manifold set into the system.

7 Remove the drier and capillary by debrazing joints with brazing torch. (Fig 1)

8 Braze the new dehydrator with liquid line and capillary tubes with copper brazing rod. (Fig 2)

9 Pressurize the unit using N_2 gas.

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10 Leak test at brazing joints by soap solution

11 If no leaks are found then vent the nitrogen gas.

12 Close the hand shut off valve.

13 Attach vacuum pump to the manifold and open the hand shut off valve.

14 Start vacuum pump and observe compound gauge which should read 28" to 30" Hg after 45 min.

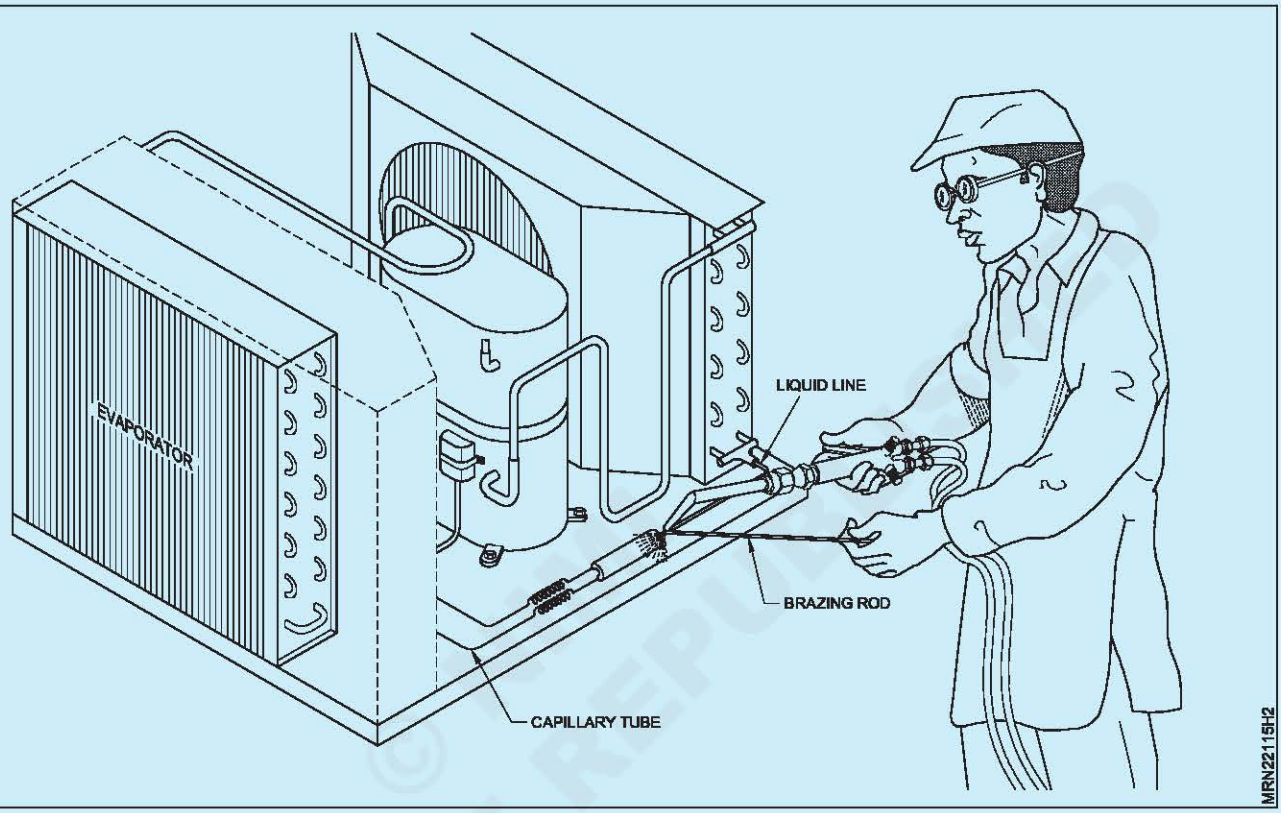
15 Observe the vacuum remains constant.

16 Remove the vacuum pump connections from the gauge manifold and attach the refrigerant , service cylinder and charge gas.

17 Check suction and discharge pressure, pinch off the charging line and remove the hand shut off valve and other connections.

18 Braze the charging port properly.

Fig 2



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Identify and service different types of evaporators

Objectives: At the end of this exercise you shall be able to
- **identify different types of evaporator**
- **shift the window AC to work spot**
- **clean the evaporator with chemical spray**
- **clean and wipe fix the unit in position**
- **check the cooling effect.**

Requirements

Tools/Instruments

- Double ended spanner - 1 No.
- Tube cutter - 1 No.
- Screw driver set - 1 No.
- Cutting plier 8" - 1 No.
- Needle file set - 1 No.
- Line tester - 1 No.
- Test lamp - 1 No.
- Flaring tool - 1 No.

Equipments

- Different type of evaporator - as reqd
- window AC - 1 No.

Materials

- Wire brush - 1 No.
- Medium grade sand paper - 1 No.
- Copper tube as needed - 1 No.
- Cleaning cloth - 1 No.
- Chemical spray (vanikline)
- Soap solution
- Hand rubber gloves
- Goggles

PROCEDURE:

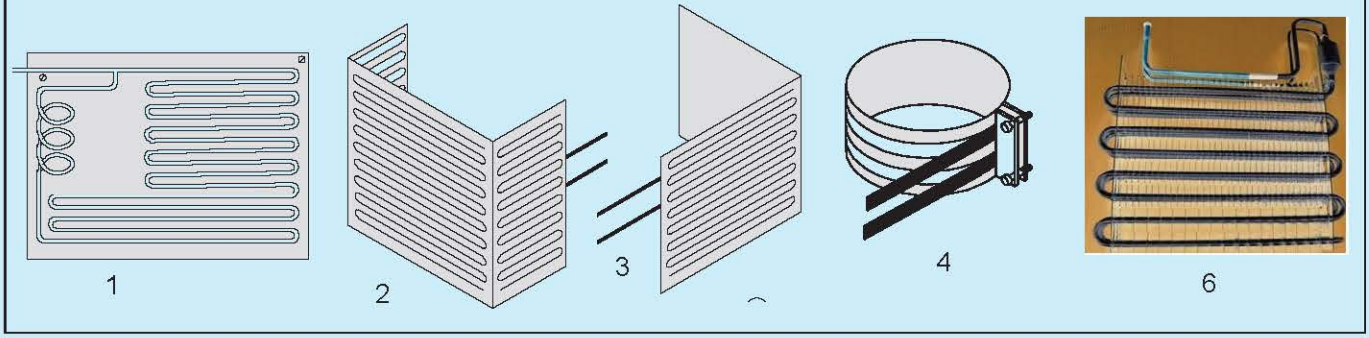
TASK 1: **Identify the types of evaporator**

1 Identify the type of evaporator and its function record in the table 1 of record sheet.

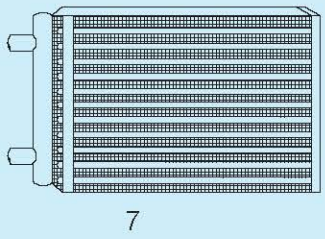
2 Observe both side of direct cooled evaporator for manufacturing details/specification if any and in record in Table - 1 or the record sheet.

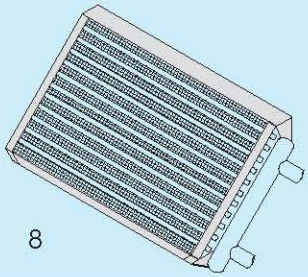
Table 1

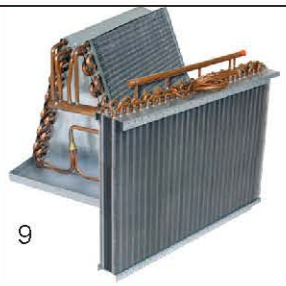
Fig. No.	Name	Application	Fig. No.	Name	Application
1			6		
2			7		
3			8		
4			9		
5			10		



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7


8


9


10

TASK 2: **Shift the window air conditioner to work spot**

1 Check the grill and room temperature, ambient temperature, air velocity and record in the table 2.

2 Stop the unit, remove the plug from the socket.

3 Unscrew the front panel remove and keep it. Take the filler to clean.

4 Pull the unit gently at the front.

5 Place the unit on the trolley with the help of two more trainees. Care should be taken by compressor side since it will be heavy.

6 Move the trolley slowly to work spot after covering that window portion temporarily with hard board or plywood.

TASK 3: **Clean the evaporator with chemical spray**

1 Unscrew the sides and top of the evaporator housing remove it, cover the electrical control unit with plastic sheet.

2 Loosen locking Allen screw of and loosen the fan motor and base bolts blower use suitable Allen key with 'T' handle.

3 Shake the fan motor for the blower to get free from fan motor shaft remove and keep it.

4 Brush the evaporator coil fins both the side after brushing with nylon brush.

5 Comb and correct the fins then clean it with chemical spray do the same procedure to evaporator fins cleaning and combing.

TASK 4: **Clean and wipe, fix the unit in position**

1 Wash the fins with soap water and clean water. Blow air, clean the fins and the bed with hand air blower.

2 Dry the evaporator coil fins and the base of the unit.

3 Remove the plastic sheet covered to the control unit. Clean and fix the blower fan, tighten the fan motor base check for free rotation.

4 Cover the evaporator with housing top cover by tightening the screws.

5 Move the trolley with the unit near the window frame.

6 Lift and put it with co trainees, push it in position gently.

7 Put your hand inside the evaporator air discharge plenum and rotate and check the blower and tan rotating free and smooth.

8 Place the clean filter and fix the front panel start the unit.

TASK 5: **Check the cooling effect.**

1 Check the present ambient temperature.

2 Check the room temperature.

3 Check the grill temperature.

4 Check the grill air velocity.

5 Record and find the improvement in cooling effect after service in table given below.

Table 2

Window Ac make and capacity	Evaporator service	Ambient temperature	Room temperature	Grill temperature	Grill air velocity
	Before				
	After				

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Perform leak test, flush to remove oil by dry nitrogen

Refer Ex : 1.11.71

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Identify and explain different colour code of different type refrigerant cylinder

Objective: At the end of this exercise you shall be able to
- **identity and explain different colour code of different type refrigerant cylinder**

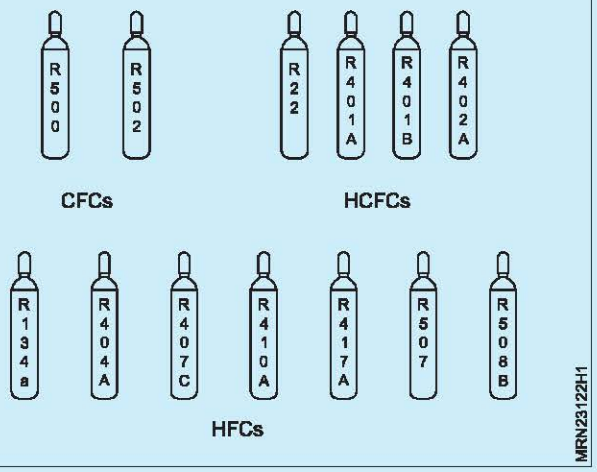
Different types of cylinder one number each

Refrigerant	Chemical name	Color code
R-11	Trichlorfluoromethane	Orange
R-12	Dichorodifiucrmethane	White
R-13	Chlorotrifluorothane	Light Blue
R-113	Trichlorotrifluoroethane	Dark purple
R-114	Dichlorotetrafluoroethane	Navy Blue
R-12/114	Dichorodifluoromethane, Dichlorotetrafluoroethane	Light gray
R-13B1	Bromotrifluoromethane	Pinkish Red
R-22	Chlorodifluoromethane	Light Green
R-23	Trifluoromethane	Light Blue Gray
R-123	Dichlorotrufluoroethane	Light Blue Gray
R-124	Chlorotetrafluoroethane	DOT Green
R-134a	Tetrafluoroethane	Light Blue
R-401A	Chlorodifluoromethane, Difluoroethane. Cholorotetrafluoroethane	Pinkish Red
R-401B	Chlorodifluoromethane, Difluoroethane, Chlorotetrafluoroethane	Yellow-Brown
R-402A	Chlorodifluoromethane, pentafluorothane, propane	Light-Brown
R-402B	Chlorodifluoromethane, Pentafluoroethane, propane	Green-Brown
R-403B	Chlorodifluoromethane. Octafluoropropane, propane	Light gray
R-404A	Pentafluoroethane, Trifluoroethane, Tetrafluoroethane	Orange
R-407C	Difluoromethane, Pentafluoroethane, Tetrafluoroethane	Brown
R-408A	Chorodifluoromethane, Trifluoroethane, Pentafluorothane	Medium purple
R-409A	Chlorodifluoromethane, chlorotefluoroethane, chlorodifluoroethane	Medium Brown
R-410A	Difluoromethane, pentafluoroethane	Rose
R-414B	Chlorodifluoromethane, chlorotetrafluoroethane, Chlorodifluoroethane, Isobutane	Medium Blue
R-416 A	Tetrafluorethane, chlorotetrafluoreoethane, Bulane	Yellow-Green
R-417A	Pentafluoroethane. Tetrafluoroethane, Isobutane	Green

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Refrigerant	Chemical name	Color code
R-500	Dichlorotrifluoromethane, Difluoroethane	Yellow
R-502	Chlorodifluoromethant, chloropenlafluoroethane	Light purple
R-503	Chlorotrifluoromethane, Trifluoromethan	Blue-Green
R-507	Pentafluoroethane, trifluoroethane	Aqua Blue
R-508B	Trifluoromethane, Hexafluoroethane	Dark Blue

Fig 1



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Recover refrigerant from a faulty machine

Objective: At the end of this exercise you shall be able to
- **set recovery machine to extract refrigerant.**

Requirements

Tools / Equipments

- Trainees tools kit - 1 No
- Piercing valve - 1 No
- Recovery cylinder (2kg) - 1 No
- Weigh scale 5 kg - 1 No
- 2 way gauge manifold - 1 No
- Stop watch - 1 No
- Deep freeze or bottle cooler or water cooler or Refrigerator with CFC charge of about 200 gm - 1 No
- Alternatively, a window room A.C (ITR / 1.5. TR) which has about 850gm HCFC - R - 22 charge. - 1 No
- Recovery machine suitable refrigerant - 1 No

Materials

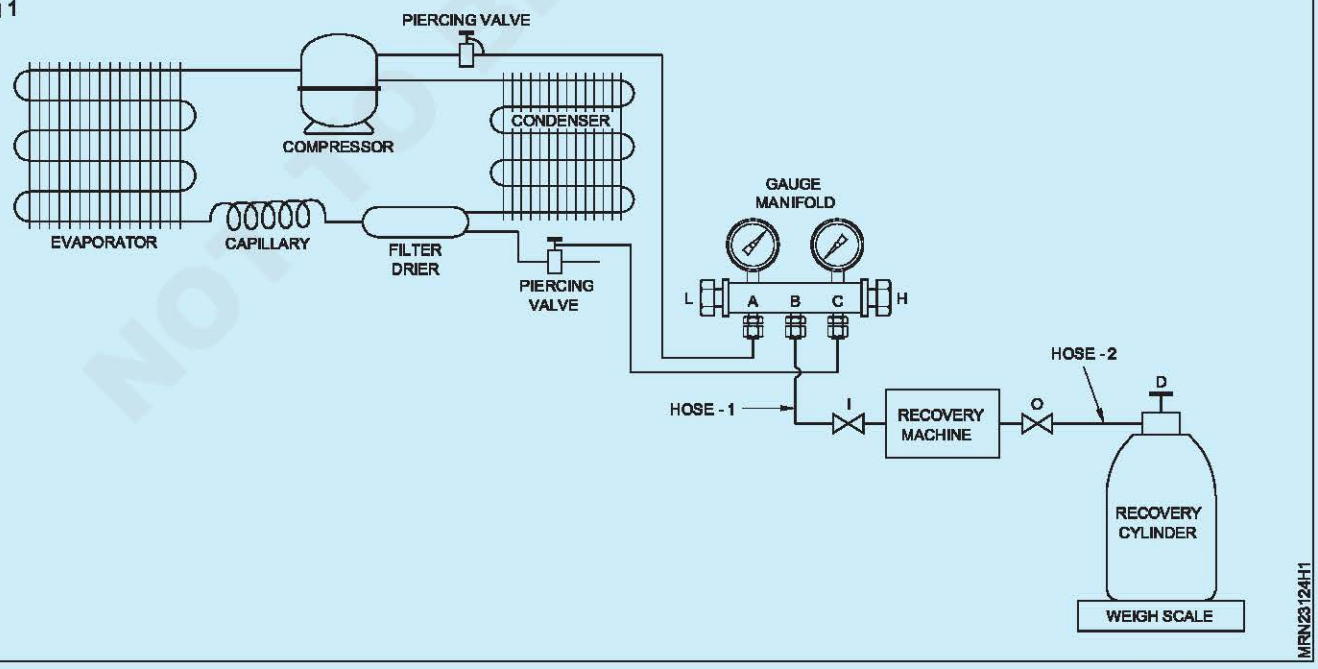
- Charging hoses - 3 No
- Rubber gloves - 1 par
- Goggles - 1 No
- Cotton waste - as reqd
- Insulation tape - 1 No
- Oil - as reqd
- Brush - as reqd

Use recovery machine to extract refrigerant from a sealed system.

Recovery machine will have to be evacuated from both inlet and outlet ends before being connected to the system.

If R-22 is being recovered, it should be ensured that the recovery machine, particularly. its compressor and motor are suitable for R-22.

Fig 1



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TASK 1: **Set recovery machine to extract refrigerant**

1 Evacuate the empty recovery cylinder before placing it on the weigh scale. then place it on the weigh scale and note its weight.

2 Position piercing valves over the suction (compressor) process tube filter driers process tubes.

3 Connect the outlet of the piercing valves, using charging hoes to A& C on the gauge manifold. Ensure valves L & H are closed.

4 Connect hose H_1 from 'B' on manifold inlet I (valve) of recovery machine.

5 Connect hose H_2 from outlet valve 'O' of recovery machine to recovery cylinder.

6 The system and recovery machine have now been hooked up for operation.

7 Pierce compressor process tube with piercing valve P_1 and purge the gas at A before retightening. Repeat the same exercise for P_2 and purge at 'C'.

8 Open valves L & H and purge hose H_1 at 1 (Intel to recovery machine).

9 Open inlet valve 'I' of recovery machine. start the recovery machine and purge the hose H_2 at D before opening the valve of the recovery cylinder. Simultaneously start the stop watch after setting it at 'O'.

10 Continue running the recovery machine till the machine stops by tripping at its low pressure cut-out.

11 immediately close the cylinder valve and also record.

a the stop watch reading.

b The weight of the cylinder now filled with refrigerant.

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Transfer refrigerants from one cylinder to another using ice.

Objective: At the end of this exercise, you shall be able to
- **transfer refrigerant to cylinder.**

Requirements

Tools/Instruments

- Double ended spanner 4.7 to 16mm - 1 No.
- Platform scale o to 40 kg - 1 No.
- Leak detector - 1 No.
- Charging line - 1 No.
- Tray - 1 No.
- Goggles - 1 No.

Materials/components

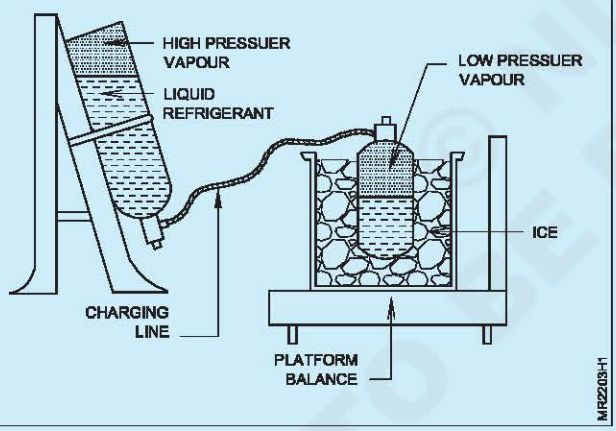
- Ice - as reqd.

PROCEDURE

TASK 1: **Transfer refrigerant to cylinder.**

1 Keep the large cylinder. (Fig 1) upside down an rack as shown

Fig 1



2 Cool the empty service cylinder using ice and keep it correct position on a weighing machine.

3 Connect both the cylinders by means of a charging line.

4 Weaving goggles open the large cylinder and purge the charging line carefully.

5 Test leak and open both cylinder valves.

6 Noting the reading of the weighing machine transfer the required amount of refrigerant to the service cylinder.

7 Close the storage cylinder valve and allow some time to flow refrigerant from the charging line to service cylinder.

8 Close the service cylinder valve and disconnect the cylinders.

9 Plug the cylinder valves and test the leaks.

Safety precautions

1 **While purging be careful for not loosing more refrigerant.**

2 **After transferring keep both the cylinders closed well.**

3 **Do not purge HC blend gas**

4 **Do not vent CFC 12**

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Measure pressure and temperature of refrigerants

Objective: At the end of this exercise you shall be able to
- **observe pressure and temperature of refrigerant**
- **use the pressure temperature chart**
- **identify flammability and toxicity of refrigerants**
- **measure pressure temperature of refrigerants**

Requirements

Tools/Instruments

- Gauge manifold - 1 No
- Double end spanner - (set [6mm to 32mm]
- Adjustable spanner 200mm - 1 No
- Ratchet wrench - 1 No
- Trainees kit - 1 No
- Tong tester - 1 No
- Valve key - 1 No
- Cutting plier - 1 No

Materials/components

- R22 gas in cylinder - 1 No
- Soap water with brush - 1 No
- Cotton waste - 1 No
- Charging hose - 2 Nos
- Brush - 1 No

Equipment

- Split A/C 1.5 T.R - 1 No

PROCEDURE

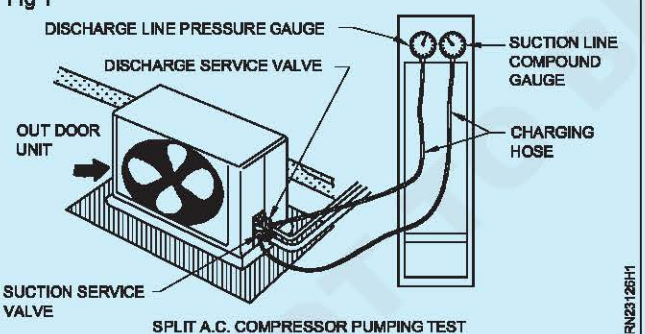
TASK 1: **Observe pressure temperature R22.**

1 Remove discharge and suction service valve cap of split A/C.

2 Check both the service valves port are closed.

3 Connect gauge manifold with service valve

Fig 1



4 Fix 300 (lbs) psig gauge with hose uncharged port and 150 psig gauge with hose on suction side port

5 Starts the compressor and note the discharge pressure and suction pressure.

6 Measure suction line and discharge line temperature with digital thermometer by fix the thermometer on suction and discharge line separately.

Note: a) Measure the suction pressure of the unit. If suction pressure is67 psig for R22 and check the coil temperature by using chart.

b) and compare the coil temperature with digital thermometer readings.

Likewise measure the pressure and temperature for other refrigerants. (refer chart).

TASK 2: **perform use of pressure temperature chart**

1 Measure the temperature by a thermometer and record it.

2 Check and verify the pressure reading corresponding to the temperature in the pressure temperature chart.

TASK 3: **Identify flammability and toxicity of A3 and A2L of refrigerants**

Note; ASHRE - 34; Safety classification of refrigerants for toxicity flammability

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Sl. No.	Refrigerants	Flammability	toxicity
1	HFC - 32 HFO - 1234 YF HFO - 1234 ZC	A2L mild flammable	Lower toxicity
2	HC - 290 HC - 600a	A3 higher flammable	Lower toxicity

TASK 4: **Measure pressure and temperature of, refrigerant**

1 Take refrigerant cylindrs of HCFC - 22

2 Remove king valve cap and blind nut

3 Connect charging hose one end with cylinder and other end with pressure gauge and plug it.

4 Clamp the Digital thermometer sensor with cylinder body

5 Open king valve a little and read the pressure and temperature and note down in table.

6 Put the setting inside a cold room and take five readings at various temperatures

7 Compare the readings with the refrigerant pressure temperature chart.

8 Close cylinder valve remove gauge and isolate cylinder

9 Repeat same procedure using refrigerant cylinders of ammonia, HFC - 32, HFC - 134a, R404A, R - 407C and R - 410A, HFOs

Use special fittings and gauge for ammonia

Sl.No.	Refrigerant name	Temperature	pressure

Refrigerant pressure Temperature chart

	R22		R134a		R410A		R404A		R404A		R407C		R407C	
	Saturated		Saturated		Saturated		Bubble		Dew		Bubble		Dew	
°C	Kpa	psi	kpa	psi	Kpa	psi	kap	psi	kpa	psi	kpa	psi	kpa	psi
-40	4	0.6			73	10.7	34	4.9	30	4.3	19	2.7		
-38	14	2			90	13	47	6.8	42	6.1	30	4.4		
-36	25	3.6			108	15.6	60	8.7	55	8	43	6.2	3	0.5
-34	37	5.3			126	18.3	75	10.8	69	10.1	56	8.2	14	2
-32	49	7.1			147	21.2	90	13	85	12.3	71	10.2	25	3.6
-30	63	9.1			168	24.4	106	15.4	101	14.6	86	12.4	37	5.4
-28	77	11.1			191	27.7	124	18	118	17.1	102	14.8	51	7.3
-26	92	13.4	0	0	215	31.2	143	20.7	137	19.8	119	17.3	65	9.4
-24	108	15.7	10	1.4	241	35	162	23.6	156	22.6	138	20	80	11.6
-22	126	18.2	20	2.9	269	39	183	26.6	177	25.6	158	22.9	96	13.9
-20	144	20.9	31	4.6	298	43.2	206	29.8	199	28.8	179	25.9	113	16.4
-18	163	23.7	43	6.3	329	47.7	229	33.3	222	32.2	201	29.1	132	19.1
-16	184	26.7	56	8.1	362	52.4	254	36.9	247	35.8	224	32.5	152	22
-14	206	29.9	69	10.1	396	57.5	281	40.7	273	39.6	249	36.1	172	25
-12	229	33.2	84	12.2	433	62.8	308	44.7	300	43.6	276	40	195	28.2
-10	253	36.8	99	14.4	471	68.4	338	49	329	47.8	303	44	218	31.7
-8	279	40.5	116	16.8	512	74.2	369	53.3	360	52.2	333	48.3	244	35.3
-6	306	44.4	133	19.3	555	80.5	401	58.2	392	56.9	364	52.7	270	39.2

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	R22		R134a		R410A		R404A		R404A		R407C		R407C	
	Saturated		Saturated		Saturated		Bubble		Dew		Bubble		Dew	
°C	Kpa	psi	kpa	psi	Kpa	psi	kap	psi	kpa	psi	kpa	psi	kpa	psi
-4	335	48.6	151	21.9	600	87	435	63.1	426	61.8	396	57.5	298	43.3
-2	365	52.9	171	24.8	647	93.8	471	68.3	462	67	430	62.4	328	47.6
0	397	57.5	191	27.8	697	101.1	509	73.8	499	72.4	467	67.7	359	52.1
2	430	62.3	213	30.9	749	108.6	548	79.5	538	78.1	504	73.2	392	56.9
4	465	67.4	236	34.3	804	116.5	590	85.5	579	84	544	78.9	427	62
6	501	72.7	261	37.8	861	124.8	633	91.8	622	90.3	586	85	464	67.3
8	540	78.3	286	41.5	921	133.5	678	98.4	667	96.8	629	91.3	503	72.9
10	580	84.1	313	45.4	983	142.6	726	105.3	714	103.6	675	37.9	544	78.8
12	621	90.1	342	49.6	1049	152.2	775	112.4	764	1.8	723	104.8	586	85
14	664	96.5	372	53.9	1118	162.1	827	119.9	815	118.2	773	112.1	631	91.5
16	711	103.1	403	58.4	1189	172.5	881	127.8	869	126	825	119.7	678	98.4
18	759	1.1	436	63.2	1264	183.3	937	135.9	925	134.1	879	127.6	727	105.5
20	809	117.3	470	68.2	1342	194.6	996	144.4	983	142.6	936	135.8	779	113
22	861	124.8	507	73.5	1423	206.4	1057	153.3	1044	151.4	995	144.4	833	1.8
24	915	132.7	544	79	1507	218.6	1120	162.5	1107	1.6	1057	153.3	889	129
26	971	1.8	584	84.7	1595	231.4	1187	172.1	1173	1.2	1121	162.7	949	137.6
28	1030	149.3	626	90.7	1687	244.7	1255	182.1	1242	1.1	1188	172.3	1010	146.5
30	1091	158.2	669	97	1782	258.5	1327	192.5	1313	1.4	1258	182.4	1075	155.9
32	1154	167.4	714	103.6	1881	272.9	1401	203.2	1387	201.2	1330	192.9	1142	165.6
34	1220	176.9	761	1.4	1984	287.8	1479	214.4	1464	212.4	1405	203.8	1212	175.8
39	1288	186.8	810	117.6	2091	303.3	1559	226.1	1544	224	1483	215.1	1285	186.3
40	1432	207.7	915	132.7	2317	336.1	1728	2.6	1713	248.5	1648	239	1440	208.9
42	1508	218.8	971	1.8	2437	353.5	1818	263.6	1803	261.5	1735	251.6	1522	2.8
44	1587	2.2	1029	149.2	2561	371.4	1910	277.1	1895	274.9	1825	264.7	1608	233.2
46	1669	242.1	1089	157.9	2690	3.1	2006	291	1991	288.8	1918	278.2	1697	246.2
48	1754	254.4	1152	167	2823	409.5	2106	305.5	2031	303.3	2015	292.2	1790	259.6
50	1841	267.1	1217	176.5	2962	429.5	2209	3.4	2194	318.3	2115	306.7	1886	273.6
52	1932	2.2	1284	186.2	3105	4.3	2316	335.9	2301	333.8	2218	321.7	1987	288.1
54	2026	293.8	1354	196.4	3254	471.9	2427	352	2412	349.9	2325	337.2	2091	303.2
56	2123	307.9	1427	207	3408	494.2	2542	368.6	2527	366.5	2436	353.3	2199	318.9
58	2223	322.4	1502	217.9	3567	517.4	2660	385.9	2646	385.9	2550	369.8	2311	335.2
60	2326	337.4	1580	229.2	3733	541.4	2783	403.7	2770	401.7	2668	387	2427	352.1
62	2433	352.9	1661	241	3905	566.3	2911	422.2	2898	4.3	2790	404.6	2548	369.6
64	2543	368.9	1745	253.2	4083	592.2	3043	441.4	3031	439.6	2916	422.9	2674	387.8
66	2657	385.4	1832	265.8	4268	619	3180	461.3	3169	459.6	3045	441.7	2805	406.8
68	2775	402.4	1922	278.8	4460	646.9	3323	482	3312	4.4	3179	461.1	2940	426.4
70	2896	420	2015	292.3	4660	675.9	3471	503.4	3463	502.2	3318	481.2	3081	446.9

R32 pressure temperature chart

R32 Temperature (°C)	Pressure (barg)	Pressure (psig)
-40	0.76	11.04
-38	0.93	13.45
-36	1.11	16.05
-34	1.30	18.82
-32	1.50	21.79
-30	1.72	24.79
-28	1.95	28.34
-26	2.20	31.94
-24	2.47	35.77
-22	2.75	39.83
-20	3.04	44.15
-18	3.36	48.72
-16	3.69	53.56
-14	4.05	58.68
-12	4.42	64.09
-10	4.81	69.79
-8	5.23	75.81
-6	5.67	82.15
-4	6.13	88.82
-2	6.61	95.84
0	7.12	103.21
2	7.65	110.95
4	8.21	119.07
6	8.80	127.58
8	9.41	136.49
10	10.06	145.81
12	10.73	155.57
14	11.43	165.76

R32 Temperature (°C)	Pressure (barg)	Pressure (psig)
16	12.17	176.41
18	12.93	187.53
20	13.73	199.13
22	14.57	211.21
24	15.44	223.81
26	16.34	236.93
28	17.28	250.59
30	18.26	264.80
32	19.28	279.57
34	20.34	294.93
36	21.44	310.89
38	22.58	327.47
40	23.77	344.67
42	25.00	362.51
44	26.28	381.05
46	27.60	400.24
48	28.98	420.15
50	30.40	440.79
52	31.87	462.17
54	33.40	484.33
56	34.98	507.27
58	36.62	531.02
60	38.32	555.63
62	40.08	581.10
64	41.90	607.49
66	43.78	634.81
68	45.73	663.11
70	47.76	692.45

R290 pressure temperature chart

R290 Temperature (°C)	Pressure (barg)	Pressure (psig)
-40	0.10	1.42
-38	0.20	2.86
-36	0.30	4.40
-34	0.42	6.04
-32	0.54	7.79

R290 Temperature (°C)	Pressure (barg)	Pressure (psig)
-30	0.67	9.65
-28	0.80	11.62
-26	0.95	13.7
-24	1.10	15.93
-22	1.26	18.28

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R290 Temperature (°C)	Pressure (barg)	Pressure (psig)
-20	1.43	20.77
-18	1.61	23.39
-16	1.80	26.16
-14	2.01	29.07
-12	2.22	32.15
-10	2.44	35.38
-8	2.67	38.77
-6	2.92	42.34
-4	3.18	46.08
-2	3.45	50.00
0	3.73	54.11
2	4.03	58.41
4	4.34	62.90
6	4.66	67.60
8	5.00	72.50
10	5.35	77.62
12	5.72	82.95
14	6.10	88.52
16	6.50	94.31
18	6.92	100.33
20	7.35	106.60
22	7.80	113.11
24	8.27	119.88

R290 Temperature (°C)	Pressure (barg)	Pressure (psig)
26	8.75	126.91
28	9.26	134.20
30	9.78	141.77
32	10.32	149.61
34	10.88	157.73
36	11.46	166.16
38	12.06	174.86
40	12.68	183.87
42	13.32	193.20
44	13.99	202.84
46	14.68	212.82
48	15.39	223.11
50	16.12	233.74
52	16.88	244.72
54	17.66	256.06
56	18.47	267.74
58	19.30	279.81
60	20.16	292.25
62	21.04	305.07
64	21.95	318.28
66	22.89	331.91
68	23.86	345.94
70	24.86	360.40

R717 pressure temperature chart

R717 Temperature (°C)	Pressure (barg)	Pressure (psig)
-40	-0.30	-4.29
-38	-0.22	-3.13
-36	-0.13	-1.86
-34	-0.03	-0.49
-32	0.07	1.01
-30	0.18	2.63
-28	0.30	4.38
-26	0.43	6.27
-24	0.57	8.31
-22	0.72	10.51

R717 Temperature (°C)	Pressure (barg)	Pressure (psig)
-20	0.89	12.87
-18	1.06	15.41
-16	1.25	18.13
-14	1.45	21.04
-12	1.67	24.15
-10	1.89	27.46
-8	2.14	31.01
-6	2.40	34.78
-4	2.68	38.79
-2	2.97	43.05

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R717 Temperature (°C)	Pressure (barg)	Pressure (psig)
0	3.28	47.57
2	3.61	52.37
4	3.96	57.45
6	4.33	62.82
8	4.72	68.50
10	5.14	74.49
12	5.57	80.82
14	6.03	87.48
16	6.52	94.50
18	7.03	101.88
20	7.56	109.65
22	8.12	117.80
24	8.71	126.35
26	9.33	135.31
28	9.98	144.71
30	10.66	154.56
32	11.37	164.85
34	12.11	175.61

R717 Temperature (°C)	Pressure (barg)	Pressure (psig)
36	12.89	186.86
38	13.70	198.59
40	14.54	210.84
42	15.42	223.62
44	16.34	236.93
46	17.30	250.81
48	18.29	265.24
50	19.33	280.24
52	20.40	295.86
54	21.52	312.08
56	22.69	328.93
58	23.89	346.42
60	25.14	364.57
62	26.44	383.39
64	27.79	402.91
66	29.18	423.14
68	30.63	444.08
70	32.12	465.77

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Demonstrate safe handling refrigerant cylinder and king valve

Objective: At the end of this exercise you shall be able to
- **handling of refrigerant cylinder safety**
- **operate refrigerant cylinder valves**
- **identify the readings in the pressure gauge.**

Requirements

Tools/equipment		Materials	
• Valve key	- 1 No.	• Cotton waste	- as reqd
• Refrigerant cylinder	- 1 No.	• Hand gloves	- 1 pair
• Electronic weight machine	- 1 No.	• Oil	- as reqd
• Adjustable spanner 200mm		• Goggles	- 1No.
pressure gauge	- 1No.	• Charging hose	- 1No.

TASK 1: **Handling of refrigerant cylinder safety.**

1 Never drop cylinder or permit them strike each other violently.

2 Never use lifting magnet or a sling (rope or chain) to handle cylinders.

3 Caps on refrigerant cylinder are provided for valve protection .Always keep the caps on the cylinders except when the cylinder are being used.

4 Whenever refrigerant is discharged from a cylinder, always weight the cylinder immediately and record the refrigerant remaining in the cylinder.

5 Never attempt to mix gases in a cylinder.

6 when a cylinder has been emptied close the cylinder valve immediately to prevent the entrance of air, moisture, or dirt. Also, be sure to replace the valve protection cap.

7 Never use cylinders for any purpose other than their intended purpose. Do not use cylinders as rollers and supports.

8 Do not tamper with the safety devices in the valves or cylinders.

9 Open cylinder valves slowly. NEVER use wrenches or other tools except those provided by the manufacturer.

10 Be sure the threads on regulators or other connections that do not fit.

11 Always use the correct pressure gauges and regulator with the gas cylinders for which they were intended.

12 Never attempt to repair or alter cylinders or valves.

13 Store cylinders in a cool, dry place, in an

Upright position never allow a cylinders to be subjected to temperatures, above 130°F.

14 Refrigerant cylinders should never be filled over 80% of their capacity [liquid expansion may cause the cylinder to burst.

TASK 2: **Operating refrigerant cylinders valves**

1 Place the cylinders on the work table .

2 Place the cylinder on the work table vertically.

3 Remove the end dummy cap from the valve using a adjustable wrench

4 Connect one end of the charging hose with the valve port.

5 a) Connect other end of the charging hose to the compound gauge

b) Slighly loosen the hose connection at the compound gauge purge some of the air by cracking open the cylinder valve for a second and close again.

6 Ensure both ends of the charging hose are tight fit.

7 Ensure that there is no error in the compound gauge.

8 Place the valve key over turn the cylinder valve.

9 To open the cylinder, turn the valve key slowly at anticlockwise direction.

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TASK 3: **Identify the readings in the pressure gauge.**

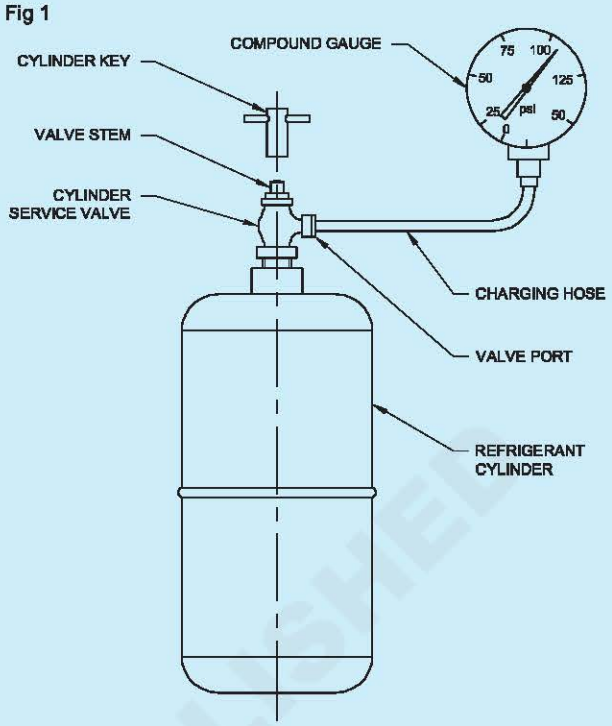
1 Watch the pointer of the compound gauge moves towards high pressure

2 Observe the pressure reading seen in the compound gauge in kg/cm2

3 To close the cylinder, turn the valve key to clockwise direction.

4 Disconnect the charging hose with the cylinder

Fig 1



IDENTIFY VARIOUS REFRIGERANTS WITH CYLINDER AND VALVES.

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Recover CFC recovery pump and cylinder on CFC filled domestic refrigerator

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

- **pierce and access the sealed system**
- **use the refrigeration system's compressor to pump out the refrigerant in the system into the recovery cylinder**
- **use a recovery machine to extract refrigerant from a sealed system.**

Requirements

Tools/Instruments

- Piercing valve - 1 No
- Recovery cylinder (2kg) - 1 No
- Vacuum pump - 1 No
- Weigh scale (0.5 kg) - 1 No
- 2 way Gauge manifold - 1 No
- Stop watch - 1 No

Equipments

- Refrigerator with CFC charge of about 200 grams. - 1 No
- Alternatively, a window room A.C (ITR/1.5 TR) which has about 850 gram HCFC 22 charge - 1 No

Materials

- Bucket containing crushed ice - 1 No

Refer Ex : 1.14.78

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Identify different insulating materials (PUF and polyurethane)

Objectives: At the end of this exercise you shall be able to
- **identify insulating foam**
- **perform safety precaution.**

Requirements

Tools/Instruments

- Trainees tools kit -1 No.

Equipments

- Old refrigerator -1 No.

Materials

- Cotton waste - as reqd.
- Gloves -1 No.
- goggles -1 No.

PROCEDURE

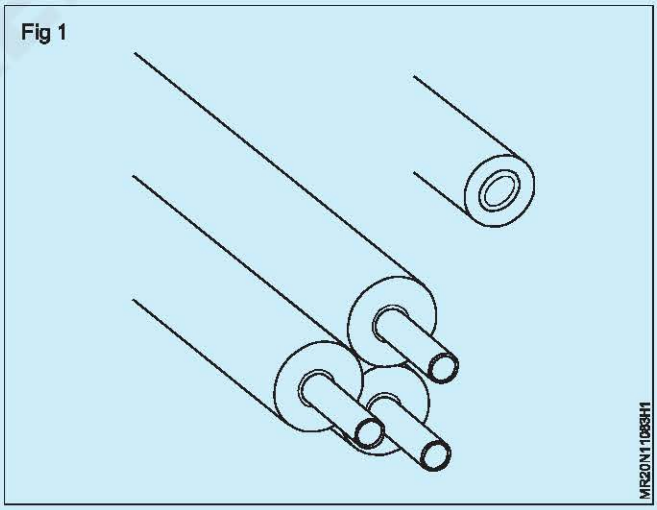
TASK 1: **Identify insulating foam**

1 Take any one refrigerator unit cabinet
2 Remove door gasket
3 Remove the inner liner using any sharp tools
4 Cut a piece of insulting materials out
5 Identify it and note physical properties.

TASK 2: **Perform safety precaution.**

1 Polyurethane form cannot be refilled
2 It is highly is flammable so avoid fire
3 It is filed by mixing two solution at instant use

Fig 1



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Fill with insulation material - PUF and glass wool in refrigeration

Objectives: At the end of this exercise you shall be able to
- **remove and fill glass wool insulating materials**
- **filling PUF**
- **safety precaution.**

Requirements

Tools/Instruments

- Screw driver - 1 No
- Combination piler - 1 No

Equipments

- Refrigerator - 1 No

Materials

- Glass wool - as reqd
- Cotton waste - as reqd
- PUF chemical - as reqd
- Plastic container - 1 No
- Wooden stick one meter long - 1 No
- Hand gloves - 1 No
- Goggles - 1 No

PROCEDURE

TASK 1: **Remove and fill glass wool insulating materials**

1 Remove side strip from the cabinet,

2 Remove all insulating materials and collect it in container.

3 Record the quantity of glass wool taken after weighing it.

4 Take same quantity of glass wool, fill into the refrigerator cabinet using wooden stick.

5 Press it for proper filling with hand gloves.

6 Ensure all sides of the cabinet covered with glass wool.

7 Fix and tight all the side panel screws after the cabinet filed with glass wool.

— — — — — — — —

TASK 2: **Filling PUF**

Polyurethane foam is the result of a reaction between two liquid components - poly of and poly of and polyisocyanate which produces air-filled micro capsules.

1 Prepare the space to fill PUF raving inner liner and outer shell with out gap.

2 Make two openings at the top one for pausing foam and other for vent.

3 Take a plastic container and pour two chemicals equal amount as per manufacture and stir for some time.

4 When it bubbling pour it in to the cabinet carefully.

5 Excess form will come out through vent and pausing openings

6 Allow it to settle and become harden

— — — — — — — —

TASK 3**: Safety precaution**

1 Do Not handle glass wool without wearing hand gloves and goggle.

2 Do not leave any gap between inner and outer cabinet of the refrigerator.

3 After completion of filling glass wool put panel or bottom panel to be screwed.

— — — — — — — —

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Acquaint with mechanical and electrical components used in window A/C

Objectives: On completion of this exercise you shall be able to
- **identify electrical parts**
- **identify mechanical parts**
- **acquainting all electrical components used in window A/C**
- **identify remote and PCB central**

Requirements

Tools/Equipments/Instruments

- Trainee's kit - 1 No.
- Test board - 1 No.
- Test lamp with 200 watts
- Multimeter/ohmmeter - 1 No.
- Line tester - 1 No.
- Knife - 1 No.

Materials

- 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.

Equipments/Components

- Complete system of window A/C - 1 No.

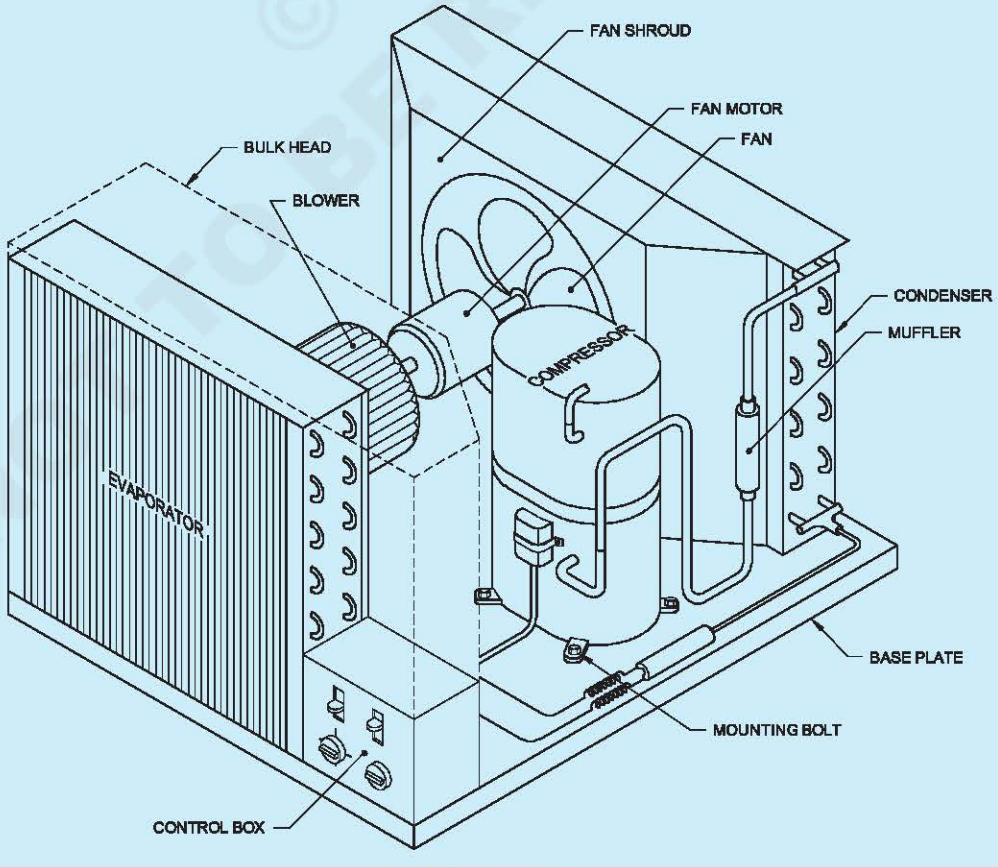
PROCEDURE:

TASK 1: **Identify electrical parts of window A/C**

1 Identify the electrical components (Fig 1)

2 Record the name of electrical components and the functions in the table 1 of record sheet.

Fig 1



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RECORD SHEET

Table 1

Label No.	Name of the identified component/part (Electrical)	Function
A		
B		
C		
D		
E		

Table 2

Label No.	Name of the identified component/part (Mechanical)	Function
F		
G		
H		
I		
J		

TASK 2: **Identify mechanical parts of window A/C**

1 Identify the mechanical compnents (Fig 1)

2 Record the name of mechanical components and the function in the table 2 of record sheet

TASK 3: **Acquainting all Electrical components used in window A/C.**

1 Remove A/C from shall 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.

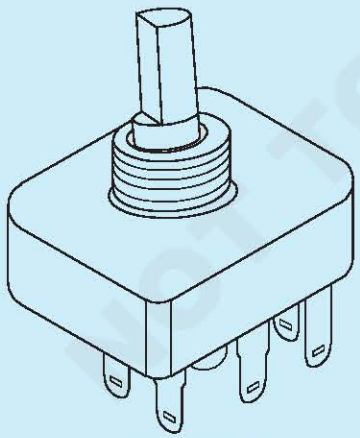
Selector switch

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



SELECTOR SWITCH

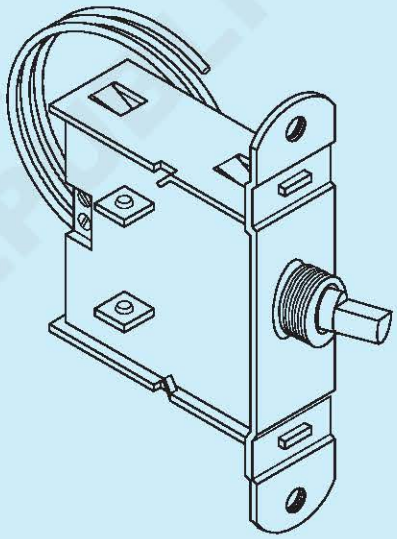
MR20N11186H1

Thermostat switch

1 Check the room temperature by stopping and starting the compressor.

2 Connected between selector switch and compressor (Fig 2).

Fig 2



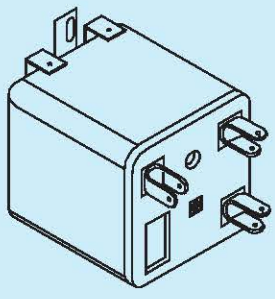
MR20N11186H2

Relay

1 Identify the relay is used in window A/C (Fig 3)

2 Connected between thermostat and compressor.

Fig 3



COMPRESSOR RELAY

MRN24137H3

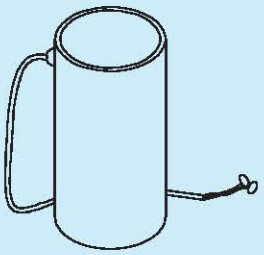
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Starting capacitor

1 Identify starting capacity in window A/C.

2 Check capacitance, it will higher than running capacitor (Fig 4)

Fig 4



STANDING CAPACITOR

MRN24137H4

Note: It should not kept on line more than 30 seconds

Running capacitor

1 Identify the running capacitor in window A/C.

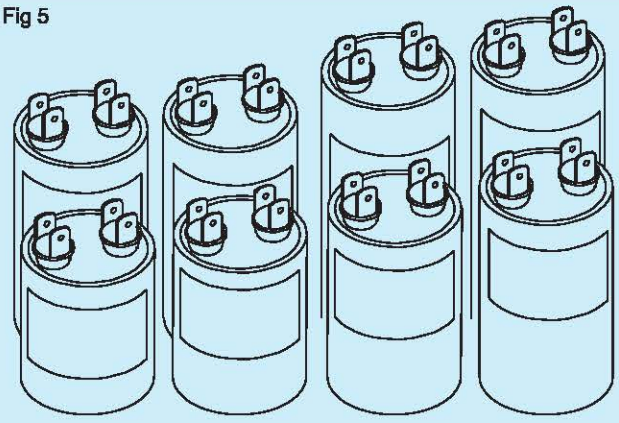
2 Connected in unit permanently (Fig 5).

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.

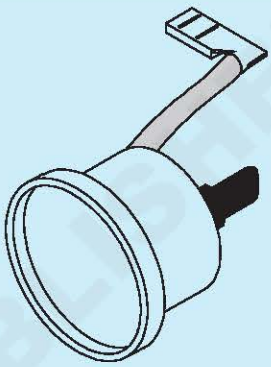
Fig 5



RUNNING CAPACITOR

MRN24137H5

Fig 6



OVERLOAD PROTECTOR

MRN24137H6

TASK 4: **Identify remote and PCB control.**

1 Identify PCB. It is doing the function of selector switch, thermostat and all controls.

2 Check the function of remote and display.

3 Change and set more functions according to manufacture. the relay will be good.

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Trouble shoot and trace wiring circuit of window A/C

Objectives: At the end of this exercise you shall be able to
- **identify the defective component of the domestic window air-conditioner**
- **tracing wiring circuit.**

Requirements

Tools/Equipments

- Window air-conditioner with the symptom "Compressor does not start" - 1 No
- Trainee's tool kit - 1 No
- Test lamp - 1 No
- Multimeter - 1 No
- Megger - 1 No
- Voltage stabiliser - 1 No

Material/Components

- Starting capacitor - 1 No
- Tong tester - 1 No
- Tri chlore ethylene - as reqd
- Cotton waste - as reqd
- Insulation tape - 1 Roll
- Wire clip - 1 Dozen
- Flexible wire
- Tags for wire
- Selector switch - 1 No
- Overload protector - 1 No
- Relay - 1 No
- Thermostat - 1 No

TASK 1 : **Trouble shoot**

Trouble shooting chart for "Compressor does not start"

Probable defect (s)	Causes / Reasons	Remedial measures
Fuse blow down	- Low voltage - High Ampere - Loose connector	- Ensure all supply leads - Connect tightly - Replace fuse
Thermostat contact open	- Volatile gas leakage - Feeler capillary tube broken - Mishandling	- Replace thermostat - Ensure proper handle - Thermostat feeler capillary tube
Selector switch contacts open	- Switch spring broken	- Replace selector switch
Neutral wire open	- Wiring short circuited	- Ensure proper wiring and proper connection in neutral wire in the circuit
Starting capacitor burnt out	- Wrong starting capacitor	Choose correct value of starting capacitor as per manufacturer's instruction
	- Relay contact burnt out - Low voltage	- Replace relay - Use voltage stabiliser
Overload protector trip	- High Ampere - High voltage	- Wait few minutes for OLP reset
Bimetallic contact burnt out	- High Ampere drawn by compressor	- Replace OLP
Compressor inter terminal connector open	- Vibration Loose base bolts	- Ensure tight all loose bolts
Main winding short circuited	- High voltage	- Use automatic voltage
Starting winding short circuited	- High voltage	- stabiliser with high voltage cut off.

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Trouble shooting chart for compressor trips frequently

Probable defects	Causes/reasons	Remedial measures
Overload protector trips frequently	Starting winding held in circuit too long	Replace winding
	Compressor motor winding weak	Replace winding
	Bearing and piston too tight	Replace worn out parts
	Incorrect wiring	Ensure correct wiring
	Low voltage	Use voltage stabiliser
	Excess load in room	Ensure correct capacity of machine
	High current drawn by compressor	
	Relay contact welded	Replace relay
	Relay contact struck up	Replace relay
	Misselection of relay	Ensure proper selection of relay
	Misposition of relay	Correct position in relay
	Bimetallic strip weak	Replace OLP
	OLP heating element broken	Replace OLP
	Loose connection in OLP	Ensure tight in all connection of OLP
Defective running capacitor	High voltage	Use voltage stabiliser
	Misselection of running capacitor	Select correct capacity of running capacitor
Starting capacitor weak	Low voltage	Use voltage stabiliser
	Compressor short cycling	Replace starting capacitor
	Relay contact welded/struck up	Replace relay
Starting capacitor burst out	Low voltage	Use voltage stabiliser
	Relay contact welded/struck up	Replace relay
High head pressure	Discharge reed partly closed	Replace discharge valve
	Discharge line partly blocked	Cut open the discharge line. Remove the block and reconnect the line and braze it.
	Air/non-condensable gas present	Ensure sufficient cleaning, flushing and evacuating the system before gas charging
	Refrigerant overcharging	Cut open and remove excess refrigerant, ensure correct quantity of gas and seal the gap of charging line.
	Condenser blocked	Clean/flush the condenser
	High ambient temperature	No remedy
	Condenser fins blocked	Clean the condenser fins
	Condenser fan motor defect	Repair/replace fan motor
	Low/high voltage	Use voltage stabiliser

Record sheet

1 Manufacturer's details for conventional type refrigerator :

2 Reported defect/complaint :

3 Identified complaint/fault :

Sl. No	Defects Identified	Identified causes for the defect	Remedial measures taken	Parts/Components replaced

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5 Condition of the conventional type refrigerator after repairing the reported defect/complaint.

6 Time taken to repair for the reported defect/complaint.

7 For additional information.

TASK 2: **Trace wiring circuit**

1 Ref (Fig 1,2,3&4) carryout the work as per the diagram

Fig 1

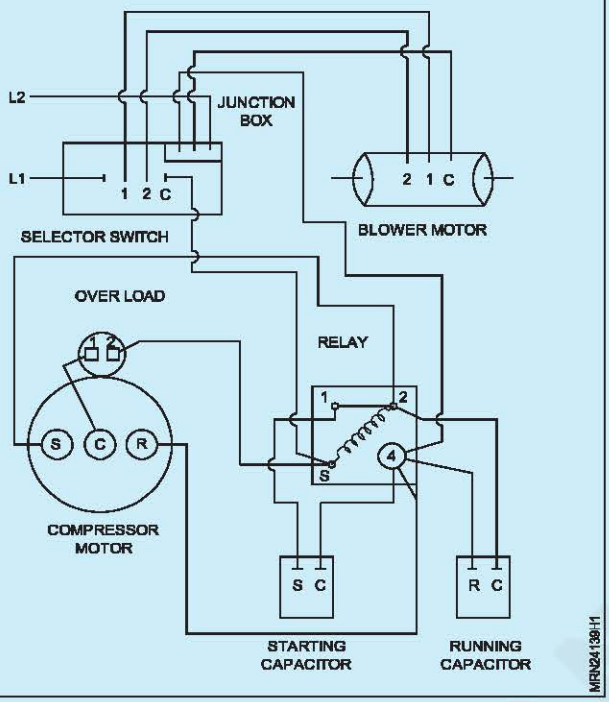


Fig 2

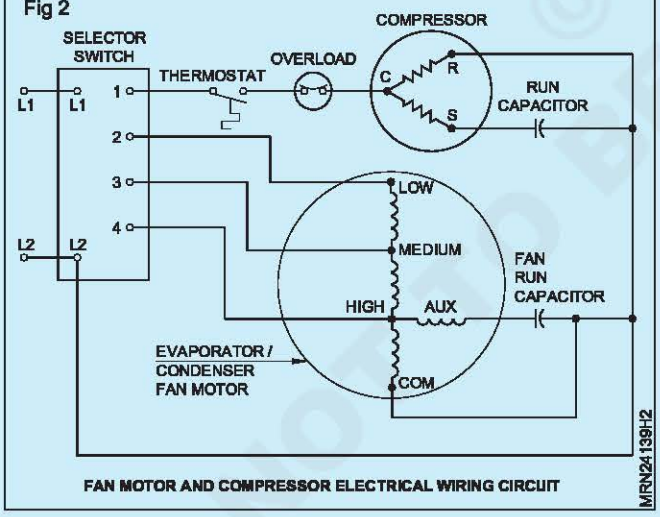


Fig 3

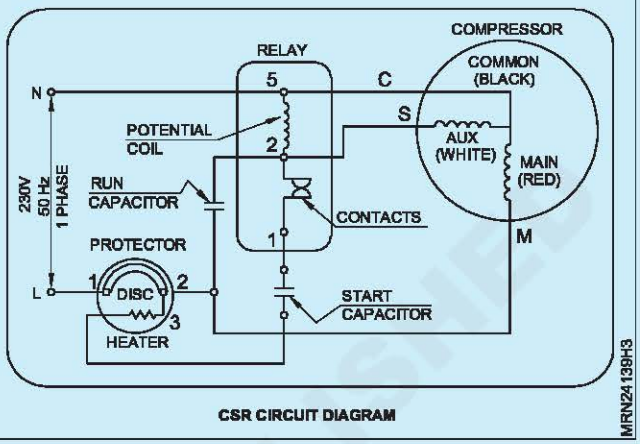
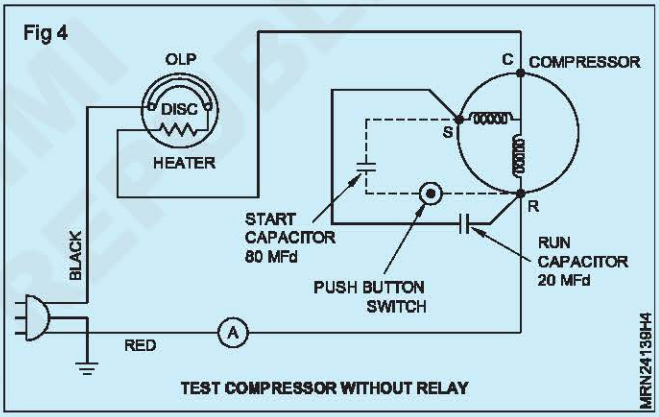


Fig 4



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Leak testing evacuation and gas charging in window A/C

Objectives: All the end of this exercise you shall be able to
- **test the leak in refrigeration system of a window A/C**
- **evacuate refrigeration system of a window A/C**
- **charge the refrigerant in hermetic system of window A/C**
- **check the performance of window A/C.**

Requirements

Tools/Instruments

- N2 cylinder with 2 stage per regulator - 1 No
- Flaring tool - 1 No
- Brazing equipments - 1 No
- Gauge manifold - 1 No
- DE spanner - 1 Set
- Adjustment spanner 6" - 1 No
- Charging hose - 2 Nos
- Cutting plier - 1 No
- Cylinder key - 1 No
- Vacuum pump 2 stage - 1 No
- Weighing scale/platform - 1 No
- Pinch off plier - 1 No
- Tong tester - 1 No
- Sling sychrometer - 1 No

Materials/Components

- Annealed cu tube 6mm - 1 No
- Flare nut brass 6mm - 1 No
- Straight union 6mm - 1 No
- Brazing rod silver/copper - 1 No
- Water tank - 1 No
- Soap water - as reqd
- Eye goggles - 1 No
- Hand gloves - 1 No
- Emery paper - 1 No
- Charging pipe ¼" pipe 6' large - 1 No
- Brazing rod flux - as reqd
- Cotton waste - as reqd
- Angle valve 6mm - 2 Nos
- Refrigerant - as reqd

Equipments

- Window A/C - 1 No

PROCEDURE

TASK 1: **Test the leak in refrigeration system of window A/C.**

1 Connect gauge manifold in to the window A/C charging line and H.P process line as in Fig 1.

2 Make sure that all thread/screw points are in tight fit position.

3 Connect N_2 cylinder line with gauge manifold using charging line.

4 Open the Nitrogen cylinder valve using valve key.

5 Regulate the pressure to 50 psig in the pressure regulator and increase after step by step up to the test pressure level.

6 Open the knob of HP (High pressure) port of gauge manifold by turning the knob gently in anti clockwise direction.

7 Observe the Nitrogen gas flowing into the system through notice the reading in the HP gauge of manifold.

8 Allow the Nitrogen flow for 15-20 seconds

9 Close the manifold valves.

10 Observe the reading in the pressure gauge (HP) manifold.

11 If the pressure not reached 300 psig again allow Nitrogen flow into the system through opening the knob of manifold.

12 Close the knob of gauge manifold

13 When the pressure reached 300 psig, close the valve of Nitrogen cylinder, loose the regulator knob.

14 Take the dry bulb thermometer and find the temperature of ambient air.

15 Note down the time

16 Tabulate the readings in the tabular column Table (1) which is given at the end of this exercise.

17 Remove the charging hose II which inter connects gauge manifold and Nitrogen cylinder.

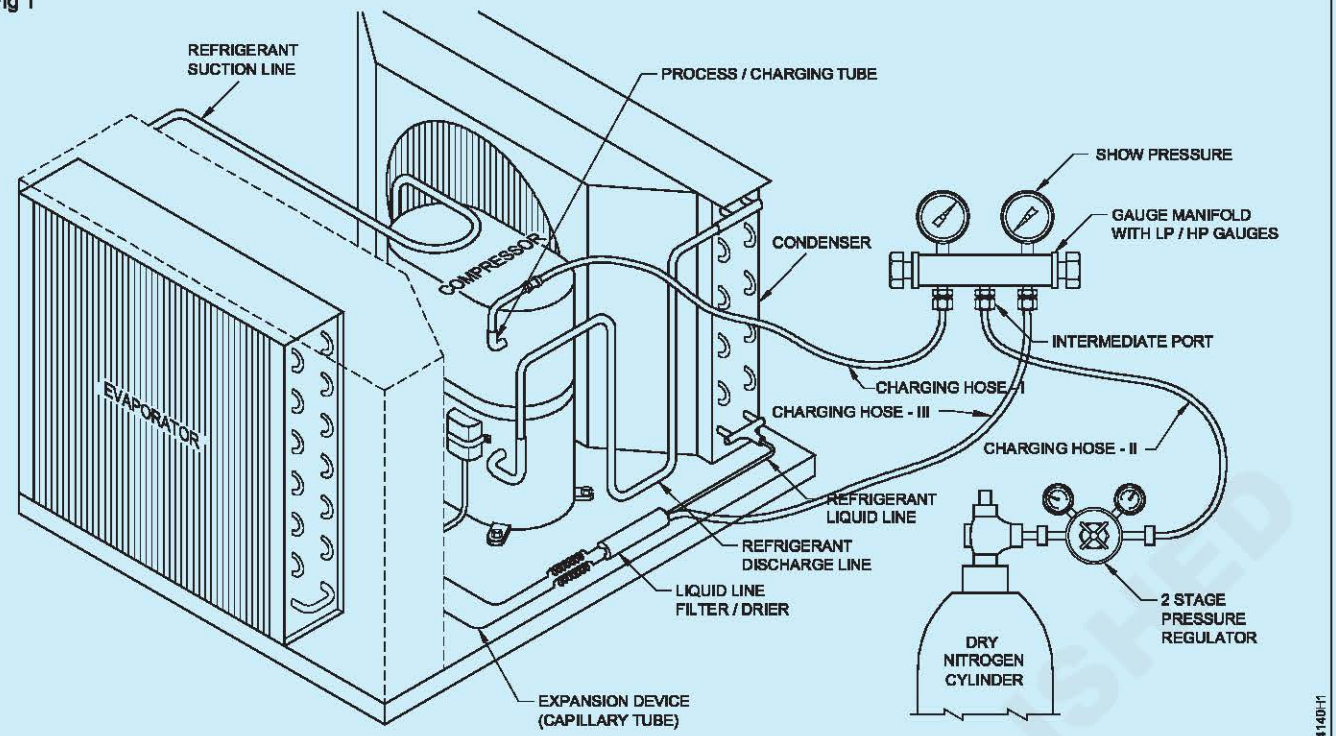
18 Close the intermediate port of manifold by dummy nut brass 6 mm.

19 Observe the reading for 24 Hrs.

20 Apply soap solution on all leak possible spot and conform no leak.

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Fig 1



LEAK TESTING IN WINDOW AIR-CONDITIONER

TABLE1

Sl. No.	Time	N2pressure	Room temperature

TASK 2 : **Evacuate the refrigerant system of window A/C**

1 Vent the N2 pressure through charging port.

2 Connect the vacuum pump through the changing port of the gauge manifold.

3 Open both hand valves of gauge manifold.

4 Switch on the vacuum pump.

5 Observe the reading and leave the system as it is for 3 to 4 hours without any disturbance.

6 Observe and record the vacuum reading on the compound gauge of the manifold.

7 Close hand valve of gauge manifold and stop the vacuum pump.

TASK 3**: Charge the refrigerant in hermetic system of window A/C**

1 Connect service cylinder with gauge manifold and purge changing line.

2 Keep the cylinder on weighting scale and note down the weight.

3 Note the weight of gas to be changed, given by manufacturer.

4 Calculate the final weight of cylinder by subtract weight to be charged from service cylinder weight and note down it.

5 Open gauge manifold valves and service cylinder valve slowly.

6 Wait for weighting scale reading come to final weight.

7 Close the gauge manifold valves and then close the cylinder valve.

8 Wait two minutes and start the unit.

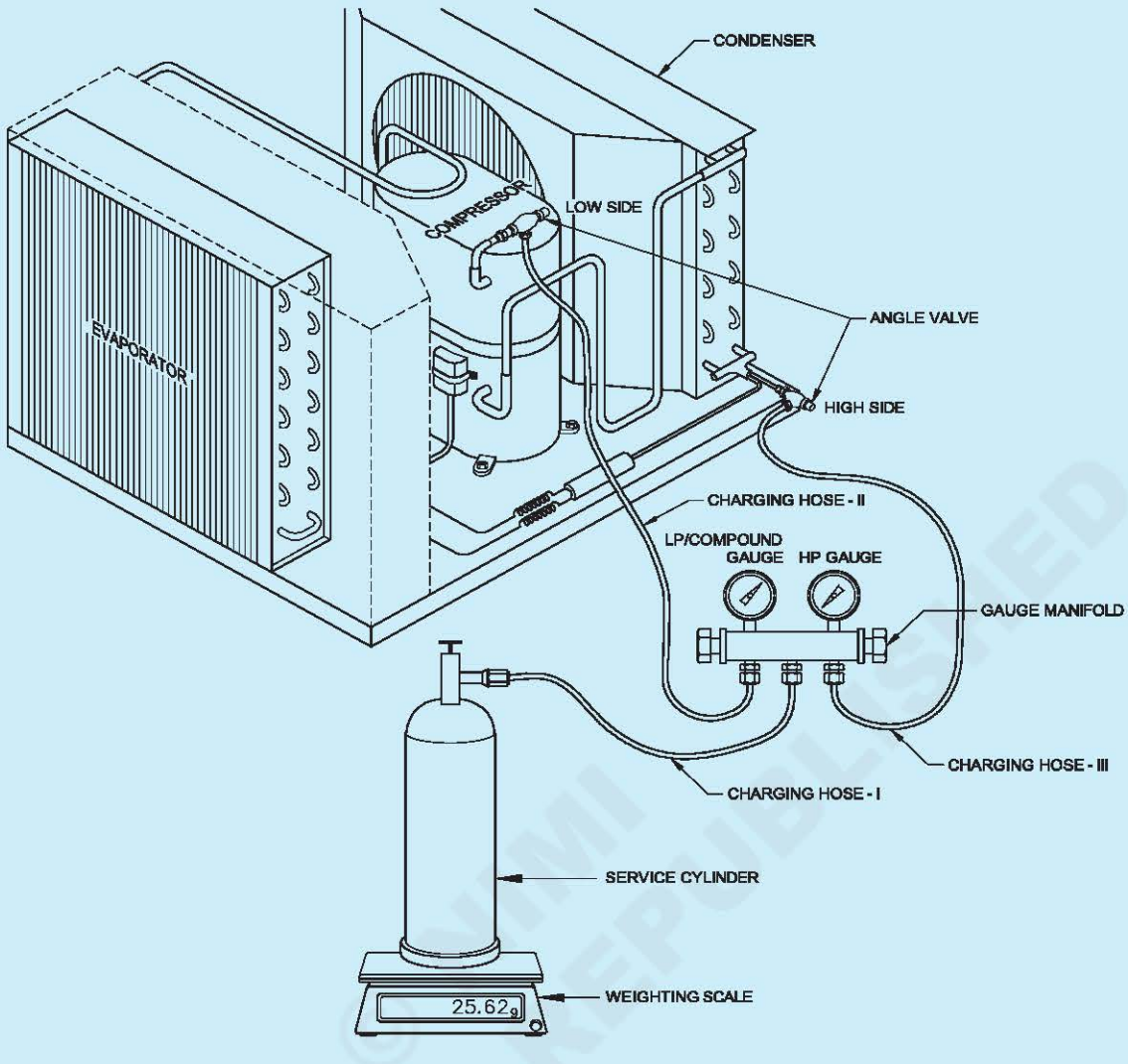
9 Run the unit 5 minutes check current and pressure.

10 Pinch both process lines two places at one inches gap and cut the lines using tube cutter.

11 Braze the mouth and check the performance

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Fig 2



CHARGE REFRIGERANT IN WINDOW A/C SYSTEM BY WEIGHT

TASK 4: **Check the performance of Window A/C**

1 Insert the unit into outer cover.

2 Run the unit atleast 2 hrs after gas charging with fully loaded

3 Now record the evaporator and room temperature.

4 Record starting and running current in table

5 Check the grill temperature it should be 45^0F to 55^0F

6 Check fan motor ampere and check compressor current and note it in Table 2.

7 Check air flow in Air conditioner (ITR = 400 cfm)

8 Compare the air flow with name plate detail

9 Check air filter and dampers for proper functioning.

TABLE2

Sl. No.	Time	Room temperature	Evaporator temperature	Current

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Installation of window A/C

Objectives: At the end of this exercise you shall be able to
- **inspect window A/C**
- **install window A/C.**

Requirements

Tools/Instruments

- Trainees kit
- Tong tester
- Hammer ball head
- Long screw driver 14"
- Cutting plier
- Drilling machines (Hand drilling machine)
- Inch tape
- Spirit level
- Thermometer

Equipments

- Window A/C with outer cover

Materials

- PVC insulation tape 12 mm width - 1 roll
- Voltage stabilizer 3.0 KVA - 1 No
- Clean cloth/sponge - 1 piece
- Marker (small one)

Note: Before you start install the A/C unit, provision should have made for window cutting, wall opening wooden frame. Fix all above work to be completed by carpenter through specification.

PROCEDURE

TASK 1**: To inspect window A/C**

1 Unpack the window A/C with from carton box and remove front grill by unscrew the screws.

2 Pullout the unit from outer cover.

3 Remove packing clamps and packings from the system.

4 Observe any oil tracing in and if found reject the unit.

— — — — — — —

Task 2: **Install window A/C**

1 Fix the outer cover inside the wooden frame with a little slope towards backside and screw it .

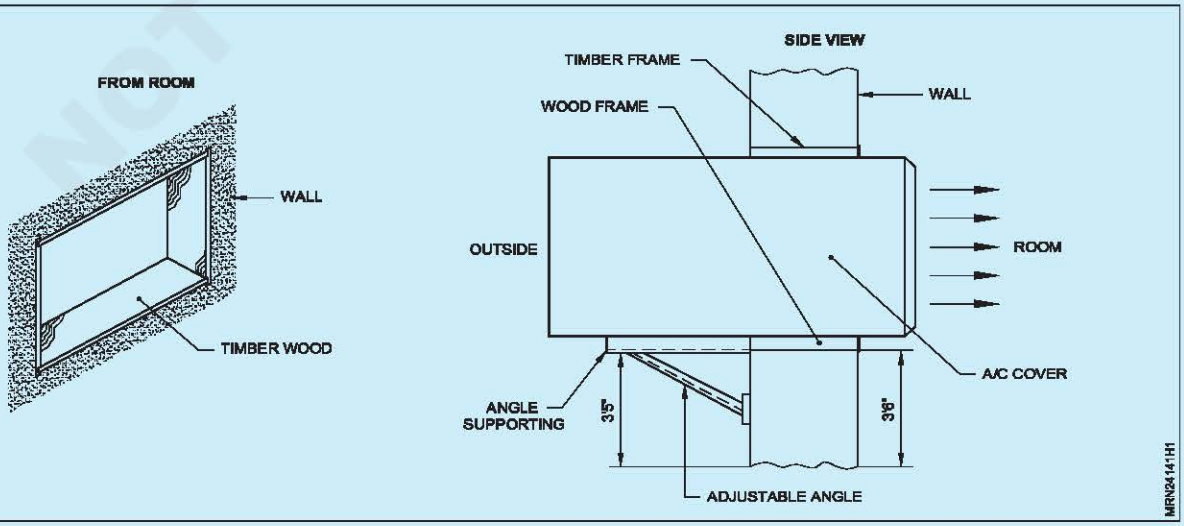
2 Insert the window unit inside outer cover gently.

3. Arrange power point near the unit and give power supply through suitable stabilizer.

4 Fix air filter and front grill run the unit continuously for one hour.

5 Check grill temperature, room temperature, ambient temperature and current drawn by the unit and note down it.

Fig 1



— — — — — — — —

Identify various components of split AC floor, ceiling, ductable and multi split A/C

Objectives: At the end of this exercise you shall be able to
- **identify mechanical and electrical components to of split A/C.**
- **identify mechanical and electrical components to duct-able A/C unit**
- **identify mechanical and electrical components of ceiling mounted split A/C.**

Requirements

Tools/Instruments
- Trainees kit
- Line Tester

Equipments
- Split A/C - 1 No
- Duct able split A/C - 1 No

PROCEDURE

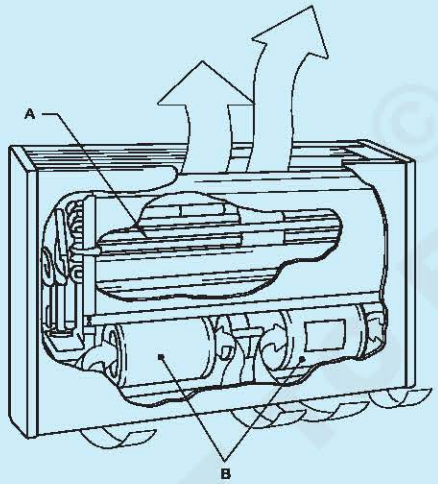
TASK 1: **Identify Mechanical and electrical components of Split A/C**

1 Remove the plug from the unit

2 Remove the grill (front panel) from the cooling unit

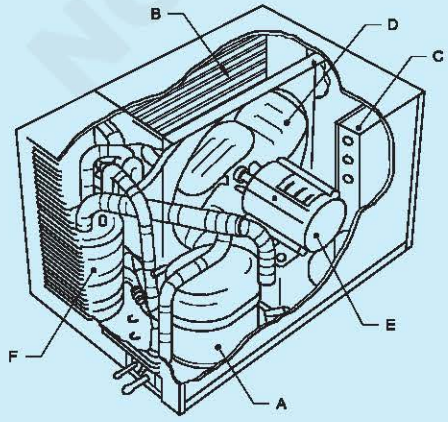
3 Trace wiring, suction and liquid line up to condensing unit.

Fig 1



SPLIT AIR-CONDITIONER INDOOR UNIT

Fig 2



SPLIT AIR-CONDITIONER OUTDOOR UNIT

4 Unscrew the condensing unit outer cover and control panel cover and remove it.

5 Identify the labelled components (Fig 1&2)and record the name of the components and functions in the Table 1 of record sheet.

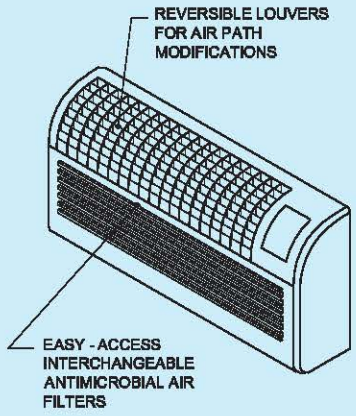
6 Refit the grill control panel cover and condensing unit outer cover.

Table 1

Label No.	Name of the identified Component/part
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	

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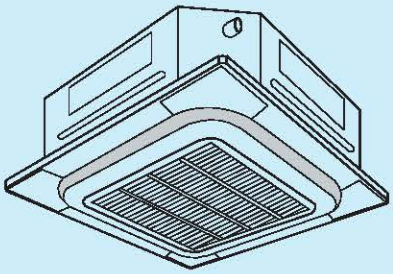
Fig 3



FLOOR MOUNTERD INDOOR UNIT

MRN25145H3

Fig 4



CASSETTE MOUNTED SPLIT A/C

MRN25145H4

TASK 2: I**dentify mechanical and electrical components of duct-able A/C unit**

1 Remove the plug from the unit

2 Remove front grill & other fittings drain out etc.

3 Remove the supply duct and return duct assembly from the indoor unit

4 Remove the side cover from the indoor unit

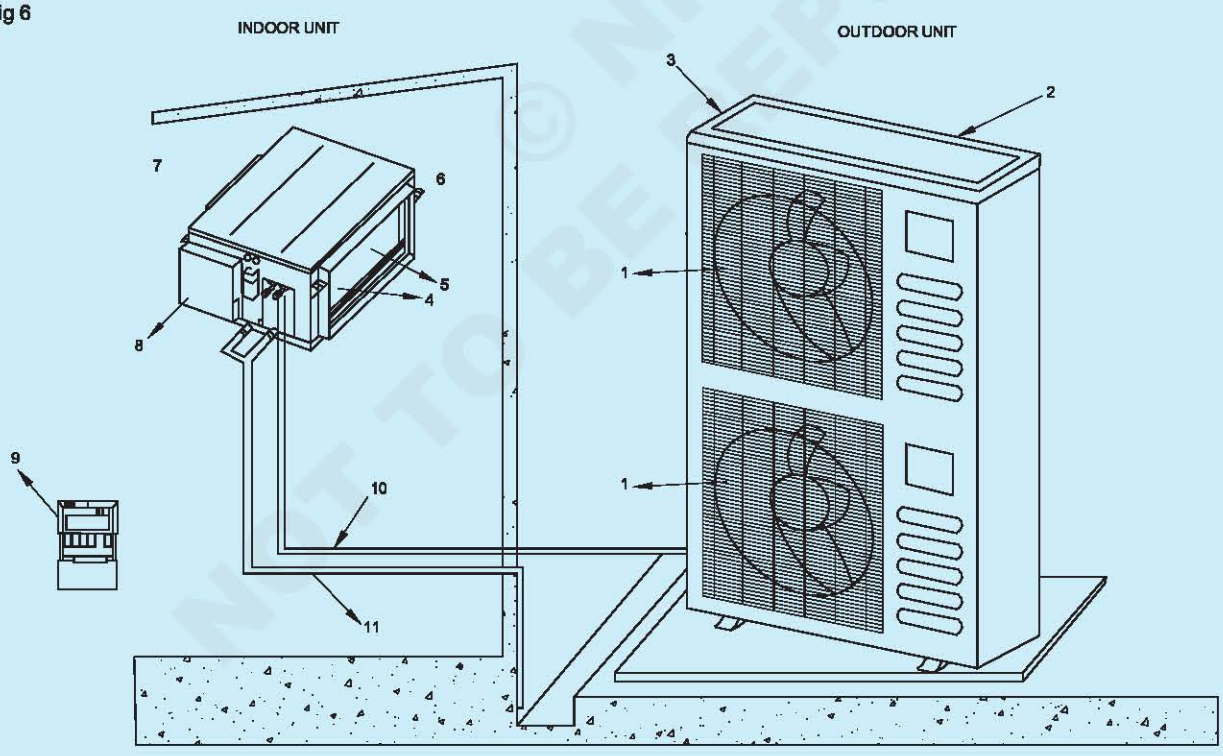
5 Trace the wiring suction and liquid line up to condensing unit

6 Unscrew the condensing unit outer cover and control panel cover and remove it

7 Identify the labelled components Fig 6 and record the name of the components and functions in the Table 2 of record sheet

8 Refit the grill, control panel cover, indoor unit cover and condensing unit cuter cover.

Fig 6

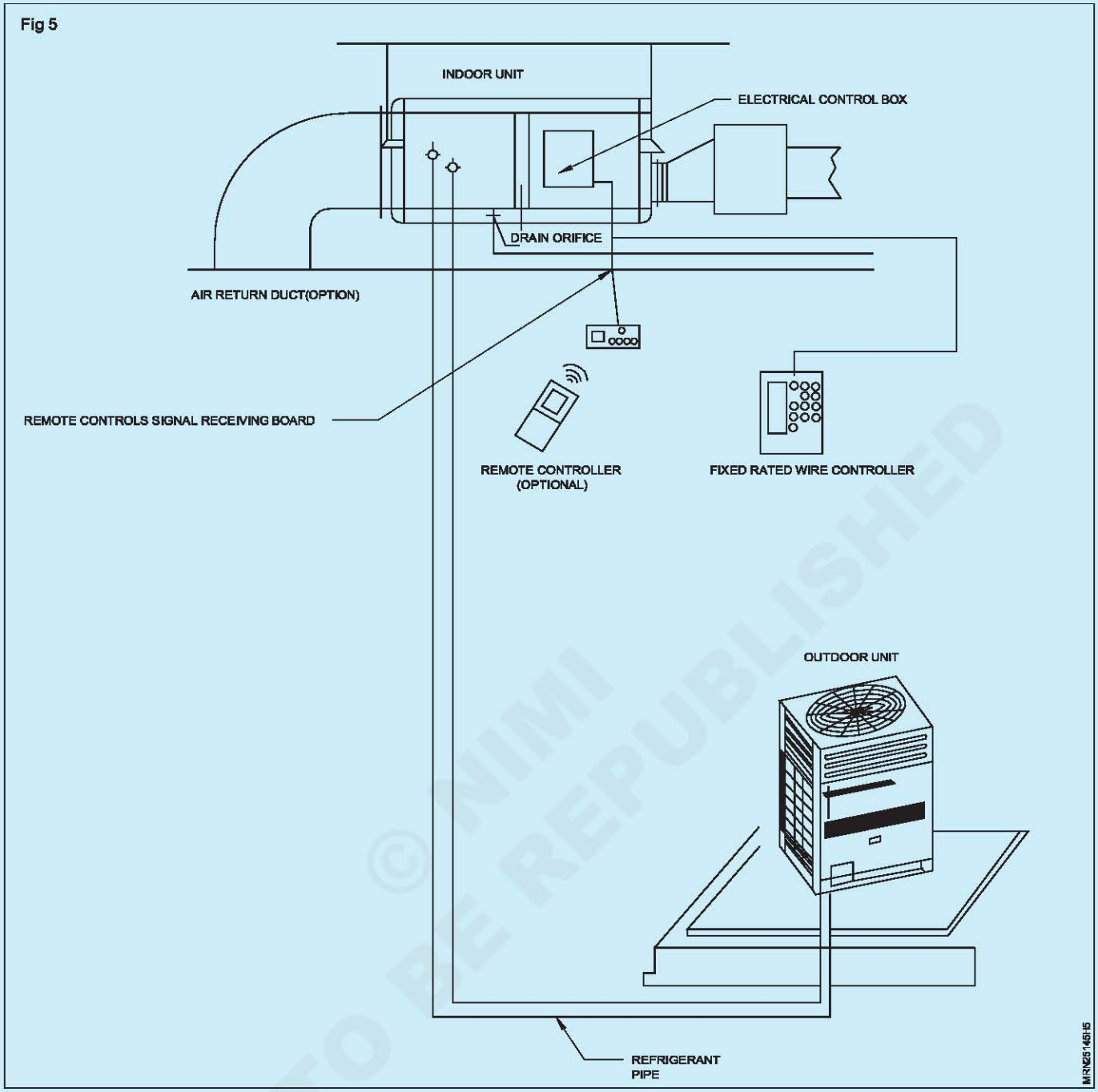


1.AIR OUTLET
2.AIR INLET
3.AIR INLET(SIDE AND REAR)
4.AIR FILTER(INSIDE AIR-IN GRILL)
5.HEAT EXCHANGER
6.AIR INLET
7.AIR OUTLET
8.E - BOX
9.WIRE CONTROLLER
10.REFRIGERANT PIPE
11.DRAIN HOSE

MRN25145H6

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Fig 5



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Table 2

Label No.	Name of the identified component/part	Function
1		
2		
3		
4		
5		
6		

Label No.	Name of the identified component/part	Function
7		
8		
9		
10		
11		

TASK 3 : **Identify mechanical and electrical components of ceiling mounted split A/C**

1 Remove the plug from the unit.

2 Remove front grill and other fittings.

3 Identify the labelled components and record file name component and functions in the task to record sheets

4 Un screw the condensing unit outer cover and control panel cover and remove it.

5 Identify the labelled components (Fig) and record the name of the components and functions in the table of record sheets.

6 Refitting the grill, control panel cover, indoor unit cover and condensing unit over cover.

Fig 1

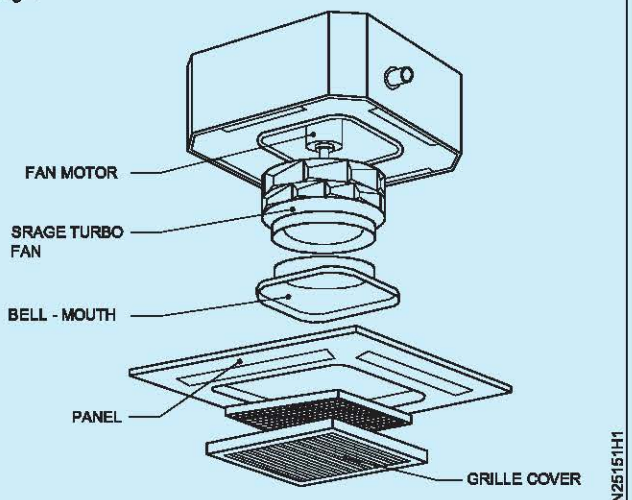
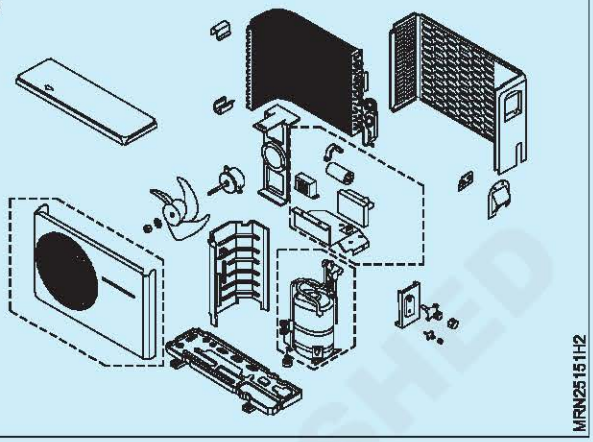


Fig 2



S.NO	Mechanical parts name	Electrical parts name
1		
2		
3		
4		
5		

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Identify electrical circuit of wall mounted split A/C

Objective: At the end of this exercise you shall be able to
- **identify electrical circuit of split A/C unit.**

Requirements

Tools/Instruments

- Screw driver - 1 No
- Tester - 1 No
- Cutting plier - 1 No
- Nose plier - 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 electrical circuit of wall mounted split A/C**

1 Switch off the unit and remove plug from the socket

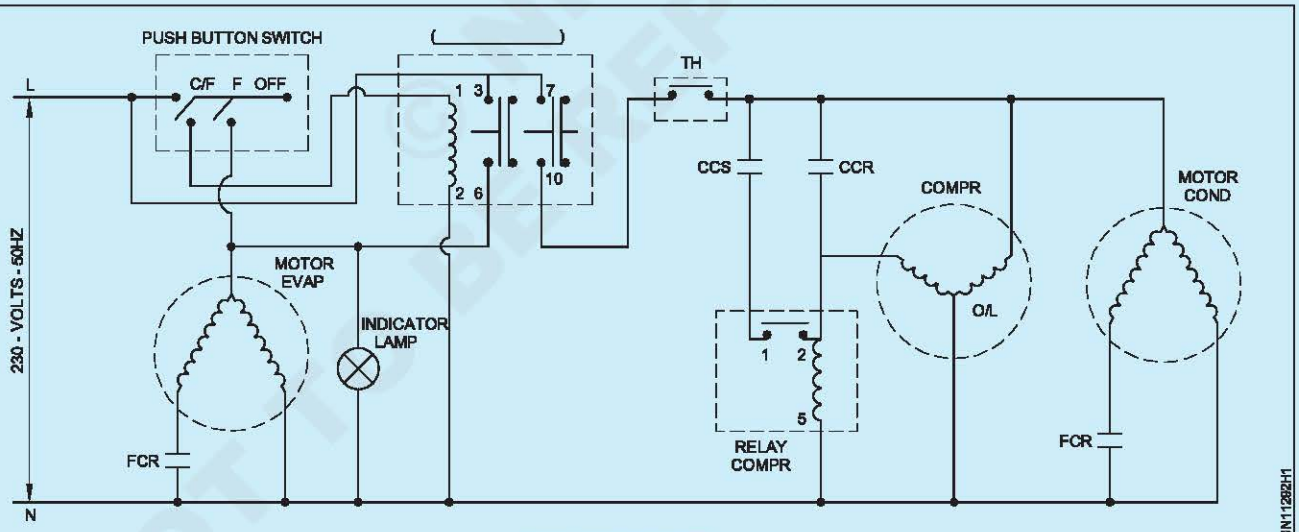
2 Remove the grill front panel from the indoor unit.

3 Remove the panels from the outdoor unit.

4 Short the capacitor, if present in the circuit.

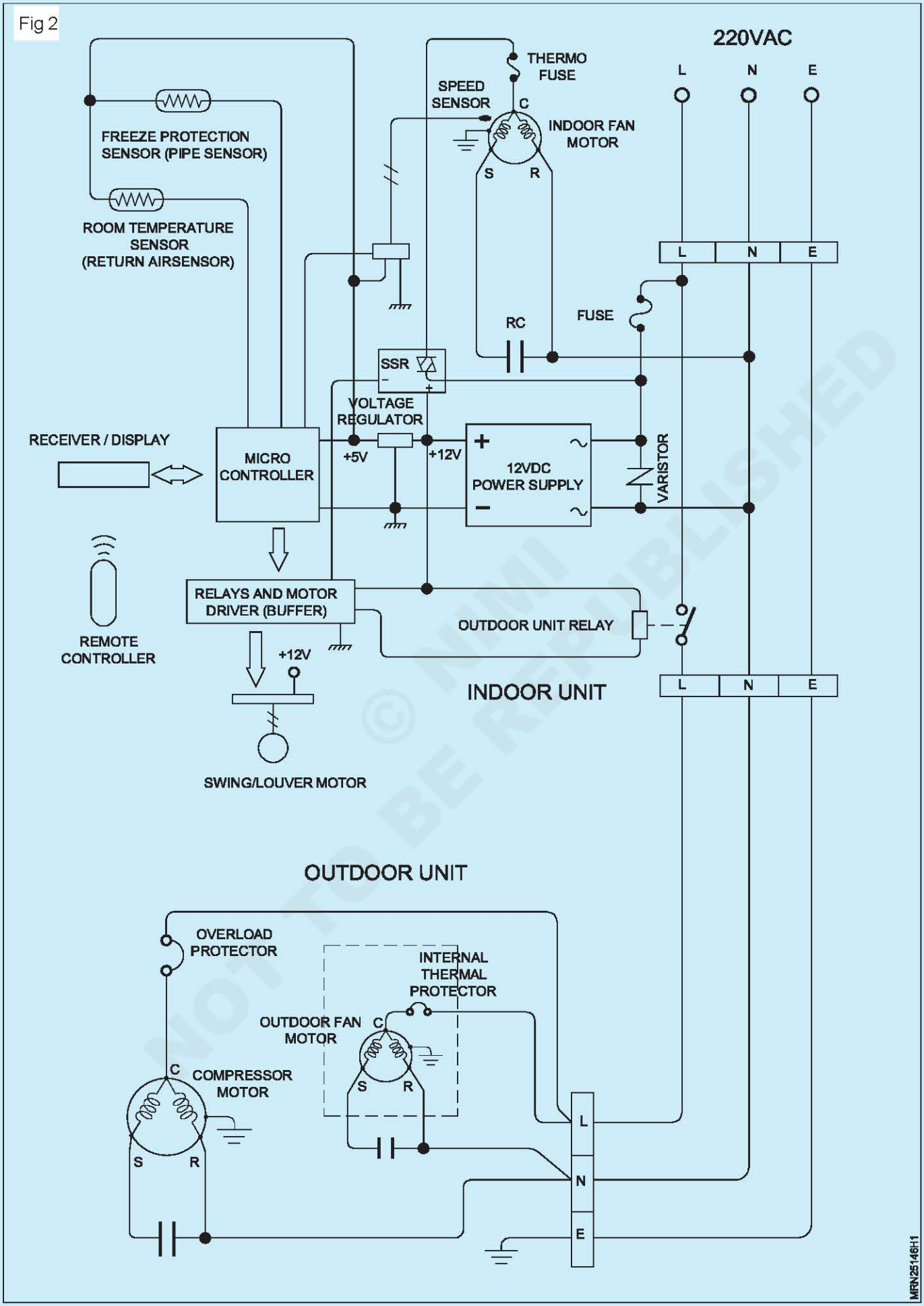
5 Identify the circuits given below.

Fig 1



NOT TO BE REPUBLISHED

Fig 2



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Test different components and fault findings in split A/C

Objectives: At the end of this exercise you shall be able to
- **carry out a test on fan motor**
- **carry out a test on capacitor**
- **carry out a test on relay**
- **carry out a test on OLP**
- **carry out a test on compressor**
- **carry out a check of wiring.**

Requirements

Tools/Instruments

- Line tester - 1 No.
- Ohmmeter - 1 No.
- Soldering iron - 1 No.

Materials/components

- Test cords - 1 No.
- Test board - 1 No.
- Test lamp with holder 200W - 1 No.
- Insulation tape - 1 roll
- Complete system of an Air-conditioner - 1 No.
- Fan motor - 1 No.
- Capacitor (run) 36 mfd - 1 No
- Capacitor (start) 100 to 120 mfd - 1 No.
- Relay (potential) - 1 No.
- OLP - 1 No.
- Soldering wire & flux wire 3/20 each colour - 2 mts
- Clips -10 Nos.

PROCEDURE

TASK 1: **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 Disconnect fan motor leads from circuit.
8 Give power connection and run it.
9 If it is run the fan motor in good condition.
10 If the fan does not run remove and service it.
11 Fix back the motor and check the alignment

— — — — — — — —

TASK 2: **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.

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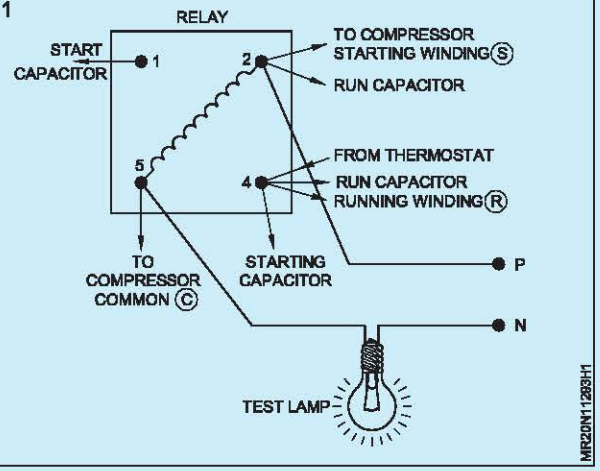
TASK 3: **Carry out a test on relay**

1 Touch the series lamp leads to '5' and '2' of the relay
2 Relay make a tic sound.
3 Touch test leads 5 to 1 relay make a chatting sound then the potential relay is found correct.

— — — — — — — —

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Fig 1



TASK 4: **Carry out a test on OLP.**

1 Switch OFF the unit.

2 Remove the compressor terminal cover.

3 'ON' the test lamp

4 Place test lamp one probe to '1' and the other to '3' of the overload.

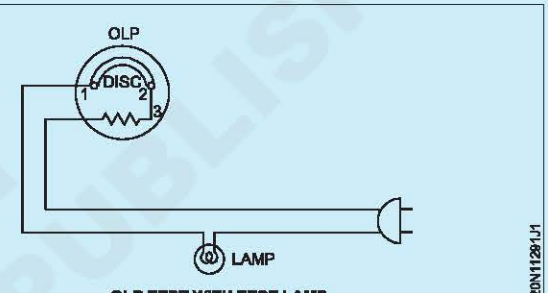
5 The bulb will glow if continuity is available in overload.

6 If the bulb does not glows, this would indicate the overload is open. Wait for 10 to 15 minutes to get cut in overload.

7 If it does not cut back in 10 to 15 minutes the overload should be changed.

8 If overload does not cut in, check for cause of overloading or overheading.

Fig 1



OLP TEST WITH TEST LAMP

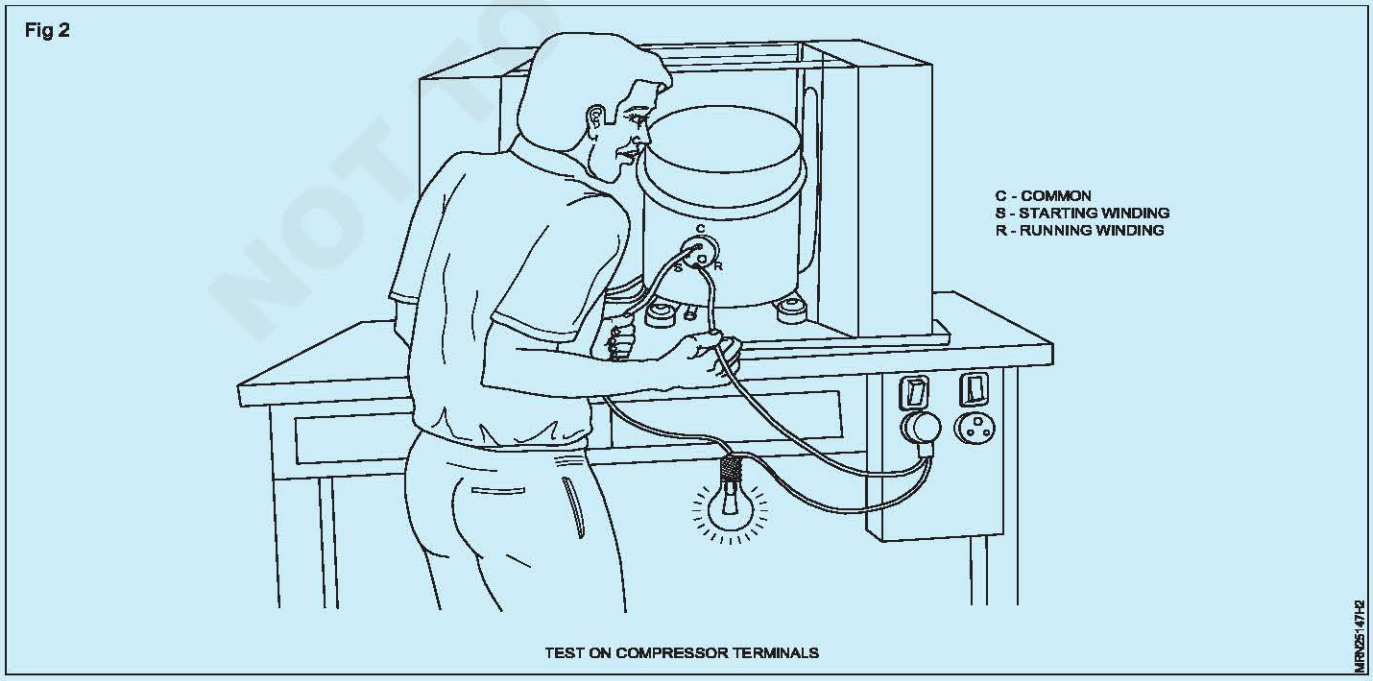
TASK 5: **Carry out a test on compressor.**

1 Check compressor motor for open circuit.

2 Check compressor motor for ground.

3 Check compressor motor for short circuit.

Fig 2



TEST ON COMPRESSOR TERMINALS

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Leak testing evacuation and gas charging in split A/C

Objectives: At the end of this exercise you shall be able to
- **test the leak in (floor/ceiling mounted) split air conditioner**
- **evacuate the split air conditioner**
- **gas charging in split air conditioner.**

Requirements

Tools/Instruments

- Nitrogen cylinder with 2 stage pressure regulator - 1 set
- Gas brazing torch with hoses and oxygen, LPG cylinder - 1 set
- Gauge manifold with LP/HP gauges - 1 No.
- Double ended spanner Nos. 6/7 to 20/22 - 1 set
- Adjustable spanner 6"(15 cm) - 1 No.
- Flaring block with yoke - 1 set
- Painting brush 1" 25mm - 1 No.
- Charging hose - 2 Nos.
- Cutting plier - 1 No.
- Cylinder key - 1 No.
- Dry bulb thermometer (stem alcohol type) 0 - 100°C - 1 No.
- Eye goggles - 1 pair
- Hand gloves - 1 pair
- Vacuum pump 2 stayed - 1 No
- Weighing machine - 1 No
- Tong tester - 1 pair
- Halide torch - 1 pair
- Refrigerant cylinder - 1 pair

Materials/Components

- Copper tube soft annealed 24 swg 1/4" OD (6mm) - 15 cm
- Flare nut brass 1/4" (6mm) - 1 No.
- Flare union brass 1/4" (6mm) - 1 No.
- Flare dummy nut brass 1/4" (6mm) - 2 Nos.
- Brazing rod silver or copper - 1 No.
- Plastic / metal mug 1 liter water volume - 1 No.
- Angle valve brass 6mm flare - 1 No
- suitable refrigerant - 2 kg

Equipments

- Split type air conditioner (Floor /ceiling mounted) - 1 No.

PROCEDURE

TASK 1: **Connect the system with gauge manifold and Nitrogen cylinder.**

1 Make sure that all pipe joints, flare points are properly brazed/ connected firmly

2 Open both service valves open.

3 Connect one end of charging hose I to the gauge port of liquid service valve

4 Connect the other end of charging hose I to high pressure (HP) port of the gauge manifold.

5 Connect one end of charging hose II to intermediate port of gauge manifold.

6 Connect the other end of charging hose II to the valve of Nitrogen cylinder through two stage pressure regulator

7 Make the joints of charging hoses tighten by using cutting pliers.

8 Connect charging hose 3 between suction service valve and L.P side of gauge manifold.

— — — — — — — —

TASK 2: **Charge Nitrogen gas into the system.**

1 Make sure that the high pressure and low pressure (HP & LP) ports of gauge manifold are closed by checking the knobs

2 Open the Nitrogen cylinder valve using valve key

3 Regulate the pressure to 50 psig in the pressure regulator and increase after step by step upto the test pressure level

4 Open both knobs of gauge manifold

5 Observe the Nitrogen gas flowing into the system through identifying Nitrogen escaping from gauge port of suction service valve

6 Observe the Nitrogen pressure starts to build up by watching the reading in the high pressure gauge of manifold.

7 Allow the Nitrogen flow for 20-30 seconds until the pressure reaches to the limit (300 psig.)

8 Close the knobs of gauge manifold.

9 Ensure that the system has got Nitrogen pressure by the reading on the pressure gauge

10 Close the Nitrogen cylinder and loose the regulator knob.

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11 Take the dry bulb thermometer and find the temperature of ambient air.

12 Note down the time.

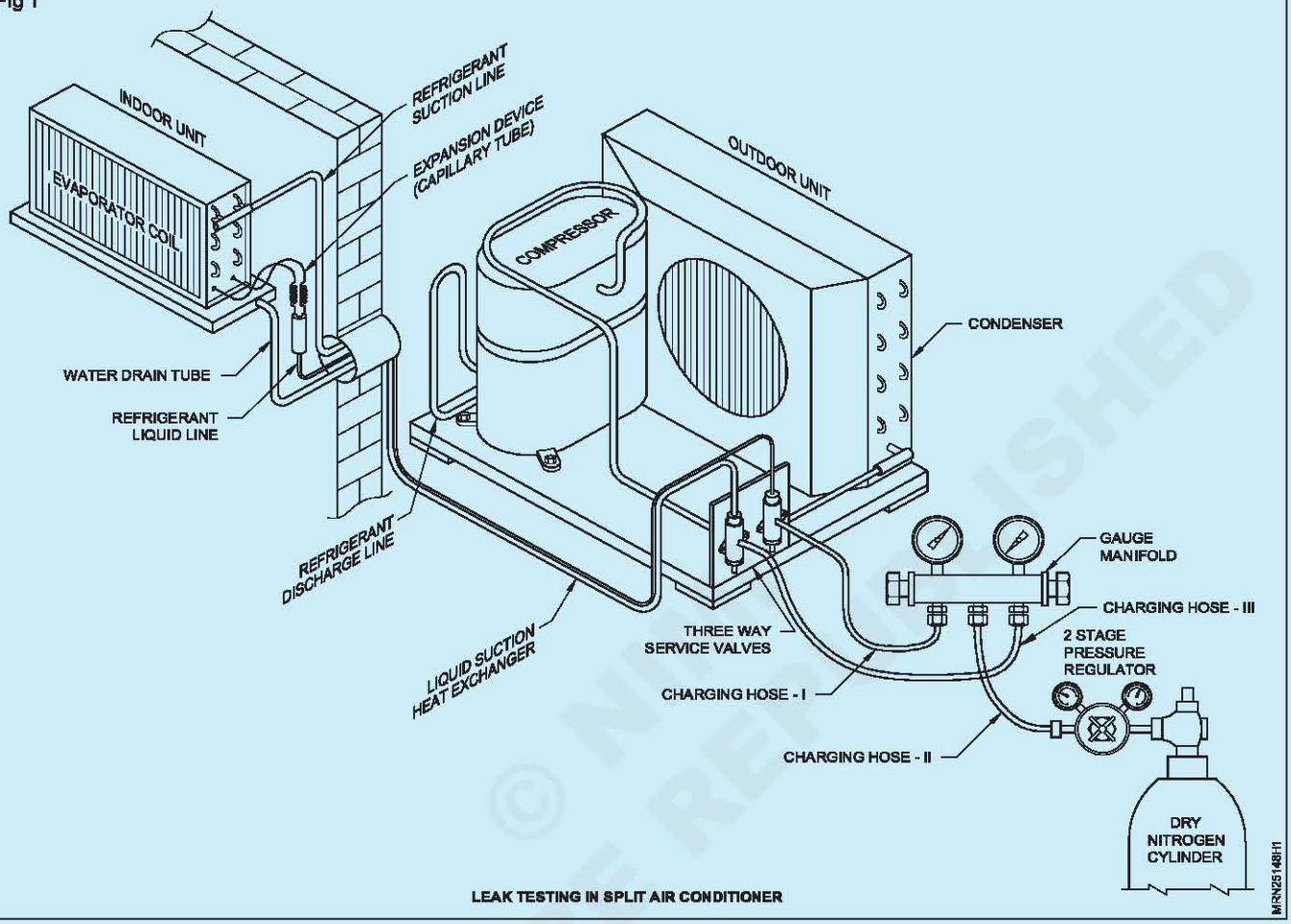
13 Tabulate the readings in the tabular column I which is given at the end of this exercise

14 Close the gauge manifold charging ports by flare dummy nut.

15 Remove the charging hose I & II from gauge manifolds and Nitrogen cylinder

16 Observe the reading for 2A hrs.

Fig 1



LEAK TESTING IN SPLIT AIR CONDITIONER

— — — — — — —

TASK 3: **Test leak with soap solution.**

1 Make the soap solution in a container by using soap concentrate and pure water

2 Make lather in the solution with sponge

3 Apply the soap solution on the joints (screwed/threaded and braced) by using brush.

4 Apply lather/foam on the joints by using sponge, if necessary

5 Carefully watch any Nitrogen bubbles escaping through the leak spots

6 Check bubbles found at any joint (if it is screwed/ threaded joints arrest the leak by using spanner/cutting plier) mark the joint by using permanent market pen.

7 Arrest leak at the brazed joints, confirm the leak and note down to carry out repairs.

8 conform there is no leak at any joints, leave the system as it is, hold the pressure for next 24 hrs (1 day)

9 Release the N_2 present and braze the leaking point.

10 Cavy out leak testing again after 24 hrs remove the scummy cap port of gauge manifold

11 Release N_2 gas by opening hand valves of gauge manifold and perform vacuuming.

Table 1

Sl.No	Time	N2 pressure	Room temperature

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TASK 4: **Connect the system with vacuum pump.**

1 Connect one end of charging hose (i) to the high pressure side (condenser outlet) and connect other end to HP(high pressure) port of gauge manifold.

2 Connect one end of charging hose (ii) to the low side (compressor process tube) and connect other end to the LP(Low pressure) port of gauge manifold.

3 Connect one end of charging hose (iii) to the intermediate port of gauge manifold and connect the other end to inlet of the vacuum pump.

4 Tighten the charging hose connection by using cutting pliers (for charging hoses), suitable size double ended spanner (for flare nuts, flare unions, flare dummy nuts etc.).

5 Make sure that the HP/LP knobs of gauge manifold should be closed.

— — — — — — — —

TASK 5: **Handle and operate vacuum pump.**

1 Confirm the electrical power supply available (1 phase, 220V, 50Hz, AC) to the vacuum pump by using a online tester and voltmeter/multimeter.

2 Plug in the power line of vacuum pump to the power socket (Test board/switch board)

3 Switch ON the vacuum pump

4 Open the valve knobs (HP and LP) gauge manifold by one by one.

5 Observe the reading available on the compound gauge of manifold. Ensure the pressure is reducing.

6 Leave the system as it is for 3 to 4 hours without any interruption/disturbance.

— — — — — — — —

TASK 6: **Dehydrate the system.**

This task is to be carried out after 2 hours from the time of switched ON vacuum pump.

1 Take a heating kit (Infrared lamp/Hot air gun) and switch ON.

2 Make sure that the system is getting vacuum and the vacuum pump is functioning.

3 Apply heat by heating kit uniformly to all areas of the system - Refrigerant tubes, condenser coil, evaporator coil, liquid line drier/filter, capillary tube etc.

4 Keep and maintain the distance between the heating kit and surface of system (15 cm) always.

Caution: Avoid/take care when heating the areas near electrical wirings / connections.

5 Continue the process for 30 min.

6 Leave the system as it is under vacuuming.

— — — — — — — —

TASK 7: **Evacuate the system completely.**

1 Notice and observe the pressure reading on the compound gauge of the manifold, it should be 100 microns or below (equivalent to -30 inches of Hg.)

2 Close LP/HP knobs of gauge manifold one by one.

3 Switch OFF the vacuum pump and disconnect the power plug.

4 Leave the system as it is to hold vacuum for one hour.

— — — — — — — —

TASK 8: **Ensure the system evacuated.**

1 Note the reading available on the compound gauge and it should be not less than the vacuum level which is achieved in previous task (i.e. -30 in Hg. or equivalent).

2 Note down the reading in the record sheet.

Procedure 8 and 9 to be carried out quickly (within 10 sec.) or as immediately as possible to avoid air entry into the system at any cause.

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Record sheet

Name of the Unit : Split AC
Heat removal capacity : Kcal/Hr
Model No. :

Table 2

Sl. No.	Date	Time				Vacuum Achieved		Remarks
		Evacuation		Dehydration				
		Start	End	Start	End	Mic.	in Hg.	
		Hrs.min	Hrs.min	Hrs.min	Hrs min			Vacuum checked Level ..... after .... hour

TASK 9: **Charging the system**

1 Charge gas immediately after evacuation.

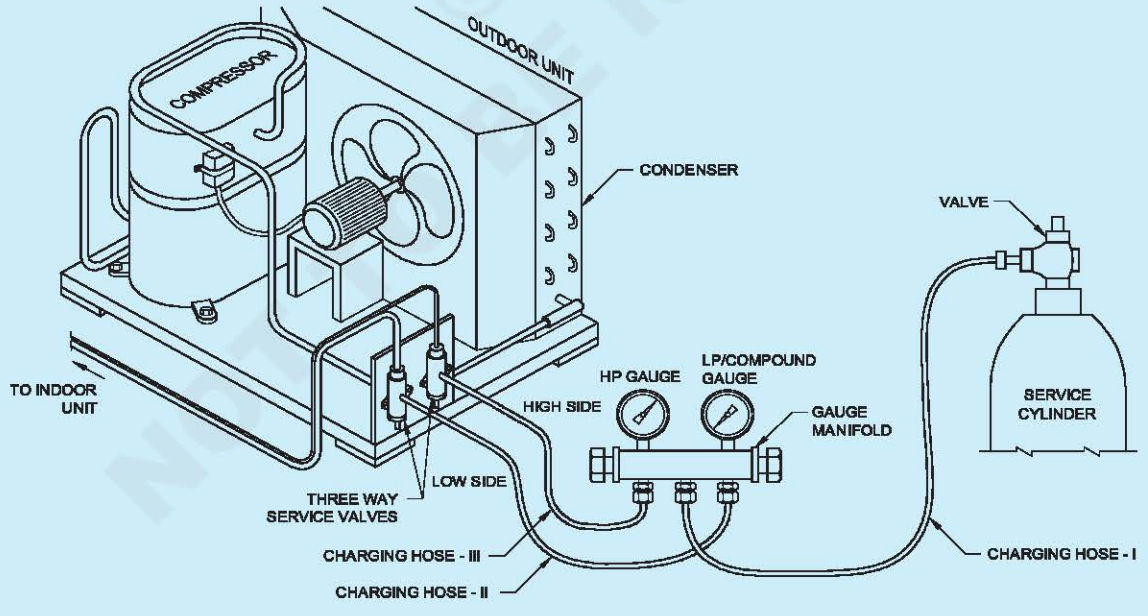
2 Connect one end of charging hose to the valve of service cylinder and connect the other end to the centre port of gauge manifold.

3 Open the service cylinder valve gently by turning the knob 1/2 to 1 turn to anticlockwise direction using valve key.

4 Purge the charging hose-3 by lossening its end at the centre of gauge manifold.

5 Observe and let the refrigerant escape out at centre port of manifold in the form of snow, them immediately tighten the end of charging hose-3 and ensure that the escape/release of refrigerant is arrested.

Fig 3



CHARGE REFRIGERANT IN SPLIT A/C SYSTEM USING SERVICE CYLINDER METHOD

TASK 10: **Charge refrigerant in to the system**

Make the wiring ready to switch "ON" the compressor and fan motor when required.

Keep the evaporator of the AC unit facing inside of a closed room/test chamber (preferred size 3m length X 3 m breadth X 3 m height)

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1 Open (partial) the low side and high side service valves one by one.

2 Observe the refrigerant flow by feeling cold in charging line and liquid line using hand/finger .

3 Observe the refrigerant flow also in LP and HP gauges and ensure that it is increasing from vacuum (LP gauge) and ' O' level (HP gauge) to above 'O' psig onwards.

4 Observe the hissing noise into the compressor during the pressure is increasing from vaccum to above positive pressure level that indicates the vaccum is breaked.

5 Open the service cylinder valve fully.

6 Fully open the valve knob LP sides of manifold.

7 Allow the refrigerant flow till it reaches 30-50 psig in the LP gauge of manifold. Then immediately close the L.P valve of gauge manifold.

8 Test the electrical power supply available and voltage is 180-230 volts by using a tong tester

10 Observe that the compressor is working by hearing the mild noise and by measuring the amperage/current using tong tester. It will be below than the full load current value which can be found from the manufacturers data.

(Note: Full load current values (amps) for some (1 phase) compressors are as follows.

S.No.	Capacity	Refrigerant	Full load Current (in Amps)	Power (KW)
1	1.0 TR	R-22	6.8	1.45
2	1.5 TR		9.1	2.0
3	2.0 TR		13.6	2.8

12 Observe the reading on the LP gauge and ensure it is 'O' or above 'O' psig level.

If the pressure in the LP gauge shows below 'O' psig level, then immediately turn the selector switch to FAN position and ensure the compressor is OFF.

Precharge additional refrigerant by reopening the angle valve (any one side) for 5-10 seconds; then turn the selector switch to 'cool' position.

Keep away heating/cooling appliances if any, presence near the appliance/system.

13 Open (more) the low side service valve to allow the refrigerant sucked by the compressor.

15 Observe the pressure readings on both LP & HP gauges and current drawn by the appliance/system.

16 Observe the cooling effect in the low side air (supply air to the room) and heating effect 'in the high air. (Exhaust air to the ambient)

17 Observe the level of heat on liquid line by touching it by hand/fingers; it may be above ambient temperature.

18 Allow the refrigerant flow till sweating (moisture condensation) of suction line or suction and discharge pressure reaches to desired limits.

For A/C application with R-22/410/417C refrigerant

Suction pressure .... 77 psig

Discharge pressure .... 300 psig

Current drawn .... Refer

Note of procedure 10

19 Close the low side valve knob of manifold.

20 Observe the final readings of suction pressure, discharge pressure and current consumption and record the values in the tabular column/record sheet.

21 Close the service cylinder valve using wrachet key and cap with dummy nut.

22 Remove the charging hoses (I, II, III) from wherever these are connected.

23 Test the cylinder valve for any leaks using soap solution.

If any leak found at outlet of valve, close the stem tightly till the leak arrested.

24 Measure the weight of cylinder using a weighing scale and record the value.

25 Let the appliance/system to work for some time.(1 hour)

26 Measure indoor and outdoor air conditions (dry bulb temp. DBT & wet bulb temp. - WBT) using a sling psychomotor.

Keep constant load to the appliance/system during charging process to facilitate setting of low and high side pressures correctly.

Keep the service cylinder into the warm water bath to improve the refrigerant flow during low ambient conditions. (below 25°C).

General note on charging process

1 While using service cylinder, Low Pressure (LP) and High Pressure (HP) of the system carefully to be watched to correctly judge the charge is complete.

2 If the refrigerant is disconnected before or after, long time reaching the required pressures. Under charge or over charge may occur which will result in poor system performance.

Record Sheet

Name of the appliance : Floor/ Ceiling mounted/Split AC

Cooling capacity : .....K.Cal/hr

Date :

Sl No	Time	Indoor condition (^{0}C)		Outdoor condition (^{0}C)		Pressure Kg/cm^2/ (psig.)		Voltage	Current	Cylinder Weight (Kg)		Net Refrigerant charge	Air Velocity
	Hrs/min	DBT	WBT	DBT	WBT	LP	HP	Volts	Amps	Before charge	After charge	(Kg)	m/sec

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Troubleshooting in split A/C

Objectives: At the end of this exercise you shall be able to
- **install ODU and IDU of split package A/C unit**
- **trouble shooting in split A/C.**

Requirements

Tools/Instruments

- 12" pipe wrench - 2 Nos
- 14 to 21 and 24 to 27 double ended spanners - 1 Set each.
- Valve key 6.4 mm - 1 No.
- Spirit level - 1 No.
- Charging hoses - 2 Nos
- Tong tester - 1 No.
- Line tester - 1 No.
- Compound gauge - 1 No.
- Pressure gauge (0 to 30 kg/cm^2) - 1 No.
- Measuring tape 5 mtr - 1 No.
- Drill bit - as per need
- L-Allen key - 1 Set
- Flaring tools - 1 No.

Materials

- Clean cloth
- Insulating material - as per need
- Nut - bolts - as per need

Equipment

- Split package A/C with ODU and IDU
- Drill machine - 1 No.

PROCEDURE

TASK 1 : **Install ODU and IDU of split package A/C unit**

1 Find a suitable location to install ODU (refer ex -No.301)

2 Identify the pipe sitings between ODU and IDU as per the installation manual.

3 Identify the site of the ducts to be used.

4 Cut out the holes for supply air duct and return air duct as per the determined duct sites.

5 Place the ODU on a solid, permanent, corrosion and weather - resistant plat form. Check the flatness of plat form.

Note : A concrete pad constructed according to the following dimensions is recommended 6" thick 48" wide and 60 long with apron in front condenser coil.

6 Coat the bottom of the unit with liquid or semi liquid water proofing compound such as cement or hot tar.

7 Install the air handling unit with cooling coil and blower along with blower motor.

8 Join the condenser outlet from ODU with the A-type cooling coil inlet through flaring nut.

9 Connect the suction line between A-type cooling coil and compressor by flaring nut or brazing.

10 Install an air filter in the path of return air to A-type cooling coil.

11 Insulate all the pipings and ducts with proper insulating material (refer ex - 264)

12 Use a vibration isolator between AHU and supply air duct.

13 Operate and check the performance of the unit.

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TASK 2 : **Troubleshoot and repair split AC**

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Condenser fan motor runs, but compressor hums and will not start

Cause	Symptoms	Remedy
Low voltage	Test lamp or voltmeter indicates inadequate voltage at compressor.	Check line voltage. Determine the location of the voltage drop.
Faulty wiring	Test lamp or voltmeter indicates inadequate voltage at compressor.	Check wiring and make necessary repairs.
Defective compressor	Test lamp or voltmeter indicates adequate voltage available at compressor.	Replace compressor.
High head pressure	Higher than normal head pressure for existing conditions.	Check head pressure and complete operation of system to remove the cause of high pressure condition.
Failure of one phase (Three phase only)	Test lamp or voltmeter indicates no voltage from one phase to ground.	Check fuses and wiring.
Defective start capacitor (Single phase only)	Starting capacitor does not indicate rated capacitance.	Replace capacitor.
Defective potential relay. (Single phase only)	Potential relay contacts do not close for starting	Replace potential relay.

Compressor will not start

Cause	Symptoms	Remedy
Thermostat setting too high	Thermostat setting above the room temperature.	Reset thermostat below room temperature.
High head pressure.	Starter overload cuts out.	Reset slarter overload and determine cause of high head pressure.
Defective pressure switch	Pressure switch contacts remain "Open" regardless or pressure.	Repair or replace pressure switch.
Loss of refrigerant charge	Pressure switch contacts "Open".	Check system for leaks, repair and recharge system.
Compressor frozen	Electrical system in operating condition with adequate voltage at the compressor.	Repair or replace compressor.

Compressor short-cycles

Cause	Symptoms	Remedy
Defective thermostat.	Thermostat differential too close.	Replace thermostat.
Incorrect setting of low pressure side of pressure switch.	Compressor cycling on low pressure switch.	Reset low pressure switch differential.
Low refrigerant charge.	Compressor cycling on low pressure switch.	Check system for leaks, repair and add refrigerant.
Defective overload.	Compressor cycling on overload	Replace overload.

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Dirty or iced evaporator.	Compressor cycling on low pressure switch.	Clean or defrost evaporator.
Evaporator blower and motor belts slipping.	Compressor cycling on low pressure switch.	Tighten or replace bells.
Dirty or plugged air fitters.	Compressor cycling on low pressure switch.	Clean or replace air filters.

Compressor runs continuously

Cause	Symptoms	Remedy
Excessive load.	High dry bulb or wet bulb temperature in conditioned area.	Check for excessive outside air, infiltration and excessive source of moisture.
Air or non-condensable gases in the system.	Higher than normal head pressure.	Purge system.
Thermostat setting too low. in conditioned area.	Lower than normal temperature	Reset thermostat.
Dirty condenser.	Higher than normal head pressure.	Clean condenser.
Condenser blower and motor belts slipping.	Higher than normal head pressure.	Tighten or replace belts.
Low refrigerant change.	Lower than normal suction pressure.	Check system for leaks, repair and add refrigerant,
Overcharge of refrigerant.	Higher than normal head pressure.	Purge and remove excess refrigerant.
Compressor valves leaking.	Pressures equalize rapidly when the system is turned off.	Replace valve plate assembly or the complete hermetic compressor.
Expansion valve or starter plugged	Lower than normal suction pressure.	Clean expansion valve or strainer.

System short of capacity

Cause	Symptoms	Remedy
Low refrigerant charge.	Lower than normal head and suction pressures.	Check system for leaks, repair and add refrigerant.
Incorrect superheat setting of the expansion valve.	Lower than normal suction pressure	Adjust superheat setting to 10˚F.
Defective expansion valve.	Lower than normal suction pressure.	Repair or replace expansion valve.
Air or non-condensable gases in the system.	Higher than normal head pressure.	Purge system.
Dirty condenser.	Higher than normal head pressure.	Clean condenser.
Condenser blower and motor belts slipping.	Higher than normal head pressure.	Tighten or replace belts.
Overcharge of refrigerant.	Higher than normal head pressure.	Purge and remove excess refrigerant.
Compressor valve leaking.	Pressure equalize rapidly when the system is turned off.	Replace valve place assembly or the complete hermetic compressor.
Expansion valve or strainer plugged.	Lower than normal suction pressure.	Clean expansion valve or strainer.
Condenser air short circulating.	Higher than normal head pressure.	Remove obstructions or causes or short circulating air.

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Head pressure too high

Cause	Symptoms	Remedy
Overcharge of refrigerant.	Higher than normal head pressure.	Purge or remove excess refrigerant.
Air or non-condensable gases in the system.	Higher than normal head pressure.	Purge system.
Dirty condenser.	Higher than normal head pressure.	Clean condenser.
Condenser blower and motor belts slipping.	Higher than normal head pressure.	Tighten or replace belts.
Condenser air short circuiting.	Higher than normal head pressure.	Remove obstructions or causes or short circulating air.

Head pressure too low

Cause	Symptoms	Remedy
Low refrigerant charge.	Sight glass indicates bubbles or liquid level valve on receiver indicates shortage of refrigerant.	Check system for leaks, repair and add refrigerant.
Compressor valve leaking.	Lower than normal head pressures and pressures equalize rapidly when system is turned off.	Replace valve plate assembly or the complete hermetic compressor.

Suction pressure too high

Cause	Symptoms	Remedy
Excessive load on system.	Compressor runs continuously and capacity is low.	Remove conditions causing excessive load.
Expansion valve is stuck in 'Open'' position.	Lower than normal head pressure.	Repair or replace expansion valve.
Incorrect superheat setting the expansion valve.	Lower than normal head pressure.	Adjust superheat setting to 10˚F.

Suction pressure too low

Cause	Symptoms	Remedy
Low refrigerant charge.	Sight glass indicates bubbles or liquid level valve on receiver indicates shortage of refrigerant.	Check system for leaks, repair and add refrigerant.
Expansion valve or strainer plugged.	Suction line warm, expansion valve or strainer may be showing frost and system capacity low.	Clean expansion valve or strainer.
Incorrect superheat setting of the expansion valve.	Suction line warm and system capacity low.	Adjust superheat setting to 10˚F.
Evaporator air volume low.	Abnormally cold suction line and low suction pressure.	Increase air over the evaporator.
Stratification of cool air in conditioned area.	System capacity low and temperature of return air low.	Increase air velocity through supply grilles.

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Compressor is noisy

Cause	Symptoms	Remedy
Worn or scored compressor bearings.	Noticeable knock in compressor.	Replace the compressor.
Expansion valve is stuck in 'Open'' position or defective.	Abnormally cold suction line and high suction pressure and lower than normal head pressure.	Repair or replace expansion valve.
Overcharge of refrigerant or air and non-condensable in system.	Higher than normal head pressure.	Purge system.
Overcharge of oil.	Oil sight glass in compressor completely filled during operation.	Remove excess oil.
Liquid refrigerant flooding back to compressor.	Abnormally cold suction line and high suction pressure.	Repair or replace expansion valve.
Shipping or hold down bolts not loosened or removed.	Noticeable transmission of vibration from compressor to rest of unit and compressor held firmly in mounting.	Loosen compressor hold down bolts so compressor is freely floating in mountings.
Lack of oil.	Oil level below mid-point of the oil sight glass in compressor during operation.	Add oil.
Broken compressor valve.	Rapid equalization of the pressures when compressor stops.	Replace valve plate assembly or the complete hermetic compressor.

Compressor loses oil

Cause	Symptoms	Remedy
Incorrect superheat setting of the expansion valve.	Visual inspection of suction line indicates long trapped portions of line.	Re-run trapped portion of suction line and locate traps as recommended in installation instructions.
Leaks in system. connections.	Presence of all at piping joints or required.	Repair leaks and add refrigerant and oil as
Shortage of refrigerator.	Lower than normal suction pressure. Sight glass indicates bubbles or liquid level valve on receiver indicates shortage of refrigerant.	Check system for leaks repair and add refrigerant.
Expansion valve or strainer plugged.	Lower than normal suction pressure.	Adjust superheat setting to 10°F.

Compressor and condenser fan motor will not start

Cause	Symptoms	Remedy
Power failure.	Test lamp or voltmeter indicates no voltage at disconnect switch.	Call power company.
Fuse blown.	Test lamp or voltmeter shows voltage on line side of disconnect switch but not on unit side.	Replace blown or defective fuse.
Thermostat setting too high.	Thermostat setting above the room temperature.	Reduce temperature setting of the thermostat.
Defective thermostat.	Thermostat contacts do not "make" when setting is below room temperature.	Repair or replace the thermostat.
Faulty wiring fan relay do not become energized.	Compressor contactor or starter and	Check wiring and make necessary repairs.

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Defective controls.	Compressor contactor or starter and fan relay do not become energized	Check and replace defective controls.
Low voltage.	Starter overload tripped.	Reset and check for cause of tripping.
Defective dual pressure control.	Dual pressure control contacts remain in ' Open'' position.	Replace the control.

Compressor will not start, but condenser fan runs

Cause	Symptoms	Remedy
Faulty wiring to compressor.	Test lamp or voltmeter indicates no voltage at compressor.	Check compressor wiring and repair.
Defective compressor motor.	Voltage available at compressor but an open winding, ground or stuck compressor prevents operation.	Replace the compressor.
Defective compressor overload (single phase only)	Overload contacts remain in ''Open'' position.	Replace overload.
Defective starting capacitor. (Single phase only)	Starting capacitor does not indicate rated capacitance.	Replace capacitor.

Condenser fan motor will not start, but compressor runs

Cause	Symptoms	Remedy
Defective fan relay. coil is energized.	Relay contacts do not ''make'' when	Repair or replace relay(s).
Faulty wiring to fan motor. voltage at fan motor.	Test lamp or voltmeter indicates no	Check fan motor wiring and repair.
Defective fan motor.	Test lamp or voltmeter indicates voltage available at motor.	Replace fan motor.

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Install IDU and ODU of wall mounted split A/C

Objectives: At the end of this exercise you shall be able to
- **install indoor unit of split A/C**
- **install outdoor unit of split A/C system**

Requirements

Tools/Instruments

- Screw driver - 1 set
- Cutting plier - 1 No.
- Hammer 450 gm. - 1 No.
- Screw spanner 8" - 1 No.
- Spirit level - 1 set
- Allen key - 1 set
- Tester - 1 No.
- Technician tool kit - 1 No
- Double end spanner set - 1 No
- Vacuum pump - 1 No
- Gauge manifold - 1 No
- swaging tool - 1 No

Equipments

- Core drilling machine - 1 No.
- Split air- conditioner - 1 No

Material/Components

- Waste (Cotton) - as reqd.
- Angle frame
- Rubber pad
- Cotton waste

PROCEDURE

TASK 1: **Install indoor unit of split A.C**

1 Keep the packed material in correct position.

2 Take away the unit from carton box and remove packing if any.

3 Clean the equipment on all sides.

4 Check for any damages/dents in anywhere in the unit.

5 Select the spot for installation.

6 Arrange power supply nearer to the Indoor unit.

7 Position the Indoor unit to make easy drain line going out of the room.

8 Provide free working space around the indoor unit.

9 Place the indoor unit holding sheet where we desired to install and level it using sprit level.

10 Mark the holes for screws and pipeline.

11 Drill a through hole of 3" on wall from pipe line

12 Fix the holding sheet using screws on wall plugs

13 Straight the tubes, insert power card, drain line and copper lines through hole gently and position the indoor unit on holding sheet.

14 Arrange proper drain line on backside.

15 Arrange power point near indoor unit with suitable stablings.

Note : Provide a little slope towards drain point while fixing holding sheet for proper drain out.

Provide some slope towards outside of hole for proper drain.

— — — — — — — —

TASK 2: **Install outdoor unit of split AC**

1 Select area/location with more air circulation.

2 Prepare angle frames as per specification of the supplier and fix on wall by anchor fastener bolts & nuts.

3 Place the O.D. unit on the mounting frames and tighten the bolts and nuts with rubber washer.

4 Provide overhead shade to protect from sun rays.

5 Provide enough area around the condensing unit for servicing/repair works.

6 Connect suction and liquid refrigerant line connections between indoor and outdoor unit.

7 Fix clamps to the refrigerant line at even distance (in between).

8 Install gauge main fold on suction gauge port of service valve.

9 Leak test using dry N_2 gas at all joints.

10 Connect cord wire to outdoor unit.

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11 Vent N2 through charging port of service valve.

12 Connect vacuum pump to gauge manifold charging port.

13 Run vacuum pump for 30 minutes and read compound gauge vacuum.

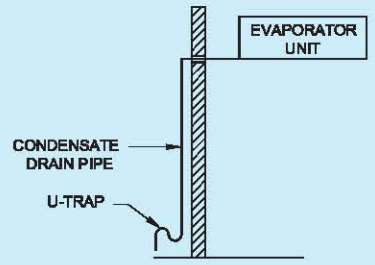
14 Close gauge manifold stop and remove vacuum pump.

15 Open suction and liquid service using allen key.

16 Run the unit and observe suction pressure, current, grill temperature, room temperature and ambient temperature.

17 Remove gauge manifold and put dummy nut on gauge port.

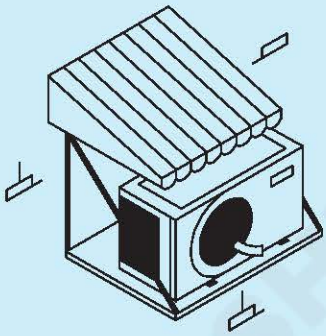
Fig 1



CONDENSATE DRAIN PIPE ARRANGEMENT

MRN25149H1

Fig 2



MRN25149H2

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Install IDU of floor, ceiling/cassette mounted split A/C

Objectives: At the end of this exercise you shall be able to
- **install IDU of floor mounted split AC**
- **install IDU of ceiling/cassette split AC.**

Requirements

Tools/Instruments

- Screw driver - 1 set
- Cutting plier - 1 No.
- Hammer 450 gm. - 1 No.
- Screw spanner 8" - 1 No.
- Spirit level - 1 set
- Allen key - 1 set
- Tester - 1 No.
- Technician tool kit - 1 No
- Double end spanner set - 1 No
- Vacuum pump - 1 No
- Gauge manifold - 1 No
- swaging tool - 1 No

Equipments

- Core drilling machine - 1 No.
- Split air- conditioner - 1 No

Material/Components

- Waste (Cotton) - as reqd.
- Angle frame
- Rubber pad
- Cotton waste

TASK 1: **Installation IDU of floor mounted split AC**

1 Keep the packed material in correct position.

2 Take away the unit from carton box and remove packing .

3 Clean and check for any damage.

4 Select the spot for installation.

5 Check the floor for level using sprit level.

6 See the possibility of water drain out from the unit.

7 Mark the base bolt position and wall hole for pipe lines

8 Put 3" hole on a wall .

9 Drill base bolt hole and fix fastener bolt.

10 Insert drain hose, suction, discharge and power connection through hole and fix indoor unit are correct position and tight bolts.

11 Arrange power supply with suitable stabling's.

— — — — — — — —

TASK 2: **Installation IDU of ceiling/Cassette split AC**

1 Keep the packed material in correct position.

2 Take away the unit from carton box and remove packing.

3 Clean and check for any damage.

4 Select the spot for installation.

5 Mark the mounting spot on ceiling.

6 Drill holes and fix anchor fastener with threaded rod of 8mm or 10mm of suitable length to hold the unit.

7 Hang the unit on threaded rod using nuts.

8 Level the unit using sprit level and correct the nuts.

9 Mark and make hole on wall to drawn out gas & liquid tube power cable and drain line.

10 lay tube line to outdoor unit using clamps.

11 Arrange drain line.

12 Arrange power supply with circuit brakes.

— — — — — — — —

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Install IDU and duct of ductable split AC

Objective: At the end of this exercise you shall be able to
- **identify IDU of ductable split AC**
- **connect duct system with ductable split AC**

Requirements

Tools/Instruments

- Screw driver - 1 set
- Cutting plier - 1 No.
- Hammer 450 gm. - 1 No.
- Screw spanner 8" - 1 No.
- Spirit level - 1 set
- Allen key - 1 set
- Tester - 1 No.
- Technician tool kit - 1 No
- Double end spanner set - 1 No
- Vacuum pump - 1 No
- Gauge manifold - 1 No
- swaging tool - 1 No

Equipments

- Core drilling machine - 1 No.
- Split air- conditioner - 1 No

Material/Components

- Waste (Cotton) - as reqd.
- Angle frame
- Rubber pad
- Cotton waste

PROCEDURE

TASK 1: **Ref Ex No :1.12.95 (Task 2)**

TASK 2 : **Connect duct system with package A/C to conditioned room**

1 Cut the canvas to the correct measurement to connect blower outlet to duct inlet, to eliminate the vibration.

2 Keep the canvas in position and tighten both the joints with nut and bolts.

3 Make arrangement for the hangers to hold the duct lines.

4 Fix the duct arrangements one by one and connect the joints with gaskets (felts), tighten with nut and bolts fix the dampers wherever necessary.

5 Fix the "L" angles wherever necessary to support the duct lines and make it to hang by hangers.

6 Bring the final end of the duct line on top of the room ceiling and cover it with blind, cover the duct with insulations in nono-conditioned areas.

7 Connect the duct branches to the diffusers to distribute the air supply to the room.

8 Check the passage on false celling for return air facility to the plant.

9 Check the air velocity to the main outlet and to the branches, and even static pressure of the conditioned room.

10 Record all the details in record sheet - 1 & 2.

— — — — — — — —

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Record sheet - 1
Materials and component used for duct system

MATERIAL DETAILS	Canvas Qty	G.I Sheets Qty	Gasket materials Qty	No.of dampers, diffusers and grills

Time taken :

— — — — — — — —

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Service of multi split AC

Objectives: At the end of this exercise you shall be able to
- **pump down gas in the ductable split AC unit**
- **check and clean cooling coil**
- **check and clean air filter**
- **check fan motor**
- **service the condenser of multi split AC**

Requirements

Tools/Equipments/Instruments

- Trainees kit - 1 No.
- Double ended spanner 14mm, 15mm 16mm, 17mm, 19mm - 1 No. each
- 1/4" valve key - 1 No.
- Pipe cutter - 1 No.
- Flaring tool set - 1 No.
- Pressure gauge - 1 No.
- Compound gauge - 1 No.
- A split A/C system - 1 No.
- Multimeter - 1 No.
- Ductable split AC - 1 No.
- Vacuum cleaner - 1 No.
- Anemometer - 1 No.
- Wire brush - 1 No.
- Fin comb - 1 No.
- Test lamp - 1 No.

Materials/Components

- 1/4" union connection - 1 No.
- 1/4" copper tube - 5 ft
- Cotton waste - as reqd.
- Flare nuts - 4 Nos.

PROCEDURE

TASK 1: **Pump down gas in multi split A/C system**

1 Check the service valves positions, both valves must be in back seat position in a given split A/C system.

2 Open the gauge port plug from suction service valve and fix a 1/4" union connector and fix a compound gauge with the help of a flared copper tube.

3 Open the gauge port plug from the discharge service valve and fix a 1/4" union connector and fix a pressure gauge by means of a flared copper tube.

4 Check the line connections, if there is any leaks, purge it.

5 Front seat the discharge service valve (liquid line).

6 Keep suction service valve in back seat crack position.

7 Start the system

8 Watch the compound gauge, it indicates "2 to 5" vacuum, stop the system.

9 Now the refrigerant will be stored in condenser.

TASK 2: **Check and clean cooling coil**

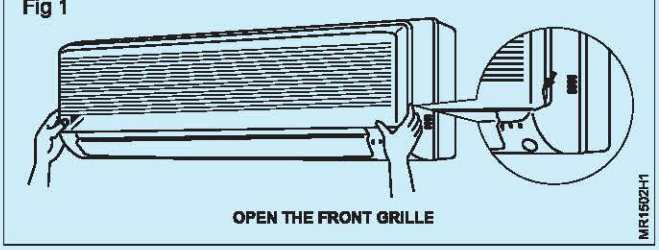
1 Start the split air-conditioner.

2 Check the air flow in cooling coil by anemometer and check grill temperature by thermometer and note the flow and temperature. If it is low flow clean the coil.

3 Remove the front and side panels with screw driver, and wash the panels with soap water. (Fig 1)

4 Remove the air filters.

Fig 1



5 Check the evaporator (cooling coil) fins if it is dirty clean it with soap solution and vacuum cleaner.

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6 Cover the blower motor.

7 Clean the evaporator coil with wire brush.

8 Clean the coil with vacuum cleaner.

9 Wash the cooling coil with caustic soda solution if necessary.

10 Comb the fins with fin comb.

11 Wash the fins with water pressure.

12 Remove the cover from blower motor.

13 Lubricate the blower motor.

14 Reset the front and side panels

15 Clean the air filters and fix.

16 Start the unit

17 Check the air flow with anemometer and compare with initial readings.

18 Check the grill temperature and current.

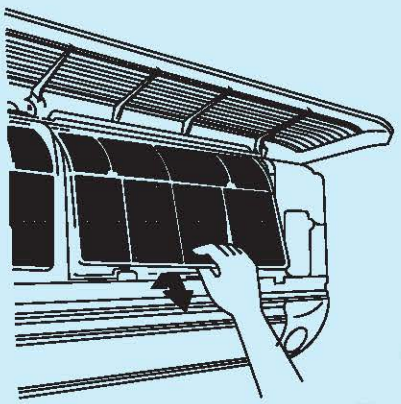
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TASK 3: **Check and clean the air filters**

1 Open the front grill.

2 Push a little upwards the tab at the centre of each air filter, then pull out the air filters down. (Fig 1)

Fig 1



PULLING THE AIR FILTERS

MR1502H2

3 Wash them with water, or clean the filters with a vacuum cleaner See (Fig 2).

Fig 2



AIR FILTER CLEANING

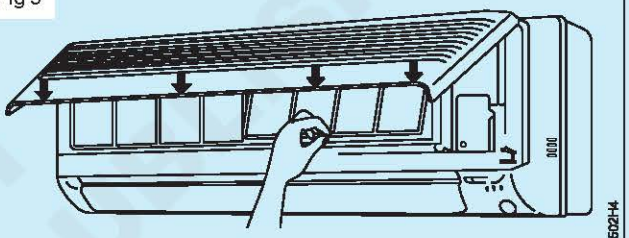
MR1502H3

4 If the dust does not come off easily, wash the filters with soft detergent with warm water.

5 Dry the filters in the shade.

6 Insert the filters into slots of the front panel. (Fig 3)

Fig 3



FILTERS SETTING

MR1502H4

7 Lock the front grills both sides and middle.

Operation with dusty air filters reduces the cooling capacity and wastes energy.

— — — — — — — —

TASK 4: **Check the fan motor**

1 Before checking, be sure to stop the operation and turn the breaker OFF.

2 Remove the capacitor from the fan motors.

3 Test the capacitor. To test the capacitor connect it with the supply the electricity for a second.

4 After removing the connection, short both the terminals (leads) of the capacitor.

5 If it gives spark, then it can be used. If it is not spark replace the capacitor.

6 Check the continuity of the running and starting winding by testing temperature or multimeter.

7 Rotate the motor shaft and check by rotating freely. Check bearings.

8 Check condenser blade and evaporator blower rotates free.

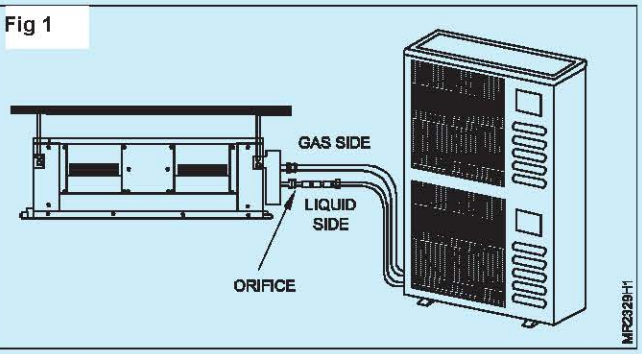
9 Lubricate the motors.

10 Clean the motors.

11 Connect electrical connection for capacitor and fan motor.

12 If condenser blade touch the condenser fins or base plate, or shroud, adjust the blade or motor. If evaporator blower touching the blower housing adjust it.

Fig 1



TASK 5: **Service the condenser of multi split AC**

1 Put your fingers and check for dust collection

2 Remove all electrical connections from compressor

3 Remove the fan motar electrical connections

4 Remove the fan blade and fan motor

5 Take a 1 ltr bucket fill with 3/4th of water mix 1/4th kg of soap powder

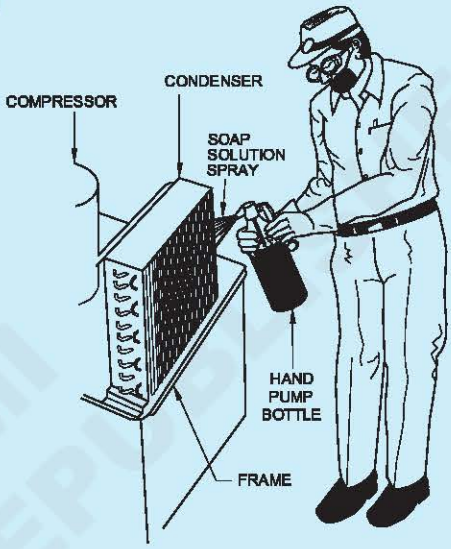
6 Take the bottle nozzle at the fan of the condenser.

7 Pump the soap solution to condenser

8 Allow to remain for 15 minutes

9 After 15 minutes spray fresh water over the condenser coil

Fig 1



CLEANING OF SPLIT A/C CONDENSER

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Identify the parts of inverter split A/C

Objective: At the end of this exercise you shall be able to
- **identify the parts of inverter split AC. (Refer Ex No : 1.8.69)**

Requirements

Tools/Instruments

• Allen Key	- 1 set
• Screw driver	- 1 set
• Tester	- 1 No.
• Cutting plier	- 1 No.
• Nose plier	- 1 No.
• Spanner (D.E.) 12mm,13mm, 14mm,15mm	- 1 set.
• Screw spanner	- 1 set

Equipments

• Inverter Split A/C system	- 1 No.

PROCEDURE

Refer Ex No : 1.8.69

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