

INSTRUMENT MECHANIC

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

Sector: ELECTRONICS & HARDWARE

(As per revised syllabus July 2022 - 1200 Hrs)



Directorate General of Training

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



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

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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 2022 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 comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Instrument Mechanic - 2nd Year - Trade Practical - NSQF Level - 4 (Revised 2022) in Electronics & Hardware Sector under** 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 Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

ATUL KUMAR TIWARI, I.A.S

Secretary
Ministry of Skill Development & Entrepreneurship,
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New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of 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 under the Craftsman and Apprenticeship Training Schemes.

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

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

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

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

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

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

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

Chennai - 600 032

EXECUTIVE DIRECTOR

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Practical)** for the trade of **Instrument Mechanic** under the **Electronics & Hardware** Sector for ITIs.

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

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

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

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

This manual is divided into eighteen modules.

Module 1	Basic Specifications of Instruments
Module 2	Measurement of Motion
Module 3	Measurement of Pressure
Module 4	Measurement of Flow
Module 5	Measurement of Solid Flow
Module 6	Measurement of Level
Module 7	Measurement of Temperature - I
Module 8	Measurement of Temperature - II
Module 9	Recorders
Module 10	Final Control Elements
Module 11	Controllers
Module 12	Controllers modes and Turning
Module 13	Programmable Logic Controllers
Module 14	Digital Control System and Networking
Module 15	Fundamentals of SCADA & DCS
Module 16	Basic of Hydraulics
Module 17	Basic of Pneumatics
Module 18	Analytical Instruments

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Instrument Mechanic 2nd Year NSQF LEVEL - 4 (Revised 2022) in Electronics & Hardware**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptual capabilities for performing the skills.

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

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

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

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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

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4	Recognize the fundamental of fluid flow, terms, different unit of flow, read specification of flow meters. And fluid pump. Perform the maintenance, Servicing and calibration and installation of variable DP flow meters / head flow meters, variable area flow meters, positive displacement eters, Electronic type flow meters and mass flow meters for fluids flow measurement. ELE/N9421	2.4.206-227
5	Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow measuring system & verify the result within standard. ELE/N9422	2.5.228-232
6	Identify, select, wire & Execute the operation of different types of level instruments use for liquid level and solid level. Carry out maintenance, Servicing, calibration and Installation. ELE/N9423	2.6.233-251
7	List out different unit of temperature, terms and read specification of temperature instruments. Perform measurement, maintenance, Servicing and calibration of Bimetallic and filled system thermometers & thermo switches. ELE/N9424	2.7.252-255
8	Identify, select, evaluate performance, install, service and calibrate temperature Indicators, Transmitters (RTD'S, Thermistors and Thermocouples types) various type of pyrometers and instruments for humidity. ELE/N9425	2.8.256-266
9	Identify, select, Operate, maintain, Service and calibrate different types of recorders. ELE/N9426	2.9.267-273
10	Identify different types of Final control elements and role. Identify different valve body, constructional feature, Dismantle, inspect parts, replace parts, recondition, check, and resetting of control valves with actuators, convertors & positioners. Install and test the performance. ELE/N9427	2.10.274-294
11	Identify fundamental of automatic control system and various functional elements in control loop. Identify, select, Install, wire, configure, test the performance, maintain, and service various types of ON-OFF and PID controllers (electronic and pneumatic).	2.11.295-305
12	Tune controller mode and evaluate performance of control loops as per specification and system application ELE/N9428	2.12.306&307
13	Identify modules of PLC, its function, Wire and connect the digital I/OS field devices to the I/O module of PLC, install Software, Hardware and configure plc for operation. Write and execute simple logic and real application programs. ELE/N9429	2.13.308 - 321
14	Operate, maintain, service, configure, install, WIRE and test HART transmitters /devices (I/O). And Net-working system for instrumentation. ELE/N9430	2.14.322 - 329
15	Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules, install Software, Hardware and configure DCS for operation with HMI. Write and execute DCS AND SCADA programs FOR real application. ELE/N9431	2.15.330 - 338
16	Identify, check constructional Feature and function of hydraulic pump, and hydraulic power system, accumulator, hydraulic hoses and fitting, Hydraulic components. Build AND test hydraulic control circuit. ELE/N9432	2.16.339 - 349
17	Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping, tubing and fitting. Build and test pneumatic control circuit. ELE/N9433	2.17.350 - 362
18	Identify constructional feature, operate, maintain, service and calibrate of Analytical instruments. ELE/N9434	2.18.363 - 368

SYLLABUS FOR INSTRUMENT MECHANIC

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 68 Hrs. Professional Knowledge 18 Hrs.	Identify the parameters of measurement systems. Identify, select, test, wire & Execute the operation of different process sensors by selecting appropriate signal conditioning for stress, strain, load displacement and Thickness. ELE/N9408	161. Finding the range, span and accuracy of instrument (example-ammeter, voltmeter etc. (04 Hrs.) 162. Test the voltmeter / ammeter using std. voltage/ current source for total range. Check the dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. (05 Hrs.) 163. Identify the strain gauge type, cantilever or load cell specification. (04 Hrs.) 164. Check the strain gauge using ohm meter / multimeter. (03 Hrs.) 165. Measure the load using strain gauge instrument. [using half (two), quarter(one), full (four) strain gauges on bridge]. (06 Hrs.) 166. Determine the sensitivity, liner range of strain gauge measurement. (06 Hrs.) 167. Make null balance and gain adjustment. Calibrate strain gauge instrument by adjusting zero and span. (05 Hrs.) 168. Identifying the various parts of LVDT. Study the specification of LVDT like range, exiting frequency, voltage, sensitivity etc. (05 Hrs.) 169. Identifying the coils in LVDT. Verifying the connection of secondary coils. Testing the LVDT coils using multimeter. (05 Hrs.) 170. Verify the LVDT characteristics by changing the displacement. (05 Hrs.) 171. Determine the liner range and sensitivity, resolution of LVDT. (05 Hrs.) 172. Measure the phase difference of LVDT secondary coils on CRO. (05 Hrs.) 173. Calibrate the LVDT by adjusting zero and span. (05 Hrs.) 174. Test and calibrate displacement meter, accelerometer and thickness instruments. (05 Hrs.)	Scope and necessity of instrumentation. Fundamentals of measurement systems- functional block diagram of measurement system. Calibration and calibration standards– basic standards, secondary standards, working standards. Fundamental units - The metric system, Base & supplementary units, Derived Units, Multiplying factors and standards of length, mass, time & frequency. Temperature & electrical units. Instrument characteristics Static characteristics– accuracy, precision, sensitivity, resolution dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. Dynamic characteristics– speed response, fidelity, lag. Error deviation, true value, data. Types of errors- systematic, random & illegitimate error. Certainty/uncertainty, validity Of result. Measuring system Response. Introduction, amplitude responses, Phase response, Delay, rise time & slew rate. Damping & its importance. Statistical analysis – arithmetic mean, deviation from the mean average deviation, standard deviation. Stress & Strain Measurement. Introduction to Strain gauges, types of strain gauges and differences. Applications of strain gauges, load cells. LVDT, RVDT, advantages and limitations. (18 hrs.)

<p>Professional Skill 36 Hrs.</p> <p>Professional Knowledge 10 Hrs.</p>	<p>Select, Installs, services and calibrate instruments for motion, speed, position, acceleration, vibration & record the data. ELE/ N9419</p>	<p>175. Measure the vibration of motor/ machine. (06 Hrs.)</p> <p>176. Servicing and maintenance vibrometers & accelerometer. (06 Hrs.)</p> <p>177. Measure the speed of motor. (06 Hrs.)</p> <p>178. Identify different parts, its function & Operation of eddy current, type AC and DC tachometer. (06 Hrs.)</p> <p>179. Servicing and maintenance of mechanical and electrical tachometer. (06 Hrs.)</p> <p>180. Identify different parts/section, its function & Operation and use Stroboscope and find motion of object. (06 Hrs.)</p>	<p>Measurement of motion, velocity / vibrometers and acceleration. Difference between tachometer and speedometers.</p> <p>Types of tachometers-Eddy current type, AC and DC tachometer. Stroboscope and its applications. seismic instrument.(10 Hrs.)</p>
<p>Professional Skill 120 Hrs.</p> <p>Professional Knowledge 35 Hrs.</p>	<p>Identify different unit of pressure, terms and operation of basic instruments. Perform maintenance, Servicing calibration and installation of field pressure gauges, switches, electronic pressure indicators and transmitters for absolute, atmospheric, gauge, vacuum and differential pressure measurement. ELE/ N9420</p>	<p>181. Measure the atmospheric pressure using barometer. (03 Hrs.)</p> <p>182. Identify specification and construction of each manometer and find their range, scale type, resolution, type of liquid using, tube material, isolation valve types, fitting types and sizes, zero adjustment and spirit bubbler etc. (05 Hrs.)</p> <p>183. Measure the differential pressure, gauge pressure and vacuum pressure using U tube manometer. (05 Hrs.)</p> <p>184 Dismantle and assemble the manometer. Cleaning the glass tube, aligning the gravity balances etc. (05 Hrs.)</p>	<p>Principle of Pressure in Liquids & Gases. Properties of matter Principles of liquid pressure, units of pressure Liquids pressure and volume, density and specific gravity. Factors affecting liquid</p> <p>Principle of Pressure in</p> <p>Liquids & Gases. Properties of matter Principles of liquid pressure, units of pressure Liquids pressure and volume, density and specific gravity. Factors affecting liquid pres- sure. Pressure relation with volume, temperature and flow. Units of pressure and unit conversions.</p> <p>Types of pressure: absolute, gauge, atmospheric and vacuum pressures and their relationships.</p> <p>Barometers, manometers types and applications.(07 Hrs.)pres- sure. Pressure relation with volume, temperature and flow. Units of pressure and unit conversions.</p> <p>Types of pressure: absolute, gauge, atmospheric and vacuum pressures and their relationships.</p> <p>Barometers, manometers types and applications. (07 Hrs.)</p>
		<p>185. Dismantle and assemble the pressure gauge (bourdon tube, diaphragm type), Identify the various parts like sensing element, link, liver, pinion gear, hair spring, pointer size shape material, sensor material etc. (06 Hrs.)</p>	<p>Types of pressure sensing elements-bourdon tube, diaphragms, capsules, and bellows. Eachontypes, shapes, material used for various applications, ranges advantages and limitations. Pressure switches types and applications.(07 Hrs.)</p>

		<p>186. Measurement of gauge pressure and vacuum pressure using bourdon tube / diaphragm gauge. (04 Hrs.)</p> <p>187. Measurement of differential pressure using diaphragm/ capsule gauge. (04 Hrs.)</p> <p>188. Identify specifications of pressure switch – range, differential pressure span, contact types, contacts current rating, number of contacts etc. (05 Hrs.)</p> <p>189 Dismantle and assemble the pressure switch – identify the various parts-sensing elements, control spring, pressure and differential pressure adjustment screws, shaft arrangement pivoting, contacts relay operation and change of contacts. Type of material using for various parts etc. (05 Hrs.)</p> <p>190. Connect and operate the pressure switch with load at various pressure and differential pressure settings. Make adjust the errors screws. (05 Hrs.)</p>	
		<p>191 Identify the basic specifications of pressure indicator/ transmitter (electronic) like range, resolution, size of display, type of sensor (symbol), sealed type, number scales, connection type, tap threading size and type-(male, female NPT/SAE), body material, mounting type (back or bottom) etc. (05 Hrs.)</p> <p>192. Test and operating the pressure transmitter with supply, milli ammeter, pressure source (pneumatic/ hydraulic). Finding the resolution, accuracy etc. (05 Hrs.)</p> <p>193. Familiar with pressure calibrator controls and settings. (03 Hrs.)</p> <p>194. Calibrating the pressure gauge using standard meter/ pressure calibrator. (05 Hrs.)</p> <p>195. Measuring gauge, vacuum and differential pressure using DP transmitter. (05 Hrs.)</p> <p>196. Calibrating the DP transmitter using standard meter / pressure calibrator. (05 Hrs.)</p>	<p>Electrical pressure transducers.</p> <p>Method of conversion, primary and secondary pressure transducers. Potentiometric pr.</p> <p>Transducers, Capacitive pr. transducers, reluctance-servo pressure transducers, strain gauge pressure transducers, piezo electric pressure transducer. Differentials pressure transducers.(07 Hrs.)</p>

		<p>197. Measuring low pressure/ vacuum using McLeod gauge. (05 Hrs.)</p> <p>198. Test & calibrate of Pressure gauges, indicators, transmitters with Dead weight Tester. (05 Hrs.)</p> <p>199. Test & calibrate of Pressure gauges, indicators, transmitters with comparator Tester. (05 Hrs.)</p>	<p>Low Pressure Measurement. Vacuum, gauges, thermal conductivity gauges, pirani gauges, thermocouple gauges, slack diaphragm. Ionization gauge, McLeod gauge, capacitance manometers. Method of pressure instrument calibration. Dead weight tester and comparators/manifolds. (07 Hrs.)</p>
		<p>200. Installation of pressure gauge in pipeline with safety valve and pig tail /siphon etc. measuring pressure in flow line. (05 Hrs.)</p> <p>201. Installation and testing of pressure switch and pressure relief valve with compressor. (05 Hrs.)</p> <p>202. Installation and testing of pressure switch with solenoid and alarm in process line. (05 Hrs.)</p> <p>203. Fault finding in pressure gauge. (05 Hrs.)</p> <p>204. Simple fault finding in pressure transmitter. (05 Hrs.)</p> <p>205. Fault finding in pressure process line. (05 Hrs.)</p>	<p>Pressure Instrument Installation and Servicing.</p> <p>Elements of pressure transmitters, Installation components, pressure taps,</p> <p>Isolation valve, instrument piping, connections and fittings blow down valve, instrument valve, pulsation damper, diaphragm seal, pressure transmitter, Installation, procedure, locating and mounting, piping, electrical wiring placing into service, guidelines for periodic maintenance, troubles shooting and repair, instrument shop safety.(07 Hrs.)</p>
<p>Professional Skill 88 Hrs.</p> <p>Professional Knowledge 27 Hrs.</p>	<p>Recognize the fundamental of fluid flow, terms, different unit of flow, read specification of flow meters. And fluid pump. Perform the maintenance, Servicing and calibration and installation of variable DP flow meters / head flow meters, variable area flow meters, positive displacement meters, Electronic type flow meters and mass flow meters for fluids flow measurement. ELE/N9421</p>	<p>206. Measurement of pressure in flow line with different flow rates. (04 Hrs.)</p> <p>207. Measurement of flow rate using fixed volume tank. (04 Hrs.)</p> <p>208. Operating fluid pump and observing the pressure at input and output. verifying flow variation by adjusting bypass line. (04 Hrs.)</p> <p>209. Measurement of DP of venturi and orifice using manometer. (04 Hrs.)</p> <p>210. Measurement of DP using DP gauge. (04 Hrs.)</p> <p>211. Adjusting the valves of manifold and observing the changes in DP gauge. (04 Hrs.)</p> <p>212. Calibrating the pneumatic DP transmitter for flow rate measurement. (04 Hrs.)</p> <p>213. Calibration electronic DP transmitter for flow rate. Verifying the square root relation and linear relation of DP. (04 Hrs.)</p>	<p>Properties of Fluid Flow.</p> <p>Basic properties of fluids, fluids in motion, getting fluids to flow, units of flow rate and quantity flow, factors affecting flow rate, Reynolds number, relation between flow rate and pressure, area, quantity Types of flow meters –head type, variable area type, quantitative flow meters.</p> <p>Mass flow meters.</p> <p>Head type of flow meters: working principle, types-venturi tube, orifice plates and its shapes. Pitot tube, flow nozzles, constructions, tapings, advantages, limitations, applications, materials used for various flows. Types of secondary devices used to measure for flow rates.</p> <p>Open channel flow meters-principle of open channel flow, weirs, notches and flumes. Various shapes and their applications, maintenance, Variable area type flow meter-</p>

		<p>214. Installing a head type flow meter with venturi or orifice, manifold and DP, milli ammeter or indicator, supply. Measuring flow rate in line. (04 Hrs.)</p> <p>215. Calibrating head type flow meter with standard volumetric tank. (04 Hrs.)</p> <p>216. Dismantling, checking, overhauling and calibration of D. (04 Hrs.)P. cell/ transmitter. (Pneumatic & electronic). (04 Hrs.)</p> <p>217. Identify and carry out preventive maintenance. (04 Hrs.)</p> <p>218. Study of construction of weirs, notches and flumes their shape and connections and use. (04 Hrs.)</p> <p>219. Install and testing of Rota meters in flow line. Vertical alignment. (04 Hrs.)</p> <p>220. Measurement of flow rate and calibrating rotameter. (04 Hrs.)</p> <p>221. Dismantle, identify different parts, its function, AND operation of various types of positive displacement meters. (04 Hrs.)</p> <p>222. Installation, testing and calibrating quantitative flow meter. (04 Hrs.)</p> <p>223. Dismantle and assemble quantitative flow meters like Oscillating piston type, Rotating vane meter, Lobed impeller and oval flow meter. (04 Hrs.)</p> <p>224. Identify and carry out preventive maintenance of positive displacement flow meters. (04 Hrs.)</p> <p>225. Installation, testing and calibration of turbine flow meter. (04 Hrs.)</p> <p>226. Installation, testing and calibration of vortex flow meter. (04 Hrs.)</p> <p>227. Installation, testing and calibration of ultrasonic flow meter. (04 Hrs.)</p>	<p>Rota meter, constructions, working principle, applications. Various shapes of float, type of materials used for body and float. Factors affecting rotameter performance, measuring gas and liquid flow.</p> <p>Positive Displacement Meters.</p> <p>Advantages and disadvantages of positive displacement meters, piston meter, oscillating piston meter, rotating vane meter, notating disk meter, lobed impeller and oval flow meter, calibrating positive displacement meters.</p> <p>Target flow meters, turbine flow meter, magnetic flow meters, vertex flow meter. Construction, working principle, advantages and disadvantage, applications. Carioles mass flow meter, thermal flow meters and summary basics of ultrasonic flow meters. The Doppler hit method. The beam deflection method, frequency difference method.(27 hrs.)</p>
<p>Professional Skill 29 Hrs.</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify, operate, maintain, trouble-shoot and calibrate the devices for solid flow measuring system & verify the result within standard. ELE/N9422</p>	<p>228. Installation, testing and calibration of mass flow meter. (05 Hrs.)</p> <p>229. Measuring semi solid liquid flow rate using flow meter.(06 Hrs.)</p> <p>230. Calibrating and adjustment of flow meter for solid flow.(06 Hrs.)</p> <p>231. Identify and carry out maintenance& preventive maintenance of solid flow measuring system. (06 Hrs.)</p> <p>232. Service and calibrate solid flow meter. (06 Hrs.)</p>	<p>Metering the flow of solid particles. Measuring volumetric and mass flow rate of solids, volumetric solids flow meter, mass flow meter for solids, belt type solid meters belt type solid meters belt speed sensing and signal processing, slurries, constant weight feeders. (09 Hrs.)</p>

<p>Professional Skill 68 Hrs. Professional Knowledge 20 Hrs.</p>	<p>Identify, select, wire & Execute the operation of different types of level instruments use for liquid level and solid level. Carry out maintenance, Servicing, calibration and Installation. ELE/N9423</p>	<p>233. Measurement of liquid level using stick gauge and converting liquid level into volume and mass (using specific gravity). (04 Hrs.)</p> <p>234. Study the construction and operation of various types of sight glasses. (04 Hrs.)</p> <p>235. Installation, testing and calibration of liquid level indicator. (04 Hrs.)</p> <p>236. Cleaning the glass tube and operating the isolation valves, calibrating zero adjustments. (04 Hrs.)</p> <p>237. Calibrating and Measuring the liquid level using float type, displacer type level systems. (04 Hrs.)</p> <p>238. Measuring the liquid level of open and close tank using pressure / DP gauge. Converting liquid height into pressure using liquid density. (04 Hrs.)</p> <p>239. Calibrating DP transmitter for liquid level measurement. Adjusting square root to linear scale display (04 Hrs)</p> <p>240. Installation, testing and calibration of liquid level indicator. (04 Hrs.)</p> <p>241. Service and calibrate different types level indicators and transmitters. (04 Hrs.)</p> <p>242. Identify and carry out maintenance & preventive maintenance of above level indicators and transmitters. (04 Hrs.)</p> <p>243. Construct and operate conductivity probe Level indicator. (04 Hrs.)</p> <p>244. Construction and operation of capacitance probes indicating transmitters and sonic level detector. (04 Hrs.)</p> <p>245. Install and test capacitance probes indicating transmitters and sonic level detector. (04 Hrs.)</p> <p>246. Service and calibrate capacitance probes indicating transmitters and sonic level detector. (04 Hrs.)</p>	<p>Principles of level measurement. Types of level measurements-solid and liquid, volume and mass, mechanical and electrical type. Surface sensing gauges, storage tank gauges, sight glasses, magnetic gauges, buoyancy, displacement gauges. Factors need to consider for open and closed channel level measurements level switches, mercury level switches in high pressure tank, level detectors, magnetic reed switches.</p> <p>Pressure head instruments. Hydrostatic pressure, specific gravity, pressurized fluids, pressure head instrumentation, air bellows, U- tube manometers, air purge systems, liquid purge systems, force balance diaphragm system.</p> <p>Electrical method conductivity and capacitance method for measuring the liquid level, capacitance probes, zero and span adjustments, sonic level detectors, point level detection.</p> <p>Solid level measurement Using weight to determine level, sonic solid level measurement with microwaves, using capacitance probes to measure solid level, diaphragm switches, nuclear gauges, microwave solid level detectors. (20 hrs.)</p>
		<p>247. Study the construction, operation and use of load cell technique to determine solid level in vessel. (04 Hrs.)</p> <p>248. Study the construction, operation and use of different types of solid level switches. (02 Hrs.)</p>	

		<p>249. Study the construction, and operation of capacitance probes transmitters, microwave level detector / gauges. (02 Hrs.)</p> <p>250. Install and test various types of solid level indicating transmitters and sonic level detector. (04 Hrs.)</p> <p>251. Service and calibrate various types of solid level indicating transmitters and sonic level detector. (04 Hrs.)</p> <p>252. Study the construction, operation and use of temperature-controlled oil bath/furnace for low and high temperature. (03 Hrs.)</p> <p>253. Dismantling identify different parts, its function, adjustment, assemble and operation of Bimetallic and fluid filled (liquid, gas and vapour) system thermometers & thermo switches. (10 Hrs.)</p>	
<p>Professional Skill 29 Hrs.</p> <p>Professional Knowledge 09 Hrs.</p>	<p>List out different unit of temperature, terms and read specification of temperature instruments. Performance measurement, maintenance, Servicing and calibration of Bimetallic and filled system thermometers & thermo switches. ELE/N9424</p>	<p>254. Install and test various types of thermometers and switches. (08 Hrs.)</p> <p>255. Service and calibrate various types of thermometers and switches. (08 Hrs.)</p>	<p>Temperature measurement. Temperature, heat, specific heat, changing physical state Fahrenheit and Celsius temperature scales Rankin and Kelvin scales, calibration of temperature scales primary and secondary standards. Industrial application of temperature measuring instruments with compensating link & precautions to be taken.</p> <p>Bimetallic and fluid filled temperature instruments. Bimetallic thermometers, liquid-in-glass thermometers, filled system thermometers, thermometer bulbs, capillary & bourdon tube, temperature transmitters for filled system, advantages & disadvantages of filled systems. (09 Hrs.)</p>
<p>Professional Skill 29 Hrs.</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify, select, evaluate performance, install, service and calibrate temperature Indicators, Transmitters (RTD'S,</p>	<p>256. Verify the characteristics of different types of RTD's, and Thermistors. (02 Hrs.)</p> <p>257. Study circuit operation of signal conditioner for RTD's, and Thermistors. (02 Hrs.)</p>	<p>Electrical temperature instrument. Resistance thermometer, how it works, RTD bridge circuits, lead wire error, RTD elements. (03 Hrs.)</p>

	Thermistors and Thermocouples types) various type of pyrometers and instruments for humidity. ELE/N9425	<p>258. Install and test various types of two and three wire RTD transmitters. (03 Hrs.)</p> <p>259. Service and calibrate various types of RTD transmitters using temperature calibrator or resistors. (03 Hrs.)</p>	
		<p>260. Verify the characteristics of different types of Thermocouples. (02 Hrs.)</p> <p>261. Study circuit operation of signal conditioner for Thermocouples based indicator and transmitters. (02 Hrs.)</p> <p>262. Install and test various types of Thermocouples based indicator and transmitters. (03 Hrs.)</p> <p>263. Service and calibrate various types of Thermocouples based indicator and transmitters using temperature calibrator or milli volt source. (03 Hrs.)</p>	protecting wells for RTD, advantages and disadvantages of RTDs, thermistors, thermocouples, Ex-tension wires, compensating for changes in reference junction temperature, construction of thermocouple junction, types of thermocouple, advantages and disadvantages of thermocouples. (03 Hrs.)
		<p>264. Measure high temperature using Optical and Radiation pyrometer. (03 Hrs.)</p> <p>265. Measure the relative humidity using humidity sensors. (03 Hrs.)</p> <p>266. Measure the various points like motor, drilling point, hill person temperature etc. using thermal imager. (03 Hrs.)</p>	Pyrometry. Molecular activity and electromagnetic radiation, defining pyrometry, effects of emittance, effects temperature, wavelength and radiated energy, pyrometers and wavelengths, using of optical and radiation pyrometer, Measurement of humidity. Thermal imagers. (03 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Identify, select, Operate, maintain, Service and calibrate different types of recorders. ELE/N9426	<p>267. Practice recording of variable signal. (05 Hrs.)</p> <p>268. Study the construction, operation and use of circular chart recorder for temperature or pressure or mV or mA. (03 Hrs.)</p> <p>269. Study the construction, operation and use strip chart recorder-pneumatic and electronic recorders. (03 Hrs.)</p> <p>270. Calibrating electronic recorder. (04 Hrs.)</p> <p>271. Calibrating pneumatic recorder. (04 Hrs.)</p> <p>272. Overhaul, check, fault find, repair, test of pneumatic, electronic recorders. (single point & multipoint). (06 Hrs)</p> <p>273. Study of paperless LCD/LED recorder. (04 Hrs.)</p>	Recorders. Introduction to recorders, Construction, working principle, various parts installation and use of pneumatic and electronic recorders. Strip-chart, circular chart. (09 Hrs.)

Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Identify different types of Final control elements and role. Identify different valve body, constructional feature, Dismantle, inspect parts, replace parts, recondition, check, and resetting of control valves with actuators, convertors & positioners. Install and test the performance. ELE/N9427	274. Installation and testing valve actuator (pneumatic) with control valve. (02 Hrs.) 275. Calibrating valve positioner with control valve. (01 Hr.) 276. Calibrating current to pressure converter. (01 Hr.) 277. Calibrating voltage to current converter. (01 Hr.) 278. Installation and testing electro pneumatic positioner with control valve. (02 Hrs.) 279. Calibrating electro pneumatic positioners with control valve. (01 Hr.) 280. Dismantle, fault finding, repair, clean, reassemble and test of actuators and positioners. (02 Hrs.)	Final control elements in process loops. Final control elements, actuators, load set Point compensation, feedback loops, control variables, effects of disturbances on performance, parts of final control sub-system, control signal, electric control signals, fluidic control signals, Pneumatic and Hydraulic Actuators. Pneumatic principles, effects of changing pressure, pressure /volume/ temperature relationship, effects of changing temp. Pneumatic actuators, diaphragm actuator, spring and springless actuators, direct and reverse acting actuator, piston actuator, positioner, Electrical actuators and their advantages. (03 Hrs.)
		281. Record specification of linear, equal, percentage quick opening control valves. (01 Hr.) 282. Record the characteristic of control valves. (01 Hr.) 283. Remove and install control valves with service line. (01 Hr.) 284. Dismantling, reconditioning, checking, replacing parts and resetting of control valves. (02 Hrs.) 285. Carry out maintenance of control valves. (01 Hr.) 286. Identifying the proximity switch and study the specifications, constructions, No. of contacts etc. (01 Hr.) 287. Installation and testing micro and limit switches with the load. Verifying its function. (01 Hr.) 288. Installation and testing capacitance or inductive proxy with the load (buzzer/ indicator etc). testing its function. (01 Hr.) 289. Installation and testing, adjusting the range of IR or ultrasonic proxy with load. (01 Hr.) 290. Installation of proxy with relay and operating high current load (like motor or AC lamp etc. (01 Hr.)	Control valves. Control valves functions and components, types of control valves, based on valve flow characteristics- liner, equal percentage, quick opening valves, globe valves, cage valves, butterfly valves, ball valves, sliding gate valves, diaphragm valves, split body valves, capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch, other control valves, control valve mechanical considerations, selecting control valves, valve positioner. (03 Hrs.)
		291. Operate of, sequential. (01 Hr.) Control and block valves. (02 Hrs.) 292. Operate of electromechanical and solid-state relay. (02 Hrs.)	Control elements applications. Feedwater control system works, sequential. valve control, control and block valves, applying relays in final control

		<p>293. Service & test and use electromechanical and solid-state relay. (02 Hrs.)</p> <p>294. Design and test sequential. Logic operation using relay. (01 Hr.)</p>	<p>elements, relay logic in operation, automatic valve control, controllers and activators, turbine control System, throttle and governor valves and activators. Introduction of internal parts of different types of control valves. (03 Hrs.)</p>
<p>Professional Skill 29 Hrs.</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify fundamental of automatic control system and various functional elements in control loop. Identify, select, Install, wire, configure, test the performance, maintain, and service various types of ON-OFF and PID controllers (electronic and pneumatic). ELE/N9428</p>	<p>295. Install, wire up and test the control operation. (03 Hrs.)</p> <p>296. Study construction & operation of ON-OFF Electronic and pneumatic Controllers. (02 Hrs.)</p> <p>297. Service and maintenance of ON-OFF Electronic and pneumatic Controllers. (03 Hrs.)</p> <p>298. Install, wire up, test and monitor the performance of control operation using ON- OFF Electronic and pneumatic Controllers. (03 Hrs.)</p> <p>299. Practical on PID controller trainer on various process parameters. (03 Hrs.)</p>	<p>Introduction to controllers. Basic block diagram of control systems. Advantages Process variable and set point, analog controllers, digital controllers, control angles and limits, control loop measuring Pv, amplifying signals final control elements, current proportioning. Hunting & its effect on the product. Types of controller and their operation. Types of controller, range limit of controllers. (05 Hrs.)</p>
		<p>300. Study construction & operation of PID Electronic / DIGITAL Controllers. (02 Hrs.)</p> <p>301. Service and maintenance of PID Electronic/ DIGITAL Controllers. (03 Hrs.)</p> <p>302. Install, wire up, Configure, test the control operation using PID Electronic / DIGITAL Controllers. (03 Hrs.)</p> <p>303. Verify the steady state and transient responses of PID Electronic / DIGITAL Controllers in P, PI, PD, PID. (02 Hrs.)</p> <p>304. Install, connect pneumatic signal, align and test the control operation using PID pneumatic Controllers. (03 Hrs.)</p> <p>305. Verify the steady state and transient responses of PID pneumatic Controllers in P, PI, PD, PID. (02 Hrs.)</p>	<p>ON/OFF controllers, direct and reverse acting controllers proportional controllers, automatic/manual split control, pneumatic control. Adaptive, limiting and batch control, ratio control system, feed forward, feedback control systems and cascade control system. Comparison between pneumatic and electronic control systems. Basic knowledge on communication protocol. (04 Hrs.)</p>
<p>Professional Skill 29 Hrs.</p> <p>Professional Knowledge 09 Hrs</p>	<p>Tune controller mode and evaluate performance of control loops as per specification and system application ELE/ N9428</p>	<p>306. Perform the control operation in manual and automatic mode. (15 Hrs.)</p> <p>307. Set "optimum setting for unit process in PID Controller (Electronic and pneumatic). (14 Hrs.)</p>	<p>Controller models and tuning. Controller tuning, setting, controller modes, proportional mode, off-set, integral mode, reset mode, derivative mode (rate), single mode controller, two mode controller, three mode controllers, tuning the control loop, step-change- response method. (09 Hrs.)</p>

<p>Professional Skill 58 Hrs.</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Identify modules of PLC, its function, Wire and connect the digital I/Os field devices to the I/O Module of PLC, install Software, Hardware and configure plc for operation. Write and execute simple logic and real application programs. ELE/N9429</p>	<p>308. Wire and connect the digital I/Os field devices to the I/O Module of PLC. (04 Hrs.)</p> <p>309. Install PLC Programming software and establish communication with PC and PLC. (04 Hrs.)</p> <p>310. Hardware configuration and Prepare the input and output addresses for each slot. (04 Hrs.)</p> <p>311. Prepare and download ladder programs for various switching Gates. (04 Hrs.)</p>	<p>Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming. (04 Hrs.)</p>
		<p>312. Write and execute program logic control operation. (04 Hrs.)</p> <p>313. Develop programs using arithmetic, / data copy operation and execute. (04 Hrs.)</p> <p>314. Write and execute program on sequence control using timers and counters. (04 Hrs.)</p> <p>315. Develop programs using shift bit operation. (04 Hrs.)</p> <p>316. Interface analog o/p module of plc with actuator, relay. (04 Hrs.)</p>	<p>Input/output devices. Definition of input /output devices, I/O interface, input modules, output modules, input devices encoders, output devices, the opto-isolators, safety. (04 Hrs.)</p>
		<p>317. Prepare programs based on on-delay and off-delay timers making on and off of a single LED taking one input and one output. (04 Hrs.)</p> <p>318. Two LEDs on and off using pushbutton as an input. first LED on for 3 sec and off for 2 sec, and second Led on for 2 sec and off for 3 sec for continuous cycle till stop is pressed. (04 Hrs.)</p> <p>319. Sequencer task using three LEDs as output and two input pushbuttons one as input (NO) for start and other for stop (NO). (04 Hrs.)</p> <p>320. Configuring the project using analog input and output instructions and implement a on off closed loop control for the given process. (05 Hrs.)</p> <p>321. Development of ladder logic for various tasks related to timers and counter based industrial applications. (05 Hrs.)</p>	<p>Processing and programming functions. The processor unit, the memory, memory organization, ladder diagrams, data logger, most used programming symbols, start, stop, station example, other programming symbol timers and counters, data manipulation instructions, alternate PLC symbols. (06 Hrs.)</p>

<p>Professional Skill 58 Hrs.</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Operate, maintain, service, configure, install, WIRE and test HART transmitters / devices (I/O). And Net-working system for instrumentation. ELE/N9430</p>	<p>322. Installing & Operating HART transmitters/devices (I/O). (10 Hrs.)</p> <p>323. Creating tag, measuring the parameter, configuring the parameter values in Hart transmitter using communicator. (10 Hrs.)</p> <p>324. Preparation network cables and connectors. Testing network cables. (07 Hrs.)</p> <p>325. Preparation of network cables - serial (RS232/485 standards or equivalent) and Ethernet. (07 Hrs.)</p> <p>326. Connect network connectivity hardware and check for its functioning. (07 Hrs.)</p> <p>327. Dismantle and assemble the desktop computer system. (07 Hrs.)</p> <p>328. Study the operation of Pulse Code Modulation and Demodulation. (03 Hrs.)</p> <p>329. Connect any one data output of the decade counter to the Data Inputs of the FSK Modulator and measure output waveform. (07 Hrs.)</p>	<p>Digital control systems: need of smart devices, HART transmitters futures, advantages, applications. Working method of HART devices, HART protocol. HART communicators and PC based HART device configuration. Steps in calibration of HART devices. Communication.(04 Hrs.)</p> <p>Networking: types of networks used in digital instrument systems. LAN, WAN, Ethernet. Point to point and multi networking. Ring, delta, star connections. Redundant Net. TCP/IP addresses and descriptions. Types of Cable categories (CAT), and their descriptions. Various types of Cable connectors. Advantages and disadvantages of co-axial cable and fiber optic cables. Various tools used in networking- wire cutter, crimp tool, memory blade holder, memory blade cartridge, cable strip tool with blade cassettes. Terminators and extra connectors, taps, calibration tool etc. fundamentals: modulation and demodulation, signal to noise ratio, digital communication basics-PWM, PCM, FSK. (10 Hrs.)</p>
<p>Professional Skill 58 Hrs.</p> <p>Professional Knowledge 14 Hrs.</p>	<p>Identify the different modules of DCS, function, Wire and connect I/Os field devices to the I/O Modules, install Software, Hardware and configure DCS for operation with HMI. Write and execute DCS AND SCADA programs FOR real application. ELE/ N9431</p>	<p>330. Wire and connect the I/O Module of DCS to field signals. (06 Hrs.)</p> <p>331. Install DCS Programming software and establish communication with PC and DCS. (06 Hrs.)</p> <p>332. Set the communication between DCS and SCADA System. (06 Hrs.)</p> <p>333. Concept of Tag/Points Generation. (06 Hrs.)</p> <p>334. Attaching points to the display Element. (06 Hrs.)</p>	<p>Fundamentals of SCADA and DCS. History of DCS development.</p> <p>Basic architecture, description advantages and disadvantages, applications.</p> <p>Terminology- RTU (remote transmitting unit, central monitoring station, types of communications, field instruments and types. (04 Hrs.)</p>
		<p>335. Practice HMI, operator panel and touch panel operation and related software. (10 Hrs.)</p> <p>336. Set up and configure HMI with PLC. (06 Hrs.)</p> <p>337. Animate objects on a HMI screen to monitor motor status. (06 Hrs.)</p> <p>338. Use security features to do tag logging and command execution. (06 Hrs.)</p>	<p>Field bus: futures, advantages, architecture, basic block diagram, working. Work station, Human Machine Interface (HMI). Controller (with basic types), field bus interfacing modules, gateway, network manager, I/O modules, field bus devices (I/O), remote transmission panel (RTP), Ethernet. Electronic device description language (EDDL) and device description (DD).</p>

			Field bus power supply and its function. Introduction of digital and multi drop communication protocol Vendors. Futures-library, call up, various visualized futures, Reports (alarms, events), history, trading etc. (10 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Identify, check constructional Feature and function of hydraulic pump, and hydraulic power system, accumulator, hydraulic hoses and fitting, Hydraulic components. Build AND test hydraulic control circuit. ELE/N9432	339. Practice symbolic representation of Hydraulic components. (02 Hrs.) 340. Familiar with hydraulic hoses and fitting. (02 Hrs.) 341. Feature and function of hydraulic pump and hydraulic power system. (02 Hrs.) 342. Feature and function of hydraulic accumulator. (02 Hrs.) 343. Service and test different types of valves. (03 Hrs.)	Basic Hydraulics: Principles of Hydraulics. Fluid power and hydraulics, force, weight and mass, pressure, work, power, energy, incompressibility and non-diffusion, hydrostatic pressure, Pascal's law, transmission of fluid power, fluid flow in pipes, Bernoulli's principle, the effect of heat on liquids. A typical hydraulic power system. Hydraulic Fluids. Functions of Hydraulic fluids, physical properties, viscosity, viscosity index, viscosity and pressure, power point, fluid selection, component protections, chemical properties, system contamination, water, dissolve air, foaming, corrosion and rusting, types of hydraulic fluids. (05 Hrs.)
		344. Design hydraulic circuit for double acting cylinder actuation. (03 Hrs.) 345. Design hydraulic circuit using Pilot operated check valve. (03 Hrs.) 346. Design hydraulic circuit using Pressure reducing Valve. (03 Hrs.) 347. Design hydraulic circuit Using Pressure relief & Pressure regulating valve. (03 Hrs.) 348. Design hydraulic Pressure sequencing circuit. (03 Hrs.) 349. Design hydraulic circuit using Pressure compensated flow control. (03 Hrs.)	Directional control valves. Directional control valve classification, review of two way valves, 'globe, gauge, plug, needle, ball, automatic two way valves, check valves, pilot operated check valves, spool valves, three ways pool valves, controlling hydraulic motors, NO and NC valves, holding valves, four and five way valves, rotary spool valves, schematic symbols, flow ratings, accessories. (04 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping, tubing and fitting. Build and test pneumatic control circuit. ELE/N9433	350. Study construction operation and use of air compressor. (02 Hrs.) 351. Operation and use of air filters, regulators and lubricator. (02 Hrs.) 352. Practice and use of Pneumatic Piping, tubing and fitting. (Metallic and non-metallic). (02 Hrs.)	Pneumatic principles, mass, pressure, work and energy, compressibility, law of pneumatics, transmission of pneumatic fluid power, pneumatic leverage, air properties, airflow in pipelines, viscosity of air pressure, Bernoulli's law, components of pneumatic power system. Primary air treatment. Air treatment, preliminary filtering, relative. Humidity, effects of moisture, water removal, dew point, moisture separators, oil

			scrubbers, air dryers, (deliquescent and absorption type) air receivers. Secondary air treatment. Methods of treatment, Contaminate separation, contaminate filtration and filter classification and rating, types of media surface filters, depth filters, absorption filters, Lubricating the air. (06 Hrs.)
		<p>353. Set up a system to provide Pneumatic (air) supply of 20 psi output from the available compressor. (02 Hrs.)</p> <p>354. Build a pneumatic circuit of a single acting cylinder being controlled by 3 way 2 position directional control valves. (03 Hrs.)</p> <p>355. Build a pneumatic circuit of a double acting cylinder being controlled by 5 way 2 position directional control valves. (03 Hrs.)</p> <p>356. Build a pneumatic AND, OR circuit by 3 way 2 position directional control valves to operate double acting cylinder. (03 Hrs.)</p> <p>357. Build a pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way 2 position directional control valves and 5 way 2 positions valve. (02 Hrs.)</p> <p>358. Build a pneumatic circuit to test logical latch circuit by 5 way 2 position, 3 way 2 valve direction control valves. (02 Hrs.)</p> <p>359. Build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way 2 direction control valves. (02 Hrs.)</p> <p>360. Cutting the metallic tube as per dimensions using tube cutter. (02 Hrs.)</p> <p>361. Bending the tube in to 90 and 45 using pipe bending tools. (02 Hrs.)</p> <p>362. Installation of simple piping diagram. (02 Hrs.)</p>	Piping houses and fittings. Requirement of piping, airflow, piping dimensions and safety factors, piping connections, compressed air piping applications, metallic tubing, tubing bending and tube fitting, tube installation, nonmetallic tube houses, hose fittings and coupling, hose installation. (03 Hrs.)
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Identify constructional feature, operate, maintain, service and calibrate of Analytical instruments. ELE/N9434	<p>363. Operation of pH meter conductivity meter and dissolved oxygen Meter. (04 Hrs.)</p> <p>364. Wire up pH meter electrode to pH meter. (04 Hrs.)</p> <p>365. Calibrate pH meter using buffer solution. (04 Hrs.)</p> <p>366. Determination of pH (by pH meter). (04 Hrs.)</p> <p>367. Wire up conductivity meter to electrode and find the electrolytic conductivity of solution. (04 Hrs.)</p> <p>368. Service and maintenance of conductivity meter & Dissolved oxygen meter. (05 Hrs.)</p>	Analytical instruments. Exposure to basic analytical instruments. Types of electrodes used for PH measurements. Relation of PH and mV. PH indicator and controllers. Conductivity meters. Dissolved gen meter. (09 Hrs.)

Instrument Mechanic - Basic Specifications of Instruments

Finding the range, span and accuracy of measuring instrument

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

- finding the range, span and accuracy of measuring instrument.

Requirements			
Tools/Instruments/Equipments			
• Standard voltmeter (0-10V)	- 1 No.	• Ammeter (0- 500 mA)	- 1 No.
• Voltmeter (0-100V) AC	- 1 No.	• Standard Ammeter (0 -500mA)	- 1 No.
		• Trainees Tool kit	- 1 Set.

PROCEDURE

Finding the range, span and accuracy of measuring instrument

- 1 Clean the given measuring instrument (voltmeter and ammeter)
- 2 Find the range, span and accuracy of given instrument with the help of instructor.

- 3 Record the identified measurement in Table 1 and check with the instructor.

Note: Do the above procedure for different instrument available in the lab with the help of instructor.

Table 1

S.No	Instrument name	Range	Span	Accuracy
1	Voltmeter			
2	Ammeter			

Test the voltmeter/ammeter using std voltage /current source for total range

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

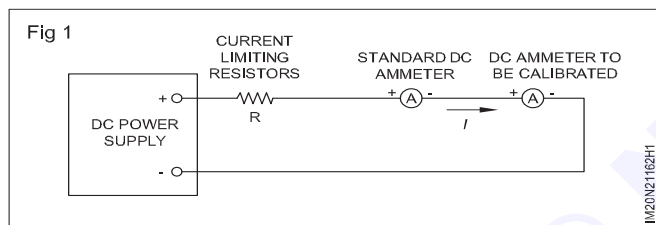
- testing the measuring instrument with standard source
- check the dead zone repeatability, reproducibility drift, dead band, lack lash, hysteresis of measuring instrument.

Requirements			
Tools/Instruments/Equipments			
• Standard voltmeter (0-10V)	- 1 No.	• Tester	- 1 No.
• Voltmeter (0-100V) AC	- 1 No.	• RPS (0-30V) DC	- 1 No.
• Ammeter (0- 500 mA)	- 1 No.	• Resistor 100 Ω/1/4 watt	- 1 No.
• Standard Ammeter (0 -500mA)	- 1 No.	Materials	
• Multimeter with test probes	- 1 No.	• PVC insulated copper cable Sq mm	- as reqd.
• Screw driver	- 1 No.		

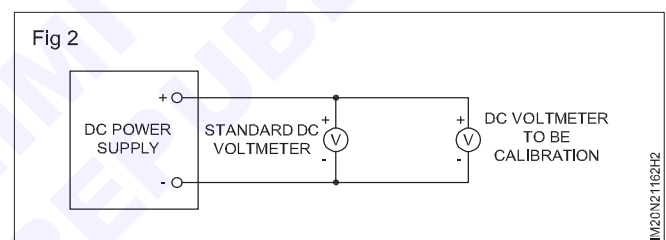
PROCEDURE

TASK 1 : Testing the measuring instrument with standard source

1 Connect the ammeter, Regulated Power Supply and resistor shown in Fig1 check with the help of instructor.



5 Connect the voltmeter, RPS and resistor as shown in fig 2 and check with the help of instructor.



2 Vary the RPS in 5V, 10V, 15V, and 20V and take the corresponding reading in both measuring and standard ammeter.

3 Record the readings in Table 1.

4 Calculate the error and percentage error in table 2 and check with the instructor.

6 Vary the RPS in 5V, 10V, 15V and 20V and take the corresponding reading in voltmeter and standard voltmeter.

7 Record the readings in Table 1.

8 Calculate the error and percentage error in Table 1 and check with the instructor.

Table 1

Name of measuring instrument	RPS voltage in V	Standard Ammeter readings(S)	Measuring ammeter Reading in A(F)	Error (F-C)	Percentage Error (F-S) x 100 / S
Ammeter	5V 10V 15V 20V	50 mA	48 mA	-2 mA	- 0.04 x 100
Voltmeter	5V 10V 15V 20V	5V	4.9V	-0.1V	- 0.02 x 100

TASK 2: Check the dead zone, repeatability, reproducibility, drift, dead zone, backlash, hysteresis of measuring instrument

- Check the dead zone, repeatability, reproducibility, drift, dead zone, backlash, hysteresis of voltmeter & Ammeter with the help of instructor.

Instrument Mechanic - Basic Specifications of Instruments

Identify the strain gauge type, cantilever or load cell specification

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

- identify the types of strain gauge.

Requirements			
Tools/Instruments/Equipments			
• Strain gauge	- 1 No.	• Load cell type strain gauge	- 1 No.
• Cantilever type strain gauge	- 1 No.	• Trainees Tool Kit	- 1 Set.

PROCEDURE

Identify the type of strain gauge

3 Fill table 1 with the help of an instructor.

- 1 Clean the working table.
- 2 Clean the strain gauges and place it on the work table.

Table 1

SI.No.	Strain gauge	Write the types of strain gauge and its parts
1		<ol style="list-style-type: none"> 1 2 3
2		<ol style="list-style-type: none"> 1 2 3

Check the strain gauge using ohm meter /multimeter

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

- check the strain gauge using ohm meter / multimeter.

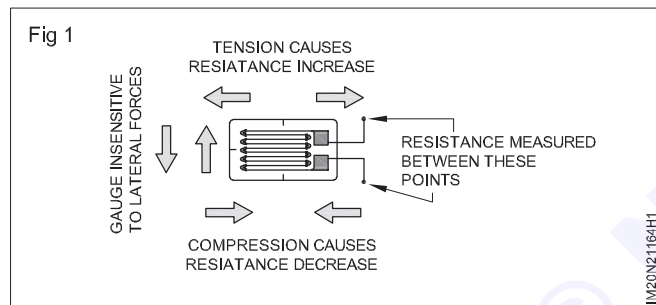
Requirements			
Tools/Instruments/Equipments			
• Bond - strain gauge 120 Ω 150 Ω	- 1 No.	• DC power supply	- 1 No.
• Ohm meter	- 1 No.	• amplifier type / Load cell type strain gauge	- 1 No.
• Multimeter	- 1 No.	• Trainees tool kit	- 1 No.

PROCEDURE

Check the strain gauge using ohm meter / multimeter

1 Connect bonded strain gauge with ohmmeter as shown in Fig 1.

2 Measure the resistance and note down the readings



Note: Instructor should give practice for measuring resistance using ohm meter for different types of strain gauge.

Measure the load using strain gauge instrument

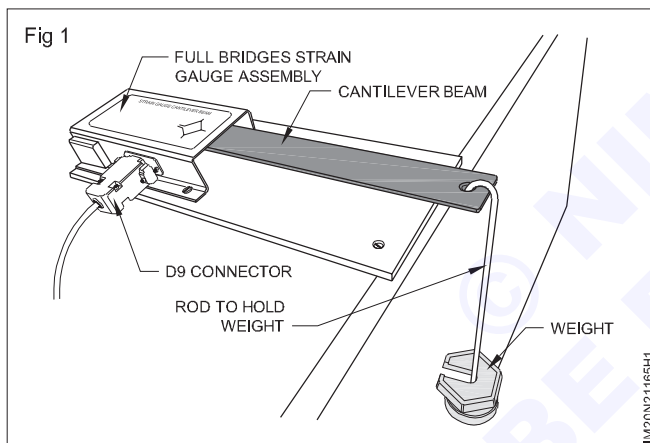
Objectives: At the end of this exercise you shall be able to
 • measure the load using strain gauge.

Requirements	
Tools/Instruments/Equipments	
<ul style="list-style-type: none"> Bonded strain gauge (120Ω different resistance value) - 1 No. Wheatstone bridge trainer - 1 No. Multimeter - 1 No. 	<ul style="list-style-type: none"> Ohmmeter - 1 No.
Materials	
<ul style="list-style-type: none"> PVC insulated copper cable 2.5 sq.mm - as reqd. 	

PROCEDURE

1 Connect the two wires from strain gauge to one arm of the Wheatstone bridge (Quarter – one) as shown in the Fig 1.

$$R_1 = R_2 = R_3 = 120\Omega, \text{ DC power supply} = 10V$$



2 Apply force / load at once end of cantilever beam as shown in Fig observe the change in resistance of strain gauge.

- 3 Switch on the wheat stone bridge trainer.
- 4 When no load, the strain gauge is in understand stage so, Wheatstone bridge voltmeter shows Zero. This is called balance stage.

Formula for Wheatstone bridge

$$R_1 / R_4 = R_2 / R_3$$

- 5 When load is applied on the cantilever beam. Strain gauge expands and observe the change in resistance.
- 6 The wheat stone bridge is in unbalanced stage.
- 7 Voltmeter shows some reading.
- 8 This voltage is directly proportional to applied load.
- 9 Apply different load and measure volts in voltmeter.
- 10 Do the above procedure from step 5 to 9 for different loads , observe the output and tabulate the readings.

Determine the sensitivity and linear range of strain gauge measurement

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

- determine the sensitivity and linear range of strain gauge.

Requirements

Tools/Instruments/Equipments

- | | | | |
|-------------------------------------|----------|----------------------|-----------|
| • Strain gauge trainer | - 1 No. | • Weight | - 10 kgs. |
| • Multimeter with probe | - 1 No. | • Screw driver 150mm | - 1No. |
| • Cantilever beam with strain gauge | - 1 Set. | | |

PROCEDURE

Note: When a conductor is subjected to load it is expanded or compressed. Due to this there is a changes in length, Area and resistance.

Changes in length = ΔL

Original length = L

Strain = $\Delta L / L$

Changes in resistance = ΔR

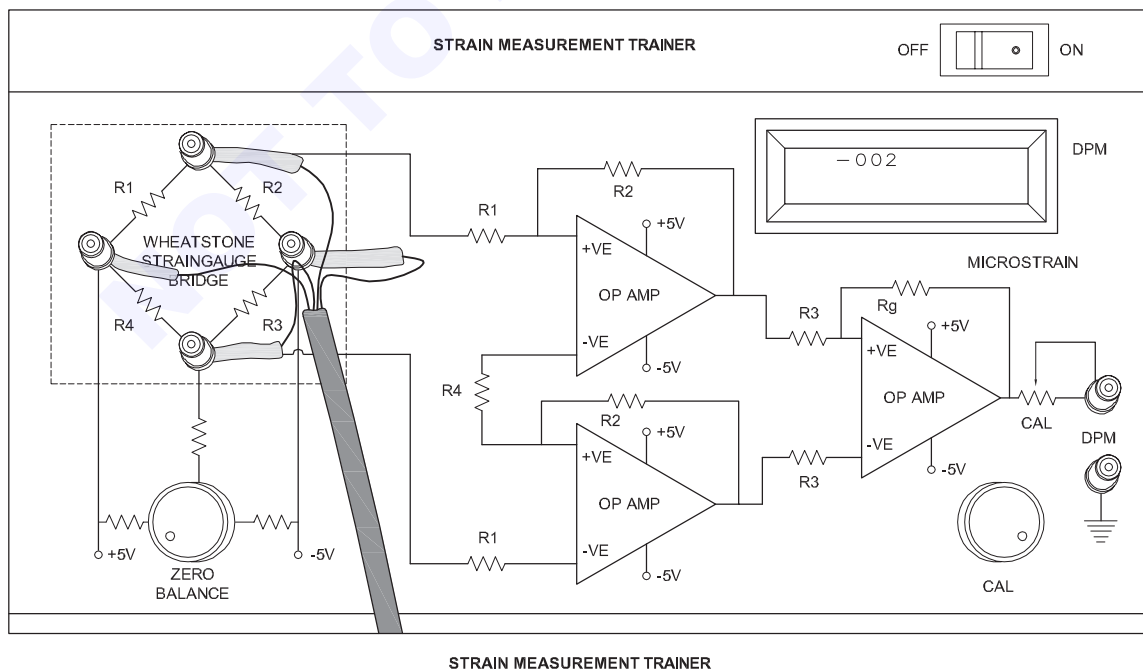
Original resistance = $\Delta R / R$

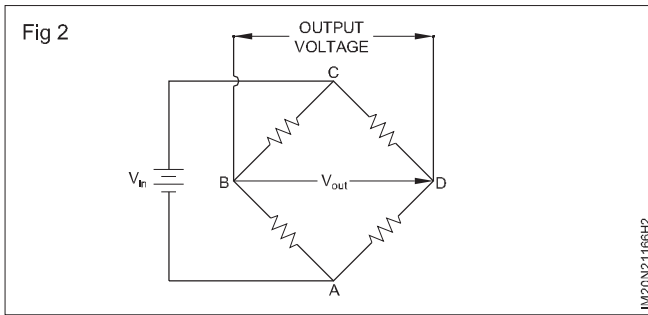
Sensitivity cord gauge factor = $\frac{\Delta R/R}{\Delta L/L}$

- 1 Strain gauge is fixed on the cantilever beam as shown in Fig 1.
- 2 Connect strain gauge with wheat stone bridge
 $R_1 = R_2 = R_3 = 120 \Omega$ as shown in Fig 2.

- 3 Give supply 10V DC to Wheatstone bridge.
- 4 Monitor the balanced state of bridge when no load is applied.
- 5 Supply 2 kg load on the cantilever beam.
- 6 Observe the pointer in the voltmeter of the bridge moves and show a value which is directly proportional to load.
- 7 Measure the resistance of strain gauge using ohmmeter (ΔR)
- 8 Resistance of strain gauge $R = 120 \Omega$ $R = x$
- 9 Note and fill the length of conductor of strain gauge using Manufactures manual with the help of the instructor.
- 10 Calculate the gauge sensitivity using the formula sensitivity.

Fig 1





Gauge sensitivity $S_g = \frac{K \Delta R^2}{\Sigma} \times G_F$ $\Sigma = \frac{\Delta R_{gl}}{R_{gl}}$

$$= \frac{K \Delta R^2 \times G_F}{(\Delta R_{gl} / R_{gl})}$$

$$Q \Delta R^2 = \frac{R_4}{R_3} \times \Delta R_{gl}$$

becomes
$$K \times \frac{R_4}{R_3} \times \Delta R_{gl} \times G_F$$

$$\frac{K \times \frac{R_4}{R_3} \times \Delta R_{gl} \times G_F}{(\Delta R_{gl} / R_{gl})}$$

$$R_4 = R_3 \text{ and } R_{gl} = R_g$$

$$\text{Gauge sensitivity, } S_g = K \times R_g \times G_f$$

$$R_g = R_2 = R_3 = R_4 = R$$

$$\text{output voltage } \Delta e_o \Delta R_g = \Delta R_2 (R_3/R_4)$$

$$\frac{\Delta R/R}{4} \times e_i$$

$$\frac{Gf\Sigma}{4} \times e_i$$

$$\Delta R G = \Delta R_2 \times \left(\frac{R_3}{R_4} \right)$$

Where ΔR_2 = Change in R_2 , to rebalance the bridge after the strain is applied.

$$\text{Now } \Delta R_2 = (R_4/R_3) R_g$$

Output of bridge = $K \Delta R_2$ where K = scale factor of ΔR_2 read out or indicator

11 Apply different loads (2 kg, 4 kg, 6 kg, 8 kg, & 10 kg) Note the corresponding voltage in table 1.

12 Plot a graph for load in x axis and output voltage in y axis.

13 Check the strain gauge with the direct range with the help of conductor.

Load in Kg	Voltage in volts
2kg	
4kg	
6kg	
8kg	
10 kg	

Calibrate strain gauge instrument by adjusting zero and span

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

- calibrate strain gauge instrument by adjusting zero and span.

Requirements			
Tools/Instruments/Equipment			
• Strain gauge trainer kit	- 1 No.	• Weights (100g x 10nos)	-10 kg.
• Multimeter with probe	- 1 No.	• Screw driver 150mm	- 1 No.
• Cantilever beam strain gauge set up	- 1 No.		

PROCEDURE

- 1 Install the cantilever beam strain setup and interface the kit.
- 2 Connect the multimeter in volt mod across T5 and GND
- 3 Switch 'ON' the module.
- 4 Initially, upload the beam and mostly the display by using zero adjustment POT (Zero calibration)
- 5 Apply the man load of 2 kg to the beam and adjust the display to 278 is strain by using gain adjustment POT (gain calibration)
- 6 Now apply the load to the beam, a strain will develop on the beam and measure the output voltage (V) across T5 of GND
- 7 Gradually increase the load and note down the output voltage (V) and actual strain.
- 8 Tabulate the values of theoretical strain, actual strain and output voltage.
- 9 Plot a graph between theoretical strain and output voltage (V)

Formula

$$\%error = \frac{\text{Original strain} - \text{Calculate strain}}{\text{Calculated Strain}} \times 100$$

Calculate strain as in Manufactures manual

$$\begin{aligned} \text{Calculate strain} &= \frac{6PL}{Bt^2y} = \frac{6 \times 1 \times 21.58}{2.8 \times (0.25)^2 \times 2 \times 10^6} \\ &= 370 \text{ M strain} \end{aligned}$$

Example:

Man Load supplied p = 1 kg

Thickness of the beam t = 0.25cm

Breath of beam B = 2.5 cm

Width of beam L = 21.58 cm

(Younger modules) $Y = \frac{2 \times 10^6 \text{ kg} / \text{cm}^2}{\text{Cm}^2}$

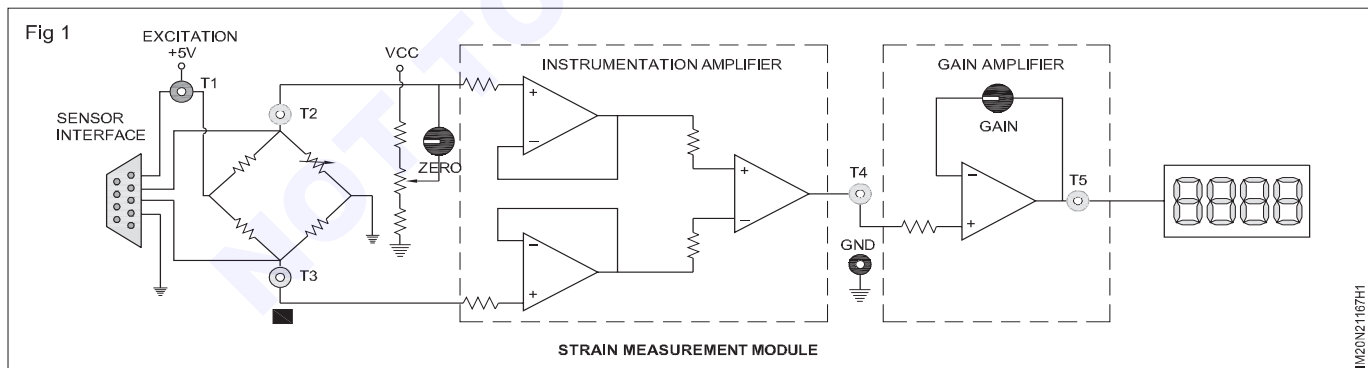


Table 1

Calculated strain	Output voltage	Original strain	% error

Instrument Mechanic - Basic Specifications of Instruments

Identify the various parts of LVDT

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

- identify the various parts , coils and specification of LVDT
- study the specifications of LVDT.

Requirements	
Tools/Instruments/Equipments <ul style="list-style-type: none"> • LVDT trainer kit - 1 No. • Multimeter with probe - 1 No. 	Materials <ul style="list-style-type: none"> • Connecting wires - as reqd.

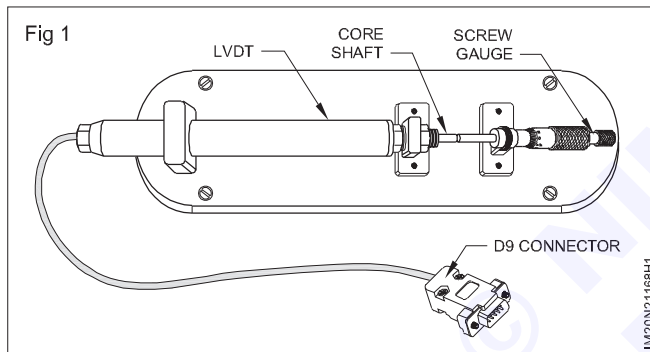
PROCEDURE

Identify the various parts, and specification of LVDT

1 Identify the parts of LVDT trainer Kit with the help of instructor and record in Table 1 (Refer 2.1.169)

2 Record the specification of LVDT with the help of instructor in Table 1

Table 1



Measurement range –
Frequency –
Voltage –
Linearity –
Operating temperature –
Type of LVDT –

Instrument Mechanic - Basic Specifications of Instruments

Identify the coils in LVDT verifying the correction of secondary coils. testing the LVDT Coils using multimeter

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

- identify the coils of LVDT trainer kit and record it in table 1
- measure the primary and secondary coil resistance of LVDT using multimeter.

Requirements			
Tools/Instruments/Equipments		Materials	
• LVDT trainer kit	- 1 No.	• Connecting wires	- as reqd.
• Multimeter with probe	- 1 No.		

PROCEDURE

Identify the various parts, and specification of LVDT

- 1 Identify the coils of LVDT trainer kit and record it in table 1.
- 2 Measure the primary and secondary coil resistance of LVDT using multimeter.

Table 1

Sl.No	Parts of LVDT	Name of the coils
1		
2		
3		
4		

Instrument Mechanic - Basic Specifications of Instruments

Verify the LVDT characteristics by changing the displacement

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

- verify the LVDT characteristics by changing the displacement.

Requirements			
Tools/Instruments/Equipments		Materials	
• LVDT trainer kit	- 1 No.	• Connecting wires	- as reqd.
• Multimeter with probe	- 1 No.		

PROCEDURE

Test of verify the characteristics of LVDT

- 1 Connect LVDT trainer kit with power supply and switch on the power.
- 2 Keep LVDT core in center and move the core front and back fill display shows zero value.
- 3 Move the LVDT – core forward and reverse 5mm, 10mm fill maximum range and note down the corresponding output voltage.
- 4 Record the output voltage in Table -1
- 5 Observe when the core of the LVDT Moves between the coil causes the change in the voltage measurements.
- 6 Draw the graph of LVDT characteristics using recorded values in table – 1

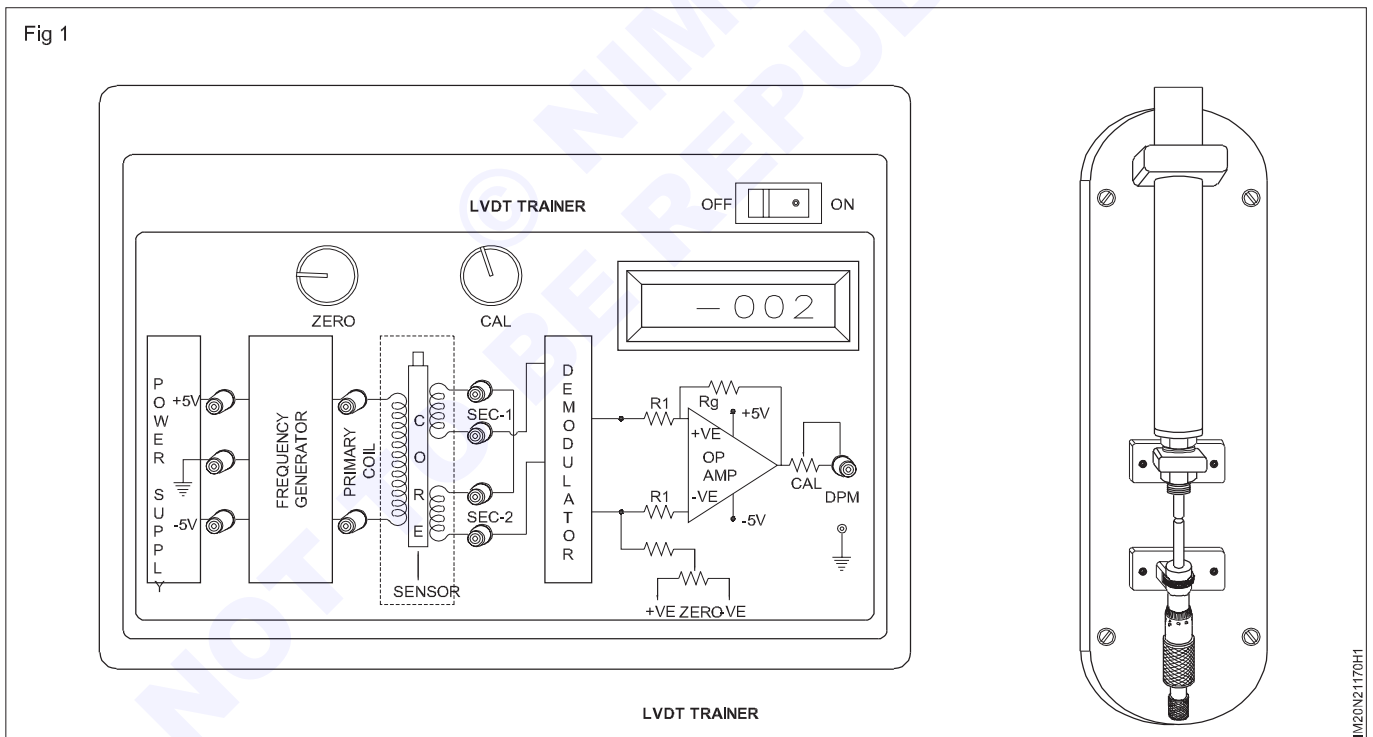


Table 1

S.No	Displacement of core (Right side)		Displacement of core (Left – side)	
	Displacement (mm)	Measurement of voltmeter (V)	Displacement (mm)	Measurement of voltmeters (V)

Instrument Mechanic - Basic Specifications of Instruments

Determine linear range and sensitivity resolution of LVDT

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

- determine linear range of sensitivity of LVDT.

Requirements			
Tools/Instruments/Equipments		Materials	
• LVDT trainer kit	- 1 No.	• Connecting wires	- as reqd.
• Multimeter with probe	- 1 No.		

PROCEDURE

Determine the linear range, sensitivity resolution of LVDT

- 1 Know about the linear range , sensitivity resolution of the given LVDT with the help of instructor.

The instructor should explain about the sensitivity, linear range and resolution of LVDT in the laboratory.

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Measure the phase difference of LVDT secondary coils on CRO

Objectives: At the end of this exercise you shall be able to
 • determine linear range of sensitivity of LVDT using CRO.

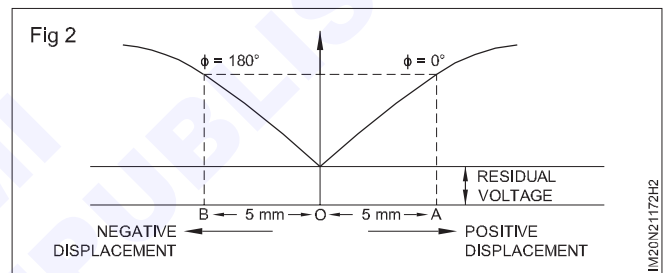
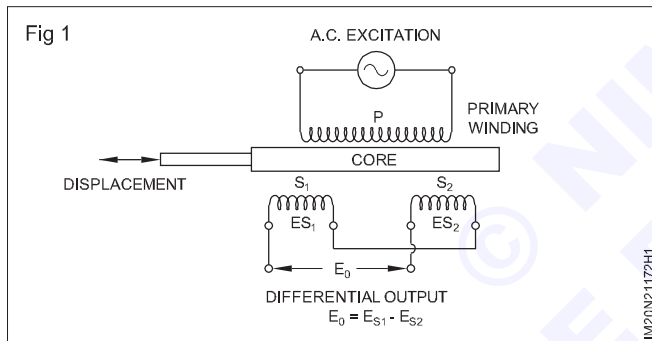
Requirements			
Tools/Instruments/Equipments		Materials	
• LVDT trainer kit	- 1 No.	• Connecting wires	- as reqd.
• Multimeter with probe	- 1 No.	• CRO	- 1 No.

PROCEDURE

Measure the phase difference of secondary coils of LVDT using CRO

- 1 Connect CRO of the secondary coil of LVDT
- 2 Observe the waveform in CRO by moving the core of LVDT as shown in Fig 1 & 2

- 3 Measure the phase difference of coils using CRO
- 4 Check the work done by the instructor.



Calibrate the LVDT by adjusting zero span

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

- calibration of LVDT
- test and calibrate outside micrometer.

Requirements			
Tools/Instruments/Equipments		Material	
• LVDT trainer kit	- 1 No.	• Connecting wire	- as reqd.
• Outside micrometer	- 1 No.		
• C-Spanner (0-250mm)	- 1 No.		

TASK 1: Calibration of LVDT

- 1 Connect the LVDT to the power supply and switch ON.
- 2 Rotate the micrometer till the display show zero. This is null balance, note down the micrometer reading.
- 3 Rotate the micrometer clockwise or anticlockwise direction till 5 mm from the null positon.
- 4 use CALKNOB to adjust the display shows 5mm.
- 5 Rotate the micrometer to zero position to the step 5 by decreasing 5mm on both side.
- 6 Draw the graph by taking measurements in Table 1 & Table 2.

Table 1 (Display positive side) (Anticlockwise direction) (null position)

Sl.No.	Original readings (mm) R_a	Measured readings (mm) R_m (mm)	Error (mm) ($R_m - R_a$)	Correction ($R_a - R_m$) (mm)	Percentage of Error $\frac{R_m - R_a}{R_a} \times 100$
1	+0.5	+0.4	-0.10	+0.10	25%
2					
3					
4					
5					

Table 2 (Display negative side) (Clockwise direction) (null position)

Sl.No	Original readings (mm) R_a	Measured reading R_m (mm)	Error ($R_m - R_a$) (mm)	Correction ($R_a - R_m$) (mm)	% Error
1					
2					
3					
4					

TASK 2: Test of calibrate outside micrometer

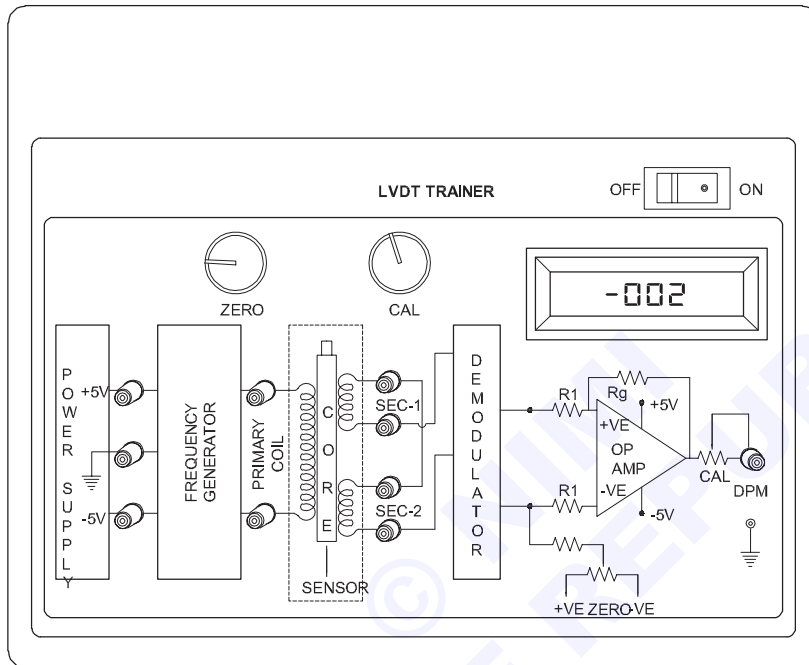
- 1 Clean the given micrometer and keep it on the table.
- 2 Rotate barrel till anvil (A) touches spindle (B).

Note: Rotate the barrel till the sound came from ratchet stop

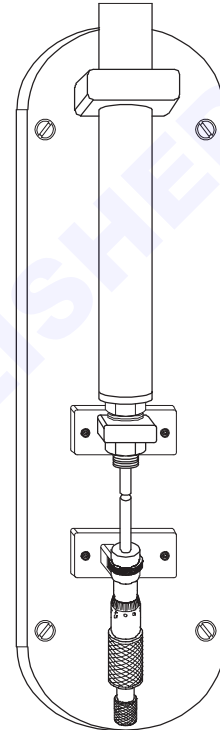
- 3 Observe the main scale zero coincide with thimble scale zero at this stage.
- 4 See for Zero error.

- 5 See for Positive error.
- 6 See for negative error.
- 7 Rotate barrel using C spanner at its end of the pin hole till the MSD and TSD zeros coincides if there is errors.
- 8 Check the work done by the instructor.

Fig 1

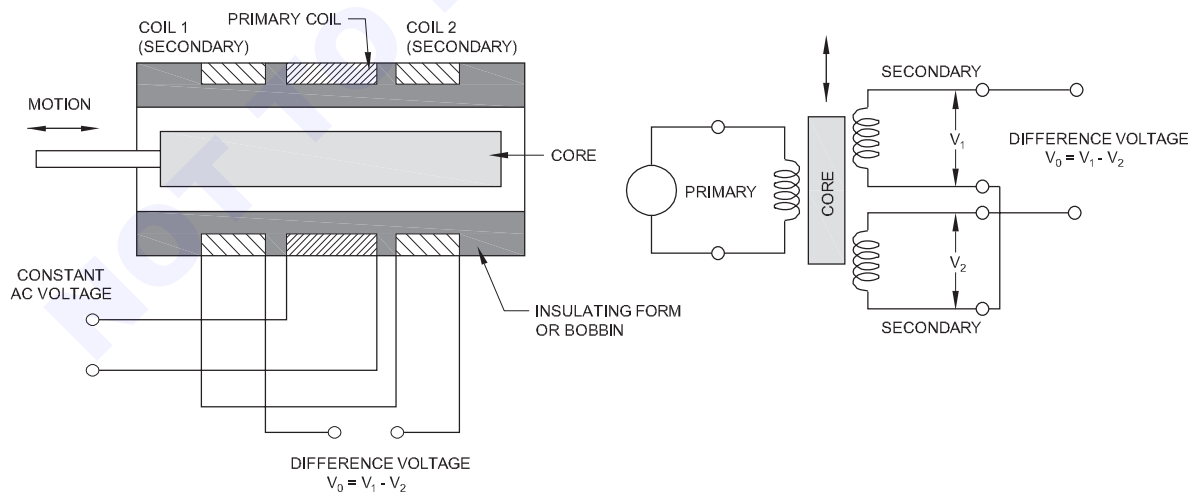


LVDT TRAINER



IM20N21173H1

Fig 2



IM20N21173H2

Instrument Mechanic - Basic Specifications of Instruments

Testing and calibrate displacement meter, accelerometer and thickness instruments

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

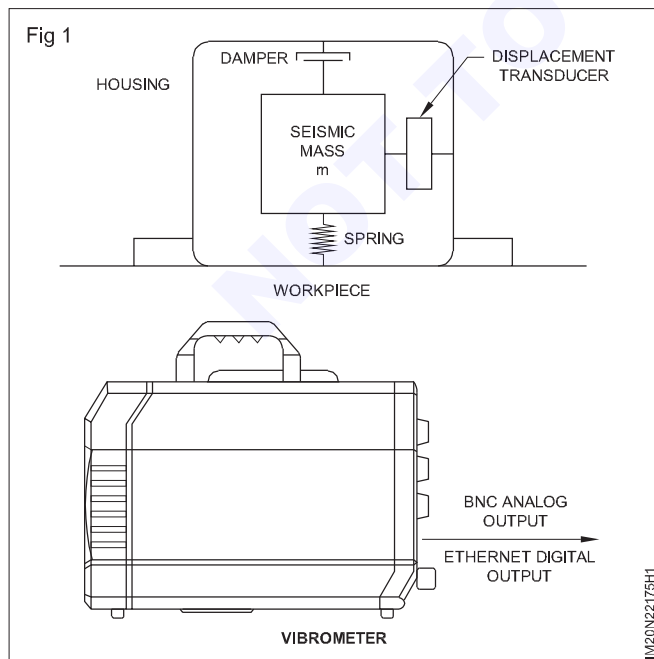
- to measure the vibration of motor / machine using vibrometer and accelerometer.

Requirements			
Tools/Instruments/Equipments		Materials	
• Seismic instrument	- 1 No.	• Connecting cable	- as reqd.

PROCEDURE

- 1 Note down the front panel and back side details using the manual of vibrometer and accelerometer with the help of an instructor.
- 2 Connect the sensor to the vibration generator to the back side of instrument BNC port/connector.
- 3 Connect the vibration generator to the back side of instrument (exciter) using the cable.
- 4 Connect instrument to 230 volt / 50 HZ supply.
- 5 Keep pot and volt pot in a minimum value.
- 6 switch on the instrument and process TARE switch till zero occur.
- 7 Keep the volt pot in maximum value.
- 8 Adjust the frequency pot in fron panel at different frequencies and measure acceleration, velocity and displacement.
- 9 Record the values in Table 1 and draw the graph.

SI.No	Displacement in micron	Velocity in m/s	Acceleration in m/s



Instrument Mechanic - Measurement of Motion

Measurement of vibration of motor/machine

Objectives: At the end of this exercise you shall be able to
 • measure vibration of motor/machine using a vibrometer.

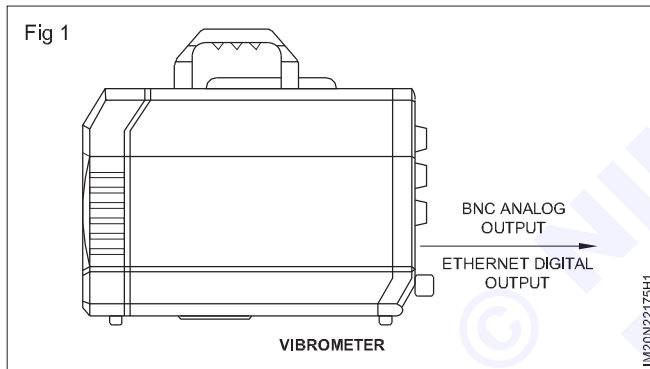
Requirements			
Tools/Instruments		Materials	
• Vibrometer	- 1 No.	• Cleaning cloth	- as reqd.

PROCEDURE

- Clean the given vibrometer.
- Connect the exciter to the DC motor.
- Start the motor and allow the system to vibrate.
- Measure the frequent of vibration using vibrometer and tabulate the reading.

Table 1

Sl.No	Speed of motor	Frequency of Vibration



Instrument Mechanic - Measurement of Motion

Service and maintenance of vibrometer and accelerometer

Objectives: At the end of this exercise you shall be able to
 • service and maintenance of vibrometer.

Requirements

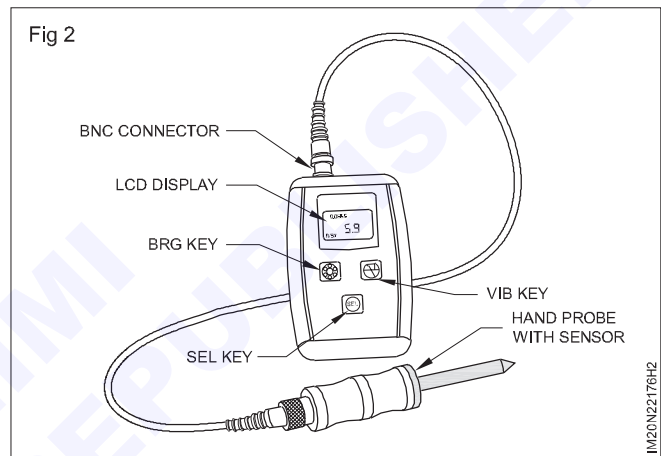
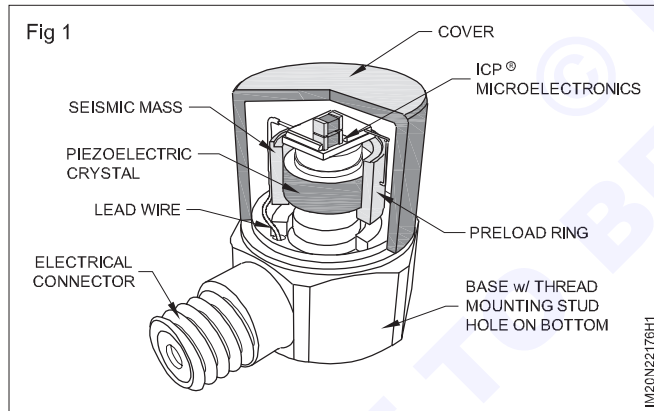
Tools/Instruments

- Vibrometer - 1 No.
- Accelerometer - 1 No.
- Screw driver (100mm) - 1 No.

PROCEDURE

- 1 Clean the work table and keep vibrometer and accelerometer on table.
- 2 Note down the defects in the outer part of the above two meters
- 3 Rectify the defects with the help of an instructor.
- 4 Periodical maintenance is necessary for proper functioning of instruments.

Note: Instruments are subjected to damage if they are not maintained properly and the defects are not rectified.



Instrument Mechanic - Measurement of Motion

Service measuring and maintenance of electrical tachometer

Objectives: At the end of this exercise you shall be able to
 • service and maintenance of electrical tachometer.

Requirements	
Tools/Instruments	
• Electrical tachometer	- 1 No.
• Screw driver (100 mm)	- 1 No.

PROCEDURE

- 1 Clean the given electrical tachometer.
- 2 Keep it on the working table.
- 3 Dismantle the electrical tachometer with the help of an instructor.
- 4 Identify its parts and list it in the Table 1.
- 5 Clean the defective parts of the tachometer using carbon tetrachloride solution.
- 6 Reassemble the parts and check with an instructor.
- 7 Connect the electric tachometer as shown in the Fig 1.

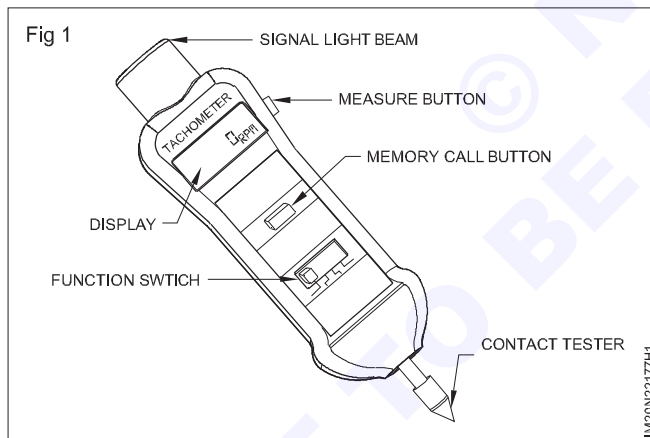
Table 1

Sl.No	Name of the Parts

- 8 Switch on the power supply and take the readings of tachometer.
- 9 Record the readings in Table 2.

Table 2

Sl.No.	Speed of motor (rpm)	Speed of electrical Tachometer (rpm)



- 10 Clean the tachometer after measuring the speed for maintenance.

Note: Choose the required range of electrical tachometer.

Instrument Mechanic - Measurement of Motion

Identify different parts its function and operation of eddy current tachometer, AC tachometer & DC tachometer

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

- identify the different parts and study about its function and operation of eddy current tachometer, AC & DC type tachometer.

Requirements			
Tools/Instruments			
• Drag up tachometer (0-600) rpm	- 1 No.	• Screw driver (120 mm)	- 1 No.
• AC type tachometer (0-600) rpm	- 1 No.	Materials	
• DC type tachometer (0-100) rpm	- 1 No.	• Cleaning cloth	- as reqd.

PROCEDURE

- 1 Clean the working table.
- 2 Dismantle the drag cup tachometer with the help of an instructor on the working table.
- 3 Identify the parts of the tachometer and study its function with the help of an instructor.
- 4 Record it in required place in Table 1.
- 5 Do the above procedure for AC & DC type tachometer and record it in the Table 1.
- 6 Check the work done with the help of an instructor.

Table 1

Sl.No	Types of Tachometer	Name of Tachometer	Parts of Tachometer	Operations of Tachometer
1			1 2 3 4 5	
2			1 2 3 4	
3			1 2 3 4	

Instrument Mechanic - Measurement of Motion

Servicing and maintenance of mechanical and electrical tachometer

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

- servicing measuring and maintenance of mechanical tachometer
- servicing measuring and maintenance of electrical tachometer.

Requirements

Tools/Measuring Instruments

- Tester - 1 No.
- Drag cup tachometer (0-600) rpm - 1 No.
- Motor (single phase) (1400) rpm - 1 No.
- Variable transformer - 1 No.
- Electrical tachometer (0-1500) rpm - 1 No.

- Screwdriver - 1 Set.
- Multimeter - 1 No.

Materials

- Cleaning cloth - as reqd.
- Cleaning brush - 1 No.
- Carbon tetrachloride - as reqd.

PROCEDURE

TASK 1: Servicing measuring and maintenance of mechanical tachometer

- 1 Clean the given mechanical tachometer
- 2 Keep it on the working table
- 3 Dismantle the mechanical tachometer with the help of an instructor as shown in Fig 1.
- 4 Identify its parts and list it in the Table 1
- 5 Clean the defective parts of the tachometer using carbon tetrachloride solution.
- 6 Reassemble the parts and check with an instructor.
- 7 Connect mechanical tachometer as shown in Fig 2
- 8 Switch on the motor.
- 9 Vary the speed of motor using variable transformer.
- 10 Note down different reading of tachometer.

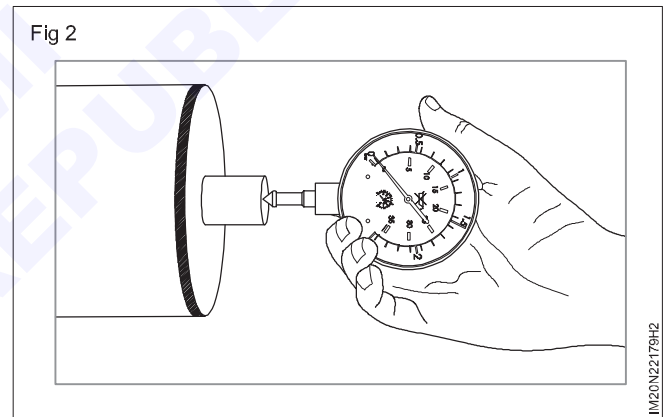
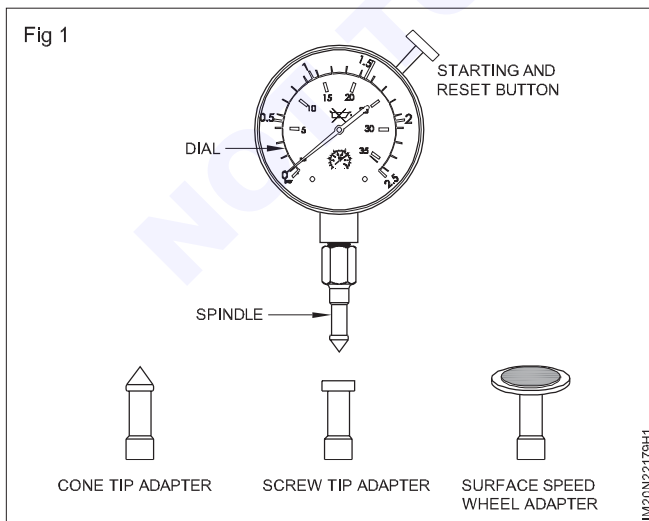


Table 1

Sl.No	Name of the Parts



Sl.No	Speed of motor (rpm)	Speed of mechanical Tachometer (rpm)

TASK 1: Experiment: servicing and maintenance of electrical tachometer

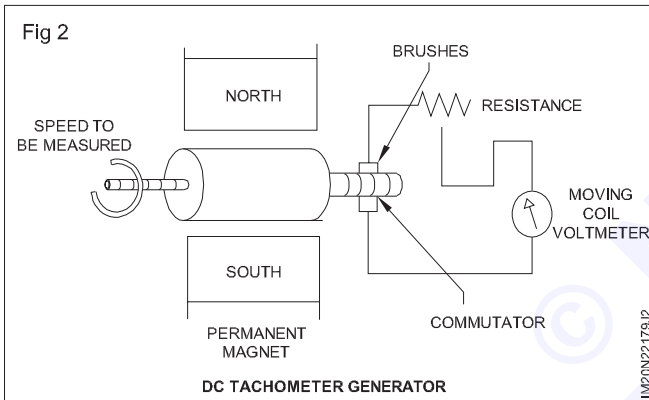
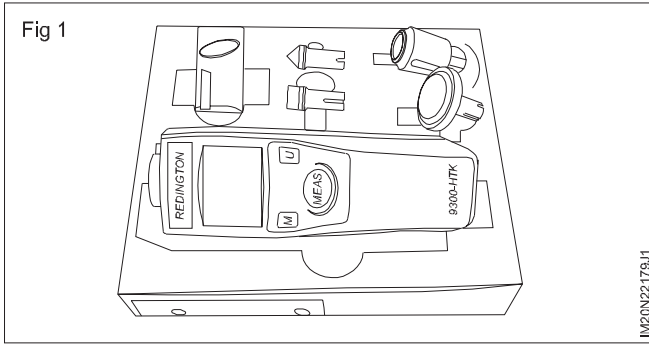
To demonstrate the proper procedures for servicing and maintaining electrical type tachometers.

Step 1: Preparation

Ensure that the tachometer is disconnected from any power source.

Step 2: Opening the tachometer (Fig 1&2)

Using the appropriate screwdriver, carefully remove the screws holding the tachometer casing together.



Step 3: Inspection

Inspect the internal components for any signs of damage, loose connections, or dirt accumulation.

Step 4: Cleaning

Using the cleaning solution and a soft cloth or a cotton swab, clean the internal components of the tachometer. Pay extra attention to any areas that seem dirty or contaminated.

Step 5: Lubrication

Apply a small amount of appropriate lubricating oil to any moving parts or rotating components. This will ensure smooth and reliable operation.

Step 6: Testing

Put on your safety gloves and goggles. Connect the tachometer to a power source and use a multimeter to test its functionality. Look for any abnormal readings or malfunctions.

Step 7: Reassembly

Once you're satisfied with the tachometer's performance, carefully reassemble the casing using the screws. Make sure everything is snug and secure.

Step 8: Calibration

Periodically calibrate the tachometer to ensure its accuracy. Calibration should be done by a qualified technician using a reference standard. The calibration frequency will depend on the manufacturer's recommendations and the level of accuracy required for your specific application.

Safety Precautions:

Always disconnect the tachometer from the power source before servicing or cleaning it.

Wear safety glasses when cleaning the tachometer.

Do not adjust the tachometer if it is damaged.

Instrument Mechanic - Measurement of Motion

Identify different parts/section its function & operation and use of stroboscope and find the motion of object

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

- identify the different parts of stroboscope
- measure the speed of rotating object.

Requirements		
Tools/Measuring Instruments		
• Stroboscope	- 1 No.	Materials
• Rotating object (Motor grinding – Machine etc)	- 1 No.	
• Screw driver 150 mm, 100mm, 200 mm	- 1 No each.	
		• Cleaning cloth - as reqd.
		• Card board disc - 150mm.

PROCEDURE

TASK 1 : Identify the different parts of stroboscope

- 1 Clean the work table and keep the stroboscope on the table
- 2 Identify the different parts of stroboscope with the help of an constructor and record its name & uses in Table 1.

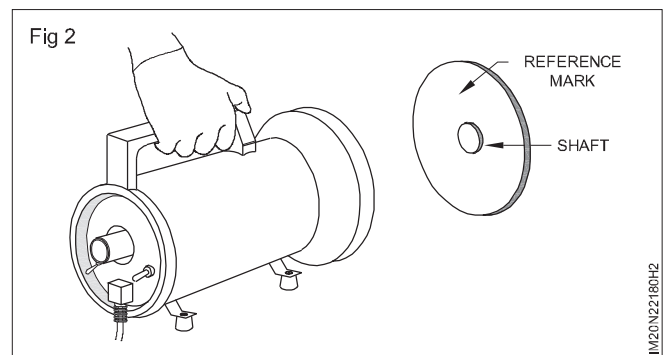
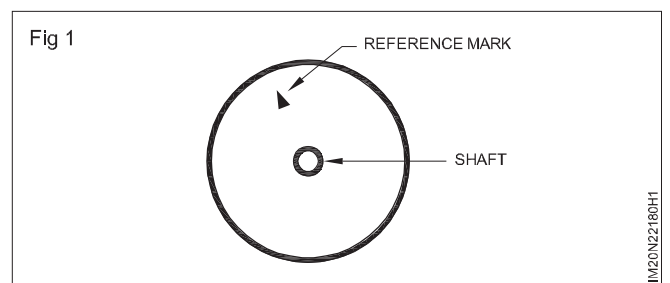
Table 1

Sl.No	Name of the parts of Stroboscope	Uses

TASK 2 : Measure the speed of rotating object

- 1 Fix the arrow card board disc in the rotating shaft as shown in Fig 1.
- 2 Place the stroboscope in front of the disc (which is fixed in the shaft) as shown in Fig 2.
- 3 Set the speed range using selector switch in the stroboscope.
- 4 Focus the light on the card board disc as shown in Fig 3.
- 5 Adjust the speed of flash light till arrow appear of the emitted light.
- 6 Adjust the speed of light till arrow appear stands still
- 7 Note down the speed in rpm in the stroboscope.

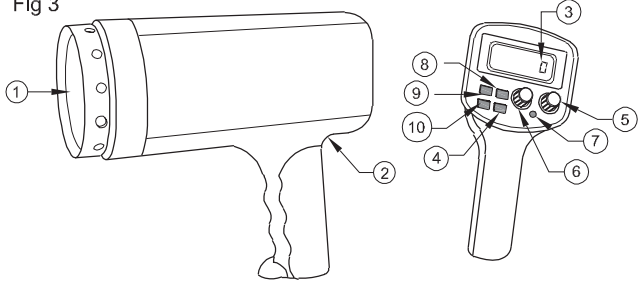
Handle the stroboscope with care avoid continuous usage of stroboscope.



IM20N22180H1

IM20N22180H2

Fig 3



- | | |
|---|---|
| 1 - FLASH TUBE (XENON LAMP) | 6 - FINE (FLASHING RATE ADJUSTING KNOB) |
| 2 - POWER SWITCH | 7 - JACK FOR EXTERNAL TRIGGERING SIGNAL |
| 3 - DISPLAY | 8 - INTERNAL/EXTERNAL TRIGGERING BUTTON |
| 4 - RANGE SWITCH | 9 - X2 BUTTON FOR FAST CHECK |
| 5 - COARSE (FLASHING RATE ADJUSTING KNOB) | 10 - /2 BUTTON FOR FAST CHECK |

IM20N2180H3

NOT TO BE REPUBLISHED

Instrument Mechanic - Measurement of Pressure

Measure atmospheric pressure using barometer

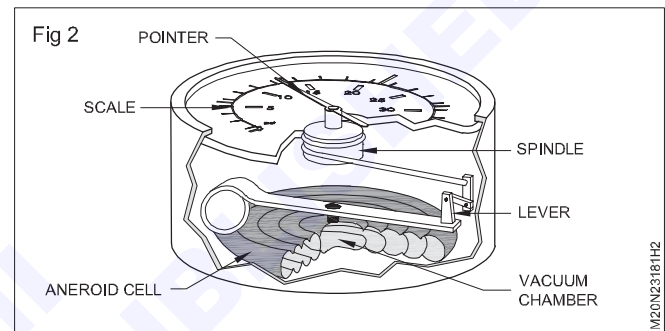
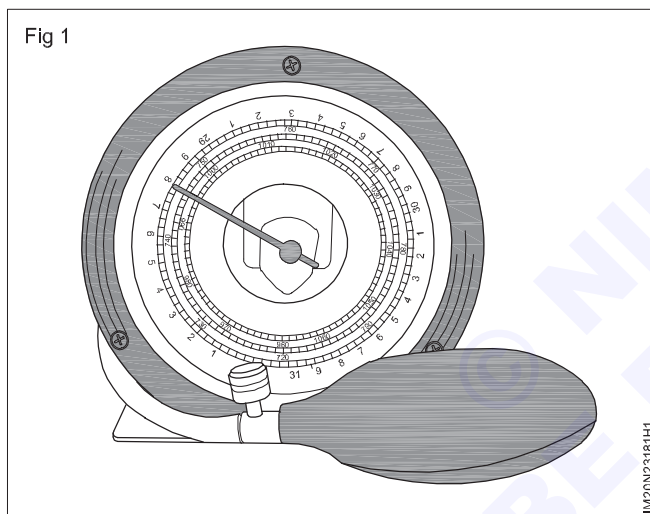
Objectives: At the end of this exercise you shall be able to

- measure atmospheric pressure using barometer

Requirements			
Tools/Instruments		Materials	
<ul style="list-style-type: none"> • Any type of barometer 	- 1 No.	<ul style="list-style-type: none"> • Cleaning cloth 	- as reqd.

PROCEDURE

- Measure atmospheric pressure using barometer
- Take the given aneroid barometer as shown in Fig 1.
- Identify parts of barometer with help of instructor



- Keep the barometer in the atmospheric pressure.
- Note down the readings of barometer in mm/Hg and hpa

Atmospheric pressure = mm/Hg
Atmospheric pressure = hpa

Instrument Mechanic - Measurement of Pressure

Identify the types of manometer and find their characteristics

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

- measure atmospheric pressure using barometer
- identify the types of manometers.

Requirements

Tools/Instruments

- Any type of barometer - 1 No.
- U-tube manometer - 1 No.
- Well type manometer - 1 No.

- Inclined tube manometer - 1 No.

Materials

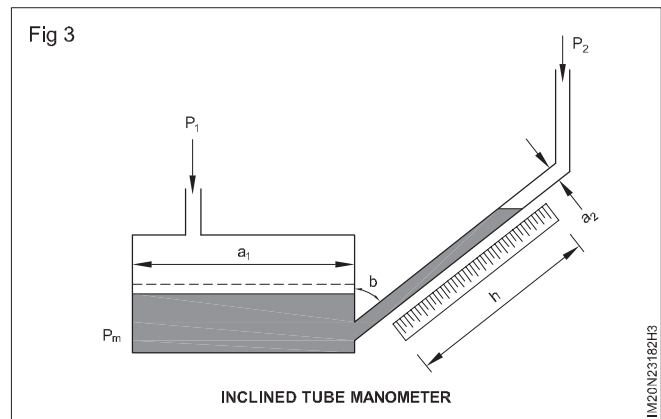
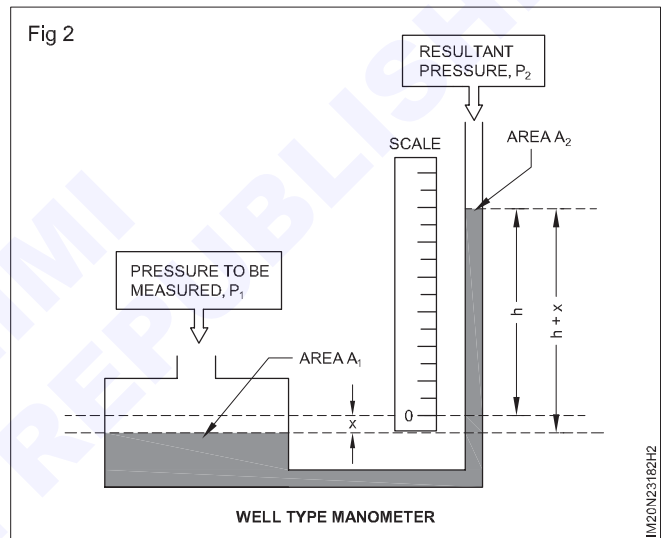
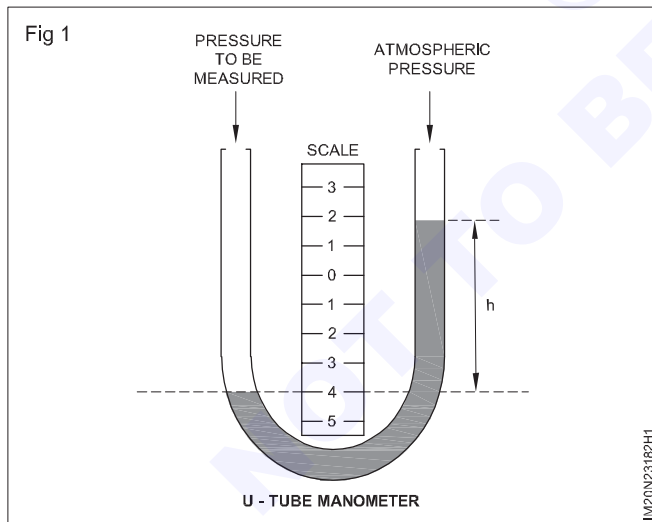
- Water - as reqd.

PROCEDURE

- Identify types of manometers
- Clean the working table
- Keep different types of manometers in laboratory on working table.
- Clean all the instruments and fitting with cloth.

Note: Instructor should explain the construction, range, type of scales, compound scale, heart count, tube material, type of liquid, valves and fittings of manometer in related theory for the exercise 2.3.182

- Identify different types of manometers.



Instrument Mechanic - Measurement of Pressure

Measure differential pressure, gauge pressure and vacuum pressure using U tube manometer

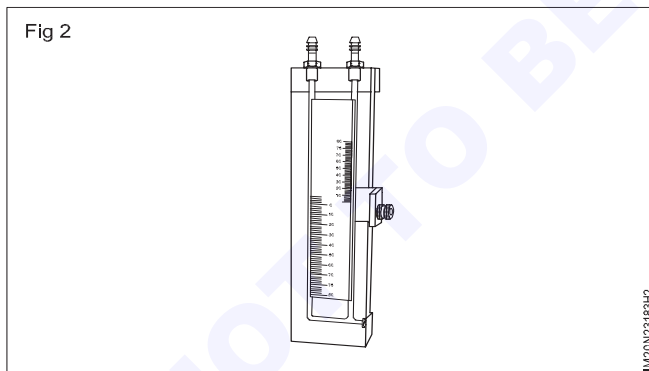
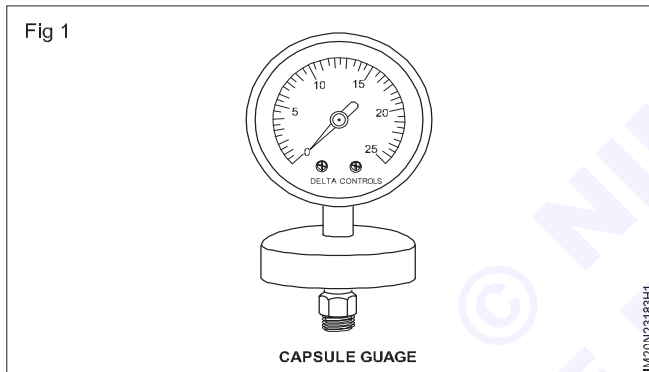
Objectives: At the end of this exercise you shall be able to

- measure differential pressure, gauge pressure and vacuum pressure using U-tube manometer.

Requirements			
Tools/Instruments		Materials	
• U-tube manometer	- 1 No.	• Water	- as reqd.
• Pump	- 1 No.	• Cloth	- as reqd.
• Trainees tool kit	- 1 No.		
• Capsule gauge 0-100 MMWC	- 1 No.		

PROCEDURE

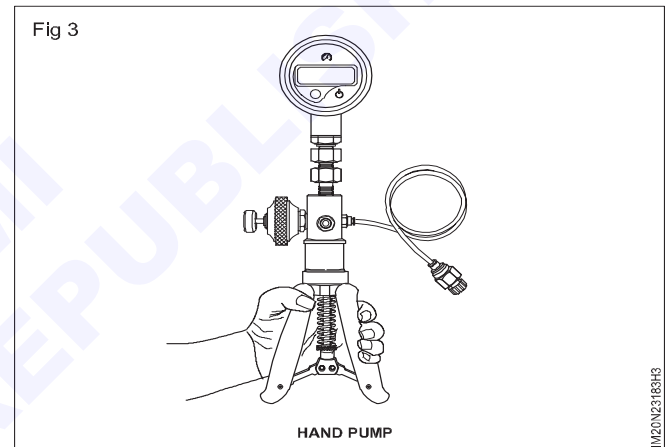
- 1 Connect Hand pump needle valve 'U' tube manometer & capsule gauge as shown in Fig 1 with the help of the instructor.



- 2 Select the required range of pressure gauge for U-tube manometer and fill the water from needle valve to left end of manometer.

Handle the U - tube manometer with care

- 3 Install the 'U' tube manometer in vertical position.
- 4 Keep mercury meniscus at zero point in the manometer.
- 5 Seal all the joints by teflon take
- 6 Open one end of manometer to atmospheric pressure.
- 7 Apply pressure using hand pump.



- 8 Open needle valve and supply low pressure to manometer.
- 9 Note down the readings in pressure gauge and manometer.

- 10 Adjust PRV and note down different readings.
- 11 Calculate differential pressure using formula.

$$P_2 - P_1 = (P - P_1) (h_1 - h_2)g$$

$$P = (P - P_1) hg$$

P = density of 'U' tube manometer liquid

P₁ density of liquid whose pressure is to be determined.

g = Acceleration due to gravity

h = Difference in liquid height manometer.

- 12 Calculate gauge pressure using the formula

$$P_{\text{absolute}} \rightarrow P_{\text{abs}}$$

$$P_{\text{atmosphere}} \rightarrow P_{\text{atm}}$$

$$P_{\text{gauge}} \rightarrow p_g$$

$$P_{\text{vacuum}} \rightarrow \nabla P_{\text{Vac}}$$

$$P_{\text{abs}} = P_{\text{atm}} + P_g$$

$$P_g = p_{\text{abs}} - p_{\text{atm}}$$

- 13 Calculate vacuum pressure using formula

$$P_{\text{vac}} = P_{\text{atm}} - P_{\text{abs}}$$

Instrument Mechanic - Measurement of Pressure

Dismantle and assemble the manometer cleaning the glass tube, aligning the gravity balance etc

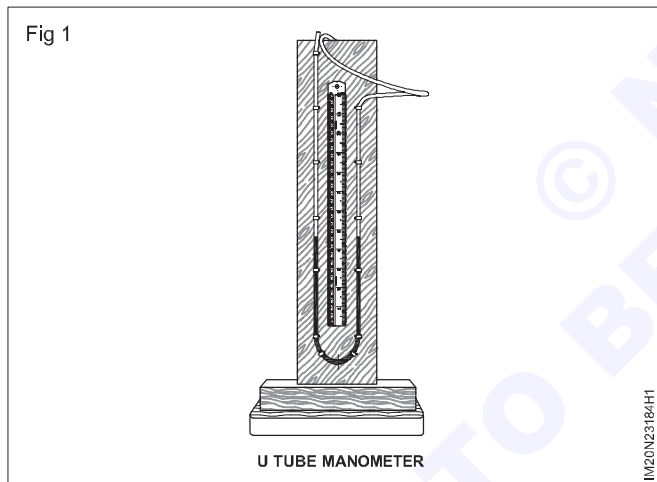
Objectives: At the end of this exercise you shall be able to
 • dismantle, clean and assemble the manometer.

Requirements			
Tools/Instruments		Materials	
• 'U' tube manometer	- 1 No.	• Chamois leather	- as reqd.
• Container	- 2 Nos.	• Blotting paper	- as reqd.
• Funnel	- 1 No.	• Mulmul cloth	- as reqd.
• Beaker	- 1 No.		

PROCEDURE

- 1 Remove the manometer assembly from wall or from stand and keep on clean table.
- 2 Tilt the assembly slowly and remove the mercury from 'U' tube and collect in PVC beaker

Note: Measuring is a costly material. It is harmful. Keep the container in safe place.



- 3 Remove the 'U' tube from housing by removing clamp screws.
- 4 Pour the soap solution into the 'U' tube and scrub with soft nylon brush.
- 5 Clean the outer surface with mulmul cloth.
- 6 Allow sometime to dry internal side of tube.
- 7 Heat the tube with hot air dry. Bow hot air so that internal water particles evaporate and tube gets dry.
- 8 Mouth the 'U' tube inside the metal housing and clamp it properly.
- 9 Clean the mercury with blotting paper and chemise leather.
- 10 Pour the cleaned mercury slowly into 'U' tube using small glass funnel.
- 11 Adjust the scale by loosening the scale screw and set the scale zero to match with meniscus of mercury column.
- 12 Mount the 'U' tube on stand or wall

Instrument Mechanic - Measurement of Pressure

Dismantle and assemble the pressure gauge, identify it's various parts

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

- dismantle and assemble bourdon tube pressure gauge and measure gauge pressure
- dismantle and assemble diaphragm type pressure gauge
- measure vacuum pressure using diaphragm type pressure gauge.

Requirements

Tools/Measuring Instruments

- Bourdon tube pressure gauge (0-5) kg /km² - 1 No.
- Screw driver set - 1 No.
- Pointer puller - 1 No.
- Air supply unit - 1 No.
- Pressure regulator (0-30) psi - 1 No.
- Vacuum pump ¼ HP, 1440 rpm 15 pascal - 1 No.

- Vacuum regulator (0-760) mm/Hg - 1 No.

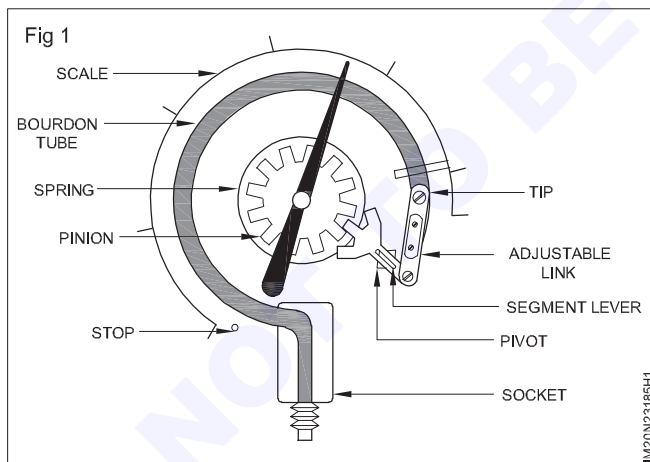
Materials

- White petrol - as reqd.
- Cleaning cloth - as reqd.
- 3AF 40 oil - as reqd.
- Teflon tape - 1 No.

PROCEDURE

TASK 1 : Dismantle Assemble bourdon tube pressure gauge and measure gauge pressure

- 1 Clean the working table
- 2 Remove the screws on the top of the pressure gauge
- 3 Remove the dial glass slowly
- 4 Remove the pointer using pointer puller
- 5 Remove the screws on the dial and take the dial.
- 6 Record the parts of pressure gauge as shown in Fig 1.
- 7 Remove 'C' type movement from the case
- 8 Remove a link an movement assembly using screw driver.
- 9 Apply SAE 40 oil to all the parts except hairspring.
- 10 Check whether the segment and pinion are worn out
- 11 Replace the worn out parts
- 12 Reassemble all the parts of pressure gauge.



- 13 Fix the dial on it then fix the pointer by pointer fixer
- 14 Close the gauge by dial glass and cover
- 15 Apply Air supply and vary the pressure regulator
- 16 Note down the readings in pressure gauge (P_{abs})
- 17 Calculate gauge pressure using formula
- 18 Check the work done by the instructor.

$$P_g = P_{abs} - P_{atm}$$

TASK 2: Dismantle and assemble diaphragm type pressure gauge

- 1 Remove diaphragm housing from the diaphragm type pressure gauge.
- 2 Remove upper and lower flange diaphragm from the housing and clean using cotton waste and cleaning solution.

Do not give pressure above the range
Use proper tools to remove the pressure gauge.

- 3 Replace defected diaphragm with the help of instructor and identify the parts.
- 4 Assemble diaphragm housing and pressure gauge with the help of instructor.

Instrument Mechanic - Measurement of Pressure

Measurement of gauge pressure and vacuum pressure using bourdon tube/ diaphragm gauge

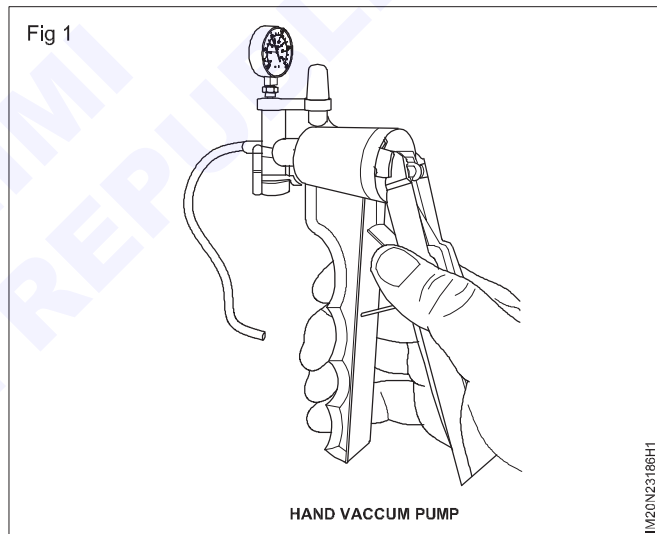
Objectives: At the end of this exercise you shall be able to

- measure vacuum pressure using diaphragm type pressure gauge.

Requirements			
Tools/Measuring Instruments			
• Bourdon tube pressure gauge (0-5) kg /km ²	- 1 No.	• Vacuum regulator (0-760) mm/Hg	- 1 No.
• Screw driver set	- 1 No.	Materials	
• Pointer puller	- 1 No.	• White petrol	- as reqd.
• Air supply unit	- 1 No.	• Cleaning cloth	- as reqd.
• Pressure regulator (0-30) psi	- 1 No.	• 3AF 40 oil	- as reqd.
• Vacuum pump ¼ HP, 1440 rpm 15 pascal	- 1 No.	• Teflon tape	- 1 No.

PROCEDURE

- 1 Connect diaphragm type pressure gauge, vacuum pump and vacuum regulator as in Fig 1.
- 2 Switch on the vacuum pump
- 3 Regulate the vacuum using vacuum regulator and note down the readings in vacuum diaphragm gauge.



Instrument Mechanic - Measurement of Pressure

Measurement of differential pressure using diaphragm/capsule gauge

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

- measurement of differential pressure using diaphragm / capsule gauge.

Requirements			
Tools/Measuring Instruments			
• Differential pressure gauge	- 1 No.	• PVC tube 6 mm	- 6 Nos.
• Air pressure regulator (0-30) psi	- 1 No.	• Foot pump (0-5) kg/cm ²	- 1 No.
• Pneumatic T – Push fittings 6mm	- 6 No.	• Needle valve	- 2 Nos.
		Materials	
		• Bulb red and green	- 1 No each.

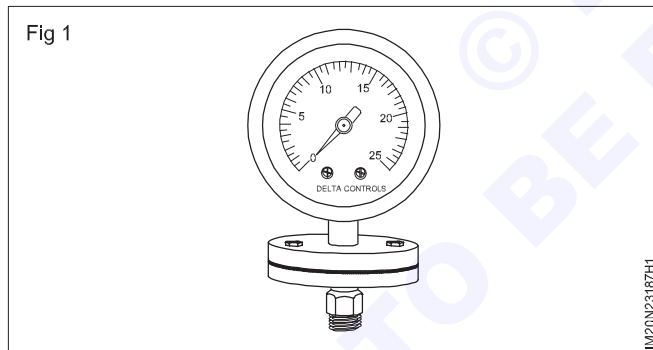
PROCEDURE

- 1 Diaphragm type differential pressure gauge, air pressure regulator, T – Push fittings, needle valve and 6 mm PVC tube as shown in Fig 1.
- 2 Check the leaks in the connection
- 3 Check the work done by the instructor
- 4 Supply pressure from foot pump
- 5 Adjust the pressure regulator to 5 psi and note down the corresponding pressure in DP gauge.
- 6 Do the above step for 10 psi, 15 psi, 20 psi & 25 psi

- 7 Close V1 & V2 needle valve if the DP gauge is faulty.
- 8 Check the work done by the instructor Table 1.

Pressure in air pressure regulator (psi) Pressure in DP gauge in psi.

Pressure in Air pressure Regulator (PSI)	Pressure in DP gauge in PSI



Instrument Mechanic - Measurement of Pressure

Identify specifications of pressure switch - range, differential pressure span, contact types, contacts current rating, number of contacts etc

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

- identify the specification of pressure switch.

Requirements			
Tools/Measuring Instruments			
• Pressure switch	- 5 Nos.	• Screw driver 150 mm	- 1 No.
• Electro mechanical & electronic type compressor 230V /AC 1/2HP (0-10) kg/ cm ²	- 1 No.	• Spanner required size	- 1 No.

PROCEDURE

TASK 1 : Identify the specification of pressure switch

- 1 Clean the working table
- 2 Keep the given different type of pressure switch on the table.
- 3 Record switch in the name plate fixed at back side eject.
- 4 Record the above details in Table 1.
- 5 Do the step 3 & 4 for other type of switch.
- 6 Check the work done by the instructor

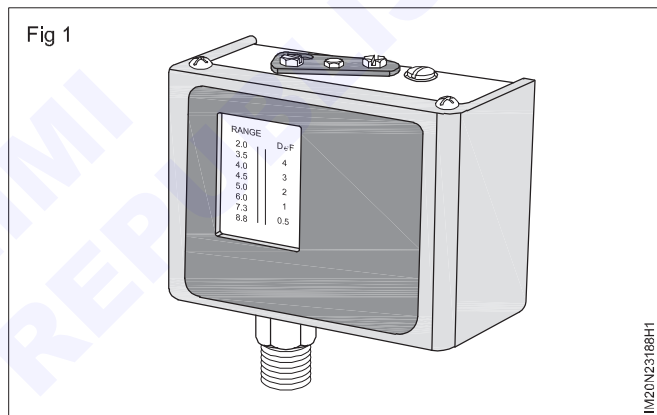


Table 1

Name of pressure switch	Range	Differential pressure gap	Type of contact	Ratio of contact current	Number of contracts

Instrument Mechanic - Measurement of Pressure

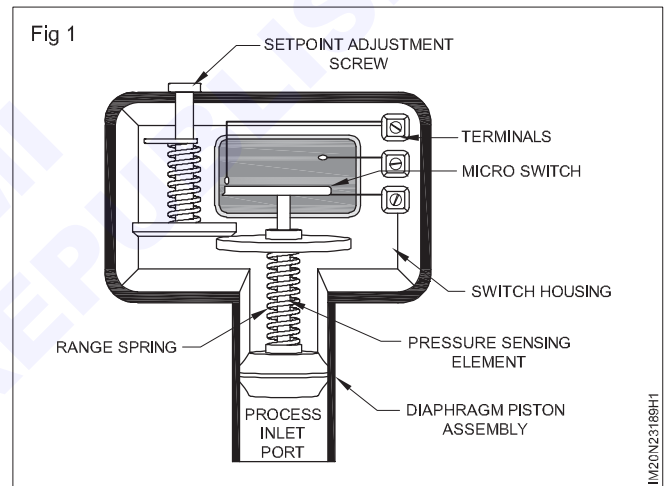
Dismantle and assemble the pressure switch - identify the various parts of pressure switch

Objectives: At the end of this exercise you shall be able to
 • dismantle & identify the parts - of pressure switch.

Requirements			
Tools/Measuring Instruments			
• Pressure switch	- 5 Nos.	• Screw driver 150 mm	- 1 No.
• Electro mechanical & electronic type compressor 230V /AC 1/2HP (0-10) kg/ cm ²	- 1 No.	• Spanner required size	- 1 No.

PROCEDURE

- 1 Clean the working table
- 2 Clean the given mechanical pressure switch and keep it on the table
- 3 Dismantle the pressure switch using screw driver
- 4 Identify the parts.
- 5 Check the work done by the instructor.



Instrument Mechanic - Measurement of Pressure

Connect and operate the pressure switch with load at various pressure and differential pressure settings make adjust the errors screws

Objectives: At the end of this exercise you shall be able to
 • connect & operate pressure switch in different pressure.

Requirements			
Tools/Measuring Instruments			
• Pressure switch	- 5 Nos.	• Screw driver 150 mm	- 1 No.
• Electro mechanical & electronic type compressor 230V /AC 1/2HP (0-10) kg/ cm ²	- 1 No.	• Spanner required size	- 1 No.

PROCEDURE

- 1 Connect red and green blubs with pressure switch, compressor, and air regulator.
- 2 Adjust pressure from compressor using air regulator to pressure switch.
- 3 Check whether the pressure switch is working or not.

NO → Normally closed (Green bulb)

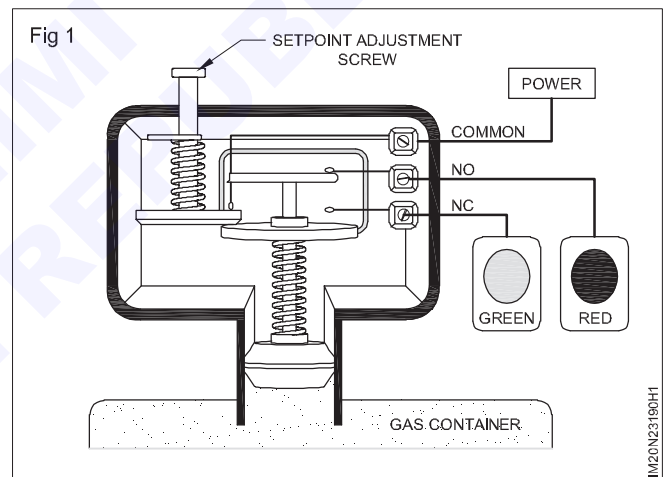
NO → Normally open (Red bulb)

Note: Green bulb is connected to normally closed contact when 230V/AC supply is given Green bulb will glow. If we increase the pressure to set point closed contact changed to normally open, then Red bulb will glow.

Be careful with AC supply

- 4 Repeat the experiment for different pressure settings and note down the switching conditions.

- 5 Adjust the differential settings also and note down the conditions of the pressure switch.
- 6 Turn range nut clockwise for higher cut and cut off pressure.



Instrument Mechanic - Measurement of Pressure

Identify the basic specifications of pressure indicator/transmitter like range, resolution, tap threading size and type, mounting type etc

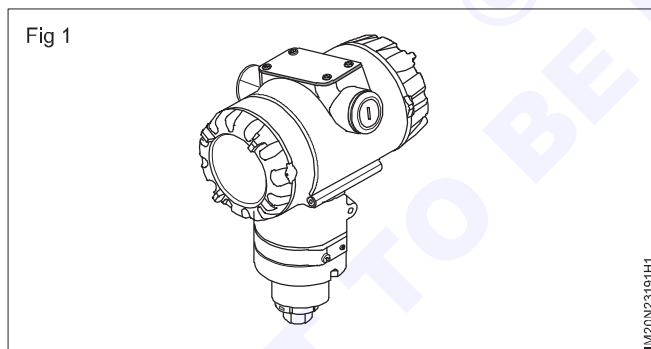
Objectives: At the end of this exercise you shall be able to
 • identify the basic specification of pressure transmitter.

Requirements	
Tools/Equipments	
• Pressure transmitter 3- 15 psi / (4-20) mA	- 1 No.
• Milliammeter (0-50) mA	- 1 No.
• RPS (0- 30) v/dc	- 1 No.
• Screw driver set	- 1 No.
• Spanner set	- 1 No.
• Foot pump (0-5) kg/cm ²	- 1 No.
• Pressure regulator (0-30) psi	- 1 No.
Materials	
• Pneumatic fittings	- as reqd.
• Mulmul cloth	- as reqd.
• Connecting wires	- as reqd.

PROCEDURE

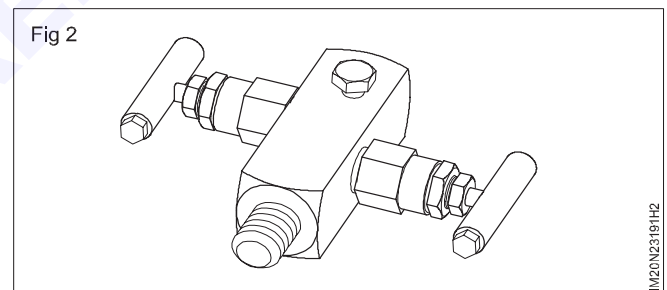
TASK 1: Identify the basic specification of pressure transmitter

- 1 Clean the working table
- 2 Clean and keep the pressure transmitter on the table.
- 3 Record the details of pressure transmitter in the name plate fixed at the backside of it.
- 4 See the pressure transmitter and its manifold as shown in Fig 1



Pressure transmitter and its manifold (Fig 2)

- Connect 24V / DC to terminal ports of pressure transmitter.
- Remove the water bubbles in PT by opening the Drain port for 4 to 5 seconds.



- Close the isolation port during maintenance and this port allows main pressure supply
- Vent manifold used for calibration of PT and also it is atmospheric pressure

- 5 Check the work done by the instructor.

Table 1

Types of transmitter	Range	Types of sensor	Types of seal	Number / scale units	Types of connections	Size of tap threading	Material	Type of mounting

Instrument Mechanic - Measurement of Pressure

Test the operating the pressure transmitter with supply, milli ammeter, pressure source

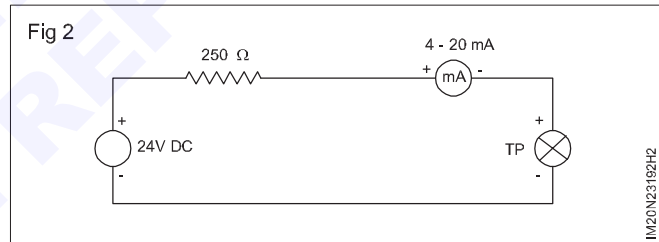
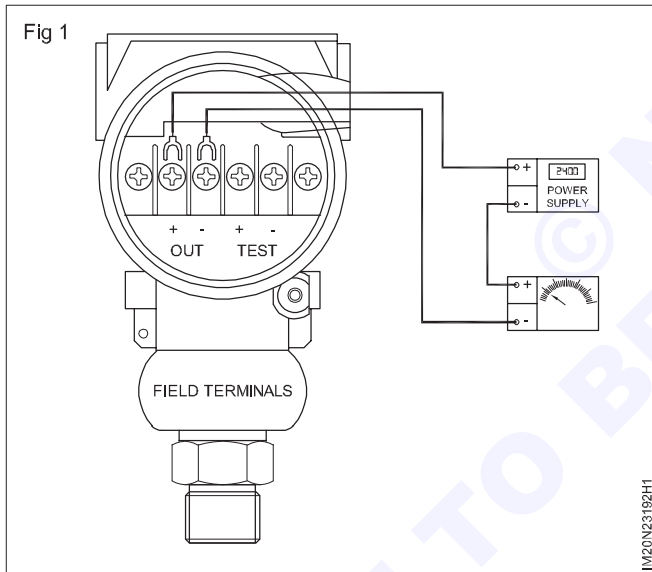
Objectives: At the end of this exercise you shall be able to

- check and operate pressure transmitter.

Requirements			
Tools/Equipments			
• Pressure transmitter 3- 15 psi / (4-20) mA	- 1 No.	• Foot pump (0-5) kg/cm ²	- 1 No.
• Milliammeter (0-50) mA	- 1 No.	• Pressure regulator (0-30) psi	- 1 No.
• RPS (0- 30) v/dc	- 1 No.	Materials	
• Screw driver set	- 1 No.	• Pneumatic fittings	- as reqd.
• Spanner set	- 1 No.	• Mulmul cloth	- as reqd.
		• Connecting wires	- as reqd.

PROCEDURE

- 1 Connect pressure transmitter, milli ammeter and 24 V DC power supply as in Fig 1.
- 2 Apply 3 psi to pressure transmitter from compressor.
- 3 Note down the reading in milli ammeter
- 4 Record the readings in table 2 by increasing the air supply from the 6 psi to 15 psi
- 5 Check the work done by instructor.



Instrument Mechanic - Measurement of Pressure

Familiar with pressure calibrator controls and settings

Objectives: At the end of this exercise you shall be able to
 • familiar with pressure calibrate controls and settings.

Requirements		
Tools/Equipments		Materials
<ul style="list-style-type: none"> Pressure calibrator (0-5)kg/cm² - 1 No. Trainees tool kit - 1 No. 		<ul style="list-style-type: none"> Cleaning cloth - as reqd.

PROCEDURE

- 1 Clean the working table
- 2 Clean the given pressure calibrator and keep it on the table
- 3 Identify the parts of pressure calibrator
- 4 Record the parts name in Table 1.

Instructor should explain about pressure calibrator in related theory 2.3.193

- 5 Check the work done by the instructor

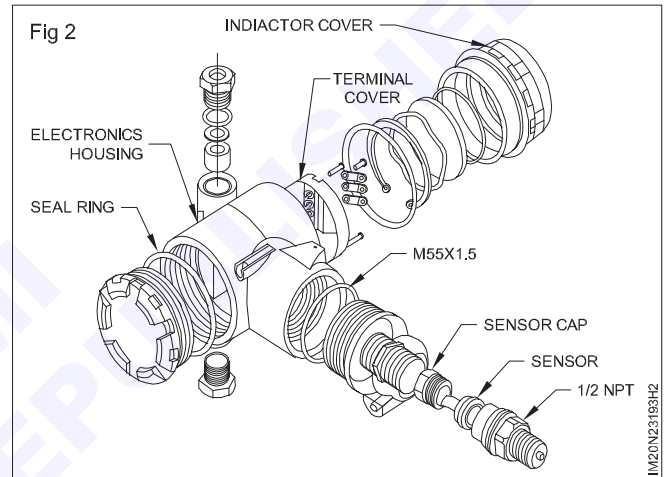
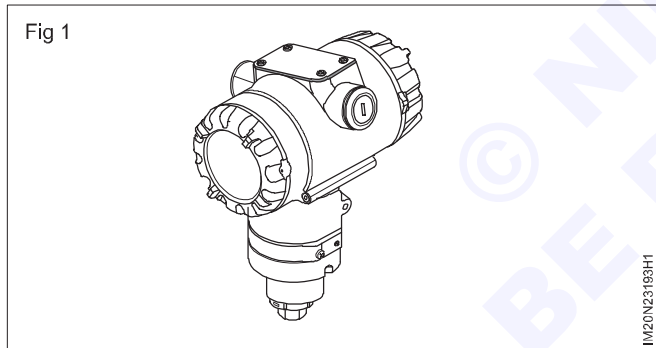


Table 1

Sl.No.	Name of the parts	Uses

Calibrating the pressure gauge using standard meter/pressure calibrator

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

- familiarize with dead weight tester of set and use the dead weight tester.
- calibrate C type bourdon type pressure gauge on dead weight tester
- maintenance of dead weight tester.

Requirements	
Tools/Equipments	
• Dead weight tester	- 1 No.
• C type bourdon gauge	- 1 No.

PROCEDURE

- Take the reassembled bourdon pressure gauge from the exercise 3.3.185
- Mount the pressure gauge in pneumatic line and check by applying pressure from air pressure regulator.
- Check the leaks by using soap solution.
- Keep the tested pressure gauge and dead weight tester on the table.
- Identify the parts of dead weight tester as in figure with the help of an instructor.
- Level the dead weight tester with bottom level screws.
- Remove the cap of oil cup and fill it with servo 40ml.
- Open the oil cups bottom valve
- Turn the piston handle anticlockwise direction to suck oil from oil cup
- Close the oil cup valve and open gauge the gauge pillar button valve
- Rotate the piston clockwise direction to push the oil into floating piston and pressure gauge mounting pillar.
- The air bubbles are coming up in gauge mounting pillar.
- By doing this, air in the system is removed and oil is filled.
- Repeat the above steps 2-3 times until all air is removed.
- When oil comes at top of mounting pillar it indicates air is completely removed from system.

Mounting and testing of gauge

- Select the suitable adopter to fix gauge
- Use the Teflon tape while fixing adopter and gauge.
- Tighten the gauge with help of spanner
- With the help of piston, apply some pressure say 50% of gauge reading.

- If there is any leak, gauge pointer slowly comes towards zero.
- Check the leak and tighten the gauge with spanner.

Test and adjustment of gauge

- 1 Flick test (Testing hair spring tension). If the hair spring tension is more or less, it cause error in gauge reading.

Testing tension

- With the piston apply pressure equal to mid-scale of the gauge.
- Disturb the pointer 2 or 3 divisions up scale and down scale with your finger if pointer returns to its original piston then the tension is cored.
- If the pointer does not return to its original position, the tension may be more or less.
- Adjust the tension property.

Zero adjustment

- If gauge is reading equal amount more.
- Divisions, then there is zero error. Adjust zero error.

Multiplication and angularly adjustment

Multiplication is adjusted by adjusting level length.

Calibration

- After proper adjustment of spring tension for zero, multiplication, angularity errors, then test the angle and prepare calibration table as shown and enter your readings.

Once the calibration is over, rotate the piston in anticlockwise direction and to suck the oil from gauge and weight platform.

- Close the gauge valve and open the oil cup valve, push oil back into oil cup.
- Repeat the above step 2-3 times till total quality of oil is brought back to cup.

Note: If the gauge is removed under oil pressure, oil will come out and spill over table ground Do take care not to remove gauge under pressure conditioner.

Remove the gauge clean it or keep it in proper place.
 Clean and keep the dead weight tester in a proper place.
 Show you calibration table to your instructor.

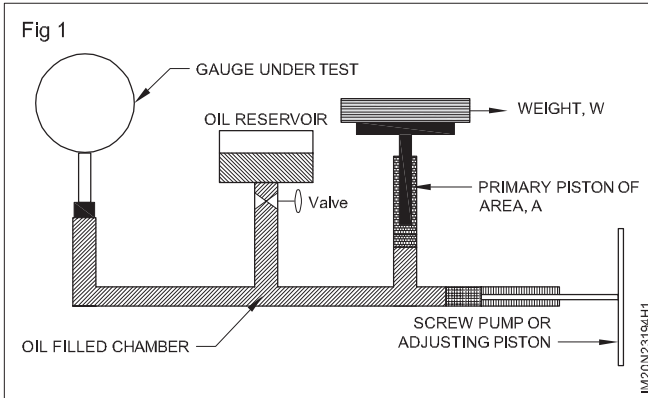
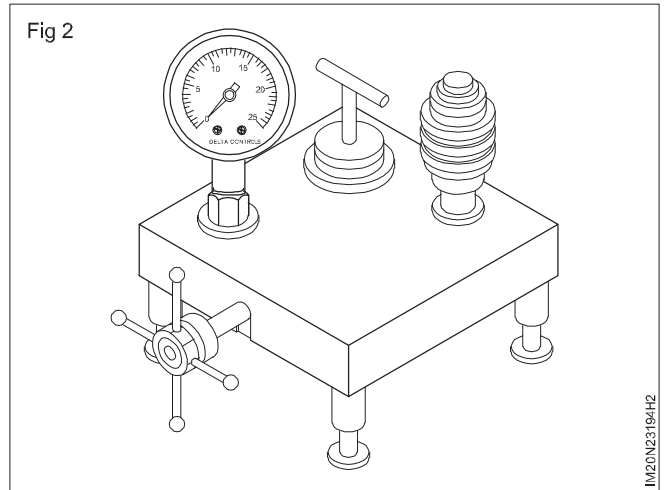


Fig 2



Sl.No	Pressuregauge readings	Calculate pressure	Error	% Error
1				
2				
3				
4				
5				

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Instrument Mechanic - Measurement of Pressure

Measure gauge pressure, vacuum pressure using DP transmitter

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

- measure gauge pressure, vacuum pressure and differential pressure using DP transmitter.

Requirements	
Tools/Equipments	
• DP transmitter (Absolute/ gauge)	- 1 No.
• Vacuum pump	- 1 No.
• Compressor (0-7) kg/cm ²	- 1 No.
• Pressure gauge (0-2) kg cm ²	- 1 No.
• Milli ammeter (0- 50) m ^A	- 1 No.
• Isolation valve 3/4"	- 1 No.
• Resistor 25 Ω-	1 No
• Orifice (Suitable for the pipeline)	- 1 No.
• Vacuum pressure gauge	- 1 No.
• Vacuum pressure regulator	- 1 No.
Materials	
• PVC Pipe 3/4	- as reqd.

PROCEDURE

Measure gauge using DP transmitter

- 1 Connect compressor, pressure gauge, Air pressure regulator and DPT as a shown in Fig 1.
- 2 Check the leak in the connection.
- 3 Switch ON the compressor
- 4 Switch ON 24 V DC supply of DP transmitter.
- 5 Vary the pressure from the compressor by Air pressure regulator from 0 to 2 kg/cm²
- 6 Note down the corresponding output in the DP Transmitter using ammeter.
- 7 Record the readings in table 1.
- 8 Check the work done by the instructor.

17 Check the leaks in the connection

18 Switch ON the compressor and DPT.

19 Open the needle valve V1

Vary the pressure from compressor by air pressure regulator from 0 to 2 kg /cm²

20 Note down the corresponding output In the DPT using ammeter.

21 Record the readings in table 3

22 Check the work done by the instructor

Note: Connect transmitter to supply with correct polarity be careful while changing the pressure.

Measure vacuum pressure using DP transmitter

- 9 Connect vacuum pump, vacuum pressure regulator vacuum gauge and DP.
- 10 Check the leaks in the connections.
- 11 Switch ON the vacuum pump and DPT
- 12 Vary the vacuum pressure from the vacuum pump by vacuum regulator from the 0 to 760 mm ttg
- 13 Note down the corresponding output in the DPT using ammeter.
- 14 Record the readings in table 2.
- 15 Check the work done by the instructor.

Gauge Pressure

Table 1

Sl.No	Pressure of air pressure in kg/ Cm ²	Output of DPT in mA
1	0.5	
2	1.0	
3	1.5	
4	2.0	

Measure differential pressure using DP transmitter.

- 16 Connect compressor Air, pressure regulator, pressure gauge orifice plate, DPT and needle valve as in Fig 1.

Vacuum Pressure

Table 2

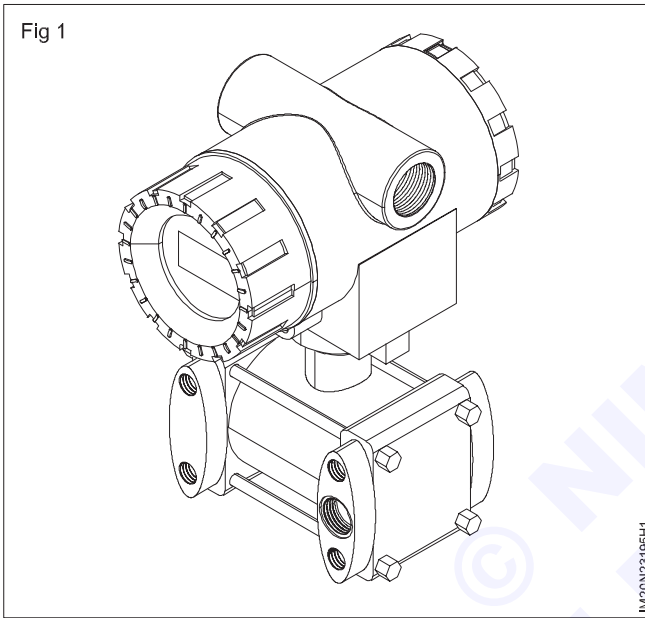
SI.No	Vacuum pressure of regulator in mm/Hg	Output of DPT in mA
1	150	
2	300	
3	450	
4	600	
5	760	

Differential Pressure

Table 3

SI.No	Pressure of air pressure in kg/ Cm ²	Output of DPT in mA
1	0.5	
2	1.0	
3	1.5	
4	2.0	

Fig 1



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Instrument Mechanic - Measurement of Pressure

Calibrating the DP transmitter using pressure calibrator

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

- test and calibrate differential pressure transmitter using pressure comparator calibrator.

Requirements			
Tools/Equipments		Materials	
• Trainees tool kit	- 1 No.	• Sprit level indicator	- 1 No.
• RPS (0-30)V DC	- 1 No.	• SAE 40 oil	- as reqd.
• Pressure calibrator/compactor 30psi/2kg /cm ²	- 1 No.	• Teflon tape	- 2 Nos.
• Digital multimeter	- 1 No.	• Cleaning cloth	- as reqd.
• Digital pressure gauge (2-30) psi	- 1 No.	• PVC tube 8mm	- as reqd.
		• Pneumatic	- as reqd.
		• Push fittings	- as reqd.

PROCEDURE

TASK 1 : Test and calibrate DPT using pressure comparator

- 1 Clean the DPT and pressure comparator and Keep it on the table.
- 2 Level the pressure comparator adjusting 4 screws at the bottom of comparator and check it with sprit level indicator.
- 3 Connect Digital pressure gauge and DPT as in Fig 1 with pressure comparator.
- 4 Connect 24V DC to DPT
- 6 Operate the pressure comparator. 3 psi to DPT then DPT shows 4mA in Ammeter.
- 7 Operate the pressure comparator and apply 15 psi to DPT then DPT shows 20mA in Ammeter.

SI .No.	Pressure in PSI	Output of DPT

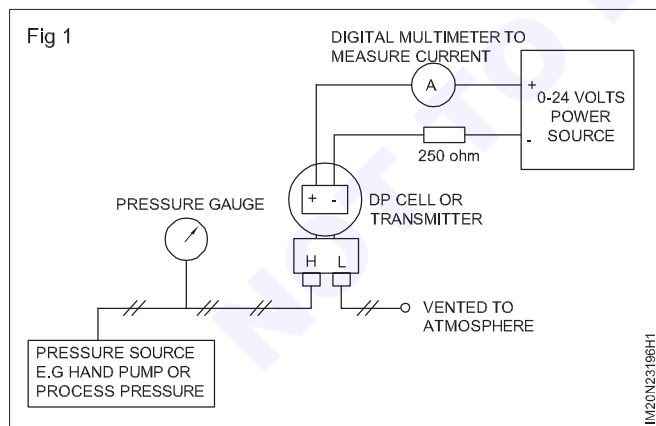
Note: In DPT press range button then press up arrow or down arrow up or down to set 4 mA and 20 mA.

- 8 Operate the pressure comparator and apply pressure from 3 to 15 Psi to DPT

Note down the corresponding output of DPT in Ammeter.

- 9 Disconnect pressure comparator and DPT form the setup

- 10 Check the work done by the instructor.



Instrument Mechanic - Measurement of Pressure

Measuring low pressure / vacuum using Mcleod gauge

Objectives: At the end of this exercise you shall be able to
 • measurement of vacuum pressure using Mcleod gauge.

Requirements			
Tools/Equipments		Materials	
• Mcleod gauge	- 1 Set.	• Mercury	- as reqd.
• Vacuum pump line	- 1 No.	• Cleaning cloth	- as reqd.

PROCEDURE

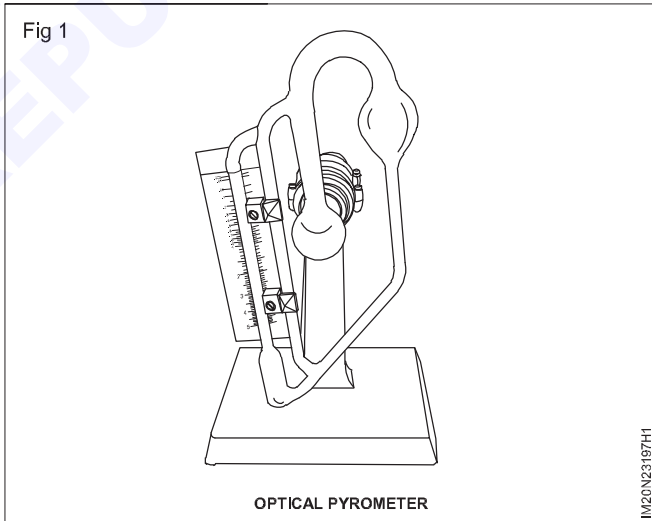
- 1 Clean the given Mcleod gauge.
- 2 Observe the diameter of A and B capillary are same and the diameter of C capillary is big as shown in Fig 1.
- 3 Observe the movable reservoir in the setup
- 4 Move the reservoir downwards till mercury in the capillary reaches zero level.
- 5 Apply vacuum pressure through the open capillary
- 6 Move the reservoir downwards till the liquid level in B and C capillary and movable reservoir coincides as shown in fig 3
- 7 Calculate the Vacuum pressure using the Formula

$$P_1 = \frac{ah^2}{V_1}$$

Where V1 → volume of bulb

- P1 → Value of unknown pressure.
- P2 → Value of known pressure
- V2 → volume of closed capillary
- A → cross sectional area of capillary
- H distance between A & B Limb
- 8 Check the work done by the instructor.

Handle the Mcleod gauge with care.



Instrument Mechanic - Measurement of Pressure

Test & calibrate of pressure gauges, indicators, transmitters with dead weight tester

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

- familiarize with dead weight tester of set and use the dead weight tester
- calibrate C type bourdon type pressure gauge on dead weight tester
- maintenance of dead weight tester.

Requirements	
Tools/Equipments	
• Dead weight tester	- 1 No.
• C type bourdon gauge	- 1 No.

PROCEDURE

- Take the reassembled bourdon pressure gauge from the exercise 2.3.185
- Mount the pressure gauge in pneumatic line and check by applying pressure from air pressure regulator.
- Check the leaks by using soap solution.
- Keep the tested pressure gauge and dead weight tester on the table.
- Identify the parts of dead weight tester as in figure with the help of an instructor.
- Level the dead weight tester with bottom level screws.
- Remove the cap of oil cup and fill it with servo 40ml.
- Open the oil cups bottom valve
- Turn the piston handle anticlockwise direction to suck oil from oil cup
- Close the oil cup valve and open gauge the gauge pillar button valve
- Rotate the piston clockwise direction to push the oil into floating piston and pressure gauge mounting pillar.
- The air bubbles are coming up in gauge mounting pillar.
- By doing this, air in the system is removed and oil is filled.
- Repeat the above steps 2-3 times until all air is removed.
- When oil comes at top of mounting pillar it indicates air is completely removed from system.

Mounting and testing of gauge

- Select the suitable adopter to fix gauge
- Use the Teflon tape while fixing adopter and gauge.
- Tighten the gauge with help of spanner
- With the help of piston, apply some pressure say 50% of gauge reading.

- If there is any leak, gauge pointer slowly comes towards zero.
- Check the leak and tighten the gauge with spanner.

Test and adjustment of gauge

- 1 Flick test (Testing hair spring tension). If the hair spring tension is more or less, it cause error in gauge reading.

Testing tension

- With the piston apply pressure equal to mid-scale of the gauge.
- Disturb the pointer 2 or 3 divisions up scale and down scale with your finger if pointer returns to its original piston then the tension is cored.
- If the pointer does not return to its original position, the tension may be more or less.
- Adjust the tension property.

Zero adjustment

- If gauge is reading equal amount more.
- Divisions, then there is zero error. Adjust zero error.

Multiplication and angularly adjustment

Multiplication is adjusted by adjusting level length.

Calibration

- After proper adjustment of spring tension for zero, multiplication, angularity errors, then test the angle and prepare calibration table as shown and enter your readings.

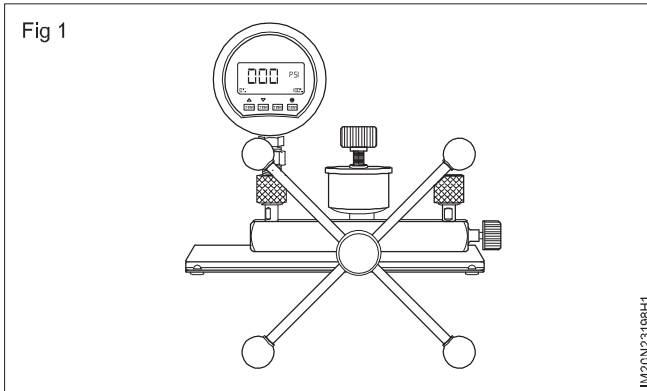
Once the calibration is over, rotate the piston in anticlockwise direction and to suck the oil from gauge and weight platform.

- Close the gauge valve and open the oil cup valve, push oil back into oil cup.
- Repeat the above step 2-3 times till total quality of oil is brought back to cup.

Note: If the gauge is removed under oil pressure, oil will come out and spill over table ground Do take care not to remove gauge under pressure conditioner.

Remove the gauge clean it of keep it in proper place.
 Clean and keep the dead weight tester in a proper place.
 Show you calibration table to your instructor.

Sl.No	Pressuregauge readings	Calculate pressure	Error	% Error
1				
2				
3				
4				
5				



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Instrument Mechanic - Measurement of Pressure

Test & calibrate of pressure gauges, indicators transmitters with comparator tester

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

- test and calibrate differential pressure transmitter using pressure comparator calibrator.

Requirements			
Tools/Equipments		Materials	
• Trainees tool kit	- 1 No.	• Sprit level indicator	- 1 No.
• RPS (0-30)V DC	- 1 No.	• SAE 40 oil	- as reqd.
• Pressure calibrator/comparator 30psi/2kg /cm ²	- 1 No.	• Teflon tape	- 2 Nos.
• Digital multimeter	- 1 No.	• Cleaning cloth	- as reqd.
• Digital pressure gauge (2-30) psi	- 1 No.	• PVC tube 8mm	- as reqd.
		• Pneumatic	- as reqd.
		• Push fittings	- as reqd.

PROCEDURE

TASK 1 : Test and calibrate DPT using pressure comparator

- 1 Clean the DPT and pressure comparator and Keep it on the table.
- 2 Level the pressure comparator adjusting 4 screws at the bottom of comparator and check it with sprit level indicator.
- 3 Connect Digital pressure gauge and DPT as in Fig with pressure comparator.
- 4 Connect 24V DC to DPT
- 6 Operate the pressure comparator. 3 psi to DPT then DPT shows 4mA in Ammeter.
- 7 Operate the pressure comparator and apply 15 psi to DPT then DPT shows 20mA in Ammeter.

SI .NO	Pressure in PSI	Output of DPT

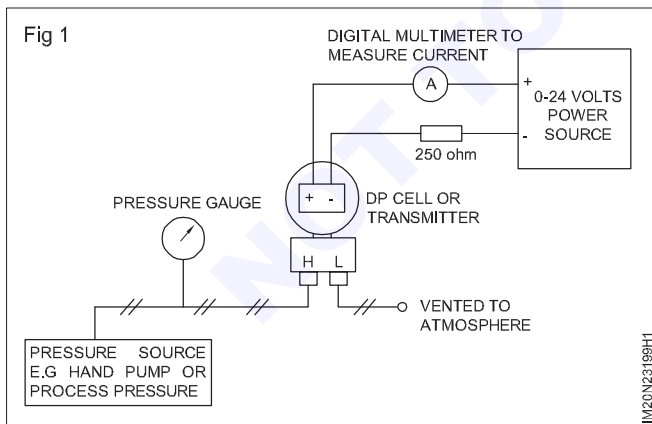
Note: In DPT press range button then press up arrow or down arrow up or down to set 4 mA and 20 mA.

- 8 Operate the pressure comparator and apply pressure from 3 to 15 Psi to DPT

Note down the corresponding output of DPT in Ammeter and note down in table 3.

- 9 Disconnect pressure comparator and DPT form the setup

- 10 Check the work done by the instructor.



Instrument Mechanic - Measurement of Pressure

Installation of pressure gauge in pipeline with safety valve and pig tail / siphon etc

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

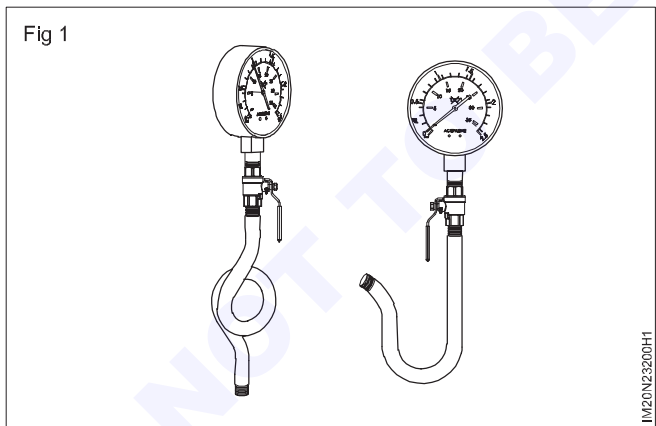
- installation of pressure gauge in pipeline with safety valve and digital / siphon etc. Measuring pressure in flow line.

Requirements			
Tools/Measuring instrument			
• Pressure gauge (0-5) kg /cm ²	- 1 No.	• Temperature Trainer setup	- 1 No.
• Siphon/Digital 12" – q tube 10 kg / cm ² /300°C	- 1 No.	• Adjustable spanner	- 1 No.
• Safety valve 1/2"	- 3 Nos.	Materials	
• Pump ½ HP/ 230V	- 1 No.	• Adaptors	- as reqd.
• Resistor tank 20 lit	- 1 No.	• Teflon tape	- 1 No.
		• Water	- as reqd.
		• Mulmul cloth	- as reqd.

PROCEDURE

- 1 Fill water inside Pigtail /siphon as shown in Fig 1.
- 2 Fit pressure gauge, Pigtail /siphon, safety valve using suitable adopter.
- 3 Check the leakage in the Fitting.
- 4 Switch ON the pump.
- 5 Open HV2 valve and Fill tank 2.
- 6 Switch ON the heater.
- 7 Observe the water is heated in tank 2.
- 8 Open the safety valve, observe and measure the pressure through the Pigtail /siphon
- 9 Check the work done by the instructor

Note: Be careful with heater during practical
Remove pressure gauge using suitable spanner.
Pigtail/siphon convert the vapor to liquid at low temperature and keep the pressure sensor safety.



Instrument Mechanic - Measurement of Pressure

Installation and testing of pressure switch and pressure relief valve with compressor

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

- install and check pressure switch, compressor and relief valve in process line pressure.

Requirements	
Tools/Measuring instrument	Materials
<ul style="list-style-type: none"> • Compressor (0- 10) kg/cm² - 1 No. • Pressure switch psi mechanical - 1 No. • Ball valve - 1 No. • Solenoid valve 230 V AC - 1 No. • Foot pump (0-5) Kt / cm² - 1 No. • Pressure gauge (0- 30) psi - 1 No. • Spanner - 1 No. • Foot pump outlet needle valve - 1 No. 	<ul style="list-style-type: none"> • Nylon PVC tube 6 mm - 10 meters. • Pneumatic Fittings – Linear elbow, T connector - each 2 Nos. • Teflon tape - 1 Roll • Connecting wires - as reqd. • Insulation tape - 1 No.

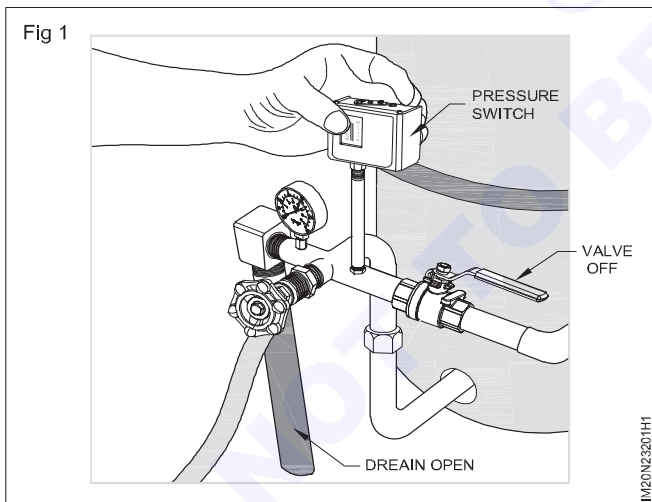
PROCEDURE

TASK 1: Install and check pressure switch, compressor and pressure relief valve in process line

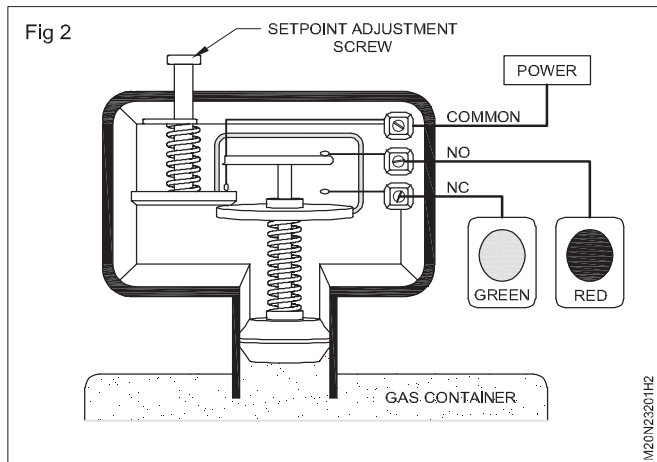
- 1 Connect red and green bulb with compressor.
- 2 Apply pressure from compressor to pressure switch
- 3 Check whether the pressure switch is working or not
NO --> Normally opened
NC --> Normally closed

Be careful with AC supply

- 4 Connect starter in compressor, pressure switch, AC supply and motor as shown in Fig 2 and check with instructor.
- 5 observe air supply from the compressor to switch and relief valve.
- 6 Confirm the pressure switch is connected in AC normally close contact by giving 230V supply.
- 7 Observe when set point reaches 60 psi normally close contact in pressure switch is changed to normally open and compressor is switched off.
- 8 Observe when set point reaches 40 psi the compressor is switched on, check the work done by instructor.



Note: Red bulb is connected to normally closed contact when 230V. Supply is given; Red bulb will glow. If we increase the pressure to set point normally close contact is changed to normally open, then the green bulb will glow.



Instrument Mechanic - Measurement of Pressure

Install and testing of pressure switch solenoid and alarm in process line

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

- install and check pressure switch, solenoid and alarm in process line.

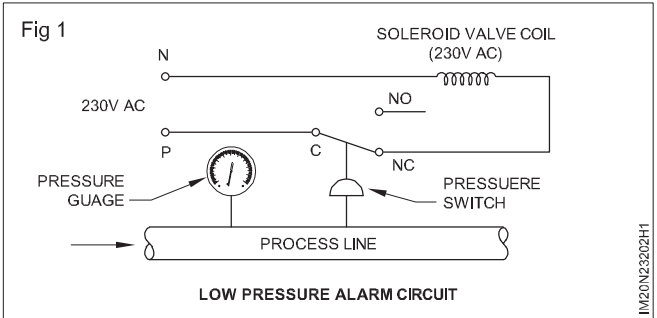
Requirements	
<p>Tools/Measuring instrument</p> <ul style="list-style-type: none"> • Compressor (0- 10) kg/cm² - 1 No. • Pressure switch psi mechanical - 1 No. • Ball valve - 1 No. • Solenoid valve 230 V AC - 1 No. • Foot pump (0-5) Kt / cm² - 1 No. • Pressure gauge (0- 30) psi - 1 No. • Spanner - 1 No. • Foot pump outlet needle valve - 1 No. 	<p>Materials</p> <ul style="list-style-type: none"> • Nylon PVC tube 6 mm - 10 meters. • Pneumatic Fittings – Linear elbow, T connector - each 2 Nos. • Teflon tape - 1 Roll. • Connecting wires - as reqd. • Insulation tape - 1 No.

PROCEDURE

- 1 Verify that the solenoid valve is 230V /AC by using the name plate in it.
- 2 Check the pressure switch by doing the procedure with the help of an instructor.
- 3 Connect air filtered regulator, pressure switch, solenoid valve, test gauge ball valve and needle valve as shown in figure 4 without leakage.
- 4 Connect solenoid valve, alarm, pressure switch and 230 V / AC supply as shown in figure 1 and check with the instructor.
- 5 Apply pressure to air pressure regulator using food pump. And open the needle valve. 1 and 2.
- 6 Observe no supply in solenoid valve it is connected to normally open contact.
- 7 Observe when pressure reaches 30 psi, the normally open contact in pressure switch is changed to normally closed contact and 230 V is supplied to solenoid valve.
- 8 Note the readings in pressure gauge and pressure.
- 9 Use ball readings in pressure gauge and pressure.

Note: Close needle Valve 1 & 2 if faults occurs in air pressure regulator

- 10 Observe when pressure reaches 10 psi the contact changed in pressure switch and 230 V /AC supply is cutoff in solenoid valve.
- 11 Check the work done by instructor.
- 12 Connect pressure switch NO & NC contact with care.



Instrument Mechanic - Measurement of Pressure

Fault finding in pressure gauge

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

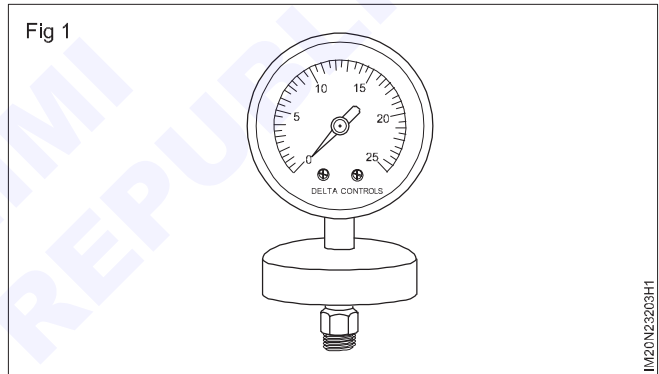
- identify the faults in pressure gauges
- identify the faults in pressure transmitters
- identified the faults in pressure process line.

Requirements			
Tools/Measuring instrument			
• Pressure gauge (0- 7) kg/cm ²	- 1 No.	• Cutting plier 150 mm	- 1 No.
• Pressure transmitter (0-2)kg/cm ²	- 1 No.	Materials	
• Pressure trainer kit	- 1 No.	• Mulmul cloth	- as reqd.
• Screw driver 150 mm	- 1 No.	• White petrol	- as reqd.

PROCEDURE

TASK 1: Identify the faults in pressure gauges

- 1 Check the working table.
- 2 Clean the pressure gauge and keep it on the table.
- 3 Check the pressure gauge physically and note down the defects in table 1.
- 4 Dismantle the pressure gauge using screw driver.
- 5 Record the faults inside the pressure gauge and in table 1.
- 6 Assemble the pressure gauge
7. Check the work done



Note: Possible defects and remedies of pressure gauge is given in related theory 2.3.203 trainees read this and rectify the faults in pressure gauges available in your lab.

Table 1

Sl.No	List of defects in pressure gauge	Remedy

Instrument Mechanic - Measurement of Pressure

Simple fault finding in pressure transmitter

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

- identify the faults in pressure gauges
- identify the faults in pressure transmitters
- identified the faults in pressure process line.

Requirements

Tools/Measuring instrument

- Pressure gauge (0- 7) kg/cm² - 1 No.
- Pressure transmitter (0-2)kg/cm² - 1 No.
- Pressure trainer kit - 1 No.
- Screw driver 150 mm - 1 No.

- Cutting plier 150 mm - 1 No.

Materials

- Mulmul cloth - as reqd.
- White petrol - as reqd.

PROCEDURE

- 1 Clean the given pressure transmitter and keep it on the table.
- 2 Check the pressure transmitter physically and note down the defects in Table 1.
- 3 Dismantle the pressure transmitter physically and note down the defects in Table 1.
- 4 Record the faults inside the pressure transmitter.
- 5 Assemble the pressure transmitter.
- 6 Check the work done by the instructor.

Note: possible defects and remedies of pressure transmitter given in related theory 2.3.303. trainees read this and rectify the faults in pressure transmitter available in your lab.

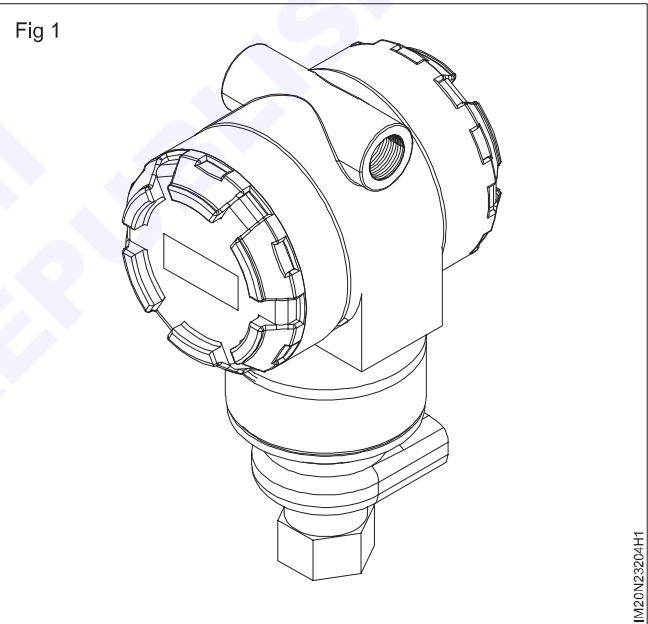


Table 1

Sl.No.	List of defects in pressure gauge	Remedy

Instrument Mechanic - Measurement of Pressure

Fault finding in pressure process line

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

- identify the faults in pressure gauges
- identify the faults in pressure transmitters
- identified the faults in pressure process line.

Requirements

Tools/Measuring instrument

- Pressure gauge (0- 7) kg/cm² - 1 No.
- Pressure transmitter (0-2)kg/cm² - 1 No.
- Pressure trainer kit - 1 No.
- Screw driver 150 mm - 1 No.

- Cutting plier 150 mm - 1 No.

Materials

- Mulmul cloth - as reqd.
- White petrol - as reqd.

PROCEDURE

- 1 Do the periodical maintenance in pressure process line available in your laboratory.
- 2 Record the faults in process line in table 1.

Note: Instructor should insist the trainees to list the defects in the pressure trainer and multiprocessor trainer available in the lab and rectify that defects.

Use proper tool to dismantle pressure gauge and pressure transmitters.

- 3 Check the work done by the instructor.

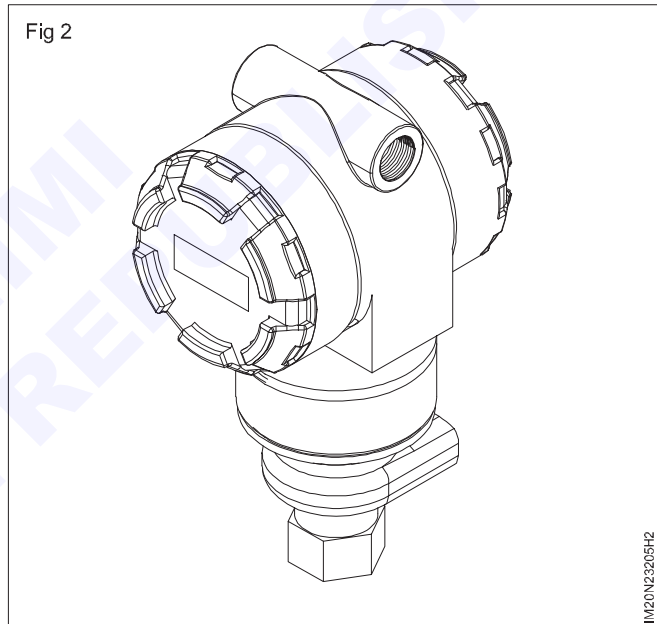
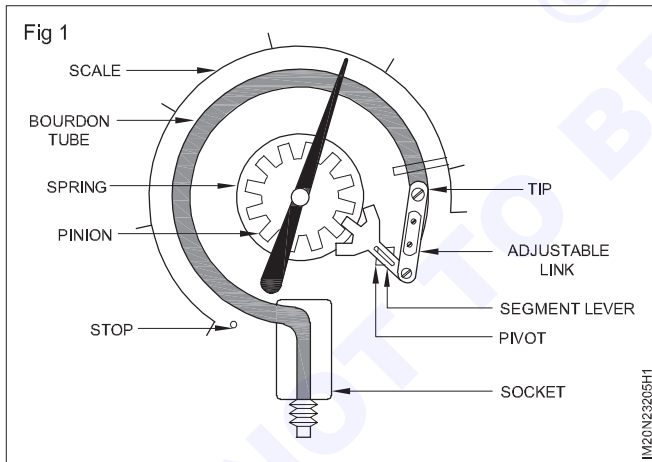


Table 1

Sl.No.	List of defects in pressure gauge	Remedy

Instrument Mechanic - Measurement of Flow

Measurement of pressure in flow line with different flowrates

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

- measurement of pressure in flow line with different flowrates.

Requirements		
Tools/Instruments		Materials
<ul style="list-style-type: none"> • Trainees tool kit • Flow trainer • Orifice platen setup • 'U' tube manometer • Water tank • Drain valve 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. - 500 litre. - 1 No. 	<ul style="list-style-type: none"> • PVC tubes 8mm - 10 Meter. • Teflon tape - 1 No. • Mercury - as reqd. • Mulmul cloth - as reqd. • Water - as reqd.

PROCEDURE

- 1 Connect orifice plate, 'U' tube Manometer , drain valve as shown in Fig 1.
- 2 Check Leakage in the connection.
- 3 Fill 3/4th of water in the tank.
- 4 Switch on the Pump.
- 5 Open V1 value 25%
- 6 Note down the pressure head 'h' in the manometer caused by orifice plate.
- 7 Do the above step for v1 is 50% , 75% and 100% open and note down 'h'.
- 8 Record the readings in table 1.
 - Be careful while connecting 230V motor.
 - Handle 'U' tube manometer with care.
 - Check the pipeline felted in correct position.
- 9 Calculate Volumetric flowrate and mass flow using formula

$$V = K \frac{\sqrt{2gh}}{\rho^n}$$

$$Q = KA \frac{\sqrt{2gh}}{\rho^n}$$

$$W = KA \frac{\sqrt{2gh}}{\rho^n}$$

Where V = velocity of flowing fluid

Q = volume flow rate

W = mass flow rate

A = cross – sectional area of pipe through

h = differential head (pressure) across the restriction element

g = acceleration due to gravity

ρ : density of the flowing fluid

B⁴ = Constant

$$K = \frac{C}{\sqrt{1 - \beta^4}}$$

Where C = discharge coefficient

β = diameter ratio

$\beta = \frac{d \text{ (diameter of restriction element)}}{D \text{ (inside diameter of the pipe)}}$

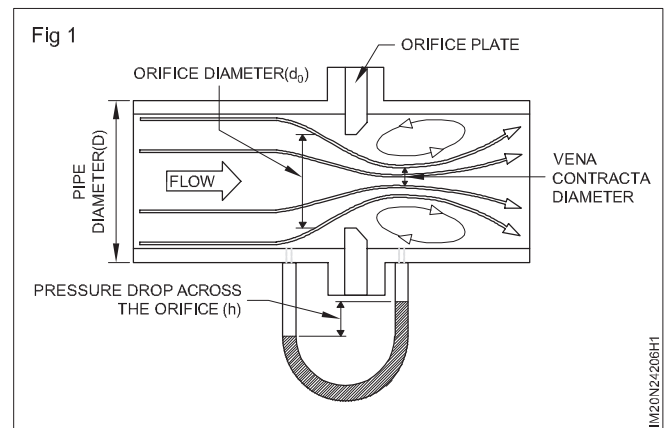


Table 1

Sl.No	Valve opening in %	Differential pressure head (h) in mm/cm
1	25%	
2	50%	
3	75%	
4	100%	

Instrument Mechanic - Measurement of Flow

Measurement of flowrate using fixed volume tank

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

- measurement of flowrate using fixed volume tank.

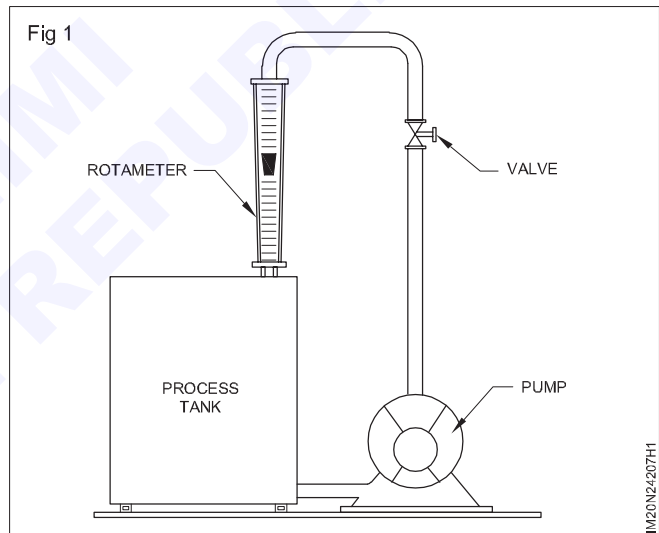
Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• Pump 230v ½ hp	- 1 No.
• Isolated valve	- 1 No.	Materials	
• Orifice plate setup	- 1 No.	• PVC pipe 1/2"	- 1 No.
• Compressor 230V/AC ½ Hp (0-7) Kg/cm ²	- 1 No.	• Storage tank 25L	- 1 No.
• Ball valve	- 2 No.	• Teflon tape	- as reqd.
• Rotameter 200Lph	- 1 No.	• Mulmul cloth	- as reqd.
• Pressure gauge (0-7) kgcm ²	- 2 Nos.	• Water	- as reqd.

PROCEDURE

Tight the float inside the Rotameter using spanner

- 1 Connect valve rotameter and pump as shown in Fig 1 and check leakage in the connection.
- 2 switch ON the pump (PTO).
- 3 Open v1 value.
- 4 Observe the float raises in the rotameter and stands in a position.
- 5 Note down the reading in the rotameter.
- 6 Check the work done by the instructor.

- If rotameter is not properly installed it affects the accuracy.
- Use filter to maintain Rotameter life.



Instrument Mechanic - Measurement of Flow

Operating fluid pump and observing the pressure at input and output, verifying flow variation by adjusting bypass line

Objectives: At the end of this exercise you shall be able to
 • measurement of flow variation by adjusting by pass line.

Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• Pump 230 V 1/2 hp	- 1 No.
• Diaphragm pressure gauge	- 2 No.	Materials	
• Isolate valve	- 1 No.	• PVC pipe 1/2 ¹¹	- 1 No.
• Compressor 230V/Ac ½ Hp (0-7) Kg/cm ²	- 1 No.	• Storage tank 25L	- 1 No.
• Ball valve	- 2 No.	• Teflon tape	- as reqd.
• Rotameter, 200 LPS	- 1 No.	• Mulmul cloth	- as reqd.
• Pressure gauge	- 2 No.	• Water	- as reqd.

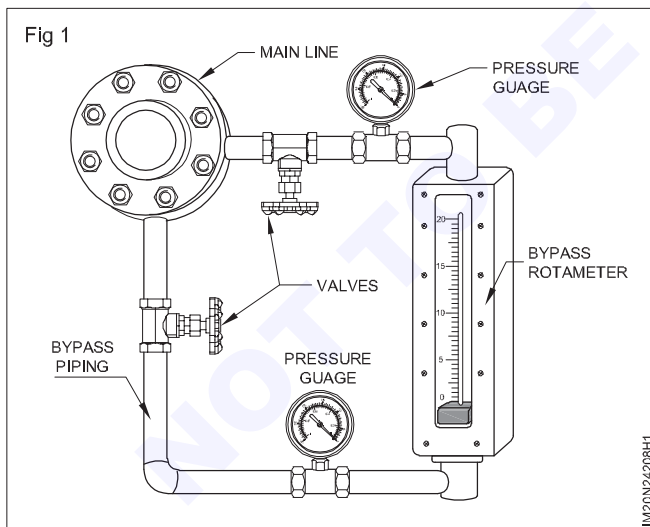
PROCEDURE

Tight the float inside the rotameter using spanner

- 1 Check the Pressure gauge is working property.
- 2 Connect valve v1 , Rotameter, pump valve v2 and pressure gauge as shown in Fig 1 and check the leakage in the connection.
- 3 Switch ON the pump and open valve v1.
- 4 Open by pass valve v2 25% and note down the input and output pressure.
- 5 Do the above procedure for valve opening of 50%, 75% and 100%.
- 6 Record the readings in table1 .
- 7 Check the work done by the instructor.

Table 1

S.no	Valve opening in %v2	Input pressure in psi	Output pressure in psi
1	25		
2	50		
3	75		
4	100		



Instrument Mechanic - Measurement of Flow

Measurement of DP of venturi and orifice using manometer

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

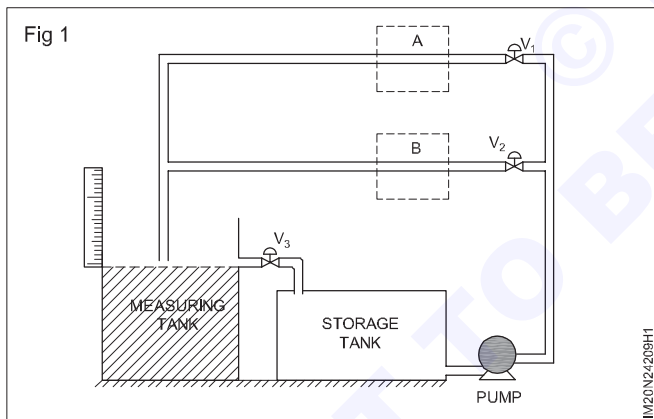
- measurement of differential pressure across venturi and orifice using manometer
- measurement of differential pressure across, orifice plate using differential pressure gauge
- observe the changes in differential pressure by adjusting the manifold valve.

Requirements	
Tools/Instruments	Materials
<ul style="list-style-type: none"> • Trainees tool Kit - 1 No. • 'U' tube manometer - 1 No. • Orifice plate / venturimeter - 1 No. • Differential pressure gauge - 1 No. • Flow trainer - 1 No. • Compressor 230v ½ HP 7 kg cm² - 1 No. • Spanner - 1 No. • Pump ½ HP 230v AC - 1 No. 	<ul style="list-style-type: none"> • Manifold valve - 3way - 1 Set. • Storage tank 500 litre - 1 No. • Insulation tape - 1 No. • Teflon tape - 1 No. • Mulmul cloth - as reqd. • Pvc 1/2 tube - 10 meter. • Isolated valve ½¹¹ - 4 Nos.

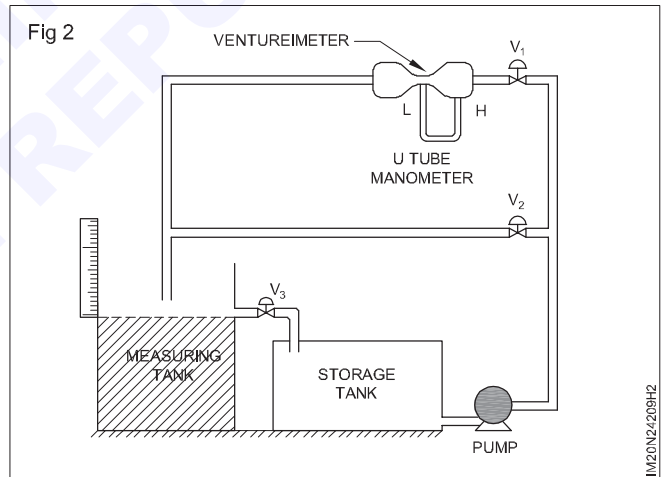
PROCEDURE

TASK 1: Measurement of differential pressure of venturi and orifice using manometer

- 1 Connect storage tank, valves, pump and PVC tubes as shown in Fig 1 and check the leakage in the connection.



- 2 Connect venturi tube and 'U' tube manometer shown in Fig 2 in the place of 'A' marked in fig 1 and check the leakage.



Note 2

Operate the cock value slowly and carefully.

Note 1
Observe that the ¾th of tank is filled with water.

- 3 Close the valve v3 and open other valves.
- 4 Switch ON the pump.
- 5 Remove air bubbles inside manometer using cock value.

- 6 Wait till the flow comes to steady state.
- 7 Observe the initial water level in the measuring tank by closing gate valve v3.
- 8 Note down the time taken for water reach a particular level in the tank.
- 9 Measure the flow rate & observe pressure difference in manometer.

Note 3

Observe the flow is in steady state before taking the reading

- 10 Record the pressure head 'h' reading in table 1 opening the valve v2 by 25% ,50%,75% and 100%.
- 11 Connect orifice plate and 'U' tube manometer as shown in Fig 3 in the plate of 'B' masked in fig 1 and check the leakage.
- 12 Close the valve V1 & V3 and open other values.
- 13 Switch ON the pump.
- 14 Record the pressure head 'h' reading in table 1 by opening the valve v3 by 25%,50%,75%, and 100%.
- 15 Calculate the flow rate by using the above formula.
- 16 Check the work done by the instructor.

$$Q = KA \frac{\sqrt{2gh}}{\rho}$$

P = Density of flowing liquid

A = Cross section area of pipe

h = differencing pressure head across restriction element

$$K = \frac{C}{\sqrt{1 - \beta}}$$

g = acceleration due to gravity

C = discharge coefficient

β = diameter ratio

$\beta = d/D$ diameter of the restriction element inside diameter of the pipe line

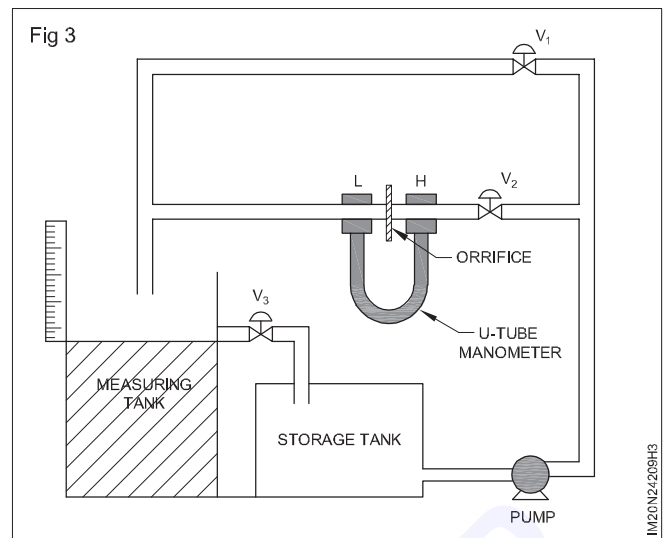


Table 1

Valve opening in % v2 & v3	Differential pressure head across venturimeter in cm(h)	Differential pressure head across orifice in cm (h)
25		
50		
75		
100		

Instrument Mechanic - Measurement of Flow

Measurement of DP using DP gauge

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

- measure differential pressure using DP gauge.

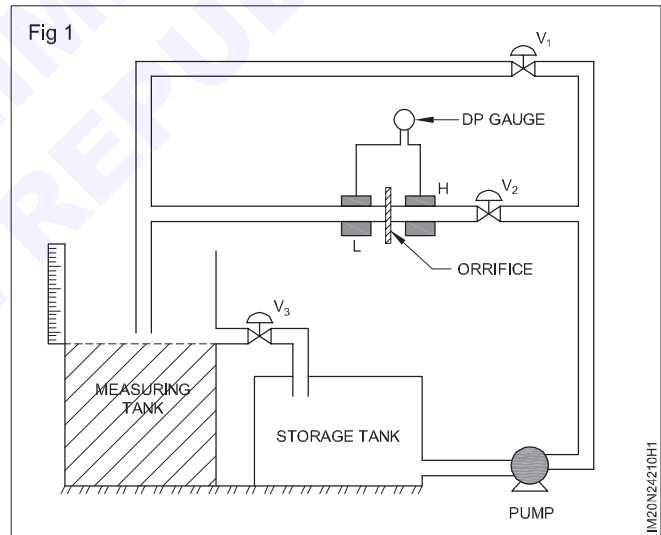
Requirements			
Tools/Instruments		Materials	
• Trainees tool Kit	- 1 No.	• Manifold valve - 3way	- 1 Set.
• 'U' tube manometer	- 1 No.	• Storage tank 500 litre	- 1 No.
• Orifice plate / venturimeter	- 1 No.	• Insulation tape	- 1 No.
• Differential pressure gauge	- 1 No.	• Teflon tape	- 1 No.
• Flow trainer	- 1 No.	• Mulmul cloth	- as reqd.
• Compressor 230v ½ HP 7 kg cm ²	- 1 No.	• Prc1/2 tube	- 10 meter.
• Spanner	- 1 No.	• Isolated valve ½ ¹¹	- 4 Nos.
• Pump ½ HP 230v AC	- 1 No.		

PROCEDURE

- 1 Connect valves, orifice plate, differential pressure gauge and pump as shown in Fig 1 and check the leakage.
- 2 Switch 'ON' the pump.
- 3 Open valve v2 and close valve v1 and v3.
- 4 Record the reading of DP gauges in table 2 by opening the valve v2 by 25%,50%,75% & 100%.

Table 1

SI. No.	Valve opening in percentage	Pressure in DP gauge in kg/cm ²
1	25	
2	50	
3	75	
4	100	



Instrument Mechanic - Measurement of Flow

Adjusting the valves of manifold and observing the changes in DP gauge

- Objectives:** At the end of this exercise you shall be able to
- observe the change in DP by adjusting the manifold valve
 - understand the operation of manifold valve.

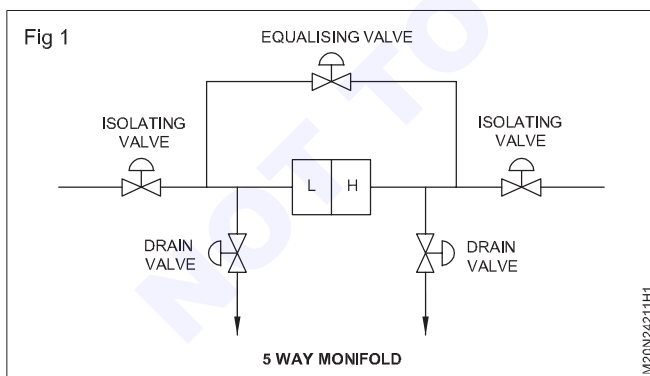
Requirements		
Tools/Instruments		Materials
• Trainees tool Kit	- 1 No.	• Manifold valve - 3way
• 'U' tube manometer	- 1 No.	• Storage tank 500 litre
• Orifice plate / venturimeter	- 1 No.	• Insulation tape
• Differential pressure gauge	- 1 No.	• Teflon tape
• Flow trainer	- 1 No.	• Mulmul cloth
• Compressor 230v ½ HP 7 kg cm ²	- 1 No.	• Prc1/2 tube
• Spanner	- 1 No.	• Isolated valve ½ ¹¹
• Pump ½ HP 230v AC	- 1 No.	

PROCEDURE

- 1 Connect DP gauge with 5 way manifold as shown in Fig 1 and check the leakage.
- 2 Close the valve v1,v2 , High pressure valve , low pressure valve and equalizer valve in manifold.
- 3 Observe the DP gauge.
- 4 Adjust the pointer in DP gauge to zero by opening the equalizer valve if the pointer is not in zero.
- 5 Close the equalizer valve.
- 6 Switch ON the pump and open valve v1 HP & LP in manifold.
- 7 Note down the reading in DP gauge by opening the valve v2 by 25%,50%,75%, and 100%.
- 8 Check the work done by the instructor.
 - Ensure that the manifold is connected properly.
 - Check the zero position of DP gauge.
 - Be careful when connecting 230v supply to pump.

Table 1

Sl. No.	Valve opening in percentage	Pressure in DP gauge in kg/cm ²
1	25	
2	50	
3	75	
4	100	



Instrument Mechanic - Measurement of Flow

Calibrating the pneumatic DP transmitter for flow rate measurement

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

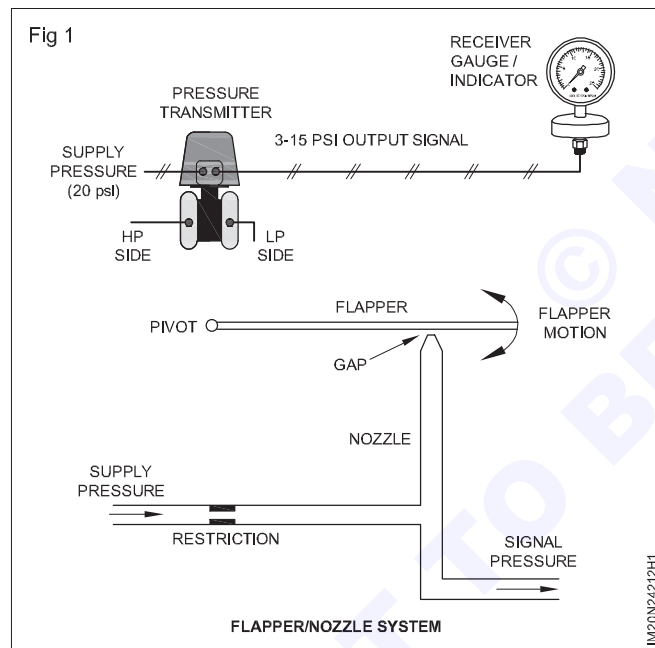
- calibration of pneumatic DP transmitter
- verifying the square root relation and linear relation.

Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Foot pump (0-5) kg/cm ²	- 1 No.
• Pneumatic DP transmitter	- 1 No.	Materials	
• Pressure gauge (0- 80) kg/cm ²	- 1 No.	• Teflon tape	- 1 No.
• Spanner	- as reqd.	• Connecting - wires	- as reqd.

PROCEDURE

TASK 1: Calibration of pneumatic DP transmitter

1 Connect DP transmitter as shown in Fig 1.



- 2 Check pneumatic the connection by instructor.
- 3 Supply minimum pressure 20 psi to the input of DPT.
- 4 Set pneumatic DPT output in 3 Psi.
- 5 Adjust the push button if the output of DPT is not in 3psi.

- 6 Supply maximum pressure 30 psi to the input of DPT.
- 7 Set pneumatic DPT output in 15 psi.
- 8 Adjust the push button if the output of DPT is not in 15psi.
- 9 Do the calibration procedure for 4 or 5 times.
- 10 Note down the readings of DPT for 22 psi, 24 psi, 26 psi, 28 psi, 30 psi.
- 11 Record the readings in Table 1.
- 12 Check the work done by the instructor.

Table 1

Input of DPT in psi	Output of DPT in psi
20	3
22	-
24	-
26	-
28	-
30	15

Instrument Mechanic - Measurement of Flow

Calibration electronic DP transmitter for flow rate. verifying the square root relation and linear relation of DP

Objectives: At the end of this exercise you shall be able to
 • calibrate the given electronic DP transmitter.

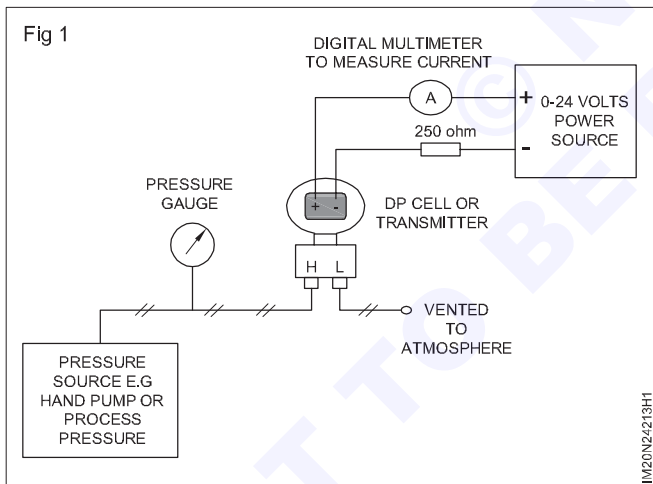
Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Foot pump (0-5) kg/cm ²	- 1 No.
• Pneumatic DP transmitter	- 1 No.	Materials	
• Pressure gauge (0- 80) kg/cm ²	- 1 No.	• Teflon tape	- 1 No.
• Spanner	- as reqd.	• Connecting - wires	- as reqd.

PROCEDURE

- 1 Connect scissor type hand pump with digital read out / foot pump to the high pressure side of DP Transmitter.

Note: DP transmitter low pressure side is vent to atmosphere.

- 2 Connect Digital multimeter, DP transmitter (Electronic) and 24v DC power supply as shown in Fig 1.



- 3 Apply 0% input is 3 psi pressure to the input of electronic DPT.
- 4 Adjust the button in the DPT till 4 mA output shown in digital multimeter.
- 5 Apply 100% input is 15psi pressure to the input of electronic DPT.
- 6 Adjust the button in the DPT till 20mA output shown in Digital multimeter.
- 7 Do the above calibration procedure 4 or 5 times.
- 8 Note down the output of DPT for 25%,50%,75% and 100%.
- 9 Record the readings.

Check the range of measuring instrument.

Instrument Mechanic - Measurement of Flow

Installing head type flow meter with orifice, manifold, DPT, milli ammeter or indicator, supply

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

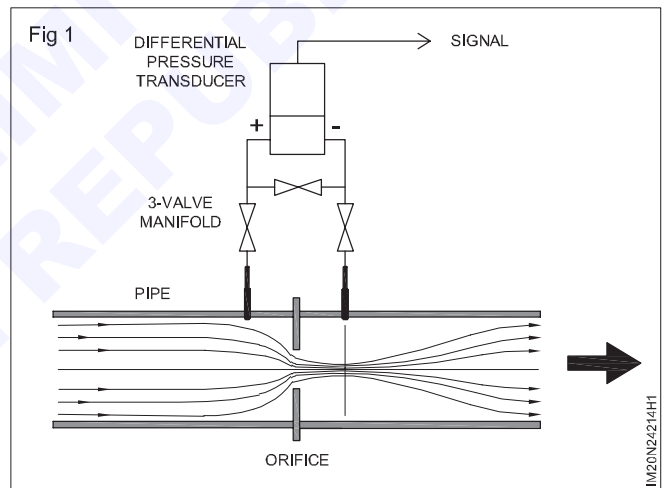
- install head type flowmeter with orifice, manifolds, DPT, milliammeter for measurement of flow rate and calibrate head type flowmeter with volumetric flowrate.

Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• Tank 20 litres	- 1 No.
• Flow trainer	- 1 No.	• Manifold 3 way valve	- 1 No.
• DP transmitter (4-20) mA	- 1 No.	Materials	
• Orifice plate 3.5cm	- 1 No.	• Water	- as reqd.
• Isolation valve ½	- 1 No.	• Pipes ½	- as reqd.
• Adaptor	- 1 No.	• Teflon tape	- 1 No.
• Pump ½ HP	- 1 No.		

PROCEDURE

- 1 Connect orifice, manifold, valve , DPT and milli ammeter as shown in Fig 1 and check the leaks in the in the connection.
- 2 Check the connection with the help of instructor.

Verify that the orifice is filled correctly fill enough water in the tank.



Instrument Mechanic - Measurement of Flow

Calibration of head type flow meter with standard volumetric tank

Objectives: At the end of this exercise you shall be able to
 • calibrate the head type flowmeter.

Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 No.	• Tank 20 litres	- 1No.
• Flow trainer	- 1 No.	• Manifold 3 way valve	- 1No.
• DP transmitter (4-20) mA	- 1 No.		
• Orifice plate 3.5cm	- 1 No.	Materials	
• Isolation valve ½	- 1 No.	• Water	- as reqd.
• Adoptor	- 1 No.	• Pipes ½	- as reqd.
• Pump ½ HP	- 1No.	• Teflon tape	- 1No.

PROCEDURE

1 Fill water in the tank.

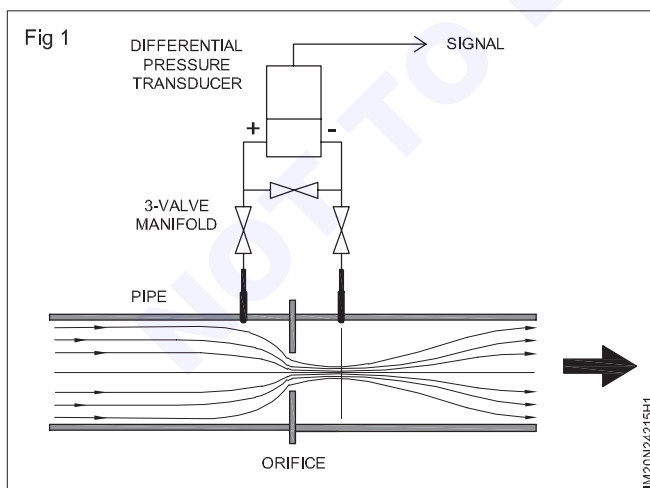
Note
3 way manifold is used to service, calibrate and maintenance of DPT without removing from the installation.

- 2 Connect milli ammeter in the output of DP Transmitter.
- 3 Give 24 vdc supply to DP Transmitter.
- 4 Switch ON the pump.
- 5 Close HV1 valve.
- 6 Open HP and LP valves of 3 way manifold.
- 7 Close the Equilizer valve of way manifold (Fig 1).

- 8 Note down the reading of DPT output (4Ma).
- 9 Note down and record the output of DPT by opening HV1 value by 25%,50%,75% and 100% using milli ammeter in Table 1.
- 10 Do the above steps from 6 to 11 if its readings are not within the limit.
- 11 Do the calibrating procedure 4 to 5 times.
- 12 Check the work done by the instructor.

Table 1

S.no	HVI valve opening in percentage	Output of DPT mA
1	20	4m
2	50	-
3	75	-
4	100	20



Instrument Mechanic - Measurement of Flow

Dismantling, checking overhauling and calibration of DP

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

- dismantling, checking and calibrating pneumatic and electronic transmitter.

Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Multi meter with probe	- 1 No.
• Electronic DPT	- 1 No.	Materials	
• Pneumatic DPT	- 1 No.	• PVC tubes 8 mm	- 2 mts.
• RPS (0-30) VDC	- 1 No.	• Connecting wires	- 2 Meters.
• Foot pump (0.5) kg/cm ²	- 1 No.	• Pneumatic Fittings	- as reqd.
• Pressure gauge (0-2)kg/cm ²	- 1 No.		

PROCEDURE

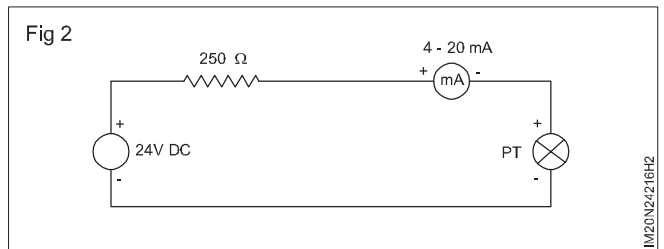
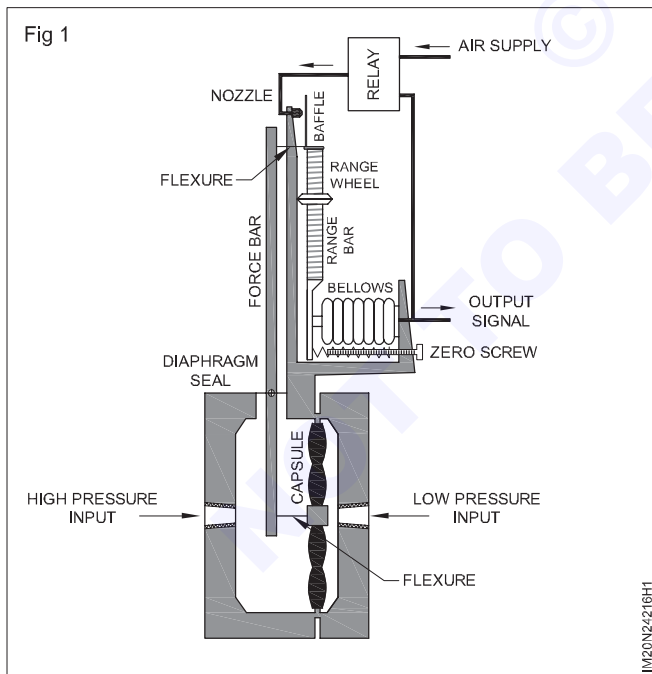
TASK 1: Dismantling, checking and calibrating pneumatic DPT pneumatic and electronic transmitter

- 1 Remove DPT Transmitter from the service line.
- 2 Close the air supply valves.
- 3 Dismantle the DP transmitter and observe the parts i.e Link, air tubes , flapper nozzle , diaphragm condition.
- 4 Replace the dejected parts with the help of instructor.
- 5 Clean the input parts and output parts of DPT and then assemble it as shown in Fig 1.

- 7 Adjust the zero and span parts of DPT and verify that the minimum pressure is in 3 psi & maximum pressure is in 15 psi.

Electronic DPT

- 8 Remove the Electronic DPT from the supply.
- 9 Remove front and back cover of DPT using proper tools.
- 10 Dismantle the electronic DP transmitter and observe the dejected parts.
- 11 Replace the dejected parts with the help of instructor.
- 12 Clean the input parts and output parts of Electronic DPT and then assemble it.
- 13 Connect the DPT as shown in Fig 2.



- 6 Give air supply 20 psi from foot pump to DPT.

- 14 Give 24v /DC supply to DP transmitter.
- 15 Adjust zero and span in DPT and then verify that the minimum output is in 4 mA and maximum output is in 20mA.
- 16 Check the work done by the instructor.

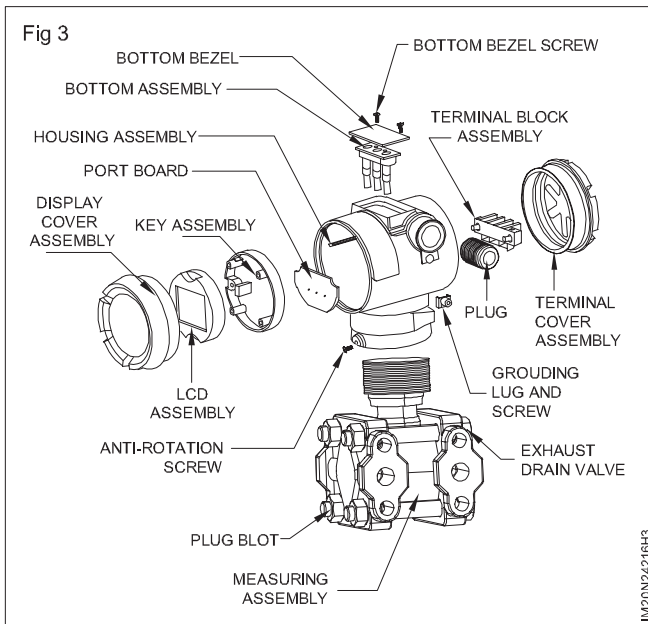


Table 1

Sl.No.	HVI valve opening in %	Output of DPT in mA.
1	25	
2	50	
3	75	
4	100	

Instrument Mechanic - Measurement of Flow

Identify and carryout the preventive maintenance

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

- identify and carry out preventive maintenance.

Requirements

Tools/Instruments

- Trainees tool Kit - 1 No.
- Electronic DPT - 1 No.
- Pneumatic DPT - 1 No.
- RPS (0-30) VDC - 1 No.
- Foot pump (0.5) kg/cm² - 1 No.
- Pressure gauge (0-2)kg/cm² - 1 No.

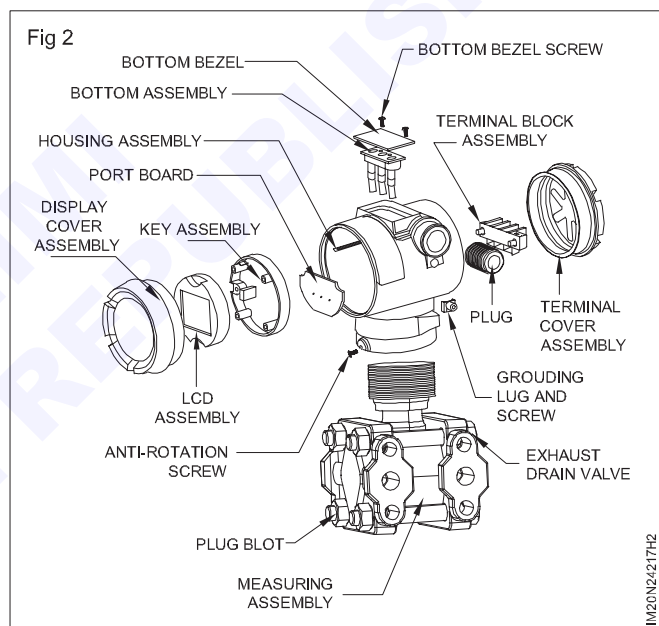
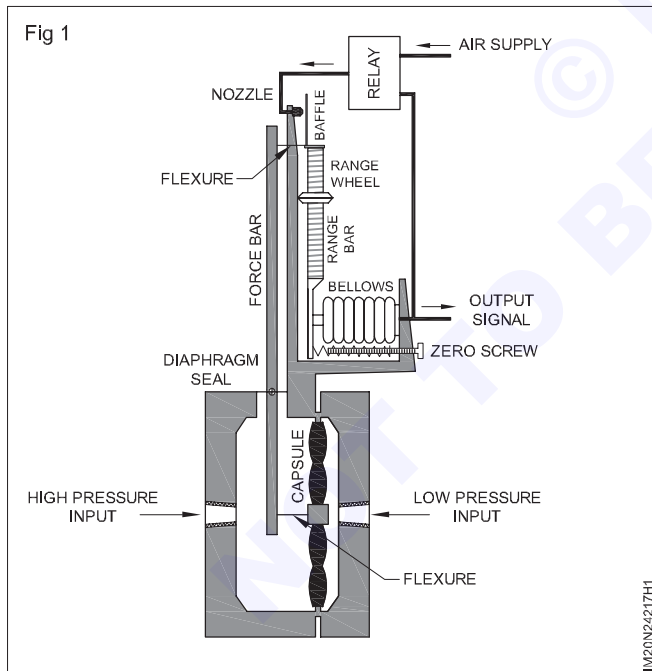
- Multi meter with probe - 1 No.

Materials

- PVC tubes 8 mm - 2 mts.
- Connecting wires - 2 Meters.
- Pneumatic Fittings - as reqd.

PROCEDURE

- 1 Connect pneumatic /Electrometer DP transmitter with correct safety device in the line
- 2 Don't connect in the vibration place
- 3 Give always cleaned, filtered dry air supply of 20 psi to pneumatic DPT
- 4 Don't give more than 24v dc supply to Electronic DPT
- 5 Connect the pipe line with valves without leakage in the transmitter



Instrument Mechanic - Measurement of Flow

Study the construction of weirs, notches and flumes their shape and connections and use

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

- study the construction, shape, connection and use by weirs, notches and flumes.

Requirements	
Tools/Instruments	
• Flumes	- 1 No.
• Weirs	- 1 No.
• Notches	- 1 No.

PROCEDURE

1 Write the uses of flumes, weirs and notches in table 1.

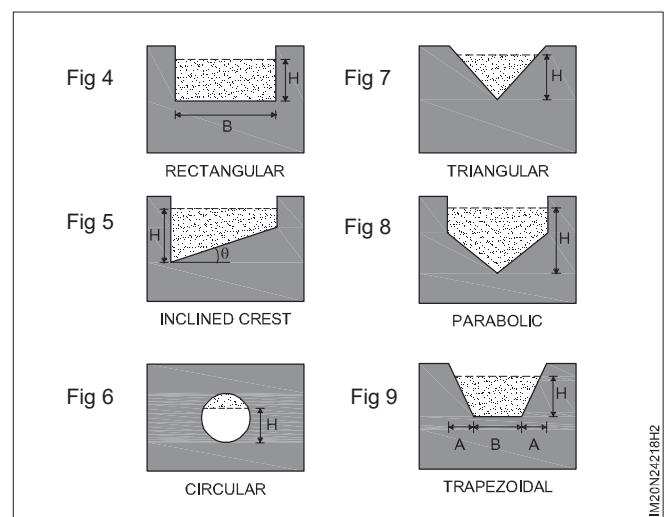
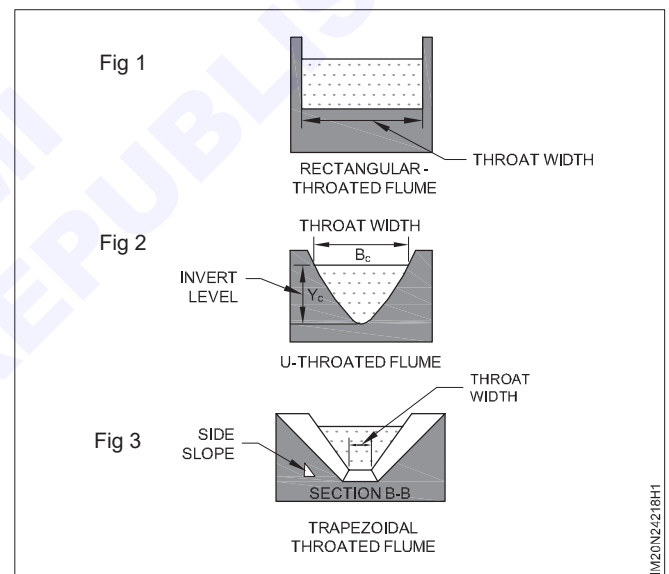
2 Check the work done by the instructor

Note: Instructor should teach about flumes weirs notches in the related theory for the Ex- 2.4.218

Table 1

SI.No	Pictures of flumes	Write the usage of flumes
1	U. flume	
2	Fig1	
3	trapezoidal flume	
	Fig 2	
	Fig 3	
	Trapezoidal	

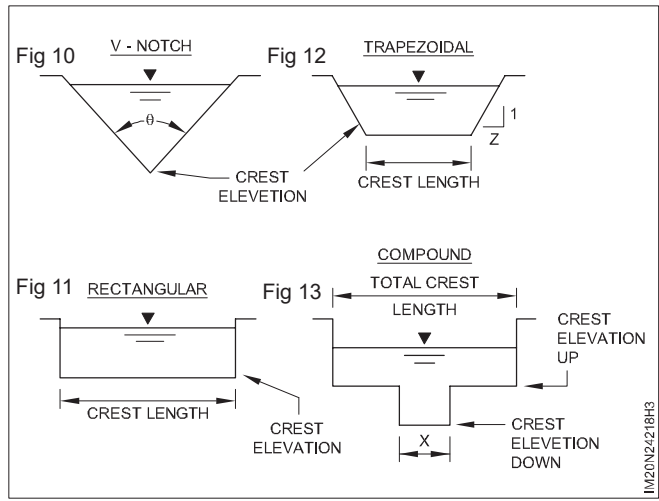
SI.No	Pictures of flumes	Write the usage of weirs
1	Rectangular Fig 4	
2	Inclined Fig 5	
3	Circular Fig 6	
4	Triangular Fig 7	
5	Parabolic Fig 8	
6	Trapezoidal Fig 9	



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SI.No	Pictures of flumes	Write the usage of Notches
1	V notches Fig 10	
2	Rectangular Fig 11	
3	Trapezoidal Fig 12	
4	Compound Fig 13	



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Instrument Mechanic - Measurement of Flow

Install and testing of rota meters in flow line vertical alignment

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

- installation of rotameter

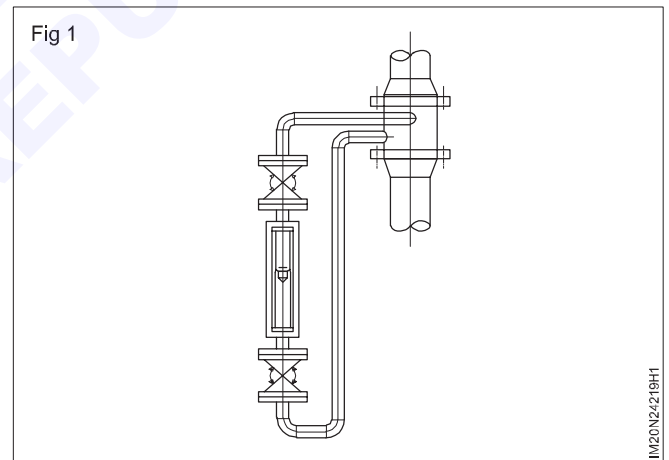
Requirements			
Tools/Instruments		Materials	
• Rotameter 0-100 mph	- 1 No.	• Mulmul cloth	- as reqd.
• Air pressure Regulator (0-30)psi	- 1 No.	• Teflon tape	- 1 No.
• Spanner set	- 1 No.		
• Pipe wrench	- 1 No.		
• Compressor (0-10) kg/cm ² 230v, ½ HP	- 1 No.		

PROCEDURE

TASK 1: Installation of Rotameter

- 1 Handle the Rotameter with care
- 2 Check the free flowing of float
- 3 Use the liquid or gas suitable to design and application
- 4 Fix the Rotameter always in vertical position as shown in Fig 1
- 5 Remove dust particle in the pipe line before installation
- 6 Fit safety by pass pipeline across Rotameter as shown in Fig 1
- 7 Connect the set up with the pipeline by the use of union joint
- 8 Fix throttle value in input, output and by pass line to protect the Rotameter
- 9 Connect such a way bottom should be connected to the inlet
- 10 Collect the water at outlet for 2 minutes.
- 11 Measure the water collected and tabulate
- 12 Increase the float height to 20mm by adjusting the inlet value

Note : If Rotameter is not properly installed it affects the accuracy of instrument For maintain Rotameter use Filter to avoid dust entering the meter



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Instrument Mechanic - Measurement of Flow

Measurement of flow rate and calibrating rotameter

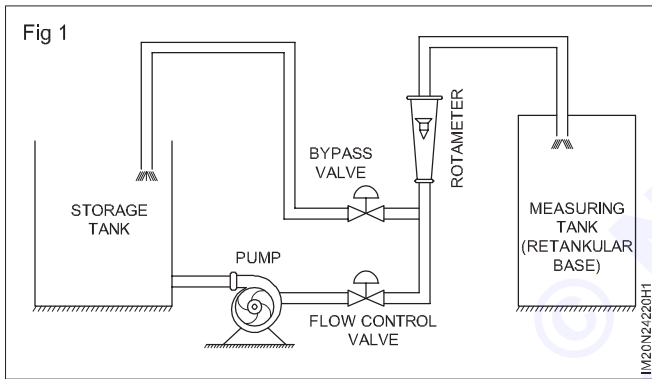
Objectives: At the end of this exercise you shall be able to

- test and measure flow rate using rotameter.

Requirements	
Tools/Instruments	
• Rotameter 0-100 lph	- 1 No.
• Air pressure Regulator (0-30)psi	- 1 No.
• Spanner set	- 1 No.
• Pipe wrench	- 1 No.
Materials	
• Compressor (0-10) kg/cm ² 230v, ½ HP	- 1 No.
• Mulmul cloth	- as reqd.
• Teflon tape	- 1 No.

PROCEDURE

- 1 Select suitable Range Rotameter
- 2 Connect the Rotameter as shown in Fig 1



- 3 Open the inlet valve slightly
- 4 Set the float at 10mm height
- 5 Wait for some time to reach steady state
- 6 Note down the exact float height
- 7 Collect the water at outlet for 2 minutes
- 8 Measure the water collected and tabulate

- 9 Increase the float height to 20mm by adjusting the inlet value
- 10 Repeat procedure 5 to 8
- 11 Tabulate the values. Calculate the actual flowrate using

$$\text{Formula . } Q_{act} = \frac{V}{T} = \frac{A \times h}{t} \text{ in m/s}$$

A → Area of storage tank

H → height of tank

- 12 Record the Qact and selected values in Table 1
- 13 Calculate correction factor (cf)

$$cf = \frac{\text{Rotameter Reading}}{\text{Actual volume flowrate}} = \frac{Q_{rot}}{Q_{rot}}$$

- 14 Calculate correction factor for every reading calculate the average of correction factor
- 15 Plot the graph between Rotameter reading in x axis and actual flowrate in y axis. (Fig Graph)

Table 1

Sl.No.	Qrot (m3/ Sec)	h(m)	t(sec)	V(m3)	Qact (m3/ sec)	cf = $\frac{Q_{rot}}{Q_{rot}}$
1						
2						
3						
4						
5						
6						

Instrument Mechanic - Measurement of Flow

Dismantle identify different parts, its function, and operation of various types of positive displacement meters

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

- identify different parts and study the operation of positive displacement meter.

Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Pointer puller	- 1 No.
• Oscillating piston type flowmeter 0 - 1000lph	- 1 No.	• Pipe wrench Adjustable	- 1 No.
• Lobed impeller type flowmeter 0 - 200lph	- 1 No.	Materials	
• Rotating vane type flowmeter 0 - 500 lph	- 1 No.	• Teflon tape	- 1 No.
• Oval type flowmeter 0 - 400lph	- 1 No.	• Mulmul cloth	- as reqd.
		• CTC (Carbon Tetra Chloride) Solution	- as reqd.

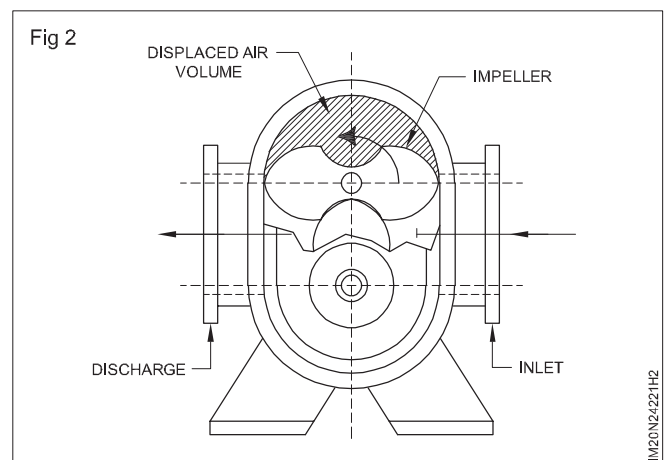
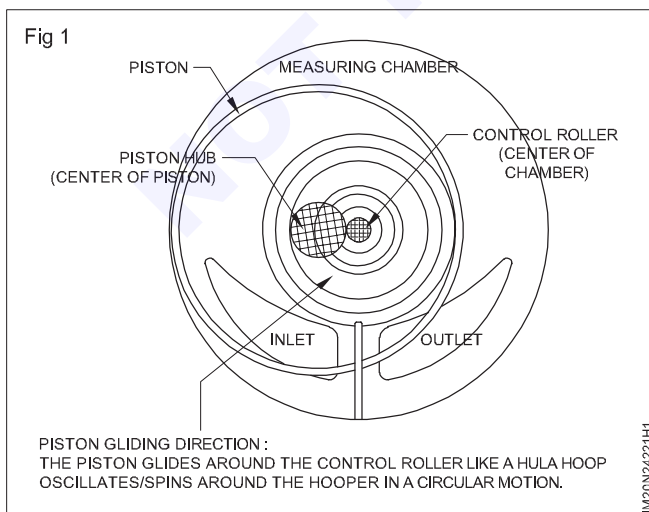
PROCEDURE

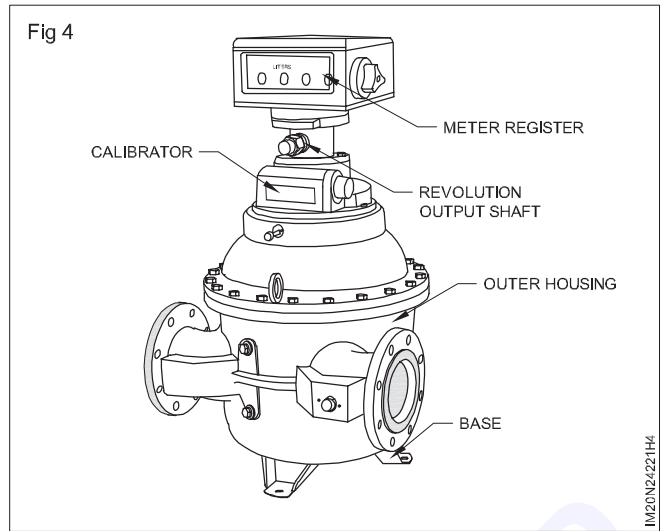
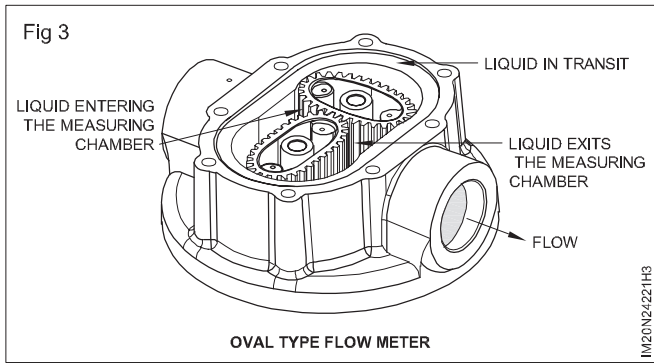
TASK 1: Identify different parts and study the operation of positive displacement meter

- 1 Clean the working table
- 2 Clean the given positive displacement like oscillating piston piston type flow meter and keep it on the table.
- 3 Identify the parts of each positive displacement meter and study its operation with the help of instructor and record it in table 1

Table 1

Sl.No.	Image of positive displacement meter	Name of flow meter	Parts of flow meter	Method of operation
1	Fig 1			
2	Fig 2			
3	Fig 3			
4	Fig 4			





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Instrument Mechanic - Measurement of Flow

Installation, testing and calibrating quantitative flow meter

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

- install, test and calibrate positive displacements flowmeter.

Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Pointer puller	- 1 No.
• Oscillating piston type flowmeter 0 - 1000lph	- 1 No.	• Pipe wrench Adjustable	- 1 No.
• Lobed impeller type flowmeter 0 - 200lph	- 1 No.	Materials	
• Rotating vane type flowmeter 0 - 500 lph	- 1 No.	• Teflon tape	- 1 No.
• Oval type flowmeter 0 - 400lph	- 1 No.	• Mulmul cloth	- as reqd.
		• CTC (Carbon Tetra Chloride) Solution	- as reqd.

PROCEDURE

- 1 Install positive displacement flow meter in horizontal or vertical position as shown in Fig 1
- 2 Ensure that the flowmeter is always filled with water by applying 2-3 psi back pressure
- 3 Fit the meter by seeing the arrow on the meter

Verify that the gears are Rotating freely before installing flowmeter
Remove the dusts inside the pipeline

- 4 Install filter before operation
- 5 Check the flowmeter is fully filled with water
- 6 Maintain the flowmeter by applying 2 to 5 psi back pressure
- 7 Connect flowmeter Via by pass valve and pipeline to water

Easy to install Sensor after installation of flow meter

- 8 Install flowmeter in the flow trainer
- 9 Measure the flowrate reserving flow trainer Manual with the help of instructor
- 10 Connect the tested flowmeter as shown in Fig 2 with master for calibration
- 11 Switch ON the pump
- 12 Open v1 valve and close v2 valve
- 13 Record the readings of test flow meter and master flowmeter in Table 1
- 14 Close v1 valve, open v2 valve and switch 'OFF' the pump

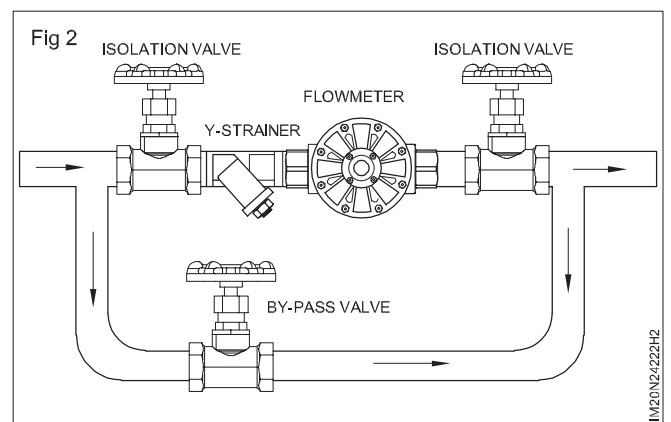
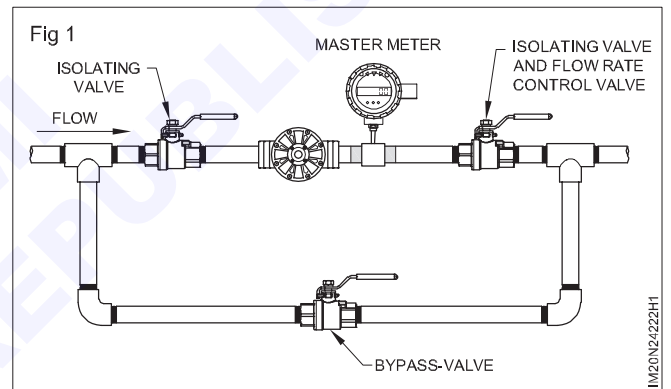


Table 1

SI.No	Readings of Test flowmeter in lph	Readings of master flow meter in lph

Instrument Mechanic - Measurement of Flow

Dismantle and assemble quantitative flow meters like oscillating piston type, rotating vane meter, lobed impeller and oval flow meter

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

- dismantle and assemble positive displacement , meters like oscillating piston flow meter and rotating vane-type flowmeter.

Requirements

Tools/Instruments

- Trainees tool Kit - 1 No.
- Oscillating piston type flowmeter 0 - 1000lph - 1 No.
- Lobed impeller type flowmeter 0 - 200lph - 1 No.
- Rotating vane type flowmeter 0 - 500 lph - 1 No.
- Oval type flowmeter 0 - 400lph - 1 No.

- Pointer puller - 1 No.
- Pipe wrench Adjustable - 1 No.

Materials

- Teflon tape - 1 No.
- Mulmul cloth - as reqd.
- CTC (carbon tetra chloride) Solution - as reqd.

PROCEDURE

- 1 Keep the given oscillating piston type flowmeter on the working table
- 2 Check visually and note down the defects as shown as shown in Fig 1
- 3 Remove Dial, pointer and washer from the meter.
- 4 Remove Gear mechanism from the meter
- 5 Clean all the parts of meter using CTC solution
- 6 Assemble all the parts in reverse order
- 7 Do the above procedure step from 3 to 7 for other positive displacement meters
- 8 Check the work done by the instructor

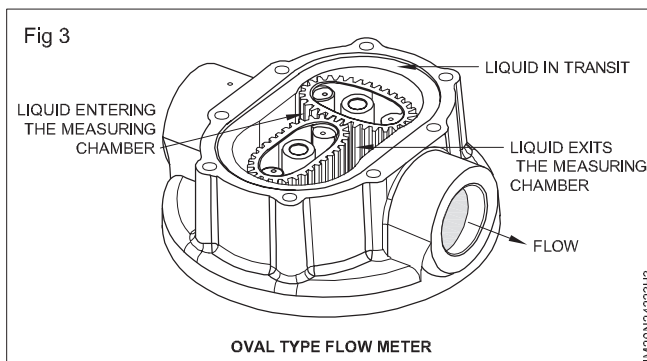
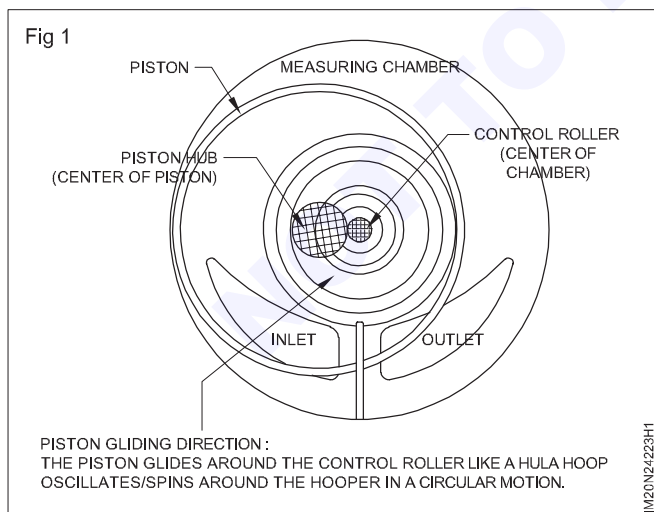
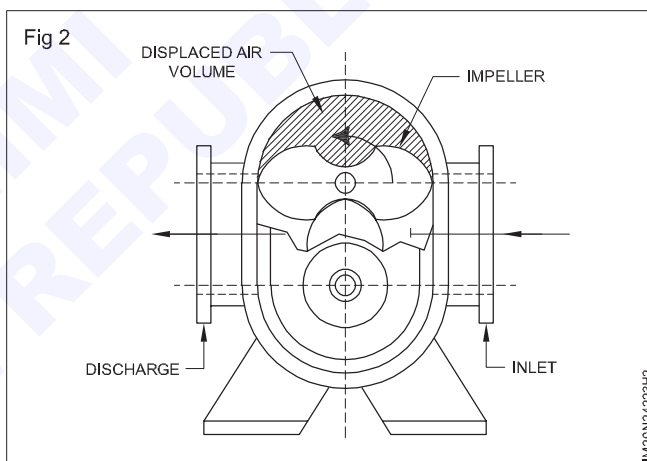
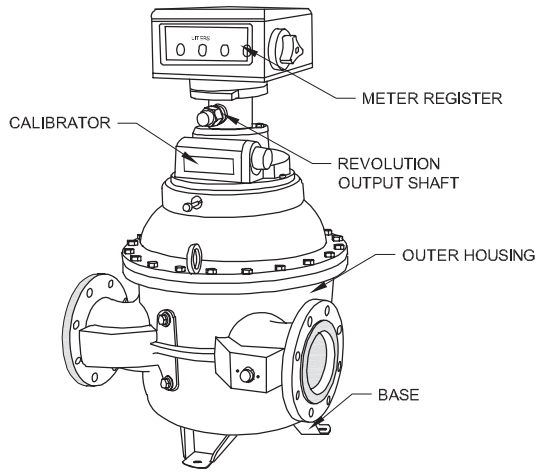


Fig 4



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Instrument Mechanic - Measurement of Flow

Identify and carry out preventive maintenance of positive displacement flow meters

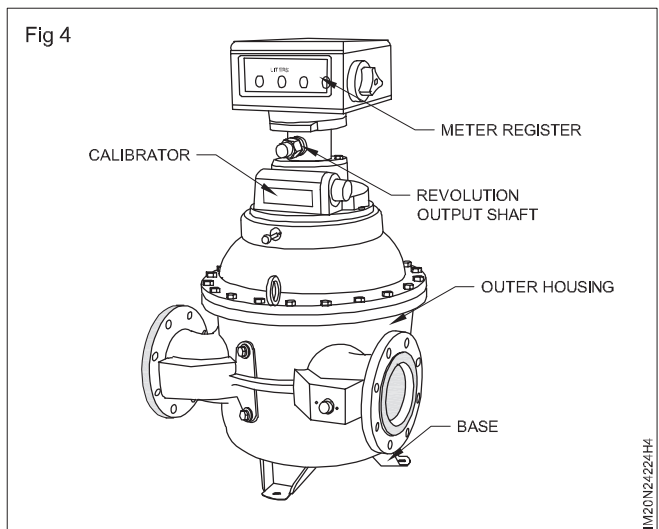
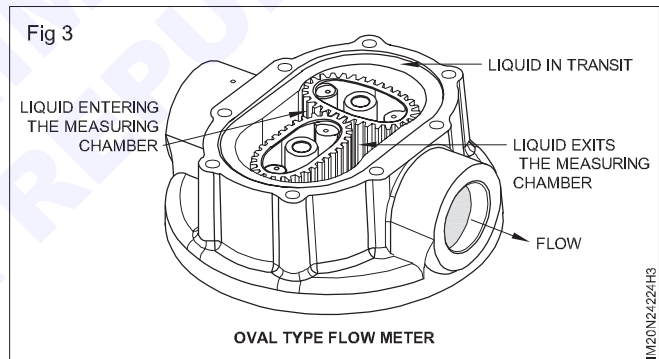
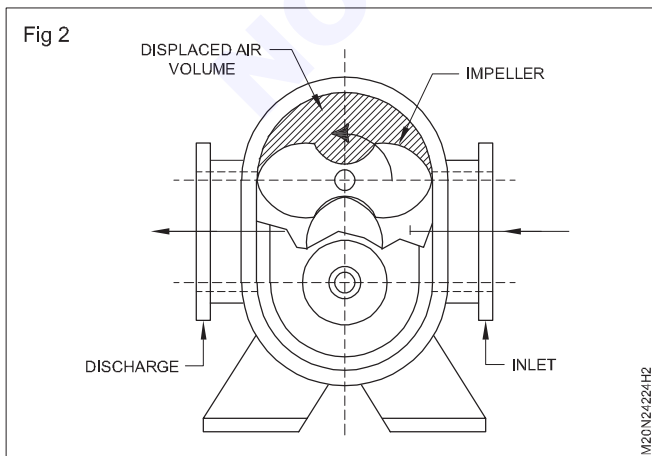
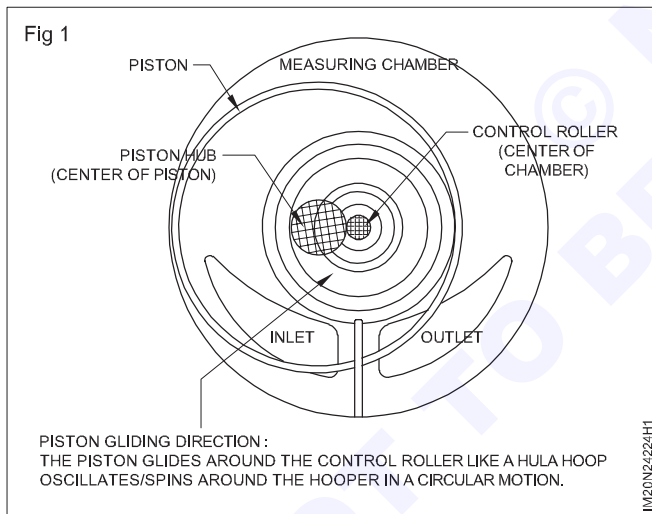
Objectives: At the end of this exercise you shall be able to

- carryout preventive maintenance of positive displacement flowmeter.

Requirements			
Tools/Instruments			
• Trainees tool Kit	- 1 No.	• Pointer puller	- 1 No.
• Oscillating piston type flowmeter 0 - 1000lph	- 1 No.	• Pipe wrench Adjustable	- 1 No.
• Lobed impeller type flowmeter 0 - 200lph	- 1 No.	Materials	
• Rotating vane type flowmeter 0 - 500 lph	- 1 No.	• Teflon tape	- 1 No.
• Oval type flowmeter 0 - 400lph	- 1 No.	• Mulmul cloth	- as reqd.
		• CTC (carbon tetra chloride) Solution	- as reqd.

PROCEDURE

- 1 Handle the flowmeter with care
- 2 Maintain the flowmeter always as per the guidelines
- 3 Use proper filter to remove dusts
- 4 Clean all the parts inside the flowmeter with suitable solution after usage
- 5 Lubricate the flowmeter with oil or Lubricant
- 6 Put proper top cover to prevent flowmeter from dry
- 7 Check the work done by the instructor



Instrument Mechanic - Measurement of Flow

Installation, testing and calibration of turbine flow meter

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

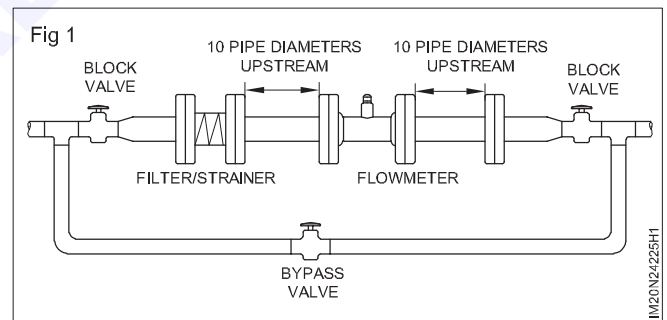
- installation of turbine flowmeter
- test and calibrate turbine flow meter.

Requirements		
Tools/Instruments		Materials
<ul style="list-style-type: none"> • Trainees tool kit • Flow Trainer • Turbine flow meter (0-80) m3 / hour • Screw driver 150mm • Spanner • Isolating valve • Bypass valve ½ • Control valve 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. - as reqd. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • PVC pipe ½ - 5 meter. • 'L' connector ½ - 2 Nos. • 'T' connector ½ - 2 Nos. • Linear connector ½ - 2 Nos. • CTC solution - as reqd. • Mulmul cloth - as reqd.

PROCEDURE

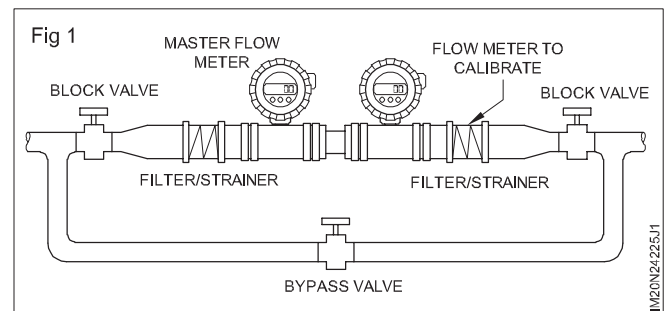
TASK 1: Installation of turbine flowmeter

- 1 Clean the turbine flowmeter and keep it on the working table
- 2 Check for any dust before installing the turbine flow meter
- 3 Make sure that the rotor rotates well.
- 4 Install the flow meter in accordance with the direction of flow
- 5 Install the flowmeter in the horizontal pipeline as shown in Fig1
- 6 Confirm that all the pressure in the pipeline is exhausted before installation of flowmeter
- 7 Fix the filter and strainer at upstream side of flow meter
- 8 Use maximum pipe length at upstream and downstream side of flow meter to retrace the performance of meter



TASK 2 : Test and calibrate turbine flow meter

- 1 Connect turbine flow meter as shown in Fig 1 and check the labs in the correction
- 2 Close isolating valve and open by pass valve after installing flow meter
- 3 Open upstream isolation value slowly to allow the liquid flow through the flowmeter and close the bypass line.
- 4 Open downstream isolating valve as allow the liquid flow through the flow mater and close the bypass valve
- 5 Use downstream isolating valve as control valve and note down the readings



- 6 Check the work done by the instructor

Note

If air gas present in the liquid inner parts be damaged

Severs incompatible with the flow meter life

Fluids incompatible with the flow meter may damage the metering components and cause inaccurate reading

7connect tested flow meter with master flow mater.

Sl.No.	Master meter capacity gpm(s)	Turbine flow meter gpm (F)	%error reading $\frac{S - F}{F}$

- 8 Record the readings for different flow rate in table1 and calculate percentage error
- 9 Do the calibration procedure if the readings are not with in the limit
- 10 Check the work done by the instructor

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Instrument Mechanic - Measurement of Flow

Installation, testing and calibration of vortex flow meter

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

- install, test and calibration vortex flow meter.

Requirements			
Tools/Instruments		Materials	
• Vortex flow meter	- 1 No.	• Teflon tape	- 1 No.
• 25.4mm to 152.4mm	- 0.75%	• Water	- 1 No.
• isolated valves	- 3 nos.	• Drain valve	- 1 No.
• water tank 50 lit	- 2 nos.		
• Trainees tool kit	- 1 No.		

PROCEDURE

- 1 Connect vortex flow meter , isolated valves and by pass valves with out leakage as sown in Fig1 and check with the instructor

Use fittings if straight pipe is not available and connect without leakage as in it 52

Trainees should read

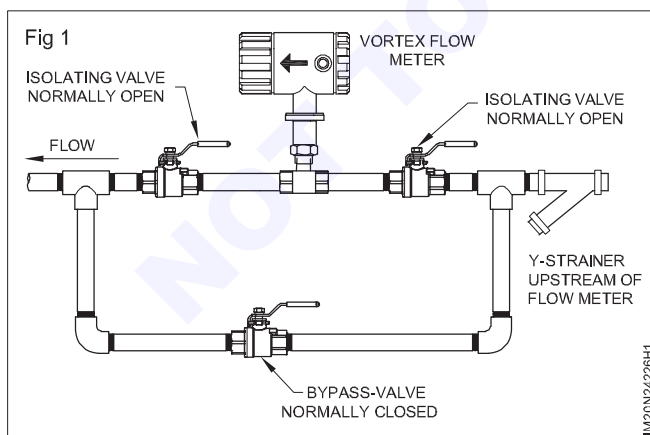
Note: the installation procedure for vortex flow meter in related theory for the 2.4.226

- 2 Give 24v dc supply to vortex flow meter
- 3 Switch no the pump and close the 7 slating valves
- 4 Note down the readings of vortex flow meter
- 5 Open the inlet and out let isolating valve and note down the readings of flow meter
- 6 Check the work done by the instructor

- 7 Do calibration if the readings are not with in the accuracy
- 8 Calculate the frequency of vortex flow meter
 $\text{frequency} = \text{conversion factor} \times \text{reference factor}$
 frequency unit=pps (pulse per second)
- 9 Set 5 check points to calibrate span (100%)
- 10 Correct frequency generator in the input of transmitter
- 11 Set maximum range in frequency generator and adjust the fire span scow till 100% of range
- 12 Set output to minimum range(0%) by disconnecting the frequency generator
- 13 Do the above calibration procedure 40 r 5 times

Observe the zero of flow meter connect electrical wire with care

- 14 Check the work done by the instructor



SI.No.	Outlet valve open in %	Vortex flow meter reading
1	0%	
2	25%	
3	50%	
4	75%	
5	100%	

Instrument Mechanic - Measurement of Flow

Installation, testing and calibration of ultrasonic flow meter

Objectives: At the end of this exercise you shall be able to
 • install, test, calibrate all transonic flow meter.

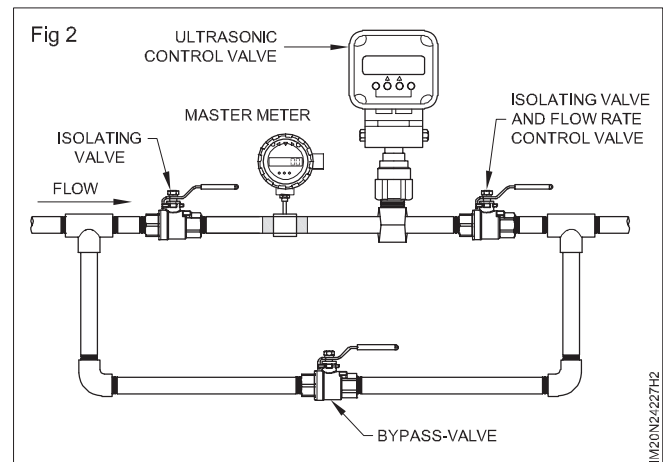
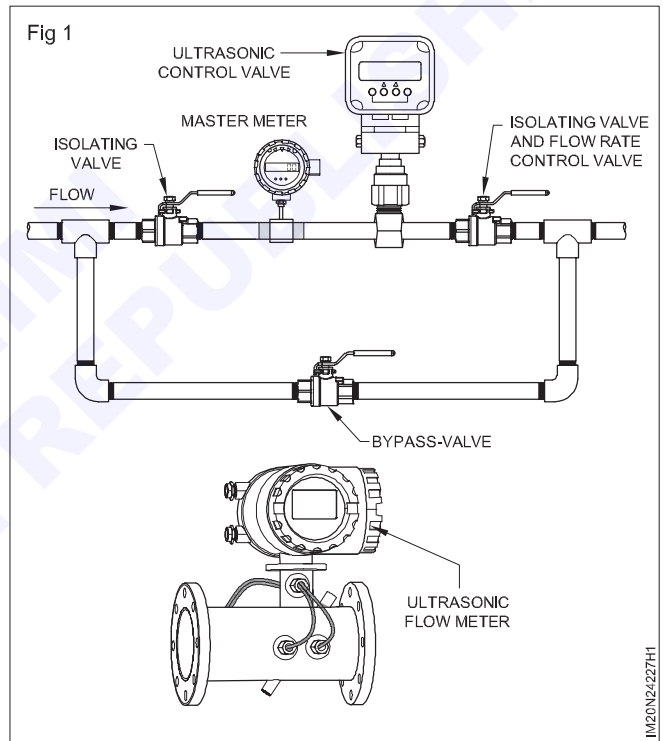
Requirements			
Tools/Instruments			
• Trainees tool kit	- 1 set.	• Isolation valve required	- 2 Nos.
• Flow meter	- 1 No.	Materials	
• Ultrasonic flow meter	- 1 No.	• Teflon tape	- 1 No.
• Water tank 500 litre	- 2 nos.	• Cleaning cloth	- 1 No.
• Pipe tank	- as reqd.		

PROCEDURE

- 1 Install all the Flow transmitters in vertical position as shown in Fig 1
- 2 Place the valves, and regulators far away from the beams of ultrasonic flow meter
- 3 Fix the isolating valves in upstream and down stream side
- 4 Connect ultrasonic flow meter in the bypass line as shown in Fig 1 and check the leaks
- 5 Close valve v1 and valve v2
- 6 Set 4ma in the flow meter before filling the tank
- 7 Switch no the pump and open valve v2 fully
- 8 Open valve v1 25% and note down the readings in the flow meter
- 9 Do the above step for valve v 1 opening by 50 %,75% and 100%
- 10 Record the readings in table Fig 1
- 11 Do master calibration method if the readings as not with in the accuracy
- 12 Connect ultrasonic flow meter with master flow meter as shown in Fig 2 and check the leakage in the setup
- 13 Switch on the pump
- 14 Close the valve v1 fully (0%)
- 15 Note down the reading in both the flow meter
- 16 Open the valve v1 fully (100%) and note down the readings
- 17 Do the calibration by opening the valve 4 or 5 times
- 18 Check the work done by the instructor.

Table 1

S.No.	Valve opening in percentage	Output of ultra-sonic flow meter in mA
1	25%	
2	50%	
3	75%	
4	100%	



Instrument Mechanic - Measurement of Solid Flow

Installation, testing and calibration of mass Exeter flow meter

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

- do installation of mass flowmeter
- do testing and calibration of mass flowmeter.

Requirements

Tools/instruments/Equipments

- Trainees tool kit - 1 No.
- Flow trainer - 1 No.
- Coriolis - 1 No.

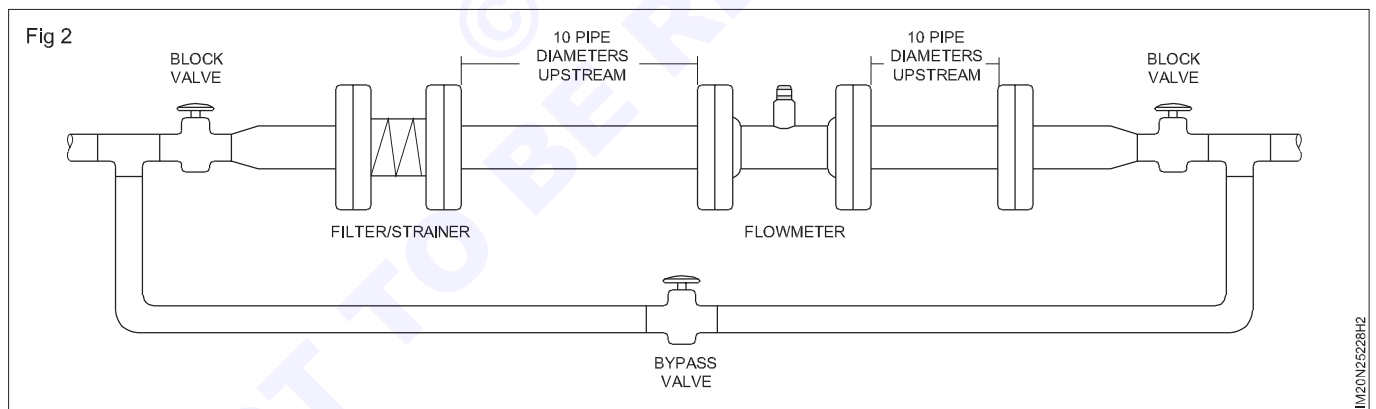
Materials

- Teflon tape - 1No.
- pipes - as reqd.

PROCEDURE

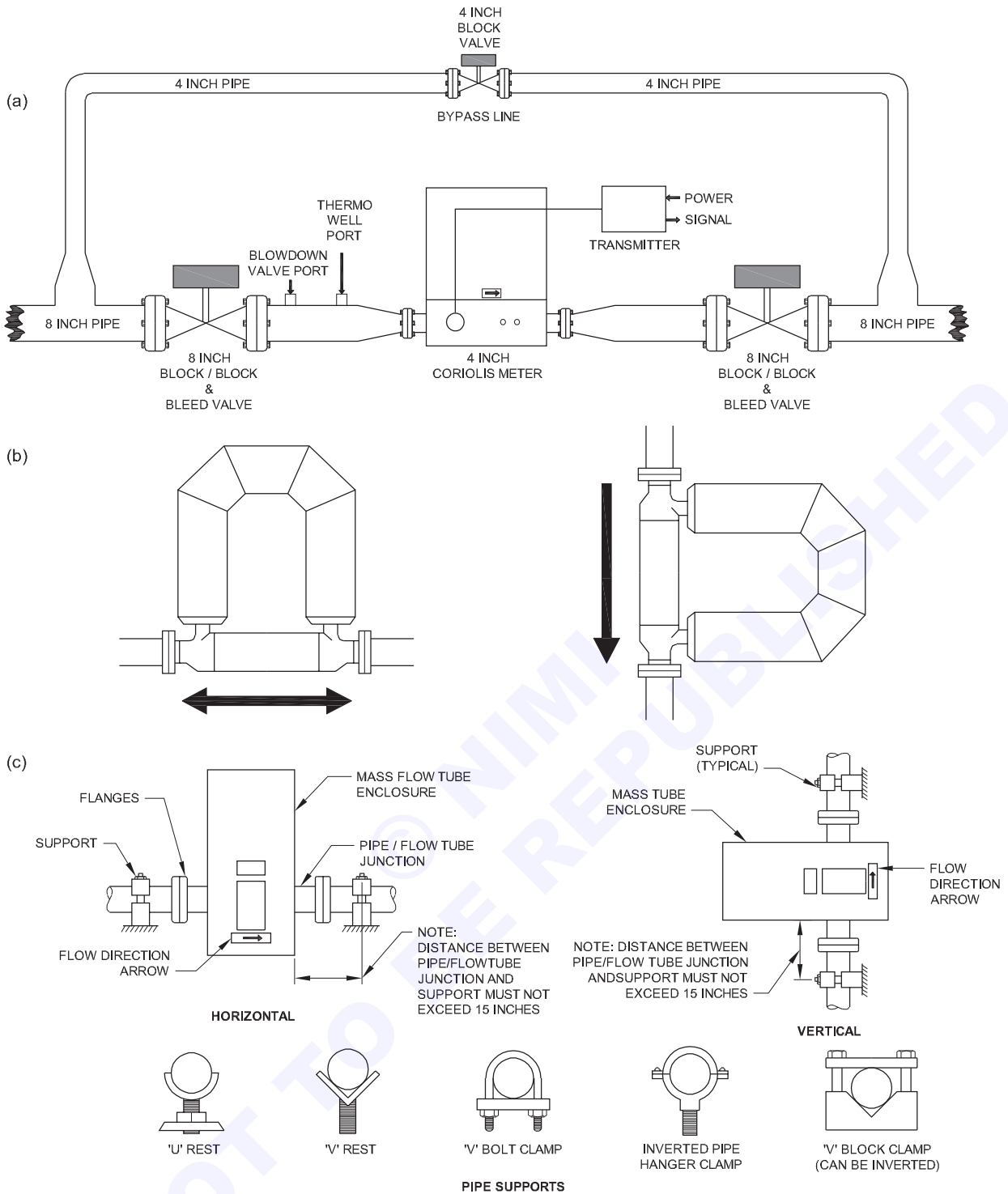
TASK 1: Installation of mass flowmeter

- 1 Clean the given mass flow meter and keep it on the working table
- 2 Install vertical upward flow pipes Fig 1b but installation is in horizontal line.
- 3 To condition the flow no requirement for straight runs of fig 1a relaxation piping upstream or downstream of the meter.
- 4 Install the meter will remain full of liquid and so air cannot get trapped inside the tubes.
- 5 Install the attachments little pulsation dampeners, flexible connections and mounting/ clamping recommended by the manufacturer as shown in Fig1c.
- 6 Use common piping for pumping into and out of storage tank.
- 7 Install strainer, filters, vapour eliminator to remove dust particles Fig 2
- 8 Install air release upstream of the meter to remove air bubbles as shown Fig 2



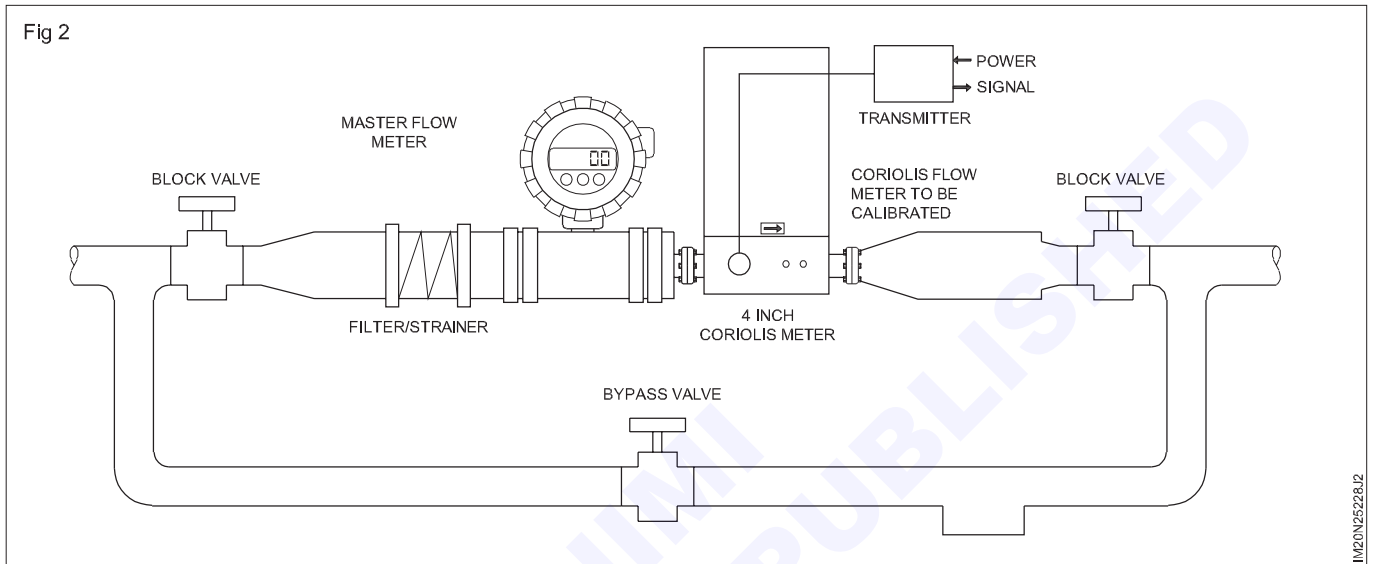
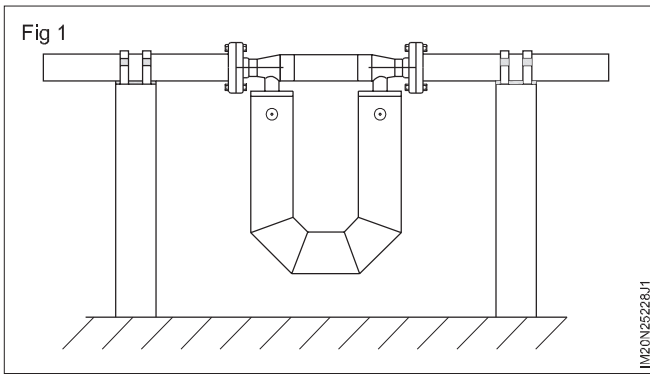
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Fig 1



TASK 2: Test and calibration of mass flow meter

- 1 Connect mass flowmeter as shown in fig 1 and check the leakage in the connection.
- 2 Close upstream valve (VI) and downstream valve v2.
- 3 Set 'Zero' in the mass flowmeter
- 4 Switch on the pump
- 5 Open upstream valve (VI) and downstream valve v2.
- 6 Note down the flow rate for every 5 minutes.
- 7 Connect mass flowmeter with master flowmeter as shown in Fig 2
- 8 Note down the flowrate in both the meter and calculate percentage error.
- 9 Do the meter calibration method 4 or 5 times till mass flow meter reaches its accuracy
- 10 Check the work done by the instructor



Instrument Mechanic - Measurement of Solid Flow

Measure semi solid liquid flow rate using flow meter

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

- measure semisolid liquid flow rate using electromagnetic flow meter.

Requirements			
Tools/instruments/Equipments		Materials	
• Trainees tool kit	- 1 No.	• Teflon tape	- 1 No.
• Flow trainees	- 1 No.	• Semisolid	- as reqd.
• Electromagnetic flowmeter	- 1 No.		
• Indicated ball valve 1"	- 2 Nos.		
• Bypass valve (Manual) 1"	- 1 No.		
• Tank (100 liter)	- 2 Nos.		

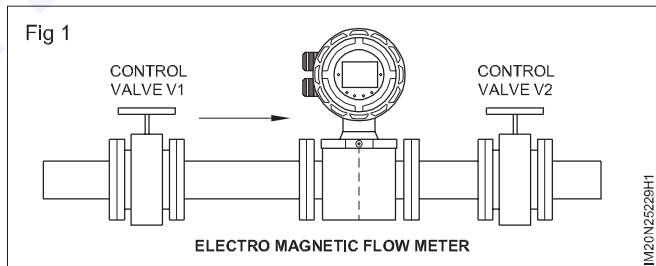
PROCEDURE

- 1 Connect electromagnetic flowmeter in the setup as shown in fig 1 and check the leakages in the connection.
- 2 Give 24 VDC supply to electromagnetic flowmeter.
- 3 Switch on the pump.
- 4 Note down the readings in flowmeter.
- 5 Open valve V_2 fully
- 6 Open valve V_1 25% and note down the readings in the electromagnetic flowmeter.
- 7 Do the above step and note down the readings in the flowmeter by opening the valve V_2 by 50 %, 75% and 100%.
- 8 Record the reading in Table 2

Sl.No.	Valve opening in percentage	Output of electromagnetic flowmeter in 4 mA
1	25%	20MA
2	50%	
3	75%	
4	100%	

The output of electromagnetic flowmeter directly proportional to the flowmeter

- 9 Check the work done by the instructor



Instrument Mechanic - Measurement of Solid Flow

Calibration and adjustment of solid flow meter

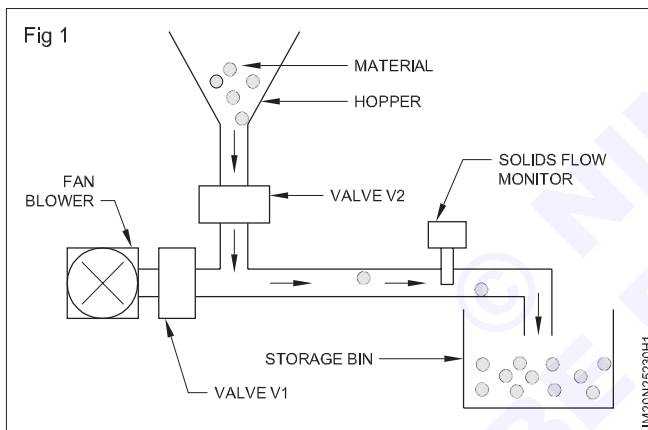
Objectives: At the end of this exercise you shall be able to
 • calibration of solid flow meter.

Requirements			
Tools/instruments/Equipments		Materials	
• Microwave solid flow meter	- 1No.	• Teflon tape	- 1No.
• Solid trainer	- 1No.	• Solid	- as reqd.
• Trainees tool kit	- 1No.		
• Multi meter with probe	- 1No.		

PROCEDURE

Calibration of solid flow meter

1 Connect microwave solid flow meter as shown in Fig 1 and check the table in the connection.



2 Close valve V₁ and valve V₂
 3 Give 24 VDC supply to microwave solid flow meter and note down its output (4mA)

- 4 Switch on the compressor pump.
- 5 Open valve v2
- 6 Open valve V₁ by 25% and note down the output of solid flowmeter
- 7 Do the above step for valve v1 opening by 50%,25%, and 100%.
- 8 Record the readings in table 1
- 9 Check the work done by the instructor.

SI.No	Valve opening percentage	Output of microwave solid flow meter
1	25%	4mA
2	50%	
3	75%	
4	100%	20 mA

Instrument Mechanic - Measurement of Solid Flow

Identify and carry out maintenance & preventive maintenance of solid flow measuring system

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

- service solid flowmeter (microwave)
- calibration of solid flow meter.

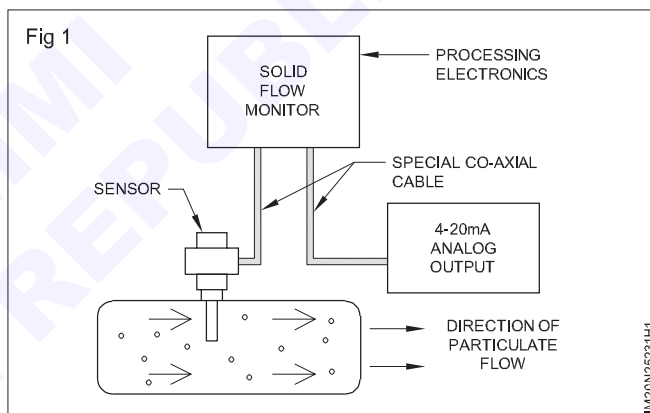
Requirements			
Tools/instruments/Equipments		Materials	
• Microwave solid flow meter	- 1No.	• Teflon tape	- 1No.
• Solid trainer	- 1No.	• Solid	- as reqd
• Trainees tool kit	- 1No.		
• Multi meter with probe	- 1No.		

PROCEDURE

Service microwave solid flowmeter

- 1 Clean the given microwave solid flow meter and keep it on the working table.
- 2 Note down the defects physically present in the meter
- 3 Remove the outer cover using suitable tool.
- 4 Check the continuity of microwave solid flow meter using multi meter.
- 5 Change the probe of flow meter if it is not working.
- 6 Change the defect parts with the help of instructor
- 7 Reassemble the flow meter and check with instructor
- 8 Connect assembled flow meter in solid flow trainer as shown in (Fig 1)
- 9 Note down the readings in table.

- 10 Do calibration if the readings are not within accuracy.
- 11 Check the work done by the instructor.



Instrument Mechanic - Measurement of Solid Flow

Service and calibrate solid flow meter

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

- calibration of solid flow meter.

Refer Ex No : 2.5.230

Instrument Mechanic - Measurement of Level

Measurement of liquid level using stick gauge and converting liquid level into volume and mass

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

- measure liquid level using stick gauge.

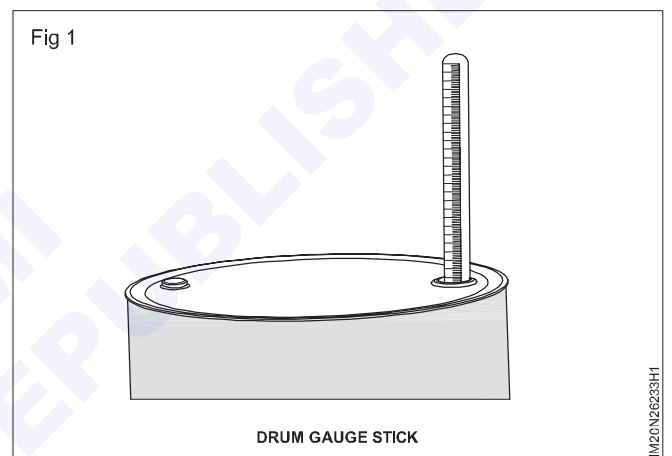
Requirements		
Tools/ Instruments/Equipments		Materials
<ul style="list-style-type: none"> • Water tank • Stick gauge (dip stick) 	<ul style="list-style-type: none"> - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Required liquid

PROCEDURE

- 1 Fill the tank with required amount of water.
- 2 Place the water tank on a flat surface.
- 3 To measure the level of fluid, a Cleaned Stick gauge should be vertically by touching the bottom of the tank.
- 4 Tank out stick gauge and note the level of liquid on the top of gauge. (Fig 1)
- 5 Increase the level of liquid in the water tank and note the different level reading (3 or 4 times).

Dip stick

- 1 Make sure the stick gauge is clean.
- 2 Use only in vertical position in tank.



Instrument Mechanic - Measurement of Level

Study the construction and operation of various types of sight glasses

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

- study, construction and operation of various types of sight glass.

Requirements			
Tools/ Instruments/Equipments		Materials	
• Trainer kit	- 1No.	• Clean cloth	- as reqd.
• Water tank	- 1No.	• Water	- as reqd.
• Types of sight glass	- 1No.	• Teflon tape	- as reqd.
• Isolation valve	- 2 Nos.		

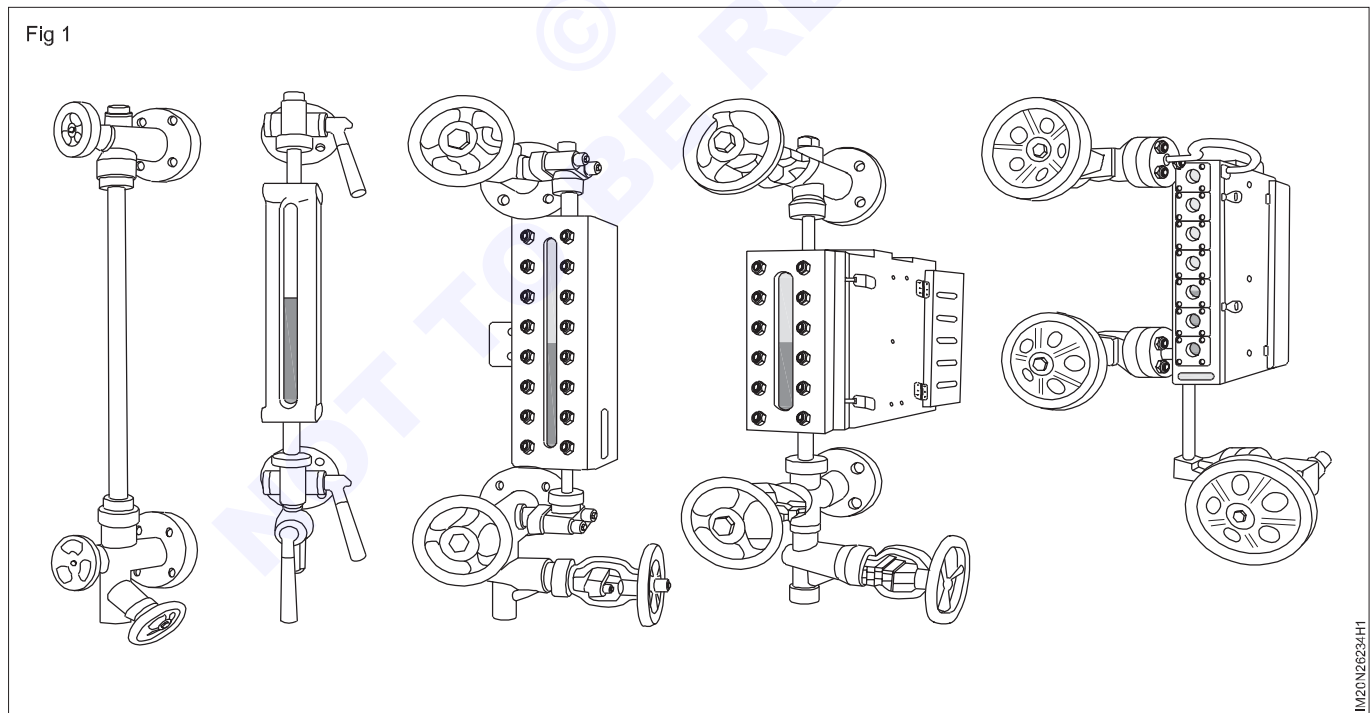
PROCEDURE

- 1 Fill in the name, construction and operation of different types of sight glass shown in the given Table 1.

Table 1

S.No.	Diagram	Name	Construction	Operation

Fig 1



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Instrument Mechanic - Measurement of Level

Installation, testing and calibration of liquid level indicator

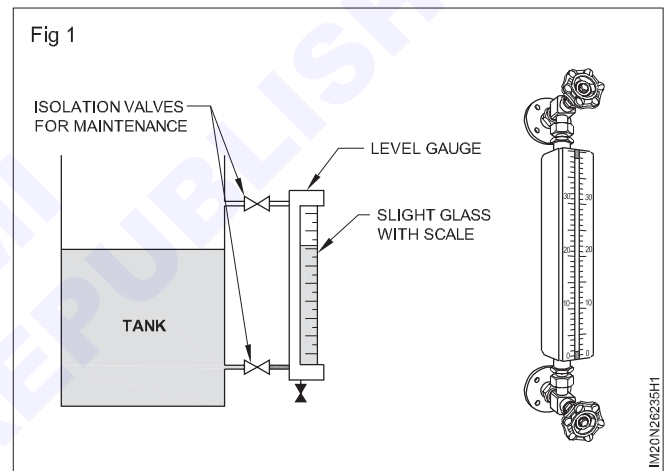
Objectives: At the end of this exercise you shall be able to

- install, test and calibrate liquid level indicator.

Requirements			
Tools/ Instruments/Equipments		Materials	
• Trainees tool kit	- 1No.	• Clean cloth	- as reqd.
• Water tank	- 1No.	• Water	- as reqd.
• Types of sight glass	- 1No.	• Teflon tape	- as reqd.
• Isolation valve	- 2 Nos.		

PROCEDURE

- 1 Clean tank and glass pipe using cloth.
- 2 Using flange fix sight glass as shown in the Fig 1.
- 3 Fix the control valve to control the flow of liquid.
- 4 The level of liquid should be noted in the scale fixed on sight glass.
- 5 Note down the readings in log note.
- 6 Take 4 or 5 readings by opening and closing valve.



Instrument Mechanic - Measurement of Level

Cleaning the glass tube and operating the isolation valves, calibrating zero adjustments

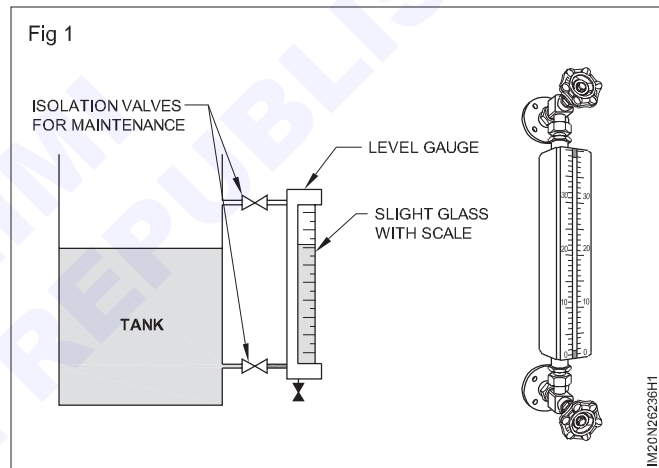
Objectives: At the end of this exercise you shall be able to

- clean the glass tube and operate solution valves and calibrating sight glass indicator.

Requirements			
Tools/ Instruments/Equipments		Materials	
• Trainer kit	- 1No.	• Clean cloth	- as reqd.
• Water tank	- 1No.	• Water	- as reqd.
• Types of sight glass	- 1No.	• Teflon tape	- as reqd.
• Isolation valve	- 2 Nos.		

PROCEDURE

- 1 Before Cleaning the sight glass tube and valve, make sure the tank is free of any liquid in the Fig 1.
- 2 Disconnect the glass tube by closing valves.
- 3 Clean the dust inside glass tube.
- 4 Open the valve and clean the dust from both sides of sight glass indicator.
- 5 Cleaned glass tube should be fixed in bottom of tank.
- 6 Adjust lower bottom of tank levels coincides with sight glass indicator 'O' valve.
- 7 Check the work done with the instructor.



Instrument Mechanic - Measurement of Level

Calibrating and measuring the liquid level using float type, displacer type level systems

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

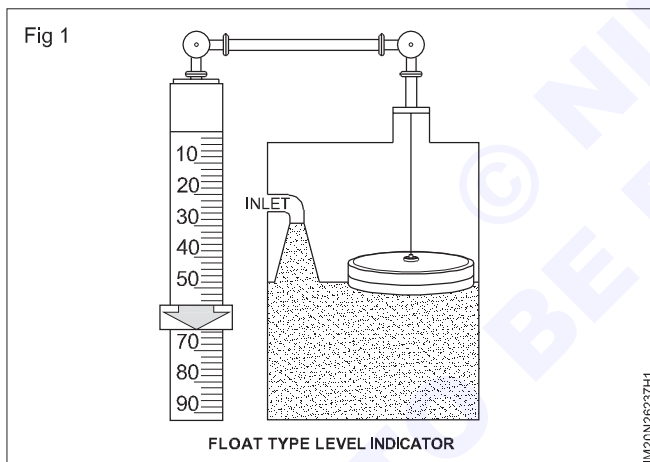
- measure and calibrate liquid level using float type level indicator
- measure and calibrate liquid level using displacer type level indicator.

Requirements			
Tools/ Instruments/Equipments			
• Trainer's kit	- 1set.	• Float type level indicator	- 1No.
• Water tank	- 1No.	• Displacer type level indicator	- as reqd.
Materials		• Storage tank	- 1 No.
• Required liquid	- as reqd.	• Isolation valve	- 2 Nos.
• Hammal cloth	- as reqd.		

PROCEDURE

TASK 1: Calibration of sight glass indicator

- 1 Fill the tank with required amount of water as show in Fig 1.



- 5 Increase the liquid level in the tank. Note the readings on the calibrated scale in indicator.
- 6 Check the work done with the help of instructor.

Note

- 1 Place the float carefully in the water
- 2 Always place the float vertically.

Calibration of sight glass indicator

- 2 Place the water tank on a flat surface.
- 3 To measure the level of fluids a cleaned float type level indicator should be placed vertically by touching the bottom of the tank.
- 4 Connect counter weight to other end of the float level indicator through pulley.

- 1 mark 'zero' before liquid filled in the tank.
- 2 Fill the liquid in the tank of maximum level (100 % span)
- 3 Measure the liquid level is float type indicator for maximum level of tank.
- 4 Repeat the above the steps 2 to 3 times and calibrate sight glass indicator.

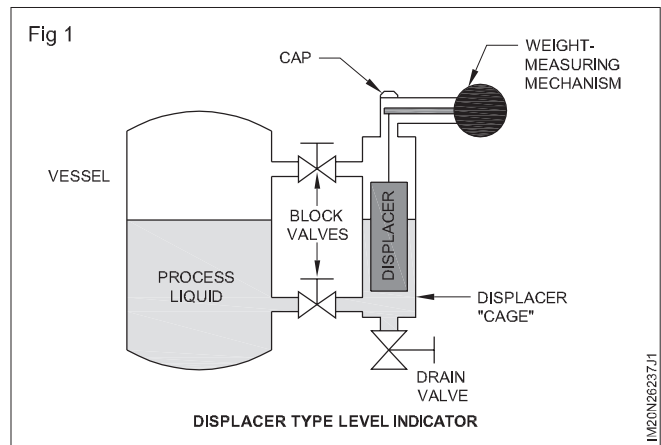
TASK 2: Measure and calibrate liquid level using displacer type level lying displacer type level indicator

- 1 Fill the tools equipment's must be properly filled as shown in the Fig 1.
- 2 displacer level indicator 'zero' when the tank is empty.
- 3 fill the tank with water.

- 4 Open the valves raise the liquid level gradually and note down the readings in the displacer level indicator.
- 5 Note down the readings for different levels and tabulate in tabular column (1).
- 6 Check the work done with the help of instructor.

Table 1

Sl.No	Liquid level (%)	Displacer level reading in(CM)
1	0%	
2	25%	
3	50%	
4	75%	
5	100%	



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Instrument Mechanic - Measurement of Level

Measure the liquid level of open and tank using pressure / DP gauge

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

- measure the liquid level of open and closed tank using pressure/DO gauge
- converting liquid height into pressure and liquid density.

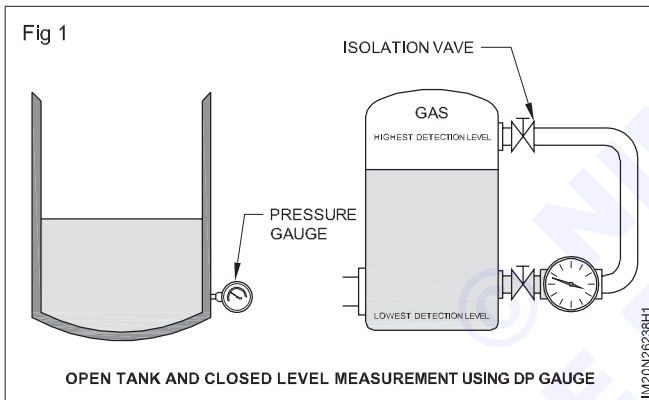
Requirements

Tools/ Instruments/Equipments

- | | | | |
|---|------------|---------------|------------|
| • Closed water tank | - 1 No. | • Cloth | - as reqd. |
| • D.P gauge (0.2 kg / cm ²) | - 1 No. | • Teflon tape | - as reqd. |
| • Isolation valve | - 2 Nos. | • Adopter | - as reqd. |
| • Trainers tool kit | - 1 No. | • Spanner | - 1 Set. |
| • Liquid | - as reqd. | | |

PROCEDURE

- 1 Place the open tank on a surface and test for leakage as shown in Fig 1.



- 7 Check the work done with help of the insolation.

NOTE: Calculate liquid pressure for open and close circular tank using blow formula.

Closed tank

$$P = \rho gh + P_1$$

Open tank

h =

$$K = \frac{C}{\sqrt{1 - \beta}}$$

$$P = \Delta p \text{ kg/ cm}^2$$

p- density

g- acceleration due to gravity

h- Height of liquid

- 2 Test isolation valve for any leakage and connect it with the tank.
- 3 Test the DP gauge of connect it do the pipe line without any error.
- 4 Fill the liquid partially through inlet port of open tank.
- 5 open the liquid filled in the through isolation valve 1 and 2 and note readings in D.P gauge.
- 6 Follow the above procedure from 1,2,3, & 4 for Closed tank and record the readings in DP gauge.

Note

- 1 Check whether D.P gauge is at zero
- 2 Check whether isolation valve is at correct position
- 3 Check drain valve.

Instrument Mechanic - Measurement of Level

Calibrating DP transmitter for liquid level measurement

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

- calibrate DP transmitter for liquid level measure and adjust square root to linear scale display.

Requirements			
Tools/ Instruments/Equipments			
• Liquid indicator	- 2 Nos.	• Connecting wires	- as reqd.
• DP transmitter	- 1 No.	• Isolation tape	- as reqd.
• Multi meter with probe	- 1 No.	• Teflon tape	- as reqd.
• Power supply unit	- 1 No.	• Water	- as reqd.
• Compressor unit	- 1 No.	• Adopter	- as reqd.
• Metal tank	- 1 No.	• PVC pipe ½ inch	- as reqd.
• Trainees tool kit	- 1 Set.		

PROCEDURE

TASK 1 : Calibration of differential pressure transmitter

- 1 Place the DP transmitter in the closed tank as in Fig 1.
- 2 Connect low and high pressure connector to the transmitter through pipe.
- 3 Give 24 V DC supply.
- 6 Repeat the above steps for 25%, 50%, 75%, 100% and note down the readings in the output of transmitter in table 1.

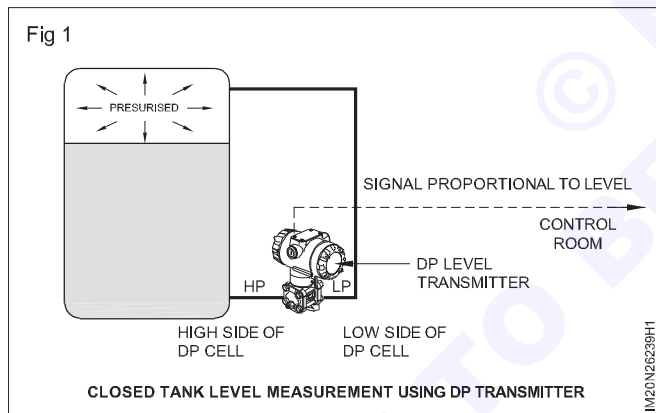


Table 1

Sl.No.	Liquid level	Output of transmitter in ma
1	0%	4ma
2	25%	
3	50%	
4	75%	
5	100%	20 mA

- 4 Set the DP transmitter output to the capacity of the tank.
- 5 Set 4 mA in DP transmitter when tank is '0'.
Fill the water at maximum level of (span) tank set the DP transmitter output 4-20 mA.

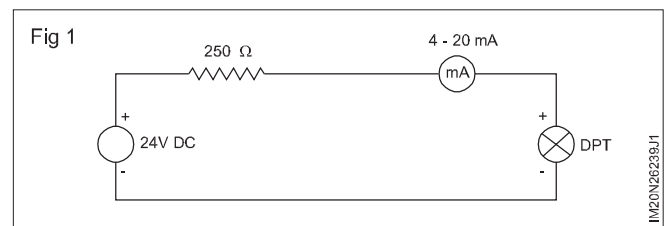
Note:

- 1 Pipes from the tank to DP transmitter should be properly filled with valves to ensure leak. Check the work with the help of instructor.
- 2 Properly insulate the power supply wire.
- 3 Do not place DP transmitter in place with vibration.
- 4 If there is any leak in the fining pipe the transmitter won't show accurate reading

TASK 2: Service and calibrate level indicator

- 1 Clean all level indicators available in your lab and keep it on table.
- 2 Note the physical effects in the indicators as in Fig 1.
- 3 Dismantle the indicator with proper tools with the help of instructor.
- 4 Clean all the parts with CTC solution and cleaning cloth.
- 5 Replace defective parts and reassemble all the parts.
- 6 Check the assemble level indicator with the help of instructor.

- 7 Test the indicator with standard level indicator using trainer.
- 8 Measure the level of liquid and tabulate all the reading.
- 9 Do calibration using master calibration method if the reading are not with in the accuracy.



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Instrument Mechanic - Measurement of Level

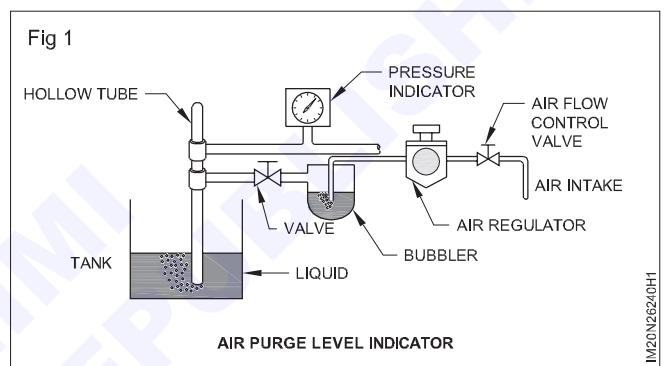
Installation, testing measurement of liquid level using air purge level measurement

Objectives: At the end of this exercise you shall be able to
 • install, test, measure liquid level using air purge level indicator.

Requirements			
Tools/ Instruments/Equipments		Materials	
• Air purge level indicator	-1No.	• Water	- as reqd.
• Water tank with valves	-1No.	• Cloth	- as reqd.

PROCEDURE

- 1 Connect all the parts as shown in Fig 1.
- 2 Slowly open the flow control valve and see air bubble occurs in the (3 to 15 psi) bubbler.
- 3 Check adequate pressure 3 to 15 psi is present when the bubble passing through bubble.
- 4 Raise the level of water in the tank slowly and observed the bubbles in it
- 5 Observe the bubble in it.
- 6 Record the reading of level indicator in table 1.



NOTE
1 At tools must be filled firmly and properly
2 Allow control valve slowly & carefully.
3 Clean all tools and Equipment after work is completed.
4 Check the work done with the instructor

Table 1

SI.No.	Pressure In psi	Liquid level in cm

Instrument Mechanic - Measurement of Level

Service and calibrate different types level indicators and transmitters

Objectives: At the end of this exercise you shall be able to
 • calibrate the given level transmitters.

Requirements			
Tools/ Instruments/Equipments			
• Level transmitter	- 1No.	• Cleaning brush	- 1No.
• Level indicator	- as reqd.	• Water tank	- 1No.
• Power supply unit - 24 V	- 1 No.	• Water	- as reqd.
• Banian cloth	- as reqd.		

PROCEDURE

- 1 Set up the level transmitter, HART communicator, power supply and multimeter as per Fig 1.
- 2 Checks the configuration of low range value (0% level, 4 mA) and high range value (100%, 20mA).
- 3 Fill the tank up to 0% level and set this condition as 0% level through HART communicator.
- 4 Fill the tank up to 100% and set this condition as 100% level through HART communicator.

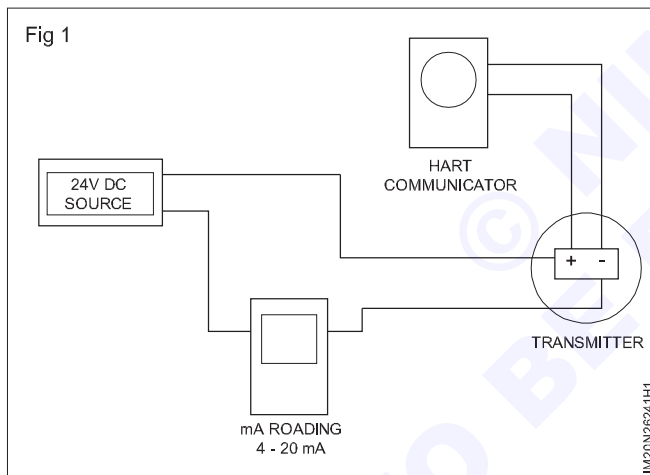


Table 1

Sl.No.	Card	mA reading
	0%	
	25%	
	50%	
	75%	
	100%	

Instrument Mechanic - Measurement of Level

Identify and carry out maintenance & preventive maintenance of above Level indicators and transmitters

- Objectives:** At the end of this exercise you shall be able to
- identify carry out maintenance of level indication and transmitters
 - preventive maintenance of have indicators and transmitter.

Requirements			
Tools/ Instruments/Equipments			
• Level transmitter	- 1No.	• Cleaning brush	- 1No.
• Level indicator	- as reqd.	• Water tank	- 1No.
• Power supply unit - 24 V	- 1 No.	• Water	-as reqd.
• Banian cloth	- as reqd.		

PROCEDURE

TASK 1: Identify carry out maintenance of level indicators and transmitters identify parts

- 1 Fix the level transmitter with the help of in instructor.
- 2 Do the following test for maintenance of level indicator and transmitter.
- 3 Service and over haul all the parts frequently and check it for proper functioning before measurement
- 4 Follow operator manual procedure for preventive maintenance of instrument.
- 5 Follow safety instruments and personal Preventive equipment in the manual guide.
- 6 Flush out the process lines by opening vent valves provided, once in a month for not clogging the pipe lines connected to transmitter and indicators.
- 7 Must arrest all the leaks in the process lines

Instrument Mechanic - Measurement of Level

Construct and operate conductivity probe level indicator

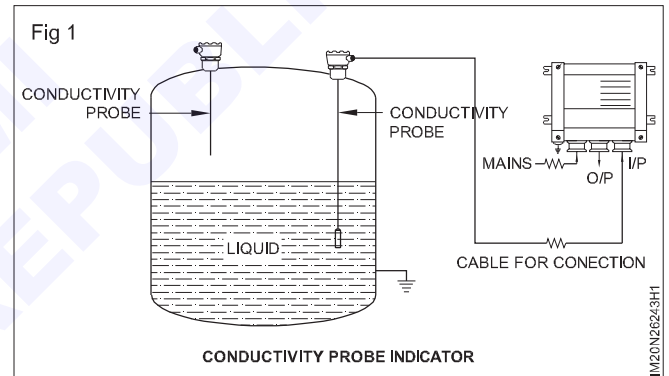
Objectives: At the end of this exercise you shall be able to
 • **construct and operate conductivity probe level indicator.**

Requirements	
Tools/ Instruments/Equipments	
<ul style="list-style-type: none"> Conductivity probe level indicator - 1 No. 	<ul style="list-style-type: none"> Distilled water - as reqd. Banjan waste - as reqd. Water tank (50 liters) -1 No.
Materials	
<ul style="list-style-type: none"> NaCl Standard solution (o – 200 l/cm) - as reqd. 	

PROCEDURE

TASK 1: Identify and note the conductivity probe level

- 1 Identify and note the conductivity probe level. Indicator parts as shown in a fig, with the help of the instructor.
- 2 An electrode is attached on left side above the liquid level as shown in Fig 1.
- 3 Connect the conducting probe the water tank.
- 4 Fill the conductivity liquid in water tank.
- 5 Connect the conductivity probe to bottom of the tank and another probe is connected top of the tank.
- 6 Switch on the motor and fill the water in tank.
- 7 Electric relay, pumps and other equipment will start working.
- 8 Note the liquid level of conductivity probe by increase the liquid level gradually.
- 9 Check the work with the help of instructor.



Note

- 1 Do not place the electrode viscous liquid such heavy oils, glycerin or ethylene glycol.
- 2 Do not place the probe in quadtone or pentane organic solvents.

Instrument Mechanic - Measurement of Level

Construction and operation of capacitance probes indicating transmitters and sonic level detector

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

- construct and operate, service, test, calibrate and install capacitance probe transmitter
- construct and operate, service, test, calibrate and install sonic level detector.

Requirements			
Tools/ Instruments/Equipments			
• Trainees tool kit	- 1 Set.	• Sonic level detector	- 1 No.
• Capacitance Probe transmitter (+ 24 vdc output 4 - 20 mA , 100 mm to 10m)	- 1 No.	• Mammal cloth	- as reqd.

PROCEDURE

TASK 1 : Construct operate service test calibrate and install capacitance probe transmitter

1 Note the below Transmitter name , parts and function in Table 1.

Transmitter fig	Transmitter Name	Transmitter Parts	Transmitter Function

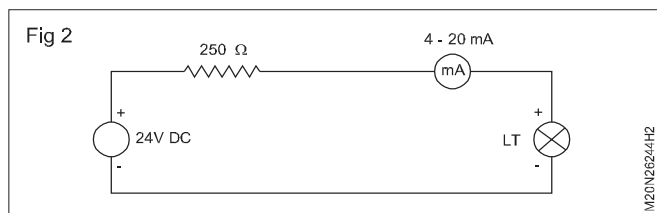
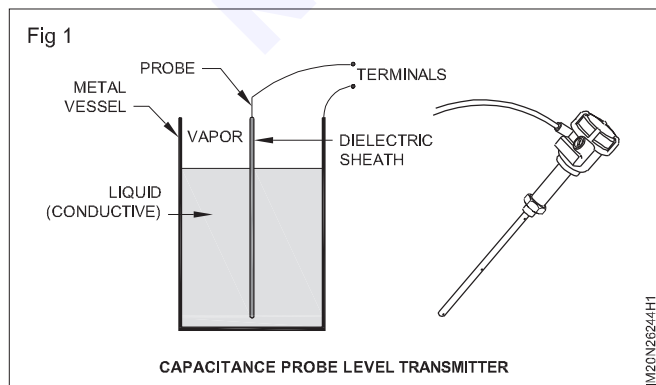
- 2 Check the work done with the help of instructor.
- 3 Note the physical defects and check with your instructor.
- 4 Open the Top corner of capacitance probe using probe screw driver.
- 5 Clean the sensor with a cloth or non – abrasive material if there is contamination.
- 6 Check the input and output connections.
- 7 Connect the capacitor probe transmitter without leakage and check with the instructor.
- 8 Capacitor probe Transmitter as show in Fig 1.
- 9 Observe that meter indicator zero if there is no liquid in the tank.

10 Switch on the pump and water level rises in tank gradually.

11 Note down the readings

Calibration of Transmitter

- 1 Identify the transmitter connection terminals as shown in Fig 2.
- 2 Set the transmitter to output 4mA using multimeter when there is no fluid level in the tank (zero)
- 3 Set the transmitter about at 20 mA using multimeter by adjusting SPAN in transmitter
- 4 Repeat the above steps 4 to 5 times and calibrate the transmitter
- 5 Check the work done with the help of instructor



SI.No	Level	Transmitter current output (mA)	Error
1	0%		
2	25%		
3	50%		
4	75%		
5	100%		

Installation of transmitter

- 1 Always install the transmitter vertically.
- 2 Check leakage in connections.
- 3 Use proper tools to install the transmitter.

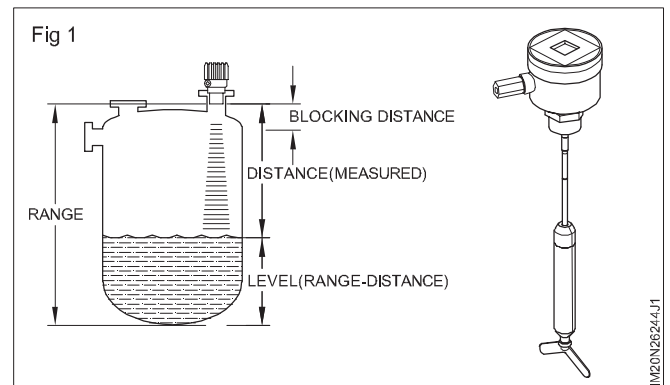
TASK 2 : Construct and operate, service, test, calibrate and install sonic level detector

- 1 Note the transmitter name, parts and function in table 1.

Table 1

Transmitter fig	Sonic level Transmitter Name	Sonic level Transmitter parts	Sonic level Transmitter function

- 2 Check the work done with the help of Instructor.
- 3 Clean the ultrasonic transmitter by placing it on the work table.
- 4 Open the top cover of the ultrasonic transmitter using appropriate tools.
- 5 Disconnect wires and cable and take the sensor.
- 6 Note the fault in the transmitter and Replace & with the help of instructor.
- 7 Testing the ultrasonic Transmitter.
 - Fit the ultrasonic transmitter vertically on top of the tank as show in Fig 1.
 - The reference level for all measurement is at the bottom of the tank.
 - 'C' is the position to be measured and 'B' is the distance between the liquid level and the ultrasonic sensor.
 - Observe that meter indicator zero if there is no liquid in the tank.
 - Switch on pump and water level rises in tank gradually.
 - Note the reading in the transmitter.
- 8 Calibration of ultrasonic transmitter.
 - Fit the ultrasonic transmitter on the top of the tank.
 - Adjust the transmitter to 4 mA , when there is no liquid in the tank (0 level).
 - Check with multimeter that 4 mA is present at the transmitter.
 - Set the transmitter output to 20 mA (SPAN) if the tank level is 100%.
 - Repeat the above procedure 4 or 5 times and calibrate it.



Install and test capacitance probes indicating transmitters and sonic level detector

Refer Exercise No 2.6.244

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Instrument Mechanic - Measurement of Level

Service and calibrate capacitance probes indicating transmitters and sonic level detector

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

- construct and operate, service, test , calibrate and install sonic level detector.

Requirements			
Tools/ Instruments/Equipments			
• Trainees Tool Kit	- 1 Set.	• Sonic level detector	- 1 No.
• Capacitance Probe transmitter (+ 24 vclc output 4 - 20 mA , 100 mm to 10m)	- 1 No.	• Mammal cloth	- as reqd.

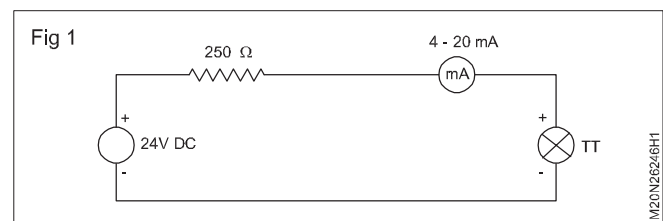
PROCEDURE

- 1 Note the transmitter name , parts and function in Table 1.

Table 1

Transmitter fig	Sonic level Transmitter Name	Sonic level Transmitter parts	Sonic level Transmitter function

- 2 Check the work done with the help of Instructor.
- 3 Clean the ultrasonic transmitter by placing it on the work table.
- 4 Open the top cover of the ultrasonic transmitter using appropriate tools.
- 5 Disconnect wires and cable and take the sensor.
- 6 Note the fault in the transmitter and Replace & with the help of instructor.
- 7 Testing the ultrasonic Transmitter.
 - Fix the ultrasonic transmitter vertically on top of the tank.
 - The reference level for all measurement is at the bottom of the tank.
 - 'C' is the position to be measured and 'B' is the distance between the liquid level and the ultrasonic sensor.
 - Observe that meter indicator zero if there is no liquid in the tank
- 8 Calibration of ultrasonic transmitter.
 - Switch on pump and water level rises in tank gradually.
 - Note the reading in the transmitter.
 - Fit the ultrasonic transmitter on the top of the tank.
 - Adjust the transmitter to 4 mA , when there is no liquid in the tank (0 level).
 - Check with multimeter that 4 mA is present at the transmitter.
 - Set the transmitter output to 20 mA (SPAN) if the tank level is 100%.
 - Repeat the above procedure 4 or 5 times and calibrate it.



Instrument Mechanic - Measurement of Level

Study the construction, operation and use of load cell technique to determine solid level in vessel

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

- use of load cell technique to determine solid level.

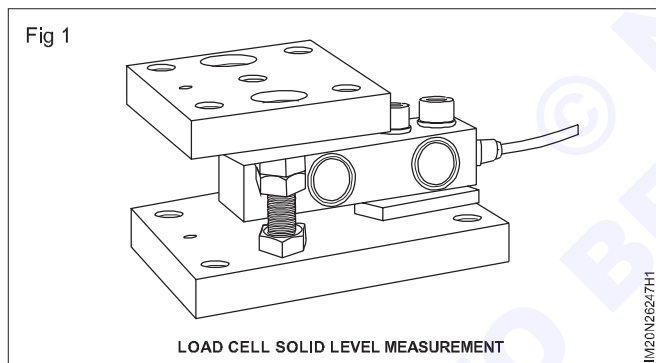
Requirements			
Tools/ Instruments/Equipments		Materials	
• Load cell	- 1No.	• Connecting wires	- as reqd.
• Power supply unit	- 24pc.	• Baniyan waste	- as reqd.
• Multimeter with probe	- 1No.		

PROCEDURE

- 1 Check the given load cell in good condition.
- 2 Fix the bad cell in the tank as shown in the Fig 1.
- 3 Give 24 v DC supply.
- 4 Check the output is zero when there are no solids in the tank.
- 5 Increase the load and note down the readings in the indicator.

Note

- 1 Ensure that the load cell shows zero before loading it .
- 2 Gradually increase the weight in load cell.



Instrument Mechanic - Measurement of Level

Study the construction, operation and use of different types of solid level / switches

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

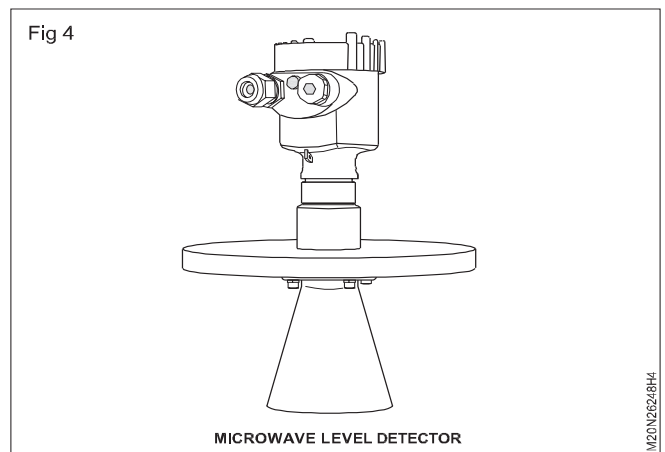
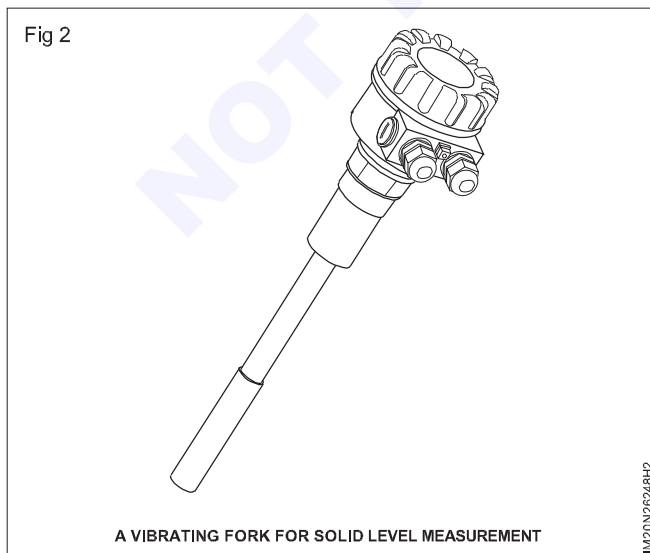
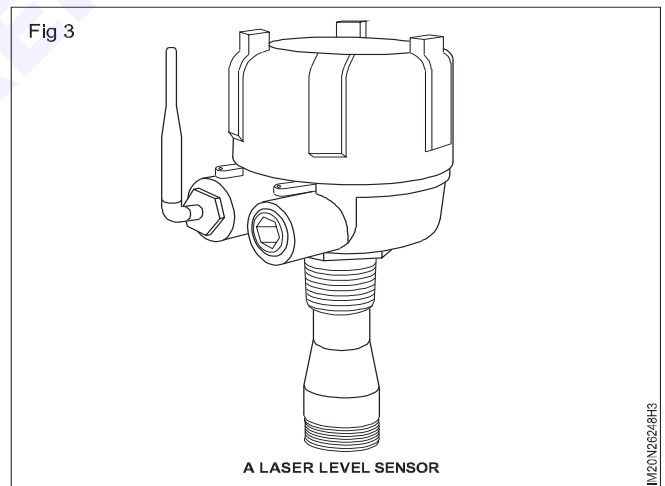
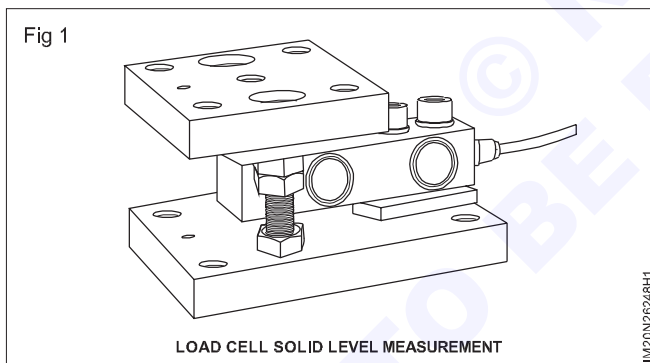
- study different types of solid level switches
- study about capacity probe transmitter and microwave level defector.

Requirements	
Tools/ Instruments/Equipments	
<ul style="list-style-type: none"> • Laser level sensor - 1 No. • Indicative level switch - 1 No. • Rotator pedal switch - 1 No. 	<ul style="list-style-type: none"> • Vibrating fork - 1 No. • Microwave level defector - 1 No.

PROCEDURE

TASK 1: Study different types of solid level switches (Figs 1 to 4)

S.No.	Solid level switch figures	Name of switches	Working principle	uses



Instrument Mechanic - Measurement of Level

Study the construction, and operation of capacitance probes transmitters, microwave level detector / gauges

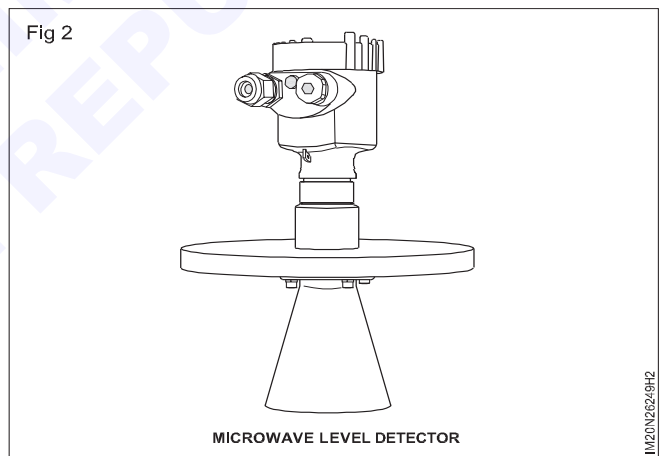
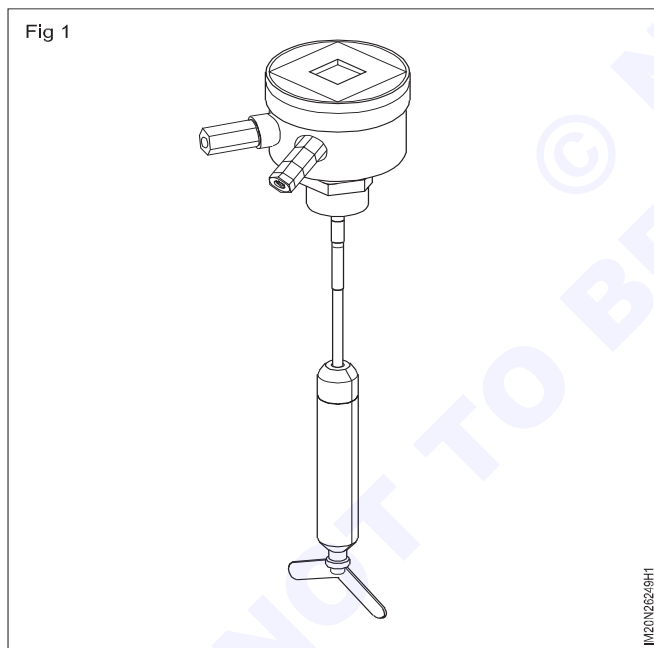
Objective: At the end of this exercise you shall be able to
 • study about capacitive probe and microwave level transmitter.

Requirements	
Tools/ Instruments/Equipments	
• Capacitive probe transmitter	- 1 No.
• Micro level transmitter	- 1 No.
• Trainees tool kit	- 1 No.

PROCEDURE

TASK 1 : Study about capacitance probe transmitter and microwave level defector (Figs 1 & 2)

S.no	Capacitance probe transmitter diagram	Name	Working	uses



Instrument Mechanic - Measurement of Level

Install and test various types of solid level indicating transmitters and sonic level detector

Refer Exercise No 2.6.251

Instrument Mechanic - Measurement of Level

Service and calibrate various types of solid level indicating transmitters and sonic level detector

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

- install test service and calibrate different types of solid level indicating transmitter.

Requirements		
Tools/ Instruments/Equipments		
• Trainee's tool kit	- 1No.	• Different types of solid indicator transmitter - 1No.
• Tank	- 1No.	• Solid state trainer
• Radar instrument transmitter	- 1No.	- 1No.

PROCEDURE

TASK 1: Fix the radar transmitter on the top of the tank

- Follow the instructions below to install the radar transmitter.
 - Install the conical shape tank at a distance of one meter as show in Fig 1.

Note: During measuring if there is any disturbance the sensitivity of the radar transmitter will be affected

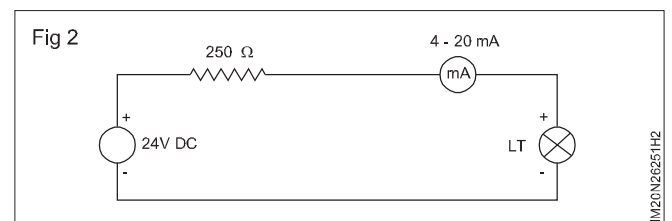
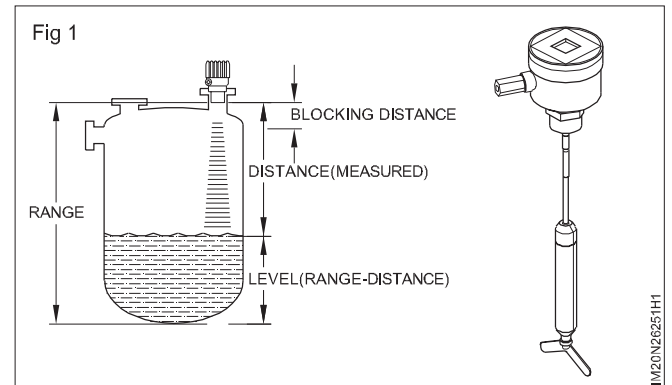
- To ensure are sudd joint flange spray and was her to keep radar transmitter stationary.
 - Fix the radar transmitter on the top of the tank.
 - (iv) Align the conveyor system horizontally.
- Check any leakage in the transmitter with the help of instructor.
 - Give the 24v DC supply to transmitter.
 - Note the transmitter output (4mA) when the tank is empty.
 - Turn on the conveyor system and fill the tank with 25% solids.
 - Switch on the transmitter and note the output.
 - Fill the tank 50%,60%,70%,80%,100% and record the transmitter output in the Table 1.
 - Repair Method
 - Note any damages on the outside of the transmitter.
 - Use the suitable tools to remove the transmitter with the help of instructor.

Table 1

Tank level	Radar output
0	
25	
50	
60	
70	
80	
100	

- If any parts are damaged replace them with the help of instructor and assemble using proper tools.
- Calibration method
 - Design as shown in Fig 2 and check with the instructor.
 - Connect transmitter input with 24 volt DC supply and output with current meter (mA).
 - Set the transmitter output 4 mA (zero) when the tank is empty (0%).
 - Set the transmitter output 20mA (SPAN) by filling the solids in the tank fully (100%).
 - Repeat the above steps 4 or 5 times and calibrate it.
 - Check the work with instructor.

Note:
Repeat the same procedure for different types solid level transmitter available in your lab with help of instructor



Instrument Mechanic - Measurement of Temperature - I

Study the construction, operation and use of temperature controlled oil bath/ furnace for low and high temperature

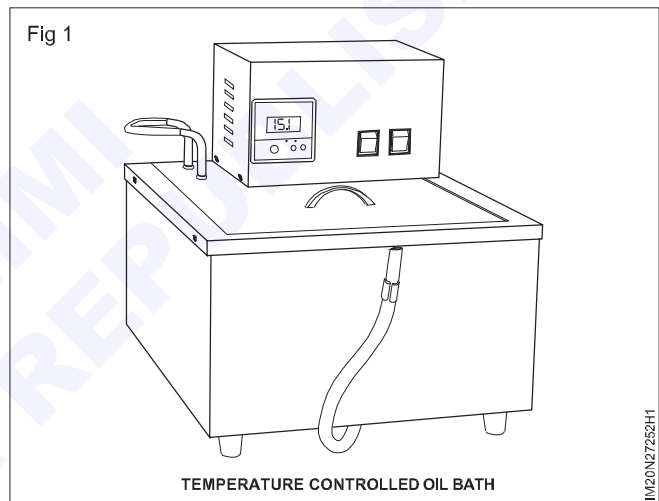
Objectives: At the end of this exercise you shall be able to

- study the construction, operation and use of temperature controlled oil bath / furnace for low and high temperature.

Requirements			
Tools/ instruments			
• Temperature controlled oil bath 0 -1200° C/ 230 VAC With temperature controller	- 1 No.	• Trainees tool kit	- 1 No.
• Oil bath - 5-300° C/ 1 litre 230	- 1 No.	Materials	
		• Cotton waste	- as reqd.

PROCEDURE

- Identify the parts of the temperature controlled oil bath.
- Check the ON - OFF condition of the heating coil.
- Vary the set point and conform the condition of the oil bath.
- Check the cooling fan of the control system works satisfactorily.



Instrument Mechanic - Measurement of Temperature - I

Dismantling identify different parts, its function, adjustment, assemble and operation of bimetallic and fluid filled (liquid, gas and vapour) system thermo meters & thermo switches

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

- dismantling, identify, different parts, assemble, install, test, service, and calibrate bimetallic thermometer
- dismantling, identify, different parts, assemble, install, test, service and calibrate mercury- filled glass thermometer
- dismantling, identify, different parts, assemble, install, test, service and calibrate vapour pressure thermometer
- dismantling, identify different parts, assemble, install, test, service and calibrate thermo switches.

Requirements			
Tools/ instruments			
• Trainees tool kit	- 1 No.	• Kettle 5 litres	-1 No.
• Bimetallic thermometer 0-250°C	- 1 No.	Materials	
• Mercury glass thermometer 0 -300°C	- 1 No.	• Ice cubes	- 1 kg
• Vapour pressure thermometer 0 -250°C	- 1 No.	• Water	- 5 litres.
• Thermo switches different type	-1 No each.	• Tank 5 lit	- 1 No.
• Temperature controlled oil bath -0° – 1200°C	- 1 No.	• Stop watch	- 1 No.

PROCEDURE

TASK 1: Dismantling , identify different parts, assemble, install, test, service and calibrate bimetallic thermometer

- 1 Clean the working table
- 2 Clean the given bimetallic thermometer and keep it on the table.
- 3 Note the room temperature from bimetallic thermometer.

The pointer in the thermometer should indicate room temperature initially otherwise faults occur in it

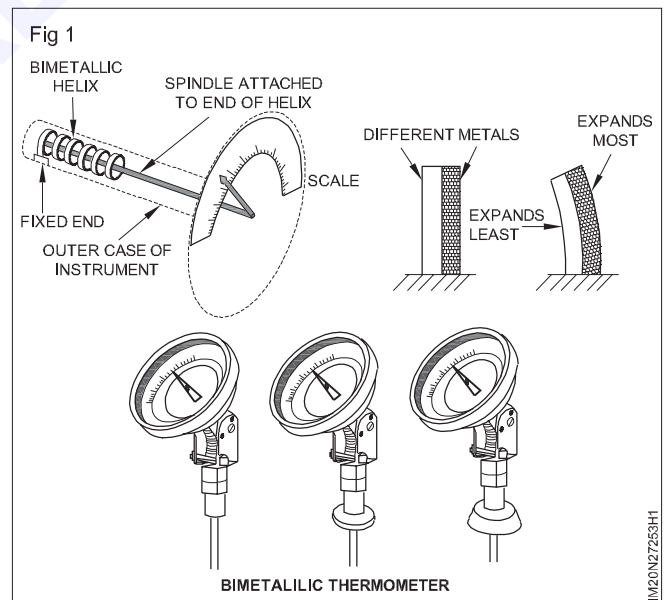
- 4 Note down the objects present on the thermometer by physical visual inspection.
- 5 Dismantle the bimetallic thermometer with the help of instructor using proper tools.

Instructor should insist the trainees to draw all the parts in log note

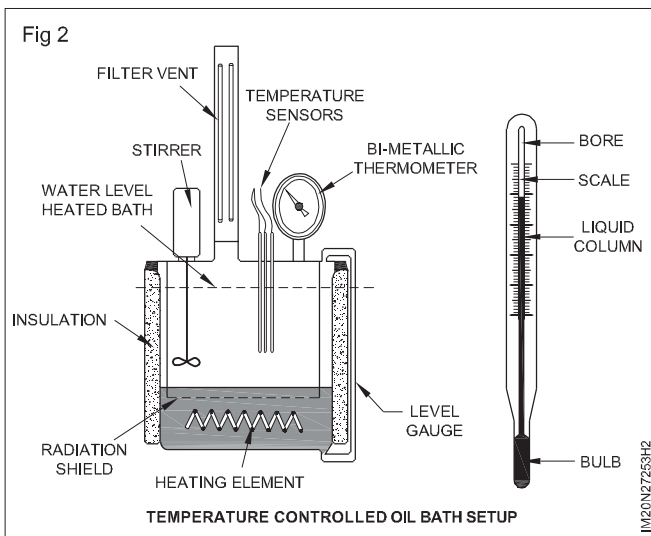
- 6 Replace the dejected parts in the thermometer with the help of instructor.
- 7 Reassemble the thermometer.

Don't install the thermometer in the temperature which is greater than its range.

- 8 Identify the parts of bimetallic thermometer.
- 9 Follow the points below to install the thermometer.



- Use the suitable spanner to fix the thermometer with the apparatus.
- Don't use the case to tight.
- Tight the thermo well first with the apparatus and then insert the thermometer in the thermo well .
- To protect the thermometer from corrosion, and damage thermo well must be used testing method



- 10 Switch ON the Temperature bath and check if the temperature is raised or not.
- 11 Note down the temperature (room) assembled thermometer and master thermo meter.
- 12 Insert the test thermometer and master thermometer into the furnace and simultaneously start the stopwatch.
- 13 Note down the readings in both the thermometer for every 2 minutes. Till it reaches 120° C
- 14 Record the readings in table 1 and calculate percentage error.
- 15 Do the calibration of thermometer if the readings are not within the accuracy.

Table 1

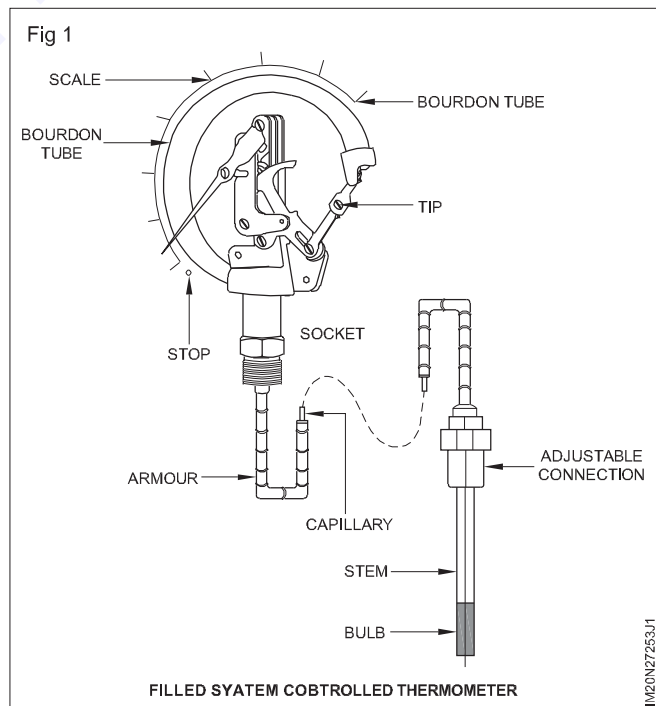
Time in minutes	Readings test bimetallic thermo meter in °C (A)		Reading of master thermo meter in °C(B)		% Error $\frac{(A - B)}{B} \times 100\%$	

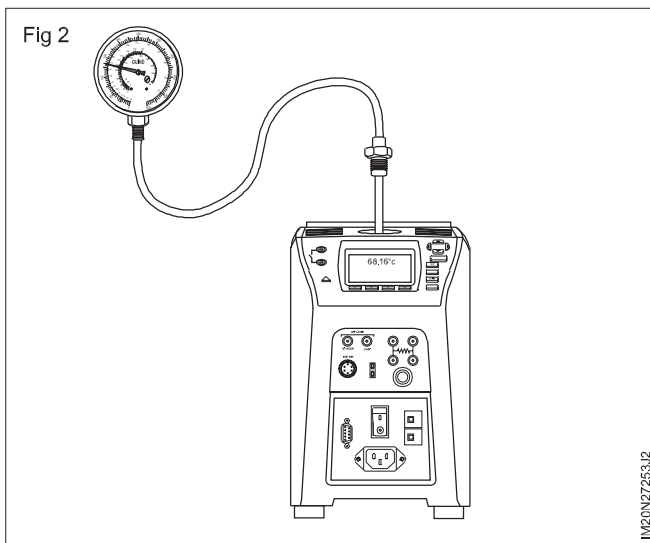
TASK 2 : Dismantling, Identify the parts, Install, test service and calibrate mercury filled glass thermometer

- 1 Clean the given mercury glass thermometer and keep it on the table.
- 2 Note down the room temperature in the thermo meter.
- 3 Note down the defects present on the thermometer by physical visual inspection.
- 4 Identify the parts of filled system thermometer.
- 5 Follow the points below to install the thermometer.
 - Install thermometer in vertical position and the bulb should be immersed fully in the medium.
 - Don't allow the mercury to freeze
 - Tap the thermometer bulb if the mercury is not elevated from it.
 - Hang the thermometer in hook while measurement.

Testing method

- Switch on the kettle and check it is or not.
- Fill water in the kettle .
- Give 230 V/AC supply to kettle





- Place the filled system thermometer in the temperature bath.
 - Take the bimetallic thermometer (master thermometer)
 - Note down the room temperature of both the thermometers
 - Insert the two thermometers into the kettle and simultaneously start the stopwatch
 - Note down the readings in both the thermometers for every 2 minutes till it reaches 100°C
- 6 Record the readings in table 2 and calculate percentage error.
 - 7 Do the calibration of thermometer if the readings are not within the accuracy.

Table 2

Time in minutes	Reading of filled system thermometer in °C (A)	Readings of bimetallic thermometer in °C (B)	% Error $\frac{(A - B)}{B} \times 100\%$

Instrument Mechanic - Measurement of Temperature - I

Install and test various types of thermo meters and switches

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

- understand various types of thermo meters
- understand various types of thermo switches.

Requirements		
Tools/ instruments		Materials
• Mercury filled thermometer	- 1 No.	• Cotton waste
• Thermal switch	- 1 No.	- as reqd.
• Oil bath	- 1 No.	
• Multi meter	- 1 No.	

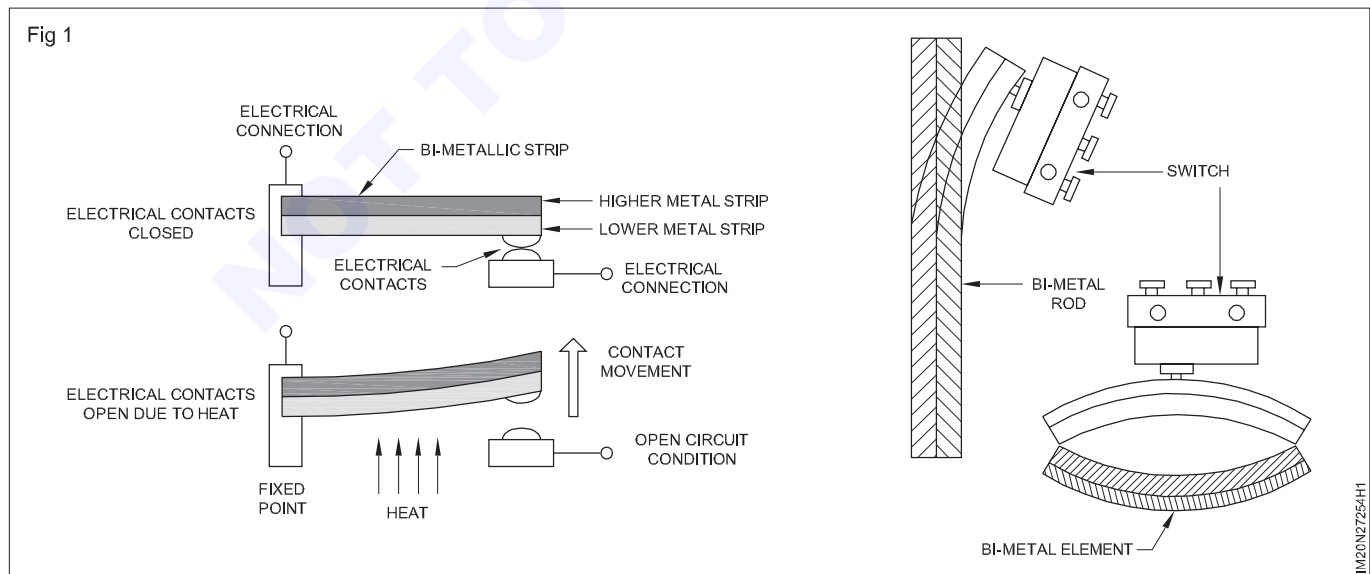
PROCEDURE

- 1 Clean the working table
- 2 Clean the given thermo switch and keep it on the table.
- 3 Note down the defects on thermo switch by physical visual inspection.
- 4 Dismantle thermo switch using proper tools with the help of instructor.

Note: Instructor should insist the trainees to draw the parts of thermo switch in log notebook.

- 5 Replace the dejected Parts and check with the instructor.
- 6 Reassemble the thermo switch.
- 7 Fill up the parts of thermo switch in the blacks as shown in Fig 1

- 8 Follow the points below to install thermo switch.
 - To protect from mechanical damage the equipment wiring is placed in the metal conduit during installation of thermo switch.
 - Install thermo switch where there is no vibration.
 - Select suitable thread/adoptor to fix thermo switch with the medium.
 - Use suitable spanner to fit thermo switch .
 - Seal all the joints with sealing compounds.
 - Use pressure relief/safety valve arrangement
- 9 Connect red, green bulb, and temperature switch as shown in Fig 2 and then insert the switch into the furnace/water bath

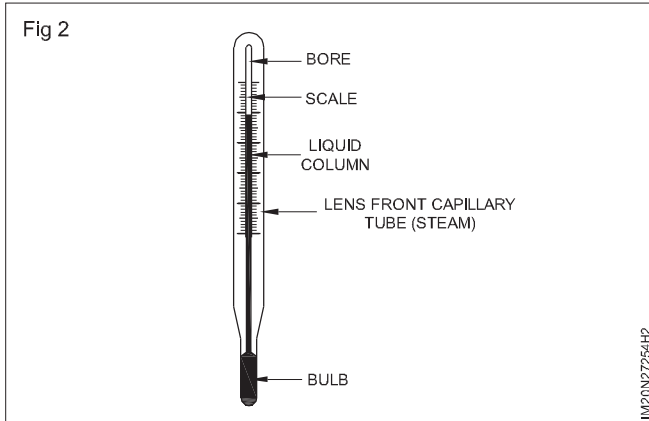


10 Connect 230V AC supply to bulbs.

11 Switch ON the furnace / water bath and AC supply

**Note: Red bulb is connected to NC Contact, when 230 V/AC supply is given Red bulb will glow.
When furnace reaches maximum set temperature NC Contact changed to NO so green bulb will glow.**

Precaution: Be careful when working in AC supply



12 Insert thermo switch in the furnace/water bath and do calibration.

13 Adjust the knob and set 60°C in thermo switch

14 Fill 3/4th of water in the kettle

15 Insert thermo switch and bimetallic thermometer into the kettle

16 Connect bulb to NO contact of thermo switch and give 230 V AC supply to bulb

Generally, bulb connected to NO contact of thermo switch so the bulb will not glow

17 Switch ON the kettle.

18 Observe that when maximum temperature set point is reached the NO contact of thermo switch is changed to NC contact and bulb glow condition.

19 Switch off the kettle and observe the temperature readings in bimetallic thermometer.

20 Observe that when minimum temperature set point is reached the NC contact of thermo switch is changed to NO contact and bulb off condition

21 Do the calibration procedure 4 or 5 times

22 Check the work done by the instructor.

Instrument Mechanic - Measurement of Temperature - I

Service and calibrate various types of thermo meters and switches

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

- servicing of thermo meters/switches
- calibration of thermo meters/switches.

Requirements		
Tools/ instruments		Materials:
<ul style="list-style-type: none"> • Mercury filled thermometer • Thermal switch • Oil bath • Multimeter 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Cotton waste <p>- as reqd.</p>

PROCEDURE

- 1 Clean the working table
- 2 Clean the given thermo switch and keep it on the table.
- 3 Note down the defects on thermo switch by physical visual inspection.
- 4 Dismantle thermo switch using proper tools with the help of instructor.

Note: Red bulb is connected to NC Contact, when 230 V/AC supply is given Red bulb will glow.

When furnace reaches maximum set temperature NC Contact changed to NO so green bulb will glow.

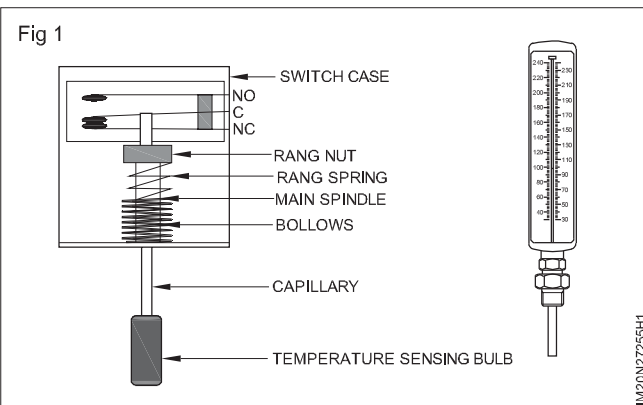
Precaution: Be careful when working in AC supply

Note: Instructor should insist the trainees to draw the parts of thermo switch in log notebook.

- 5 Replace the dejected Parts and check with the instructor.
- 6 Reassemble the thermo switch.
- 7 Fill up the parts of thermo switch in the blacks as shown in Fig 1
- 8 Follow the points below to install thermo switch.
 - To protect from mechanical damage the equipment wiring is placed in the metal conduit during installation of thermo switch.
 - Install thermo switch where there is no vibration.
 - Select suitable thread/adoptor to fix thermo switch with the medium.
 - Use suitable spanner to fit thermo switch .
 - Seal all the joints with sealing compounds.
 - Use pressure relief/safety valve arrangement
- 9 Connect red, green bulb, and temperature switch and then insert the switch into the furnace/water bath
- 10 Connect 230V AC supply to bulbs.
- 11 Switch ON th furnace / water bath and AC supply

- 12 Insert thermo switch in the furnace/water bath and do calibration.
- 13 Adjust the knob and set 60°C in thermo switch
- 14 Fill 3/4th of water in the kettle
- 15 Insert thermo switch and bimetallic thermometer into the kettle
- 16 Connect bulb to NO contact of thermo switch and give 230 V AC supply to bulb

Generally bulb connected to No contact of thermo switch so the bulb will not glow



- 17 Switch ON the kettle.
- 18 Observe that when maximum temperature set point is reached the NO contact of thermo switch is changed to NC contact and bulb glow condition.
- 19 Switch off the kettle and observe the temperature readings in bimetallic thermometer.
- 20 Observe that when minimum temperature set point is reached the NC contact of thermo switch is changed to NO contact and bulb off condition
- 21 Do the calibration procedure 4 or 5 times
- 22 Check the work done by the instructor.

Table Calibration of thermometer

S. No.	Temperature True value (in°C)	Actual Value (in°C)	Error (° C)	Error(%)
1				
2				
3				

- - - - -

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Instrument Mechanic - Measurement of Temperature - II

Verify the characteristics of different types of RTD's and thermistors

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

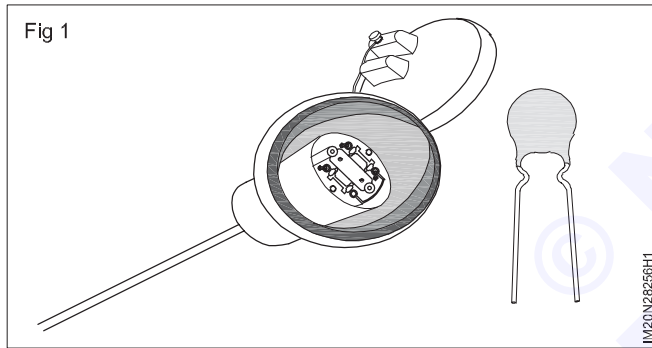
- verify the characteristics of different types of RTD'S and thermistors.

Requirements			
Tools/ instruments			
• Temperature controlled oil bath- (0-1200°C) Different types of RTD (120°C)	- 1 No each.	• Screw driver 150mm	- 1 No.
• Signal conditioner for RTD and thermistor	- 1 No.	• Multi meter with probe	- 1 No.
• Thermistor (90°C)	- 1 No.	Materials	
		• Insulation tape	- 1 No.
		• Mammal cloth	- as reqd.

PROCEDURE

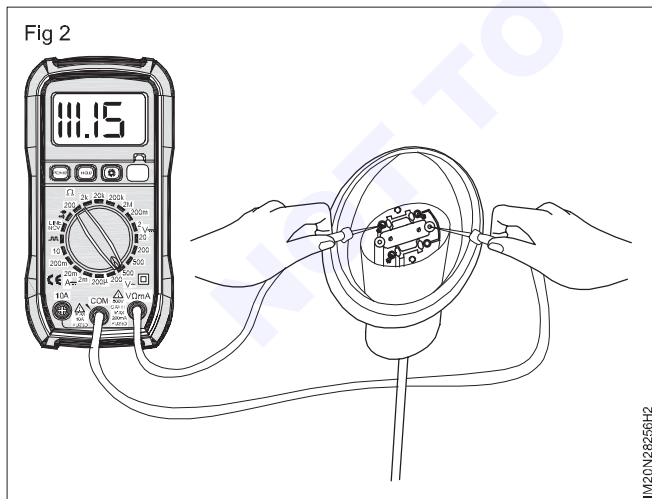
TASK 1 : Verify the characteristics of different type of RTD'S and thermistor

1 Fig 1 illustrates (RTD)- Resistance Temperature Detector and thermistor.



2 Check the continuity of RTD using multi meter.

3 Connect RTD and ohm meter as shown in Fig 2



Note : observe the resistance in the ohm meter

- 4 Give 230 V AC supply to furnace
- 5 Note the temperature of the furnace in the –temperature indicator

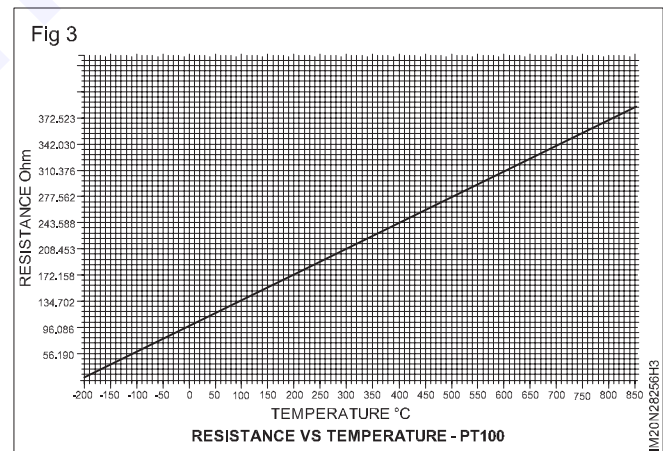
6 Insert RTD into the furnace

7 Note down the readings of ohm meter for every 10°C raise in the furnace tiel 120°C

8 Record the readings in table 1

9 Do the above procedure for different types of RTD libe copper RTD, platinum RTD, available in the laboratory.

10 Draw graph between temperature in X axis and resistance in Y axis as shown in Fig 3.



11 Observe the characteristics of RTD from the graph

12 Check the work done by the instructor

13 Check the continuity of different types of thermistor like NTC –negative temperature Coefficient and PTC – positive temperature coefficient using multi meter

14 Connect PTC thermistor with ohm meter as shown in Fig 3.

15 Give 230 VAC supply to Furnace. Note down the room temperature in furnace using temperature indicator.

16 Insert the thermistor into the furnace

17 Note down the readings of ohm meter for every 10°C raise in furnace till 90°C

18 Record the readings in table 2 .

19 Draw graph between temperature and resistance.

20 Observe the characteristics of thermistor from the graph.

21 Do the above procedure for PTC thermistor and record the readings in table

22 Check the work done by the instructor.

Table 1

Temp in °C	Resistance of copper RTD in Ω	Resistance of platinum RTD in Ω	Resistance of Nickel RTD in Ω
Room temperature 120°C			

Table 2

Temperature in °C	Resistance of PTC in Ω	Resistance of NTC in Ω

Instrument Mechanic - Measurement of Temperature - II

Study circuit operation of signal conditioner for RTD's and Thermistors

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

- study the circuit operation of signal conditioner for RTD
- study the circuit operation of signal conditioner for thermistor.

Requirements

Tools/ instruments

- Temperature controlled oil bath-(0-1200°C) Different types of RTD (120°C) - 1 No each.
- Signal conditioner for RTD and thermistor - 1 No.
- Thermistor (90°C) - 1 No.

- Screw driver 150mm - 1 No.
- Multi meter with probe - 1 No.

Materials

- Insulation tape - 1 No.
- Mammal cloth - as reqd.

PROCEDURE

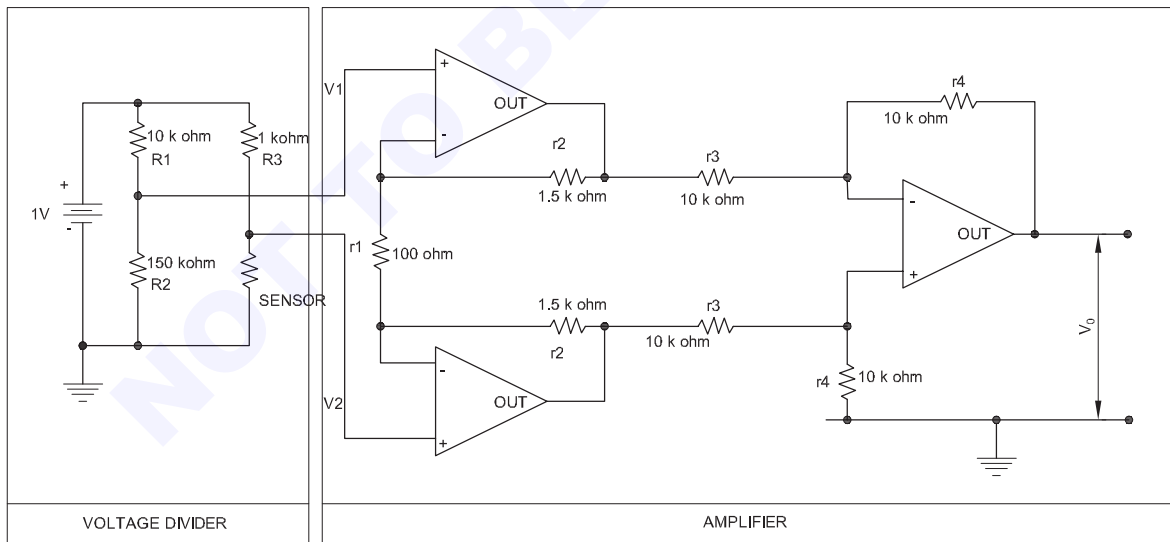
Identify the components of signal conditioner circuit, write its name and functions in the table

Write the component name and explain its function

- Instrumentation amplifier
- Op-amplifier

Sl.No.	Circuit of signal conditioner	Write the name of signal conditioner circuit

Fig 1



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Instrument Mechanic - Measurement of Temperature - II

Install and test various types of two and three wire RTD transmitters

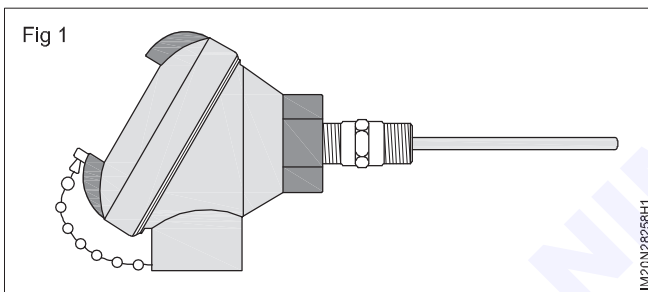
Objectives: At the end of this exercise you shall be able to

- installation of RTD and transmitter
- testing of 2 wire and 3 wire transmitter.

Requirements			
Tools/ instruments		Materials	
• 2 wire RTD	- 1 No.	• Resistance	- as reqd.
• 3 wire RTD	- 1 No.	• Connecting wires	- as reqd.
• Temperature Transmitter	- 1 No.	• Cleaning cloth	- as reqd.
• Temperature oil bath	- 1 No.		
• Multimeter	- 1 No.		

PROCEDURE

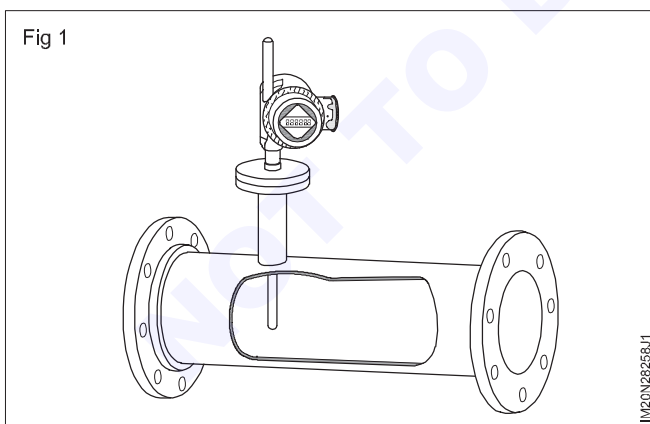
RTD with thermo well and Temperature transmitter is as illustrated below.



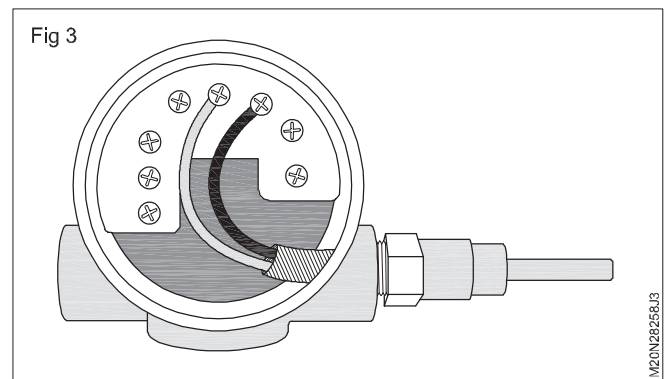
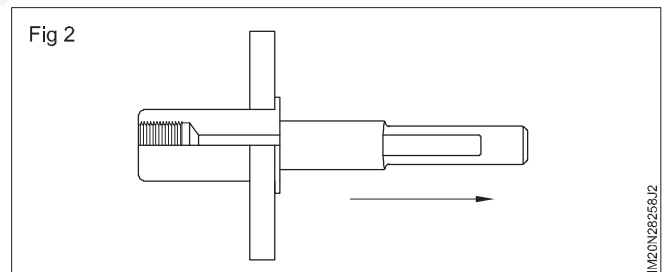
TASK 1: Installation of RTD and Transmitter

1 Thermowell installation

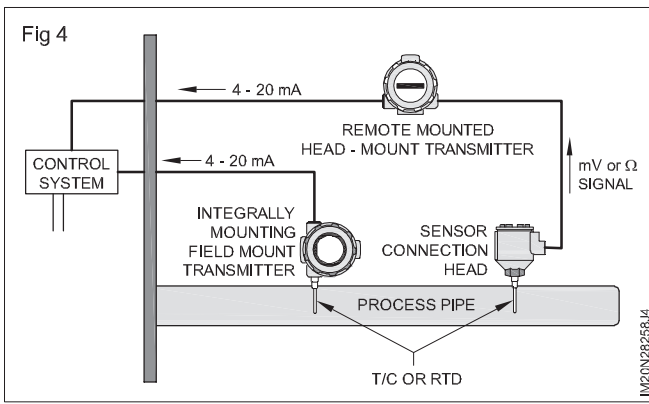
- Locate the point of penetration as in Fig 1
- Verify insertion length of RTD



- Install sensor of RTD in the thermowell as in Fig 2
- Connect the sensor wires to the terminal block of in Fig 3

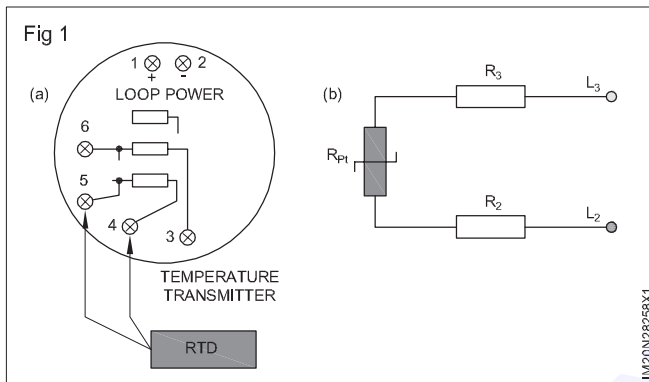


- Install transmitter in head mount as in Fig 4



TASK 2 : Testing of 2 wire RTD transmitter

- 1 Connect 2 wire RTD with temperature transmitter as shown in Fig 1



- 2 Calculate the resistance of RTD using the formula Fig 2

Formula of 2 wire RTD

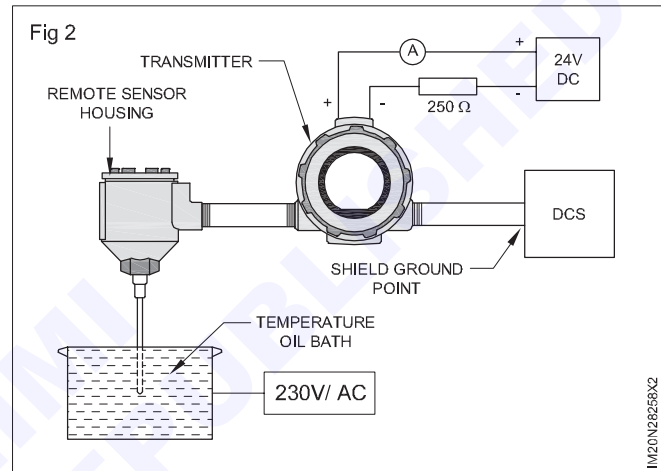
$$R_{Pt100} = R_{Pt} + R_2 + R_3$$

- R_{Pt} is Resistance of RTD
- R_2 is Resistance of first lead wire (Extension cable used to connect RTD)
- R_3 is Resistance of second lead wire (Extension cable used to connect RTD)

L2 & L3 are extension cable leads

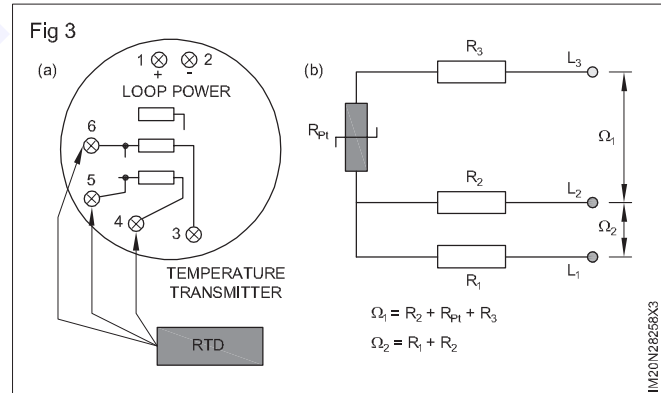
Note: the wire resistances R_2 and R_3 are included in the measured value. Wire resistance can be cancelled by calibration, but just at one specific temperature of the wire (often room temperature.)

- 3 Insert the 2 wire RTD in the temperature oil bath as shown in Fig 2
- 4 Note down the corresponding output in temperature transmitter.
- 5 Check the work done by the instructor.



Testing of 3 wire RTD transmitter

- 6 Connect 3 wire RTD Temperature transmitter as shown in Fig 3



- 7 Calculate the resistance of RTD using the formula

Formula of 3 wire RTD

$$\Omega_1 = R_2 + R_{Pt} + R_3$$

$$\Omega_2 = R_1 + R_2$$

$$\Omega_1 - \Omega_2 = R_{Pt100} = R_{Pt} + R_3 - R_1$$

- R_{Pt} is Resistance of RTD
- R_1 is Resistance of first lead wire (Extension cable used to connect RTD)

- R_2 is Resistance of second lead wire (Extension cable used to connect RTD)
- R_3 is Resistance of third lead wire (Extension cable used to connect RTD)

$L_1, L_2,$ & L_3 are extension cable leads

Ω_1 is the total resistance between lead wires L_2 & L_3

Ω_2 is the total resistance between lead wires L_1 & L_2

Note: If and only if the wire resistances R_1 and R_3 are equal you measure the true Pt_{100} resistances keep all the wire resistances $R_1, R_2,$ and R_3 equal.

- 8 Insert the 3 – wire RTD in the Temperature oil bath as shown in Fig 3.
- 9 Note down the corresponding output in the temperature transmitter
- 10 Check the work done by the instructor.

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Instrument Mechanic - Measurement of Temperature - II

Service and calibrate various types of RTD transmitters using temperature calibrator or resistors

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

- service various types of RTD transmitters
- calibrate various types RTD transmitters using resistors.

Requirements			
Tools/ instruments			
• PT 100 Ω RTD	- 1 No.	• 5 Dial resistance decade box	- 1 No.
• Copper RTD	- 1 No.		
• Multi meter with probe	- 1 No.		
• Temperature transmitter	- 1 No.	Materials	
• Screw driver 150mm	- 1 No.	• Cleaning cloth	- as reqd.
• Digital voltmeter	- 1 No.	• White petrol	- as reqd.
• 24 V DC Power source	- 1 No.	• Wires	- as reqd.

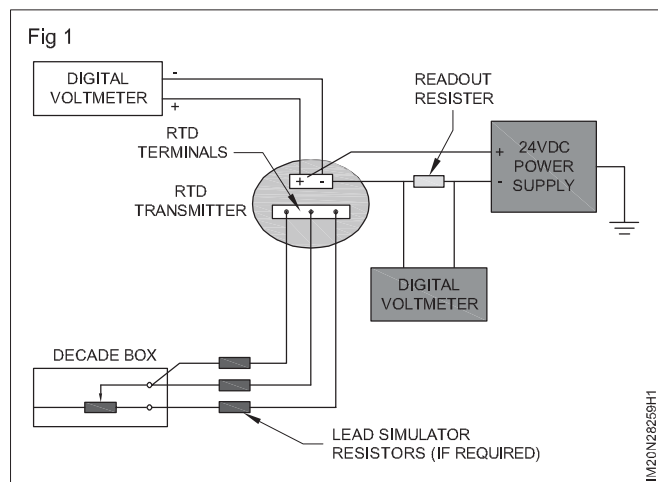
PROCEDURE

TASK 1: Service various types of RTD transmitter

- 1 Check negative and positive leads are correct.
- 2 Check correct type of cable.
- 3 Check for local heat sources affecting readings.
- 4 Check setup of temperature controller/readout.
- 5 Resolve out of range errors
- 6 Resolve sensor break /open circuit errors
- 7 Physically inspect sensor for damage
- 8 Check temperature transmitter
- 9 Test faulty resistance temperature detector with a multi meter.
- 10 Check the work done by the instructor.

TASK 2 : Calibrate various types of RTD transmitter using resistor

- 1 Locate the RTD transmitter terminal by removing the housing cover. (Fig 1)
- 2 Remove all the RTD lead connection if RTD is already connected
- 3 Determine the RTD resistance at base (0°) and full scale temperatures
- 4 Turn the power supply ON .
- 5 Set the resistance decade box to the resistance that corresponds to the base temperature
- 6 Adjust the zero pot (potentiometer) of transmitter until the output is 4 mA
- 7 Set the resistance decade box to the resistance that corresponds to the full scale temperature
- 8 Adjust the span pot (potentiometer) of transmitter until the output is 20 mA
- 9 Repeat the above steps until 4 mA and 20mA reading are obtained without read just span and zero potentiometers.



Instrument Mechanic - Measurement of Temperature - II

Verify the characteristics of different types of thermo couples

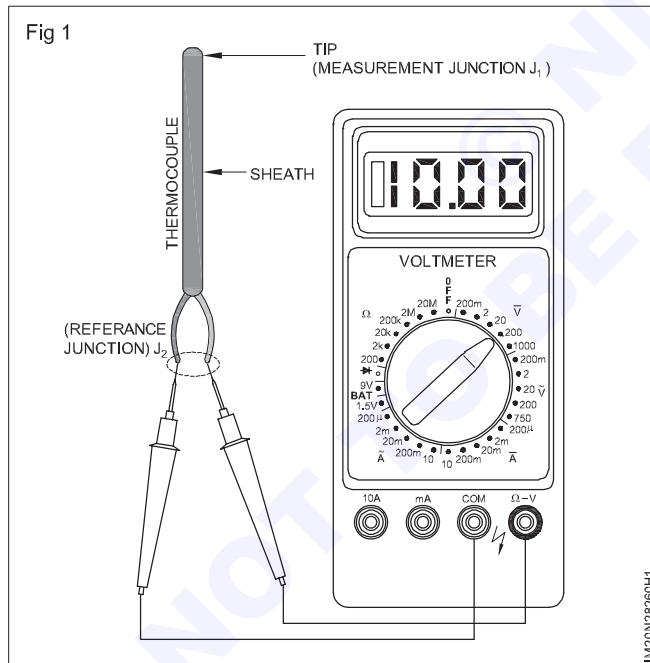
Objectives: At the end of this exercise you shall be able to
 • verify the characteristics of different thermo couples.

Requirements		
Tools/ instruments		Materials
<ul style="list-style-type: none"> Thermocouple (J&K, S&T Type) - 1 No each. Bimetallic thermometer (0-100°C) - 1 No. Kettle 5 litre - 1 No. Temperature transmitter - 1 No. Muffle furnace with temperature indicator - 1 No. 		<ul style="list-style-type: none"> Connecting wires - as reqd. Stop watch - 1 No.

PROCEDURE

TASK 1: Verify the characteristics of different type of thermocouple

- 1 Take different type of thermocouple and keep it on the working table
- 2 Note the material of thermocouple in log note
- 3 Connect thermocouple and milli voltmeter as shown in Fig 1 and check with the instructor.
- 4 Insert J type thermocouple into the furnace
- 5 Observe the 'zero' reading of millivoltmeter
- 6 Switch ON the temperature bath and note the room temperature
- 7 Note the readings of milli voltmeter for every 10°C rise in furnace till 120°C
- 8 Record the readings of milli voltmeter in table 1
- 9 Draw graph between temperature in x axis and millivolts in Y axis
- 10 Observe the characteristics of 'J' type thermocouple in the graph.
- 11 Do the above procedure for different thermocouple (K,T,&S) available in laboratory and observe the characteristics in the graph.



- 4 Insert J type thermocouple into the furnace
- 5 Observe the 'zero' reading of millivoltmeter

J – type thermocouple is made of Iron and constantan

- 6 Switch ON the temperature bath and note the room temperature

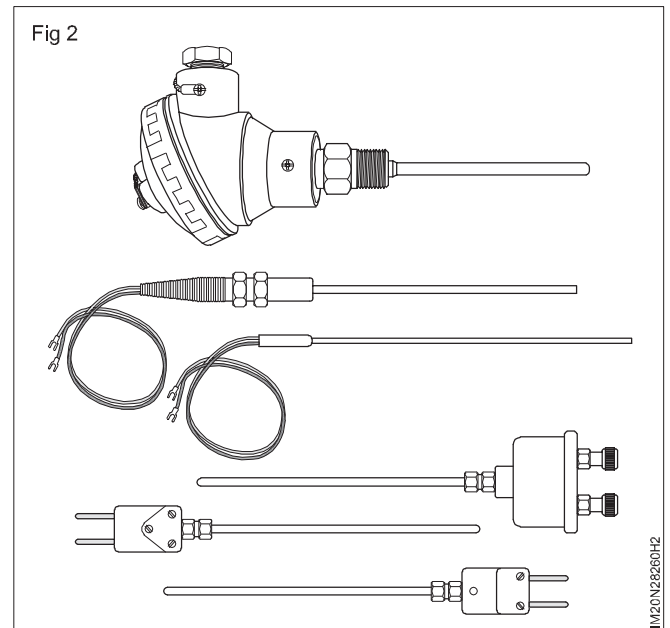


Fig 3

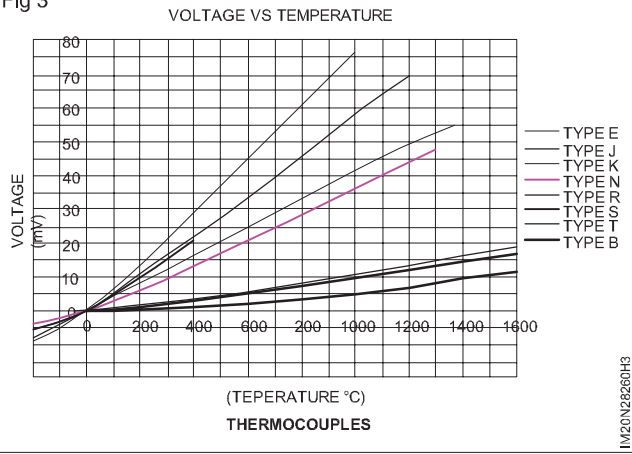


Table 1

SI. No.	Name of components	Function

Instrument Mechanic - Measurement of Temperature - II

Study circuit operation of signal conditioner for thermocouples based indicator and transmitters

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

- study the operation of signal conditioner for thermocouple based indicator and transmitter.

Requirements			
Tools/ instruments		Materials	
• Thermocouple (J&K, S&T Type)	- 1 No each.	• Connecting wires	- as reqd.
• Bimetallic thermometer (0-100°C)	- 1 No.	• Stop watch	- 1 No.
• Kettle 5 litre	- 1 No.		
• Temperature transmitter	- 1 No.		
• Muffle furnace with temperature indicator	- 1 No.		

PROCEDURE

- 1 Write the names of the components used in the circuit, study the operation and record in table 1.
- 2 Check the work done by the instructor.

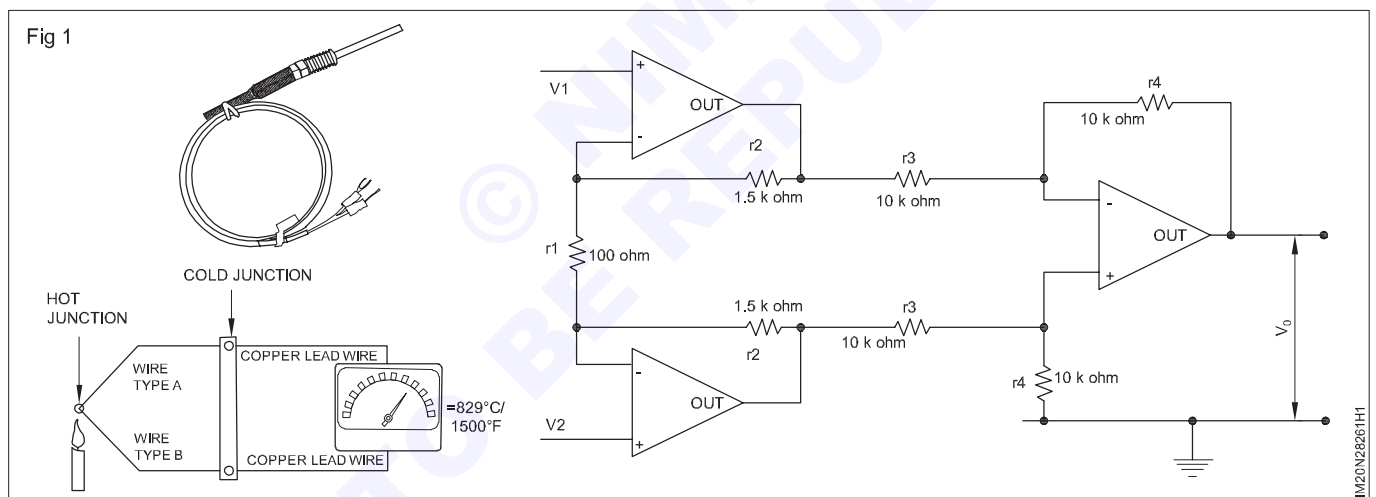


Table 1

Temperature in °C	'J' type thermo meter output in mv	'K' type thermo couple output in mv	'T' type thermo couple output in mv	'S' type thermo couple output in mv

Instrument Mechanic - Measurement of Temperature - II

Install and test various types of thermo couples based indicator and transmitters

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

- install and test different type of thermocouples
- install and test various types of transmitter.

Requirements		
Tools/ instruments		
<ul style="list-style-type: none"> • Different types of thermocouple (J,K,T,S Type) (available in your lab) -1 No each. • Transmitter(temperature) - 1 No. • Trainee tool kit - 1 No. • Temperature trainer/simulator - 1 No. • Milli voltmeter 0- 50 mv - 2 Nos. 	<ul style="list-style-type: none"> • Muffle furnace 0-1200°C - 1 No. • Resistance thermometer - 1 No. 	
Materials		
<ul style="list-style-type: none"> • Mammal cloth - as reqd. • Compensating leads or copper - as reqd. 		

PROCEDURE

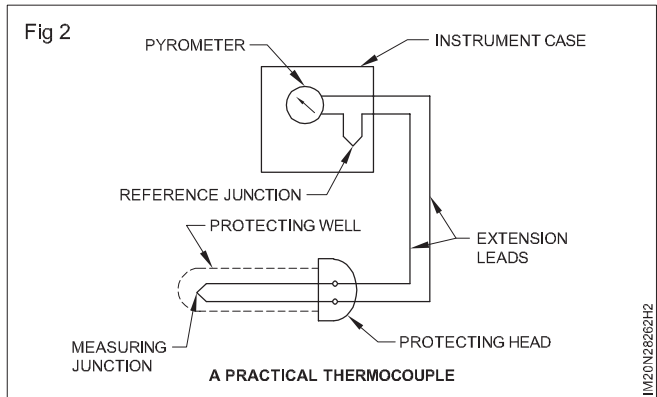
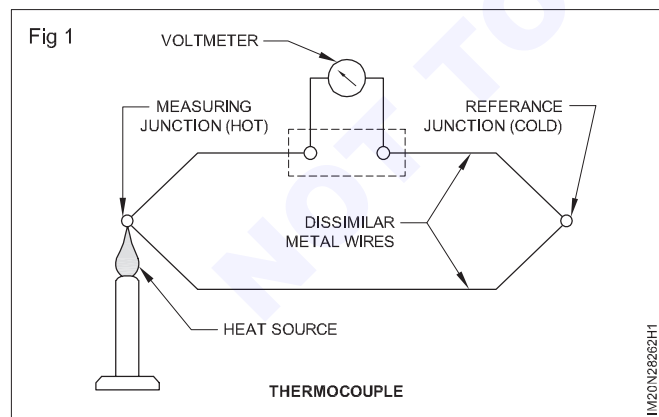
TASK 1: Identify , install and test, service and calibrate different types of thermocouple

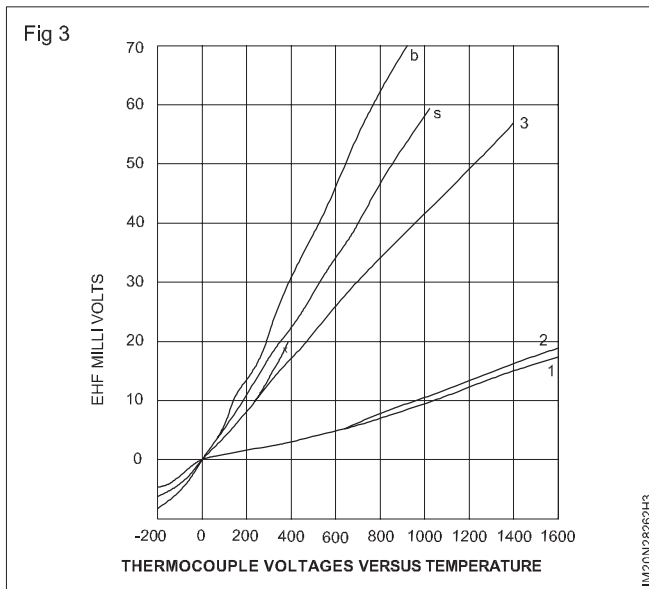
- Identify the thermocouple type using manufacturers plate.
- Keep thermocouple prove check from contamination prior to installation
- Avoid excessive bend to lead wire.
- Insure proper element in installed in proper location/ environment
- Insert the thermocouple into the thermowell.
- Thermocouple wire of the same type as the sensor must be used to hook the thermocouple
- Install the thermocouple and extension wire at least one tool away from AC power liner for best results.

Do not nun thermocouple wires in conduit with other wires.

- Testing to thermocouple
- Connect 'J' type thermocouple in millivoltmeter.
- Insert thermocouple in temperature both
- Set me temperature in the temperature bath
- Note down millivotes reading for every raise in 20°C temperature.
- Record the reading in Tabe 1.

SI.No	Temp °C	Volts m° mv
1	20° C	
2	40°C	
3	60°C	





TASK 2: Identify the Thermocouples

- Take the different types of thermocouples
- Identify each thermocouples by the marks made by the manufacturer.

The thickness or the length does not make the effectiveness of thermocouple

- Connect the thermocouple.

Instrument Mechanic - Measurement of Temperature - II

Service and calibrate various types of thermo couples and transmitters using temperature calibrator or milli volt source

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

- service and calibrate various types of thermo couples and transmitters.

Requirements		
Tools/ instruments		
• Different types of thermocouple (J,K,T,S Type) (available in your lab)	- 1 No each.	
• Transmitter(temperature)	- 1 No.	
• Trainee tool kit	- 1 No.	
• Temperature trainer/simulator	- 1 No.	
• Milli voltmeter 0- 50 mv	- 2 Nos.	
		• Muffle furnace 0-1200°C - 1 No.
		• Resistance thermometer - 1 No.
Materials		
		• Mull cloth - as reqd.
		• Compensating leads or copper - as reqd.

PROCEDURE

Servicing of thermocouple

- Take any one type ('J' or k type)
- Type thermocouple and keep it on working table.
- Clean me thermocouple with mullmull cloth.
- Open the top cover using proper screw driver.
- Take thermocouple leads from thermowell.
- Weld thermocouple leads tip if joints broken.

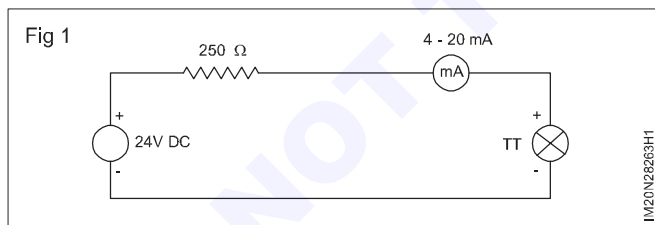
Periodically check me thermowell surface and the sensor sheath for corrosion or damages.

- Replace thermowell if damage occurred in thermowell

If we change the proving of thermo lead liner temperature measurement will be wrong

- Connect lead liner with proper polarity.

Surrounding temperature of reference junction changes it will affect the thermocouple reading



Calibration of thermocouple

- Connect 'K' type thermocouple with standard thermocouple 'S' type as shown in Fig 1 and check with instructor.
- Insert born thermocouple in the temperature bath.
- Thermo couple wires from furnace is closed and the tips are opened.
- Mean m junction temperature using resistance thermometer.
- Connect millivoltmeters to the other side of the thermocouple.
- Switch ON the temperature bath.
- Take the output of two multi voltmeter readings and record in table 1.
- Thermo couple error Δt

$$\Delta t = t - t_1 \text{ } ^\circ\text{C}$$

t = standard thermocouple temperature (S type)

t_1 = thermocouple to be calibrated K type

$$\Delta E_{mv} = E_t - E_{t_1}$$

E_t = standard thermocouple output emf reading (mv)

E_{t_1} = thermocouple to be calibrated emf output reading (mv)

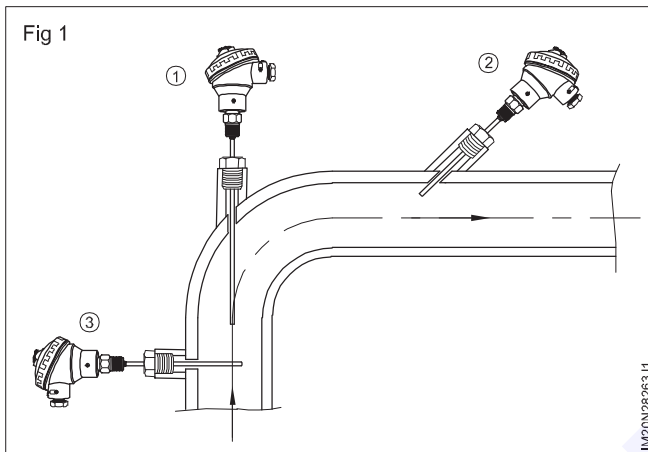
Table 1

Sl.No.	Standard Thermo couple		Calibrated thermo couple		Error	
	Temp $m^\circ\text{C}$ $t^\circ\text{C}$	Emf E_t mv	Temp $t_1^\circ\text{C}$	Emf mv E_{t_1}	$\Delta t = t - t_1$	$\Delta E = E_t - E_{t_1}$

TASK 2 : Install, test, calibrate temperature transmitter

Part - 1

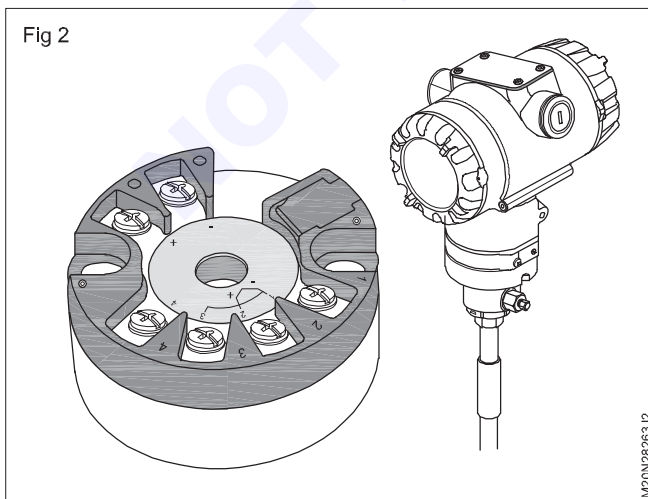
- 1 To reduce electrical noise and sensor resistance are proper electrical installation.
- 2 Make sure that the dimension of the thermo well (length, diameter, wall thickness, of the tip) comply with the requirements of measure point. In addition, in correct dimension can lead no measurement errors.
- 3 Installation side and length are three parameters that depend upon the space available and the diameter of the pipe



- 4 A well insulate pipe line or tanx around the measuring point reduces the heat transfer and the distorting influence no the ambient temperature.
- 5 In case of removing the insert make sure to remove it slow by avoid thermal shock due to the sudden variation of temperature specially for material line ceramic.
- 6 To avoid measurement errors caured by poor heat transfer the measuring insert must always be in contact with bottom of the thermowell.

Part 2 - Testing of temperature transmitter

- 1 Insert thermocouple in the temperature



- 2 Connect thermocouple output to transmitter.
- 3 Give 24DC supply to transmitter.
- 4 Switch ON furnace.
- 5 Note the output of thermo couple transmitter and record it.
- 6 Check the work with instructor.

Part 3 - Servicing to transmitter

- 1 Dismantle transmitted from process line.
- 2 Remove thermocouple /R7D connections using screw driver.
- 3 Clean the transmitter using soft cloth.
- 4 Remove transmitter outer corner.
- 5 Note the physical defects and recite them with the help; of instructo r.
- 6 Check the screws and springs and transmitter sensor wire.

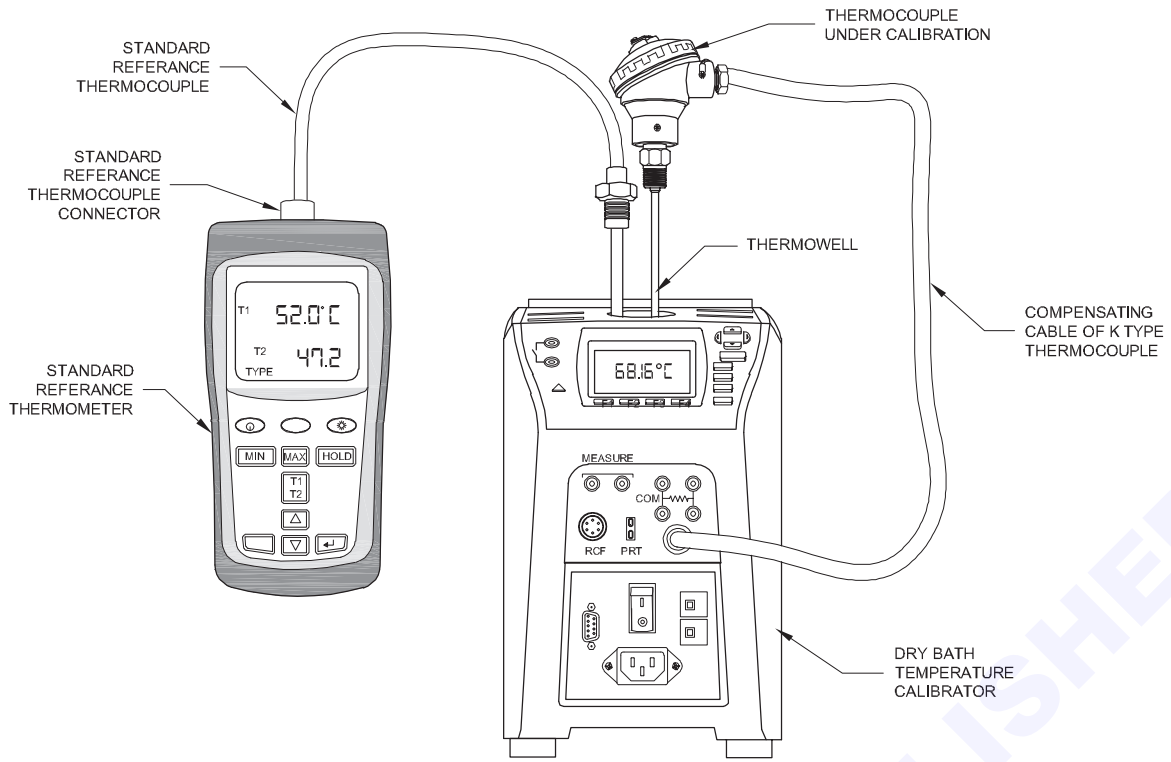
Handle transmitter carefully and safely while measuring high temperature.

- 7 Check the cable connections of transmitter.
- 8 Keep the transmitter away from dust. And handle safely

Calibrate temperature transmitter

- 1 Connect thermocouple and transmitter and check with instructor.
- 2 Remove the thermocouple transmitter terminal houring conner.
- 3 Remove the thermocouple leas connection.
- 4 Determine base and full scale temperature.
- 5 Switch ON, power supply
- 6 Use thermo couple circle to set thermocouple in trainer simulator.
- 7 Using the thermocouple simulator manual for simulation to set the thermocouples type.
- 8 Set the simulator to the (bare zero) temperature and adjust the zero pot until the output in 4ma or 40mv at the test terminals.
- 9 Set the simulator to the full scale temperature and adjust one span pot until the output is 20 mA.
- 10 Repeat the steps (2 to 9) above until both the 4 and 20 mA reading are obtained without adjusting the span and zero pots

Fig 3



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Instrument Mechanic - Measurement of Temperature - II

Measure high temperature using optical and radiation pyrometer

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

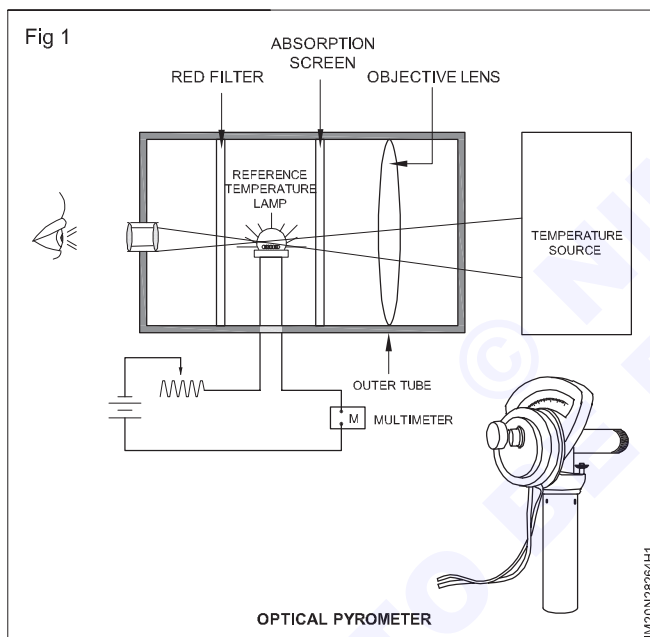
- measure high temperature using optical pyrometer
- measure high temperature using radiation pyrometer.

Requirements			
Tools/ instruments		Materials	
• Optical pyrometer 3000°C	-1 No.	• Cleaning liquid	- as reqd.
• Radiation pyrometer 2000°C	-1 No.	• Tissue paper	- as reqd.
• Muffle furnace 3000°C	-1 No.	• Mammal cloth	- as reqd.

PROCEDURE

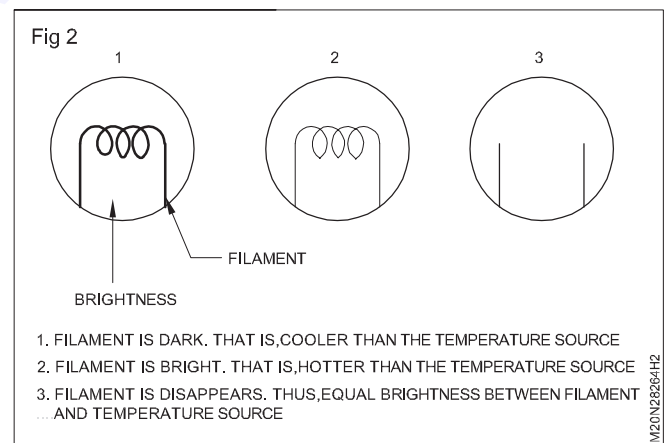
TASK 1: Measure high temperature using optical pyrometer

1 Clean the working table.



- 6 Connect the furnace, set the temperature and switch ON
- 7 Keep a hot object inside the furnace and allow it to get red hot.
- 8 Focus the optical pyrometer and adjust the rheostat until the filament of the instrument disappears as shown in Fig 2 .
- 9 Not the reading and repeat the same for two or three times.
- 10 Check the work done by the instructor

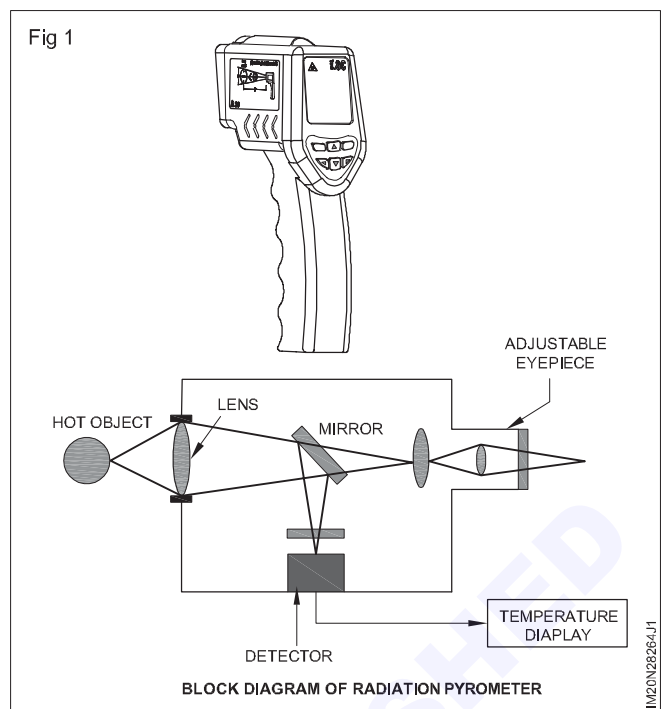
- 2 Take the optical pyrometer and clean the instrument with linen cloth
- 3 Clean the lens with tissue paper
- 4 Check the optical system and focus adjustments
- 5 Check the rheostat adjustment and see the lamp brightness and meter reading.



TASK 2 : Measure high temperature using radiation pyrometer

- 1 Take the radiation pyrometer and clean the instrument with mammal cloth as shown in Fig 1
- 2 Clean the lens with tissue paper.
- 3 Check the focus adjustments in the pyrometer.
- 4 Connect the furnace with 230 V AC supply
- 5 Set the temperature in furnace and switch ON
- 6 Keep a object (high temperature) in the furnace.

- 7 Fig 1 illustrates that the blackened disc in the pyrometer absorbs the radiation coming from the hot body which is focused on the thermopile.
- 8 Note down the readings of hot body temperature on the pyrometer
- 9 Repeat the same for two or three times
- 10 Check the work done by the instructor.



Instrument Mechanic - Measurement of Temperature - II

Measure the relative humidity using humidity sensors

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

- measure humidity using hair & hygrometer
- measure humidity using wet and dry bulb thermometer.

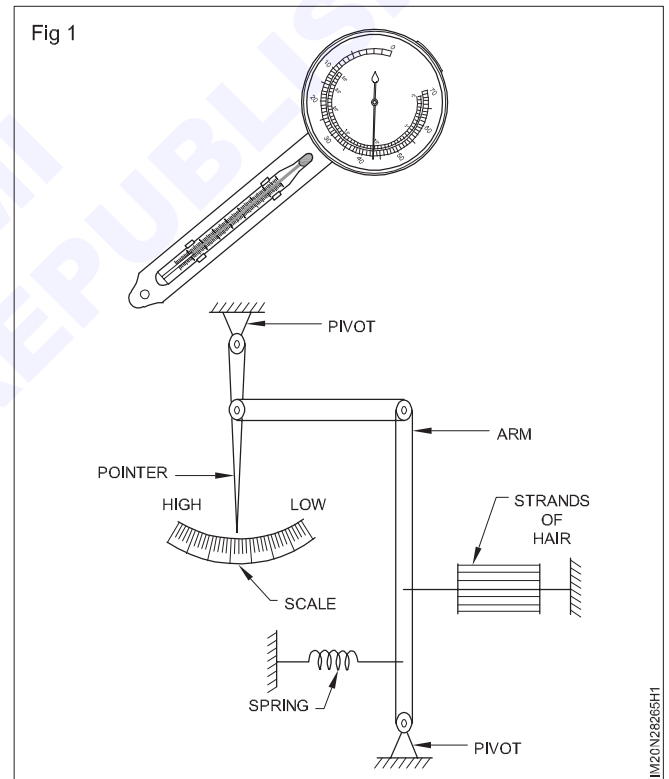
Requirements			
Tools/ instruments		Materials	
• Hair hygrometer	- 1 No.	• Mammal cloth	- as reqd.
• Hair dryer	- 1 No.		
• Wet and dry bulb thermometer	- 1 Set.		

PROCEDURE

TASK 1: Measure humidity using hair hygrometer

- 1 Take and clean the dial type hair hygrometer as shown in Fig 1.
- 2 Blow air through the mouth and note the readings on the hygrometer.
- 3 Observe the changes in humidity.
- 4 Blow air through the hair dryer and note the readings
- 5 Keep the hygrometer in cold place and note the readings.
- 6 Record all the readings.

Hygrometer is a very sensitive handle with care.

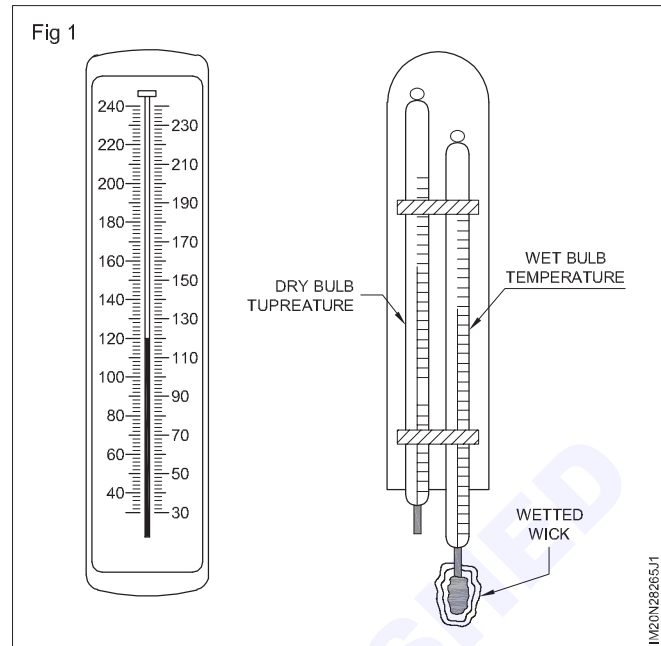


TASK 2: Measure humidity using wet and bulb thermometer

- 1 Fill clean water in the glass bowl
- 2 Tie the muslin sleeve at the bulb of wet thermometer. (Fig 1)
- 3 Keep the wet bulb thermometer with muslin sleeve in glass bowl.
- 4 Note down the readings of both thermometer
- 5 Calculate the difference in readings of both wet and dry bulb thermometer
- 6 Refer instruction manual and note the humidity readings
- 7 Do the same procedure by blow air through hair dryer and note down the readings.

- **Handle the thermometer with care.**
- **Avoid parallax error**

- 8 Check the work done by the instructor.



Instrument Mechanic - Measurement of Temperature - II

Measure the various points like motor, drilling point, hill person temperature etc using thermal imager

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

- measure the various points line motor, drilling point, and hill person temperature using thermal Imager.

Requirements			
Tools/ instruments		Materials	
• Thermal imager	- 1 No.	• Liquid soap	- as reqd.
• Motor	- 1 No.		
• Drilling	- 1 No.		

PROCEDURE

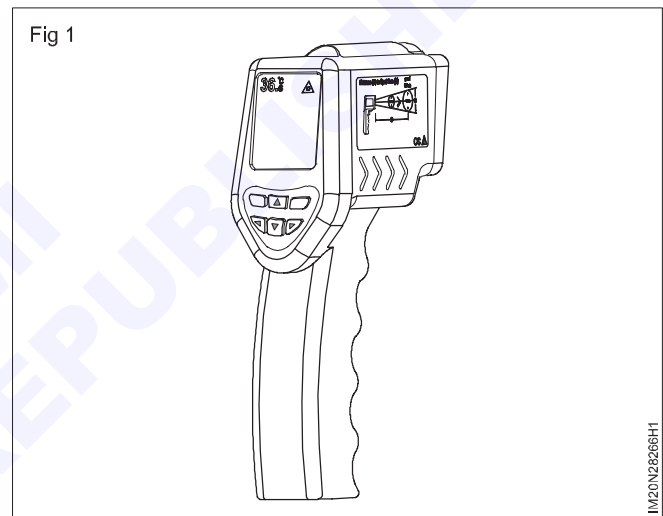
- 1 Clean the working table.
- 2 Clean the thermal imager and keep it on working table.

Are wet cloth or liquid soap to clean the thermal imager

Do not are abrasive compound or isopropyl alcohol to clean the shell or window or lens.

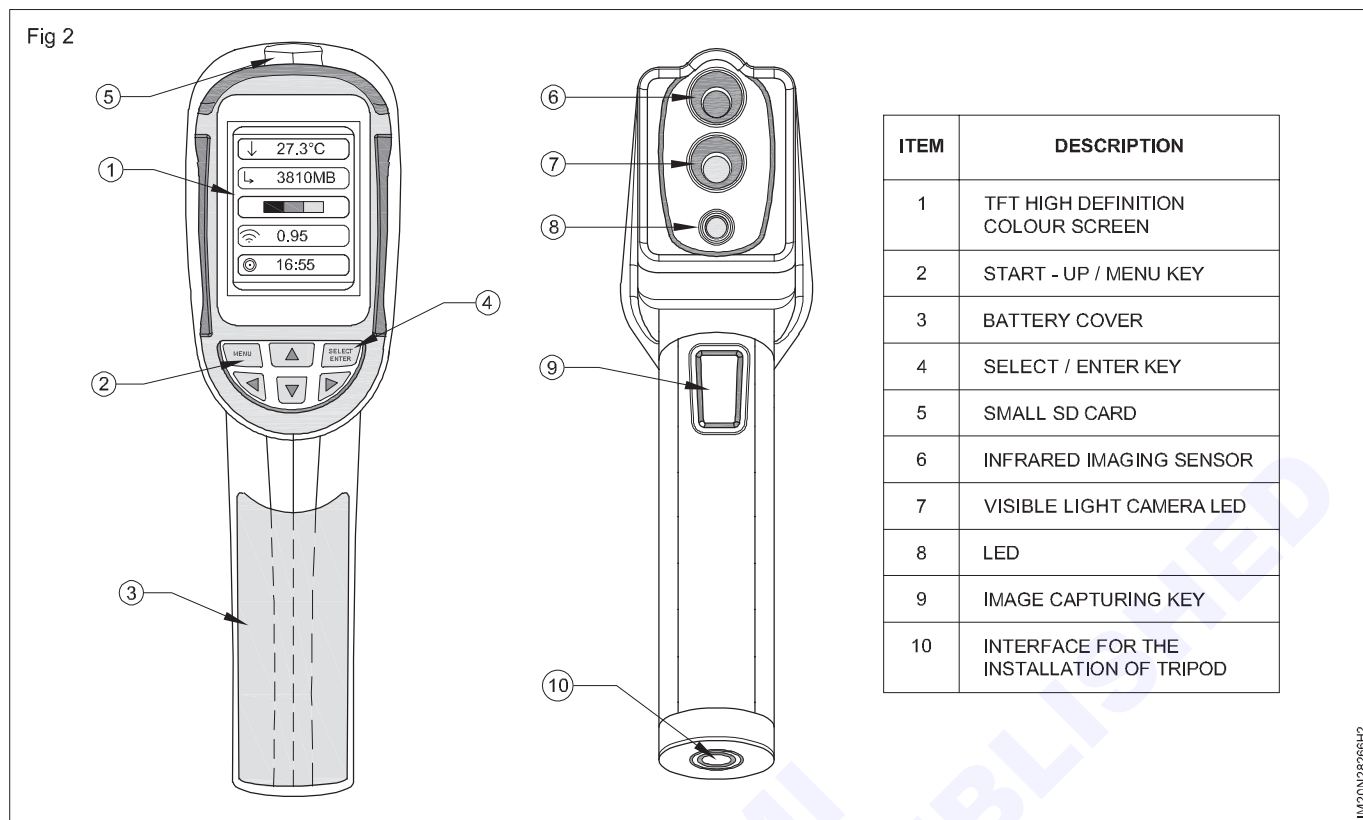
- 3 Measure the temperature of motor using manufacture manual instructions with the help of instructor.
- 4 Do the above step for drill point and ill persons temperature.
- 5 Check the work done by the instructor.

Fig 1 shows Thermal imager



Item	Description	Item	Description
1	TFT high definition color screen	6	Infrared imaging sensor
2	Start-up/menu key	7	Visible light camera
3	Battery cover	8	LED
4	Select/enter key	9	Image capturing key
5	Small SD card	10	Interface for the installation of tripod

Fig 2 shows the parts of thermal imager.



Practice recording of variable signal

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

- practice recording of pressure signal using pneumatic circular chart recorder
- practice recording of temperature signal electronic circular chart recorder.

Requirements

Tools/ Instruments

- Compressor(0-100psi) (Or) - 1 No.
- Foot pump - 1 No.
- Pressure regulator - 1 No.
- Needle valve - 1 No.
- Pressure gauge(o to 7KG) - 1 No.
- Pneumatic circular chart Recording - 1 No.

- Furnace (0 to 1200°C) - 1 No.
- Thermo couple k type - 1 No.

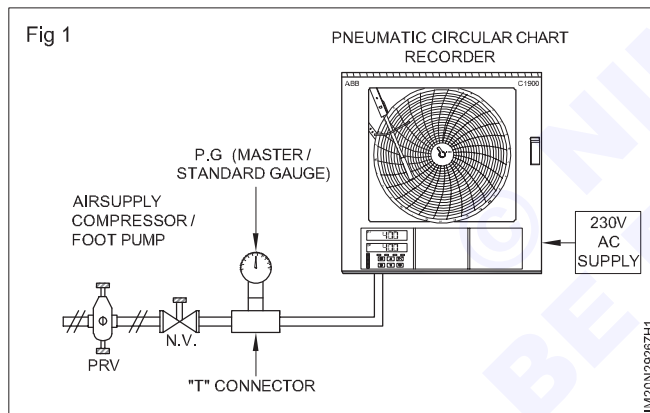
Materials

- Compensating leads (or)copper wires - as reqd.

PROCEDURE

TASK 1: Practice recording of pressure signal pneumatic circular chart recorder

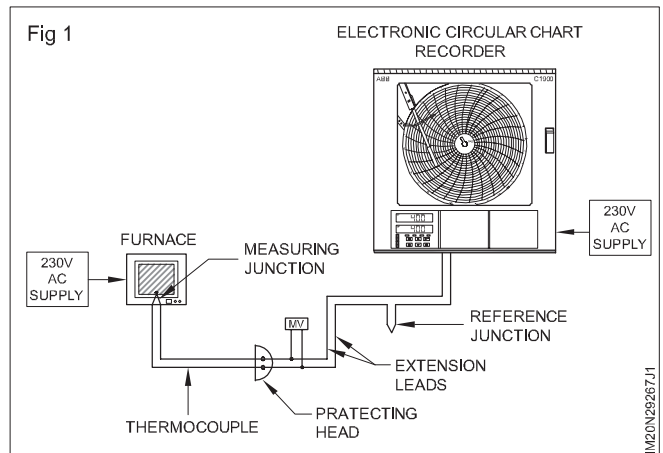
- 1 Connect compressor, pressure regular value, needle value , master pressure gauge and pneumatic circular chart recorder as shown in Fig 1.



- 2 Check the leakage in the connection using soap solution.
- 3 Check the connections with the help of instructor.
- 4 Switch on the compressor
- 5 Apply 1kg/cm² using pressure regulator value to pneumatic recorder.
- 6 Open the needle value.
- 7 Observe the corresponding pressure in pressure gauge and pneumatic circular chart recorder
- 8 Do the above steps from 5 to 7 for various pressure up to 7kg /cm²
- 9 Check the work done by the Instructor

TASK 2: Practice recording of temperature signal using electronic circular chart recorder

- 1 Connect, furnace, thermocouple, wires leads and electronic chart as shown in Fig 1.
- 2 Check the connections with the help of instructor
- 3 Switch on the furnace
- 4 Insert the thermocouple into the furnace
- 5 Observe the corresponding out-put in mV meter and electronic circular chart recorder up to 250°C
- 6 Check the work done by the instructor



Study the construction, operation and use of circular chart recorder for temperature or pressure or mV or mA

Objectives: At the end of this exercise you shall be able to
 • identify the parts, study the function and uses of circular chart recorder.

Requirements		
Tools/ Instruments		Materials
• Trainees kit	- 1 No.	• Cotton cloth - as reqd.
• Circular chart recorder 0-1200°C	- 1 No.	• Chart - as reqd.
• Thermocouple	- 1 No.	• Ink - as reqd.
• Furnace (1200°C)	- 1 No.	• Connecting leads - as reqd.
• Tester	- 1 No.	

PROCEDURE

TASK 1: Identify the parts the function and uses of circular chart recorder

- 1 Clean the working table
- 2 Keep the given circular chart recorder on the table and clean it
- 3 Remove the screws of recorder using screw driver.

Note: keep the screws in a box with care

- 4 Identify the parts of circular chart recorder as shown in Fig 1

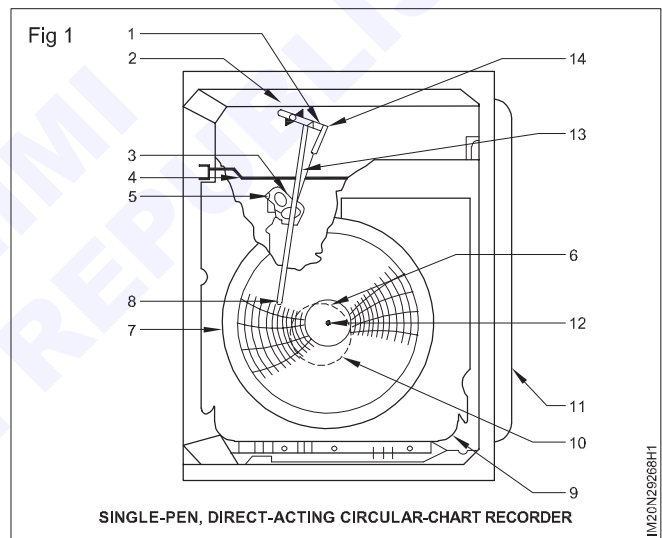
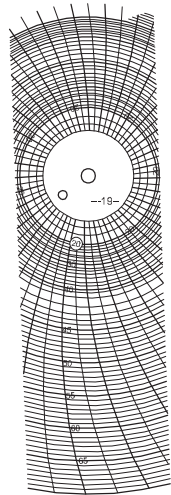


Table 1

Name of the circular chart	Function	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

Fig 2



MIDNIGHT
SECTION OF AN 12-IN CIRCULAR CHART

IM20N29268H2

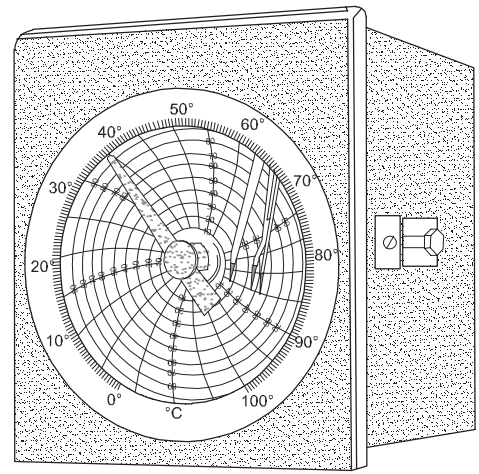
- 5 Write the name of the parts, its function and uses of circular chart recorder in Table 1.

Note:

Instructor should teach the name of the parts, function and use of circular chart recorder.

- 6 Check the work done by the instructor

Fig 3



THE RECORDER CAN BE SUPPLIED WITH ELECTRICAL CONTROL CONTACTS AND THEIR ASSOCIATED RELAYS OR PROPORTIONAL ELECTRONIC CONTROL TO OPERATE INTO FIELD ELECTRO-PNEUMATIC CONVERTER OR THE PROPORTIONAL 0-15mA D.C. SIGNAL CAN BE USED TO OPERATE A SATURABLE REACTOR

TEMPERATURE RECORDER / INDICATOR

IM20N29268H3

Study the construction, operation and use of strip chart recorder pneumatic and electronic recorders

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

- identify parts operation and uses strip chart recorder (pneumatic and electronic recorders).

Requirements			
Tools/ Instruments			
• Strip chart recorder 0-1200°C	- 1 No.	• Furnace 1200°C	- 1 No.
• Thermocouple	- 1 No.	• Trainees tool kit	- 1 No.

PROCEDURE

TASK 1: Identify the parts and study the function of strip chart recorder

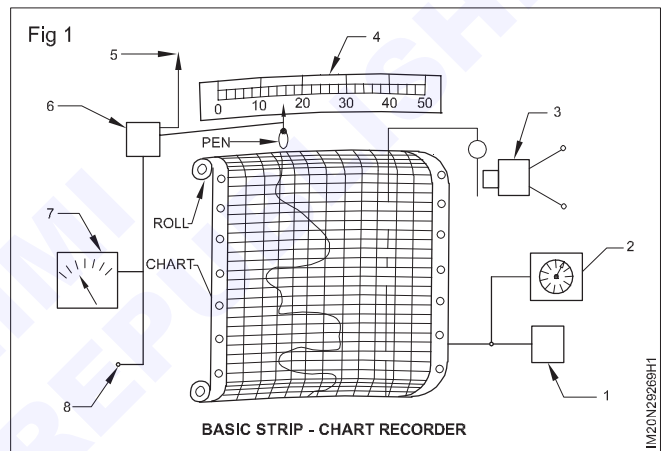
- 1 Clean the working table
- 2 Keep the given strip chart recorder on the table and clean it.
- 3 Remove the screws of recorder using screw driver.

Note : keep the screws in a box with care

- 4 Identify the parts of strip chart recorder as shown in Fig 1

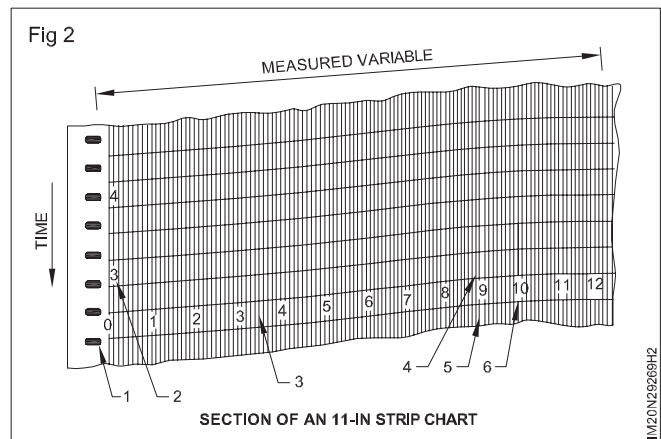
Note : Instructor should teach the name of the parts and function of strip chart recorder in related theory 2.7.269

- 5 Write the name of the parts, its function and uses of strip chart recorder in Table 1.



Name of the parts	Function	Uses
1		
2		
3		
4		
5		
6		
7		
8		

- 6 Fill in the blanks in Fig 2
- 7 Check the work done by the instructor



Calibrating electronic recorder

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

- understand overhaul, check, fault find repair, test and calibrate electronic recorder.

Requirements

Tools/ Instruments

- Electronic recorder - 1 No.
- Screw driver - 1 No.
- Trainees tool kit - 1 No.
- Multimeter - 1 No.

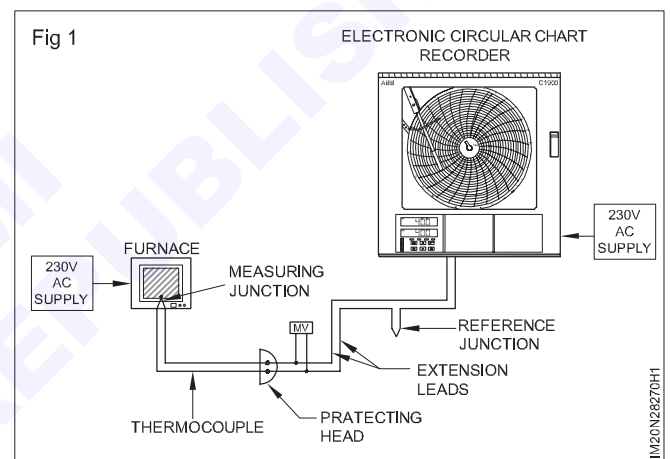
Materials

- Cotton Cloth - as reqd.
- Connecting wires - as reqd.

PROCEDURE

TASK 1: Overhaul, check, fault find repair, test and calibrate electronic recorder

- 1 Allow the electronic recorder to stabilise at a low temperature just above the minimum scale with the measuring element
- 2 Adjust the zero screw to bring the pen to zero
- 3 Allow the recorded to stabilise with a measuring element in high temperature (maximum scale)
- 4 Repeat the zero and span adjustment two (or) three times
- 5 Check the intermediate readings with the thermo couple and observe the recorded out put in the chart
- 6 Check the work done by the instructor



Calibrating pneumatic recorder

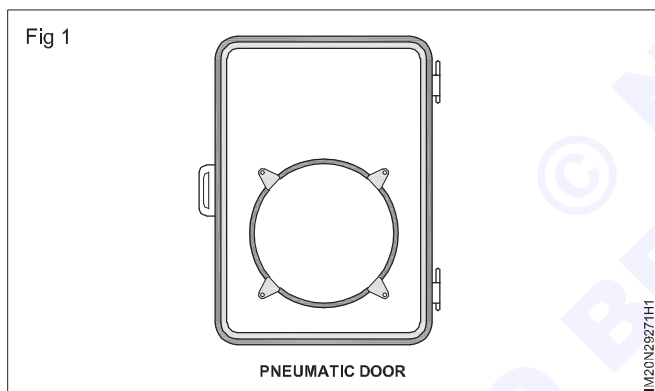
Objectives: At the end of this exercise you shall be able to
 • overhaul, check, fault find repair, test and calibrate pneumatic recorder.

Requirements			
Tools/ Instruments			
• Pneumatic circular chart recorder	- 1 No.	• Electronic strip chart recorder	- 1 No.
• Foot pump (or) compressor (0-100psi)	- 1 No.	• Trainees tool kit	- 1 No.
• Pressure regulator with pressure gauge	- 1 No.	Materials	
• Screw driver	- 1 No.	• Cotton Cloth	- as reqd.
• Spanner	- 1 No.		

PROCEDURE

TASK 1: Overhaul, check, fault find repair, test and calibrate pneumatic recorder

- 1 Clean the working table
- 2 Disconnect pneumatic recorder from pressure source
- 3 Clean the given pneumatic circular chart recorder on the table and keep on it
- 4 Open the front door of recorder. (Fig 1)



- 5 Unscrew the hub and bake the chart as shown in Fig 2.
- 6 Push chart plate gently to words top to case to align screws with holes as shown in Fig 3.
- 7 Remove the screws from chart drive

Note: Keep the chart drive screws safely for reassembling

- 8 Disconnect linkage, ratio arm and span adjustment arm as shown in Fig 4.
- 9 Remove three screws from pressure element connector and push connector upwards from exterior of case as shown in Fig 5.

Following defects occur in the pneumatic recorder.

- Damage in outdoor
- Worn out screws in chart hub
- Bend in linkage, ratio arm and span as justingarm

- Corrosion on shaft drive battery
 - Leakage in pressure element
- 10 Replace the defective parts with the help of instructor
 - 11 Reassemble all the parts in reverse order of demanding and check with the instructor as shown in Fig 6.

Note : After assembling the pressure element check the joint using soap solution.

- 12 Connect air supply source, pressure regulator and pressure recorder (pneumatic) as shown in Fig 7.
- 13 Apply pressure using air pressure regulator
- 14 Observe the recorded output in the pneumatic recorder
- 15 Vary the pressure by air pressure regulator from psi to 100 psi
- 16 Observe the recorded output in the chart of pneumatic recorder
- 17 Compare the recorded output in the chart with the given air supply
- 18 Calibrate the recorder if the output is not with in the accuracy

Calibration

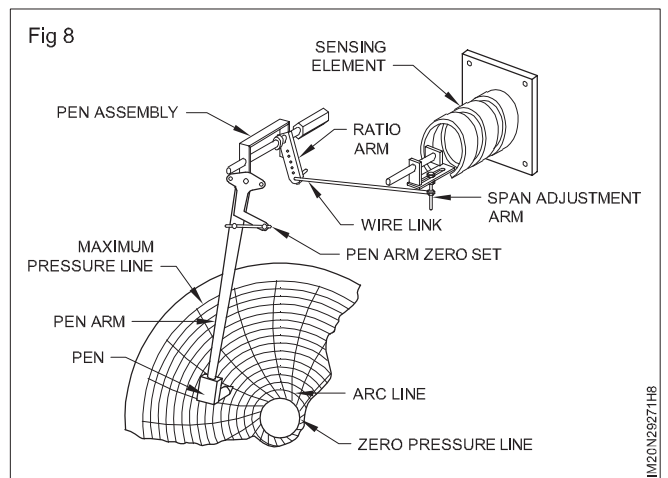
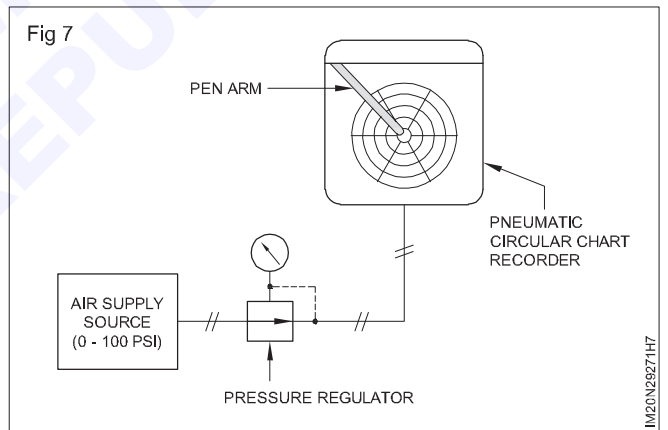
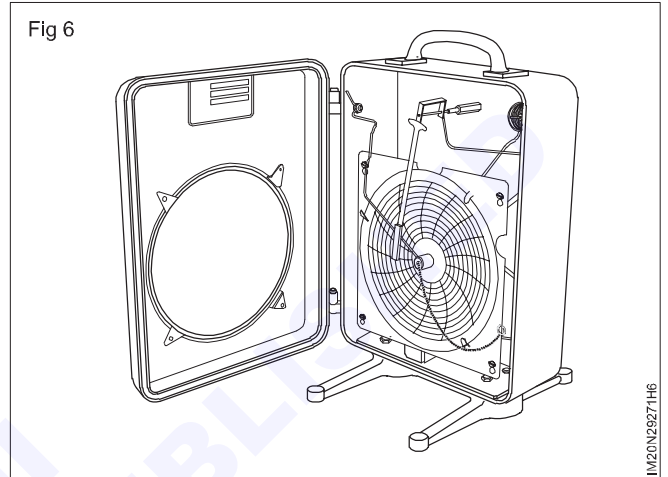
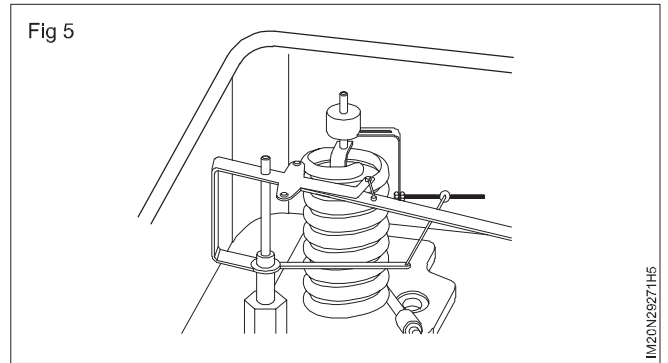
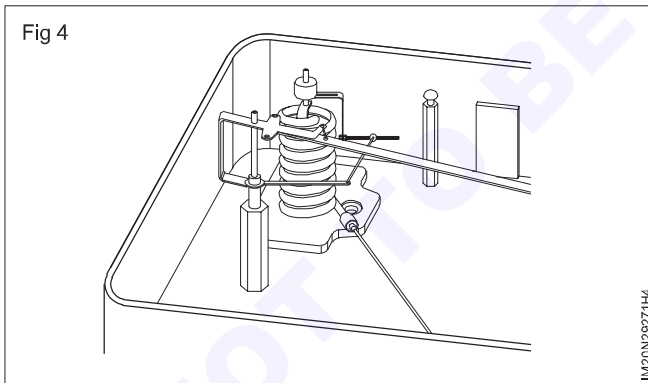
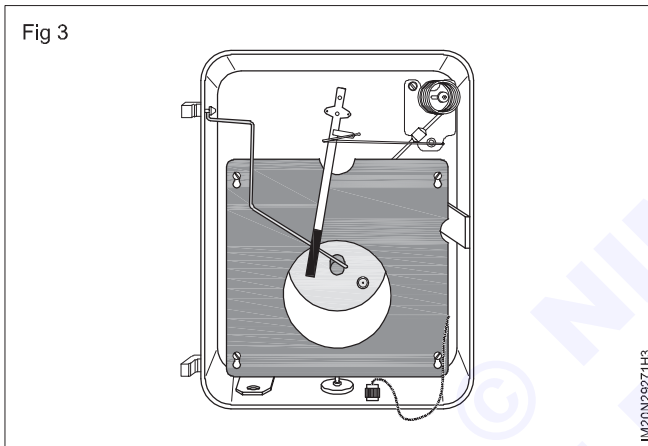
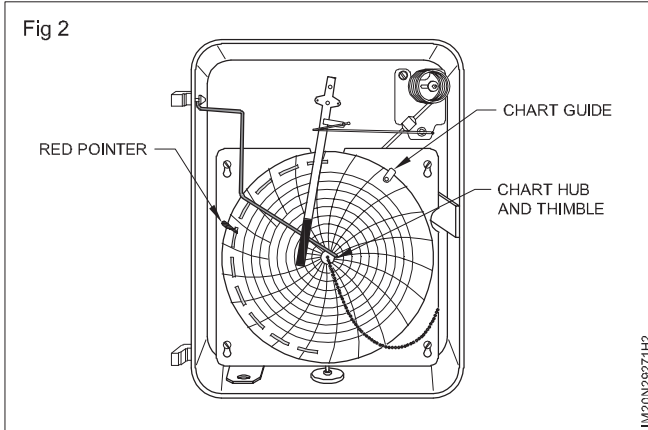
- 19 Release the pressure (0psi)
- 20 Observe the recorder that the stylus pen is in 200 position
- 21 Adjust the zero screw in clock wise (or) anticlockwise direction set pen arm (styles) at zero position
- 22 Apply maximum pressure (100psi)
- 23 Observe the recorder that the pen is in maximum position (100psi)
- 24 Adjust the span adjustment hut (Fig 8)in click wise (or) anticlockwise direction to set the pen arm at span position

25 Repeat the zero and span adjustment two (or) three time for calibration

26 Check the intermediate reading by applying air supply

27 Observe the recorded output in the chart

28 Check the work done by the instructor.



Overhaul, check, fault, find, repair, test of pneumatic electronic recorders (single point & multi point)

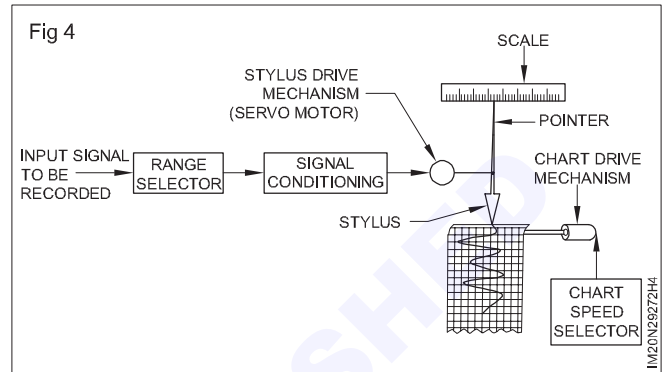
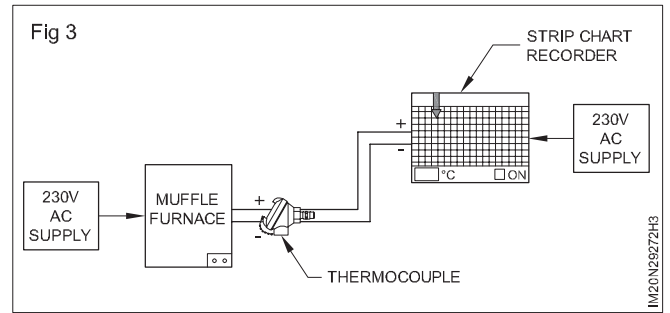
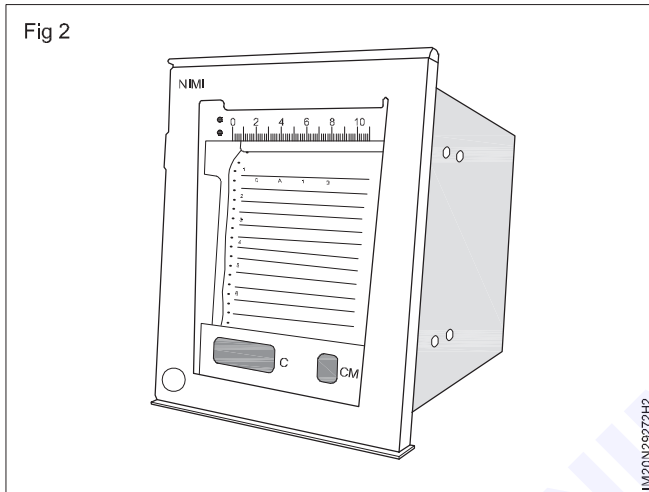
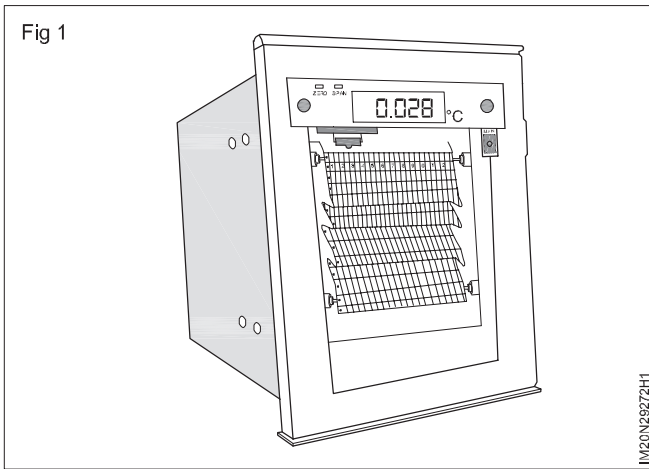
Objectives: At the end of this exercise you shall be able to

- overhaul, check, fault find repair and test of calibrate pneumatic recorder
- overhaul, check, fault find repair and test of calibrate electronic recorder.

Requirements			
Tools/ Instruments			
• Pneumatic recorder	- 1 No.	• Multimeter	- 1 No.
• Electronic recorder	- 1 No.	Materials	
• Screw driver	- 1 No.	• Cotton Cloth	- as reqd.
• Spanner	- 1 No.	• Cleaning solution	- as reqd.
• Trainees tool kit	- 1 No.		

PROCEDURE

- 1 Clean the working table
 - 2 Disconnect electronic pneumatic chart recorder from the power supply line
 - 3 Clean the given electronic pneumatic chart recorder and keep on the table
 - 4 Open the front door
 - 5 Take the chart by removing the screw
 - 6 Remove the chart drive mechanism
- Note:**
Keep the screws safely for re-assembling.
- 7 Disconnect range selector, and signal conditioning pcb
 - 8 Remove the stylus drive mechanism
 - 9 Remove chart drive mechanism
- Following defects occur in the electronics pneumatic chart recorder
- Damage in out door
 - Worn-out screws in chart drive mechanism
 - Damage in stylers drive in mechanism and chart drive mechanism
 - Short circuits in signal conditioning pcb
 - Coils burnt in servo motor
- 10 Replace the defective parts with the help of instructor
 - 11 Trace signal conditioning pcb and rectify it
 - 12 Re-assemble the parts in reverse order of dismantling check with the instructor. (Fig 1&2)
 - 13 Connect muffle furnace to 230 AC supply
 - 14 Connect thermo couple and electronic strip chart recorder using wires with correct polarity
 - 15 Connect 230v AC supply to strip chart recorder
 - 16 Switch on the furnace and strip chart recorder
 - 17 Insert the thermocouple in to the furnace
 - 18 Observe the recorded temperature of electronic strip chart recorder
 - 19 Compare the recorded output with the furnace temperature
 - 20 Calibrate the strip chart recorder if the output is within the accuracy



Study of paperless LCD/LED recorder

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

- identify the parts connection to terminals of paperless LCD/LED recorder.

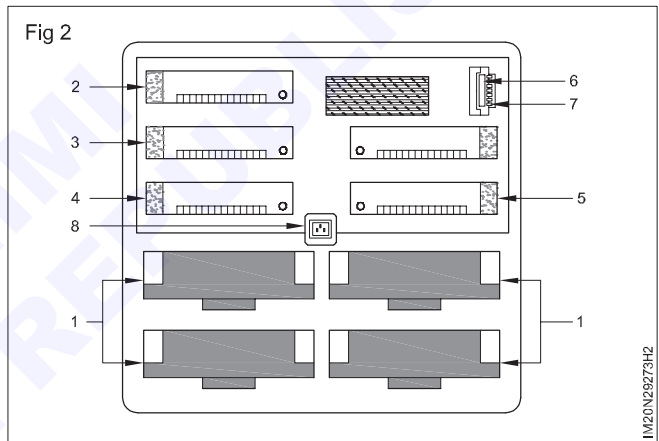
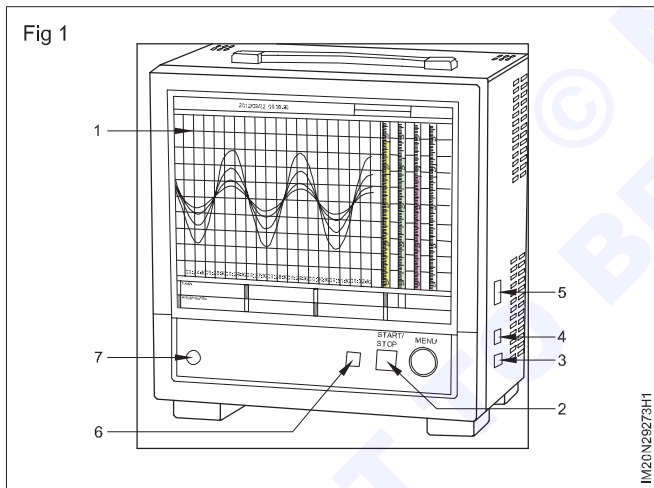
Requirements			
Tools/ Instruments		Materials	
• Paperless LCD/LED recorder	- 1 No.	• Mammal cloth	- as reqd.
• Trainees tools kit	- 1 No.		

PROCEDURE

TASK 1: Identify the parts and connection to terminals as paperless LCD/LED recorder

- 1 Clean the working table
 - 2 Clean the paperless LCD/LED recorder and keep it on the table
 - 3 Remove the screw of recorder using screwdriver
- Note: keep the screws in a box with care**
- 4 Identify the parts of paperless LCD/LED recorder as shown in Fig 1 and record it in Table 1.

- 5 Identify the connection to terminals of paperless LCD/LED recorder as shown in Fig 2 and record at Table 1



Note: Instructor should teach the construction operation of paperless LCD/LED recorder from related theory for exercises 2.7.267

Table 1

Name of the parts of paperless LCD/LED recorder	Name of the connection to terminals of paperless LCD/LED recorder
1	1
2	2
3	3
4	4
5	5
6	6
7	7

- 6 Check the work done by the instructor.

Installation and testing of valve actuator (pneumatic) with control valve

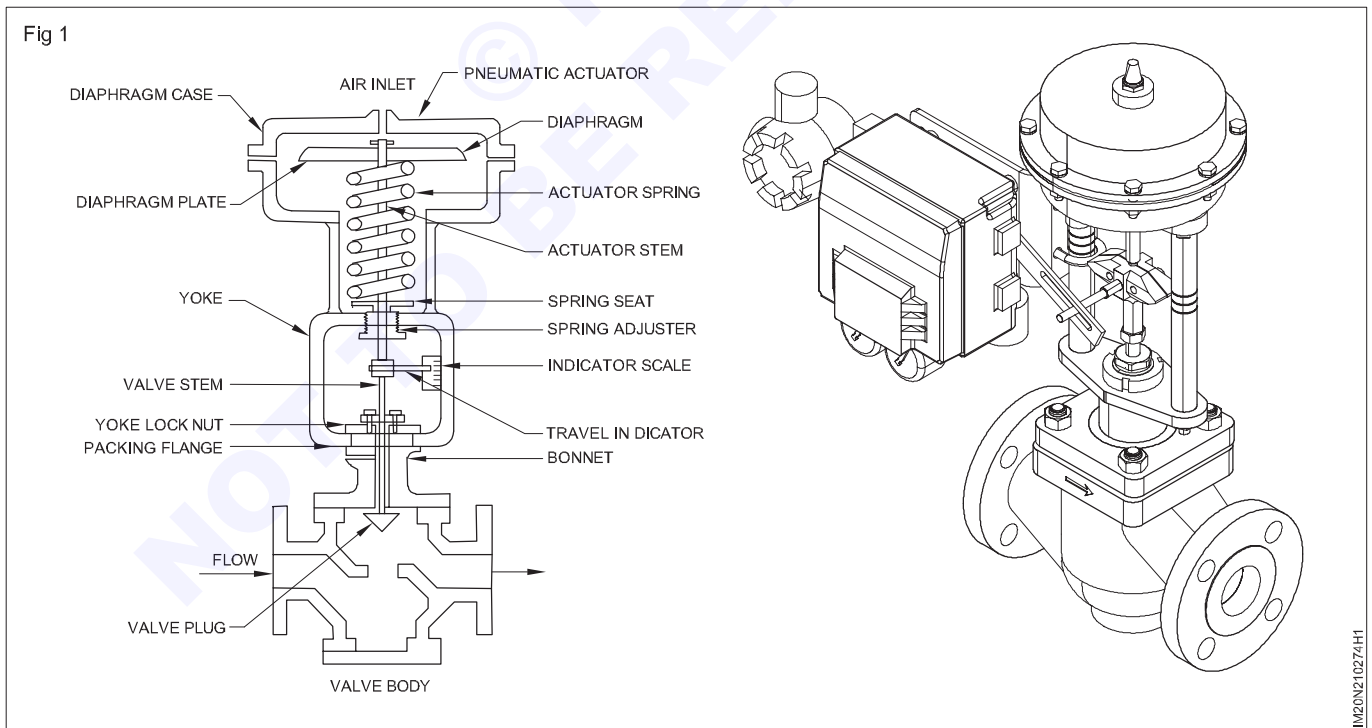
- Objectives:** At the end of this exercise you shall be able to
- installation of valve actuator with pneumatic control valve
 - testing of valve actuator (pneumatic) with control valve
 - calibration of value positioner with control valve.

Requirements			
Tools/Instruments		Equipment/Machines	
<ul style="list-style-type: none"> • Control valve • Ring Spanner • Adjustable spanner • Screw driver 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Air regulator (FRL) 	- 1 No.
		Materials	
		<ul style="list-style-type: none"> • Cotton waste • Cleaning solution • Poly urethane tube 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No.

PROCEDURE

Installation of valve actuator (Pneumatic) with control valve

- 1 Properly clean the given control valve using cotton waste in cleaning solution.
- 2 Note down the specification of the given control valve.
- 3 Correct the PU tube to the actuator.
- 4 Connect the PU tube to the compressor
- 5 Open the valve and check whether air is pushed the diaphragm.
- 6 Test the valve actuator after giving required air supply.



Calibration of valve positioner with control valve

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

- calibration of valve positioner with control valve.

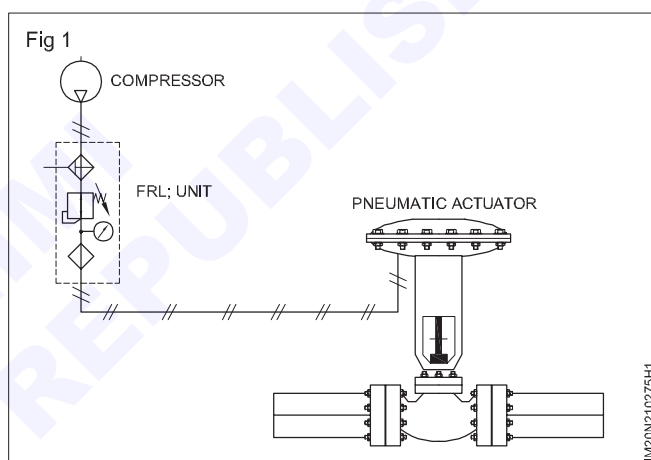
Requirements		
Tools/Instruments		Materials
<ul style="list-style-type: none"> • Control valve • Valve positioner • Trainees toolkit • Air regulator 	<ul style="list-style-type: none"> - 1 No. - 1 No. - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Cotton waste • Cleaning solution
		<ul style="list-style-type: none"> - 1 No. - 1 No.

PROCEDURE

Calibration of valve positioner

- 1 Connect the PU tube to the valve positioner.
- 2 The outer kind of the PU tube connect to the compressor through an air filter regulator (FRL unit)
- 3 Then adjust the air regulator output to 3 psi, 6 psi, 9 psi, 12 psi and 16 psi.
- 4 The actuator valve lifts up 0% 25%, 50%, 75%, 100% of valve opening.

Result:



Air regulator	Actuator valve position	Error
3 psi	0%	
6 psi	25%	
9 psi	50%	
12 psi	75%	
16 psi	100%	

Calibrate the given I to P converter

Objectives: At the end of this exercise you shall be able to
 • calibrate the given I to P converter.

Requirements			
Tools/Instruments			
• Adjustable spanner	- 1 No.	• I to P converter	- 1 No.
• Screw driver	- 1 No.	Materials	
Equipment/Machines		• Pneumatic fitting	- 1 No.
• Air compressor	- 1 No.	• Connecting wires	- 1 No.
• Pneumatic regulator	- 1 No.	• Pneumatic supply 10-7kg	- 1 No.
		• Milli ampere source (4-20mA)	- 1 No.

PROCEDURE

Calibration of I to P convertor

- 1 Check the tools and equipment's.
- 2 Identify the specification of I to P convertor.
- 3 Prepare the test circuit sector for I to P convertor as shown in fig 1.
- 4 Identify the input and output part of pneumatic supply
- 5 Apply the standard pressure in between (20 to 30 PSI)
- 6 Switch 'ON' the power supply of milli ampere source.
- 7 Adjust the zero error by adjusting screw at 4Ma.
- 8 Apply the current in 4 to 20 mA range.
- 9 Adjust the span error by adjusting span adjustment screw.
- 10 Observe the output in pressure gauge and note down on observation table.
- 11 Find out the theoretically output pressure values with the help of following formula.

$$X = \text{Conversion} \times \left(\frac{\text{Value of conversion} - \text{Value of actual range}}{\text{actual range}} \right)$$

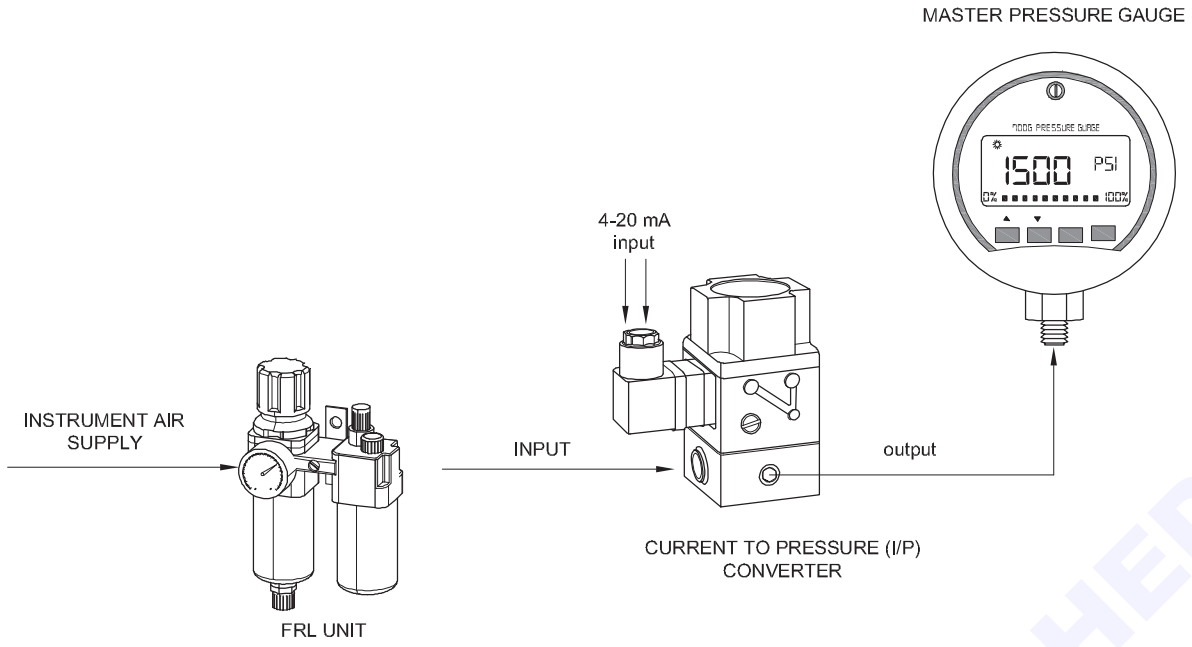
$$\text{Conversion range} = X + \text{Minimum value of conversion range}$$
- 12 Find out the error and % error on following formula

$$\text{Error} = \text{Measured reading} - \text{Standard reading}$$

$$\% \text{Error} = \frac{\text{Error}}{\text{True Value}} \times 100$$

SI.No.	Applied current mA	Indicating pressure psi	Std. Calibrated pressure	Error	% Error

Fig 1

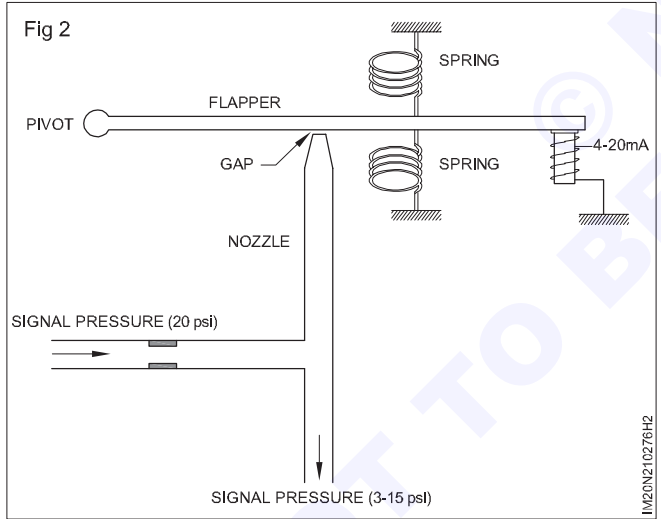


IM20N210276H1

Safety Precautions

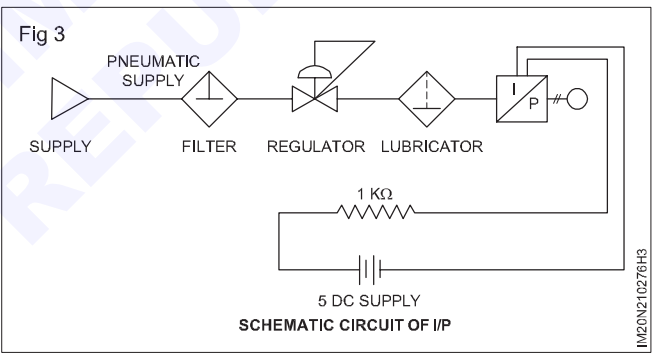
- 1 Don't apply pressure to I to P converter more than 30 psi.
- 2 Adjust the zero and span before turning reading.
- 3 Adjust the zero and span screws with and very carefully.
- 4 Ensure the milli ampere supply of zero before power on the supply.
- 5 Use alignment screw drive for adjusting O and span.

Fig 2



IM20N210276H2

Fig 3



IM20N210276H3

Calibration of voltage to current converter

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

- calibration of V to I convertor
- understand circuit of V to I converter.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Voltmeter- 1 No.	
• Multimeter	- 1 No.	• Ammeter (mA)	- 1 No.
• Wire stripper	- 1 No.	Materials	
Equipment/Machines			
• Regulated DC power supply	- 1 No.	• Variable resistor	- 1 No.
		• Connecting wires	- 1 No.

PROCEDURE

- 1 Collect the tools and equipment's.
- 2 Check the condition of equipment and note down the specification.
- 3 Connection are down as per circuit diagram.
- 4 Set the power supply voltage 5V DC.
- 5 Note down the observation reading in the observation column by varying the potentiometer reading.

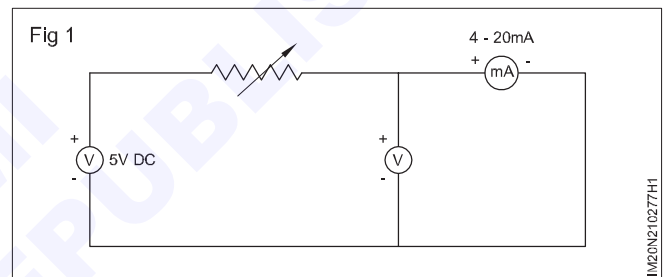


Table 1

SI.No.	Voltmeter reading	Milli ammeter reading
1		

Installation of electro pneumatic positioner with control valve

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

- dismantle, fault finding, repair, reassemble and testing of electro pneumatic valve position
- to calibrate the electro pneumatic valve position connecting wires.

Requirements

Tools/Instruments

- Adjustable spanner - 1 No.
- Screw driver - 1 No.
- Electro-Pneumatic positioner - 1 No.

Equipment/Machines

- Multimeter - 1 No.
- Current source (4-20mA) - 1 No.

- Pressure gauge (0-30 psi) - 1 No.

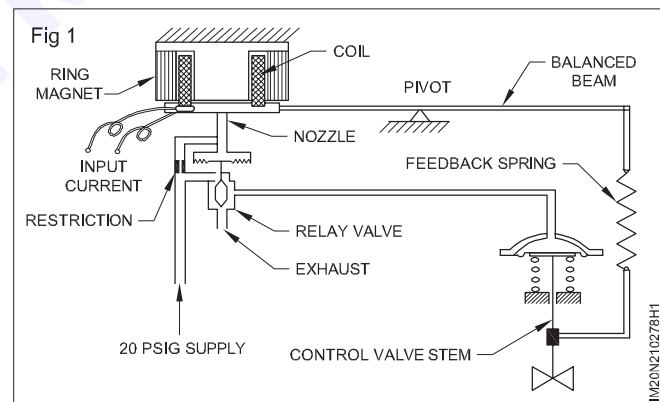
Materials

- Connecting wires - 1 No.
- Teflon tape - 1 No.
- Cotton waste - 1 No.
- Pu tube - 1 No.
- One touch fitting - 1 No.
- Control valve - 1 No.

PROCEDURE

Dismantle & fault finding, repair and assemble the electro pneumatic

- 1 Dismantle the electro-pneumatic valve positioner.
- 2 Identify the parts and clean the parts by using cotton waste and cleaning solution.
- 3 Re-assemble the electro pneumatic positioner.
- 4 Pneumatic and electrical connections are done as per the P&I diagram.
- 5 Give air supply 20 psi to the input part electro pneumatic positioner.
- 6 Give 4-20mA current signal to the terminals of electro pneumatic positioner.
- 7 The output of the electro pneumatic positioner given to the control valve.
- 8 Vary the current signal 4-20mA in terms of 0%, 25%, 50%, 75% and 100% and note down output of the electro pneumatic positioner.
- 9 Also observe the valve opening of control valve.
- 10 For zero calibration adjust the zero calibration position electro pneumatic positioner ie, for 4mA the output should be 3 psi.
- 11 For spam calibration ie, for 20mA the output should be 15 PSI if there is any change adjust the spam prisoner in the E/Pneumatic prisoner.



Calibrating electro pneumatic positioners with control valve

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

- calibration of electro pneumatic positioners.

Requirements			
Tools/Instruments		Materials	
• Adjustable spanner	- 1 No.	• Connecting wires	- 1 No.
• Screw driver	- 1 No.	• Teflon tape	- 1 No.
• Electro-Pneumatic positioner	- 1 No.	• Cotton waste	- 1 No.
Equipment/Machines		• Pu tube	- 1 No.
• Multimeter	- 1 No.	• One touch fitting	- 1 No.
• Current source (4-20mA)	- 1 No.	• Control valve	- 1 No.
• Pressure gauge (0-30 psi)	- 1 No.		

PROCEDURE

Calibration of electro pneumatic positioner

- 1 Pneumatic and electrical connections are done as per the P&I diagram.
- 2 Give air supply 20 psi to the input part electro pneumatic positioner.
- 3 Give 4-20mA current signal to the terminals of electro pneumatic positioner.
- 4 The output of the electro pneumatic positioner given to the control valve.
- 5 Vary the current signal 4-20mA in terms of 0%, 25%, 50%, 75% and 100% and note down output of the electro pneumatic positioner.
- 6 Also observe the valve opening of control valve.

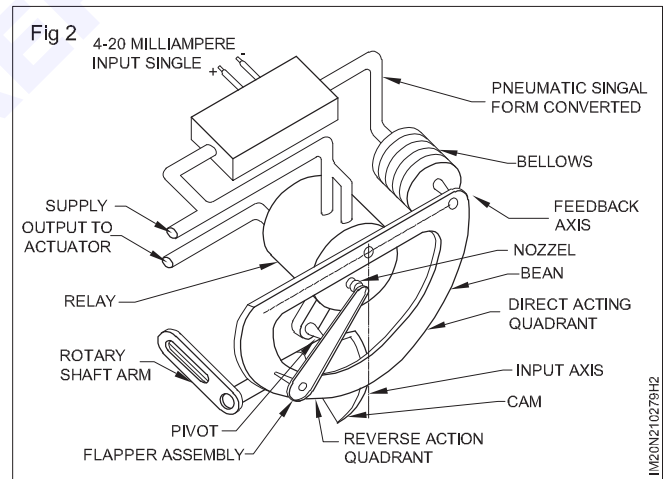
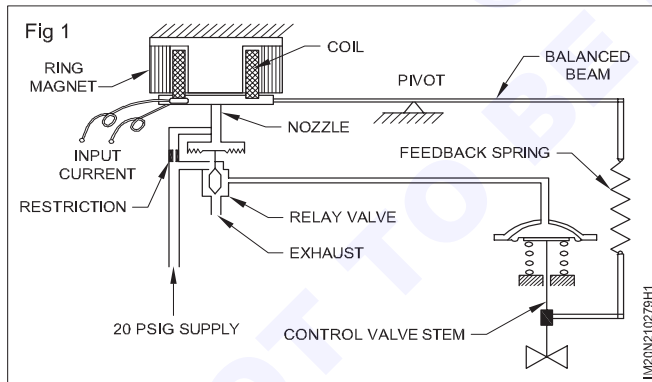


Table 1

Sl.No.	Current mA	Air output PSI	Control Valve position	Error	% Error

Result:

Dismantle fault finding repair, clean reassemble and test of actuators and positioners

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

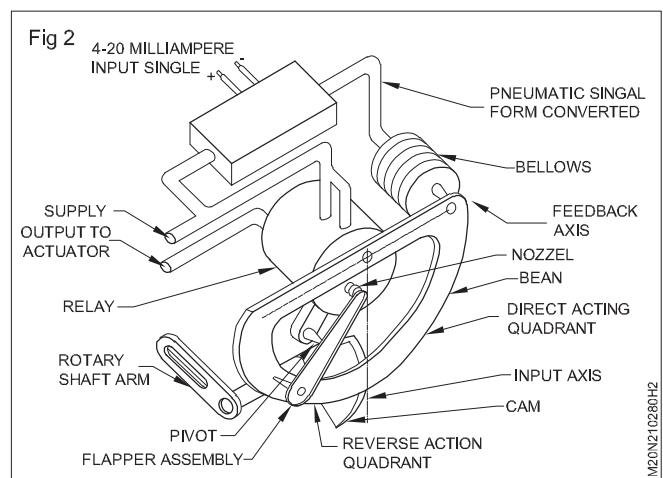
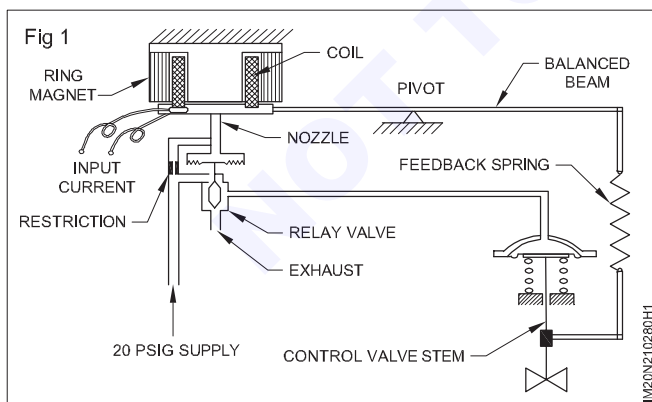
- dismantle, fault finding, repair, reassemble and testing of electro pneumatic valve position
- to calibrate the electro pneumatic valve position connecting wires.

Requirements			
Tools/Instruments			
• Adjustable spanner	- 1 No.	• Pressure gauge (0-30 psi)	- 1 No.
• Screw driver	- 1 No.	Materials	
• Electro-Pneumatic positioner	- 1 No.	• Connecting wires	- 1 No.
Equipment/Machines		• Teflon tape	- 1 No.
• Multimeter	- 1 No.	• Cotton waste	- 1 No.
• Current source (4-20mA)	- 1 No.	• Pu tube	- 1 No.
		• One touch fitting	- 1 No.
		• Control valve	- 1 No.

PROCEDURE

Dismantle & fault finding, repair and assemble the electro pneumatic

- 1 Dismantle the electro-pneumatic valve positioner.
- 2 Identify the parts and clean the parts by using cotton waste and cleaning solution.
- 3 Re-assemble the electro pneumatic positioner.
- 4 Pneumatic and electrical connections are done as per the P&I diagram.
- 5 Give air supply 20 psi to the input part electro pneumatic positioner.
- 6 Give 4-20mA current signal to the terminals of electro pneumatic positioner.
- 7 The output of the electro pneumatic positioner given to the control valve.
- 8 Vary the current signal 4-20mA in terms of 0%, 25%, 50%, 75% and 100% and note down output of the electro pneumatic positioner.
- 9 Also observe the valve opening of control valve.
- 10 For zero calibration adjust the zero calibration position electro pneumatic positioner ie, for 4mA the output should be 3 psi.
- 11 For span calibration ie, for 20mA the output should be 15 PSI if there is any change adjust the span prisoner in the electro pneumatic prisoner.



Characteristics of control Valve

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

- understand the linear characteristics of control valve
- 1 linear
- 2 equal percentage
- 3 quick opening.

Requirements

Tools/Instruments

- Adjustable spanner - 1 No.
- Double end spanner - 1 No.
- Screw driver - 1 No.

Equipments/Machines

- Control valve (linear, equal percentage, quick opening) - 1 No.

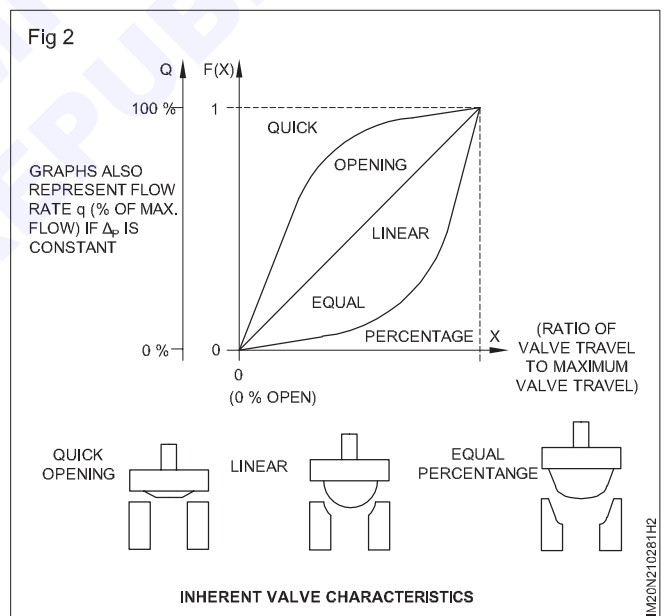
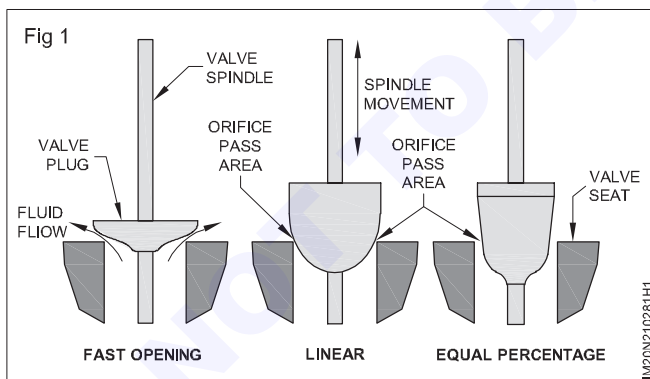
- FRL - 1 No.
- Rotameter setup - 1 No.

Materials

- Cotton waste - 1 No.
- Teflon tape - 1 No.
- One touch fitting - 1 No.

PROCEDURE

- 1 Dismantle the control valve and identify a parts.
- 2 Cleaning the parts by using cotton waste and cleaning solution.
- 3 Re-assemble and observe the working of control valve.
- 4 Study the characteristics of the equal percentage valve by connecting the control valve with flow control set up consisting rotameter.
- 5 Repeat the experiment for linear and quick opening.



Record the characteristics of control valve

Refer Exercise: 2.10.281

Remove and install control valves with service line

Objectives: At the end of this exercise you shall be able to
• understand the installation of control valve in process line.

Requirements

Tools/Instruments

- Adjustable spanner - 1 No.
- Double end spanner - 1 No.
- Control valve - 1 No.
- Screw driver - 1 No.

Materials

- Cotton waste - 1 No.
- Teflon tape - 1 No.

PROCEDURE

- 1 Remove the control valve from the service line.
- 2 Clean the control valve and note the specifications.
- 3 Dismantle the control valve using proper tools.
- 4 Identify the parts.
- 5 Service the components if needed.
- 6 Reassemble the valve.
- 7 Calibrate the control valve.
- 8 Install the control valve.

Dismantling reconditioning checking replacing parts and resetting of control valves

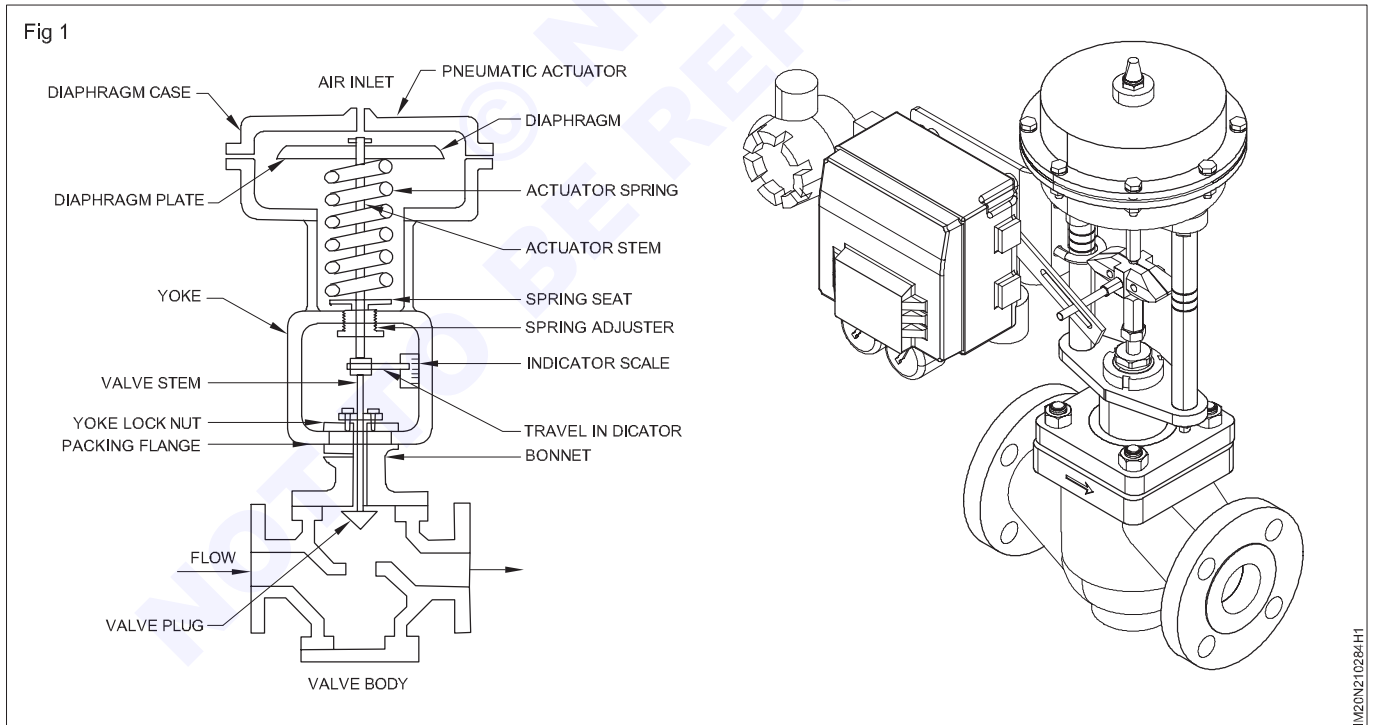
Objectives: At the end of this exercise you shall be able to

- identify to dismantle the control valve
- identify to recondition the control valve
- identify to reset the control valve.

Requirements			
Tools/Instruments		Materials	
• Adjustable spanner	- 1 No.	• Cotton waste	- 1 No.
• Double end spanner	- 1 No.	• Teflon tape	- 1 No.
• Control valve	- 1 No.		
• Screw driver	- 1 No.		

PROCEDURE

- 1 Remove the control valve from the service line.
- 2 Clean the control valve and note the specifications.
- 3 Dismantle the control valve using proper tools.
- 4 Identify the parts.
- 5 Service the components if needed.
- 6 Reassemble the valve.
- 7 Calibrate the control valve.
- 8 Install the control valve.



Carry out maintenance of control valve

Objectives: At the end of this exercise you shall be able to
 • carry out the maintenance of control valve.

Requirements			
Tools/Instruments			
• Adjustable spanner	- 1 No.	• Packing tool	- 1 No.
• Double end spanner	- 1 No.	Materials	
• Control valve	- 1 No.	• Cotton waste	- 1 No.
• Screw driver	- 1 No.	• Cleaning solution	- 1 No.

PROCEDURE

TASK 1: Replacement of Diagram of control valve

- | | |
|---|---|
| 1 Clean the control valve. | 4 Reassemble the upper and lower casing. |
| 2 Dismantle the diagram using proper tools after reducing the spring tension. | 5 Tight the spring by rotating spring loading bolt. |
| 3 Fix the new diagram of proper size. | 6 Check the valve operation for 0 to 100%. |

TASK 2: Gland packing of control valve

- | | |
|--|--|
| 1 Open the gland follower dog bolts and open the gland follower. | 4 Wipe the area with a clean cloth. |
| 2 Remove the packing rings using packing tools. | 5 Wind the packing material round the mandrel as many times as the number of rings required. |
| 3 Clean the shaft well using a nonflammable non toxic solvent. | 6 Refit the packing rings and re tight the dog bolts in the bonnet. |

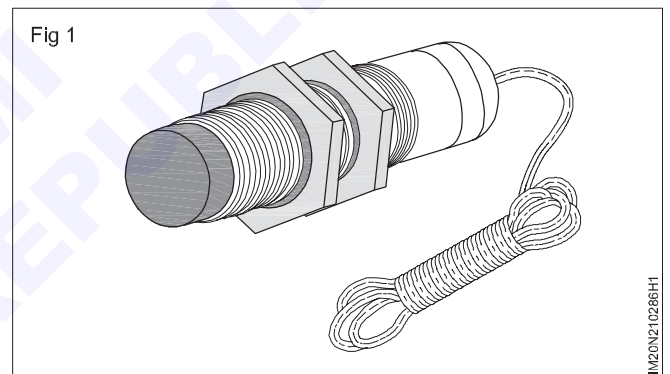
Identify the proximity switch (inductive/capacitive type) and study the specification

Objectives: At the end of this exercise you shall be able to
 • identify the proximity switch (inductive/capacitive type).

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Power supply unit -24V DC	- 1 No.
• Wire stripper	- 1 No.	• AC lamp	- 1 No.
• Multimeter	- 1 No.	• Electro-mechanical relay coil supply 24VDC	- 1 No.
Equipment/Machines		Materials	
• Proximity switch (inductive/capacitive type-pnp)	- 1 No.	• Connecting wire	- 1 No.
		• Cotton waste	- 1 No.

PROCEDURE

- 1 Note down the specification of inductive proximity.
- 2 Note down the specification of capacitive proximity.



Installation and testing micro and limit switches with load

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

- install limit switch with load
- test the operation of contact type limit switch.

Requirements

Tools/Instruments

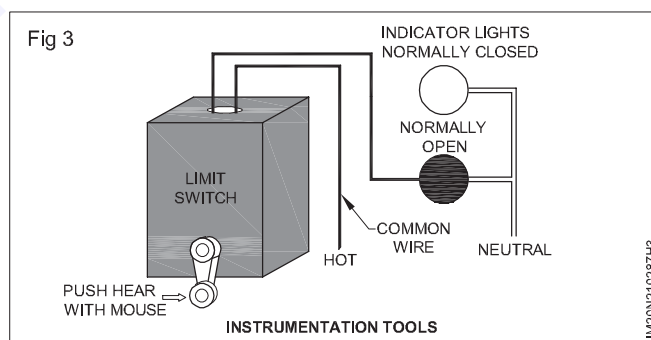
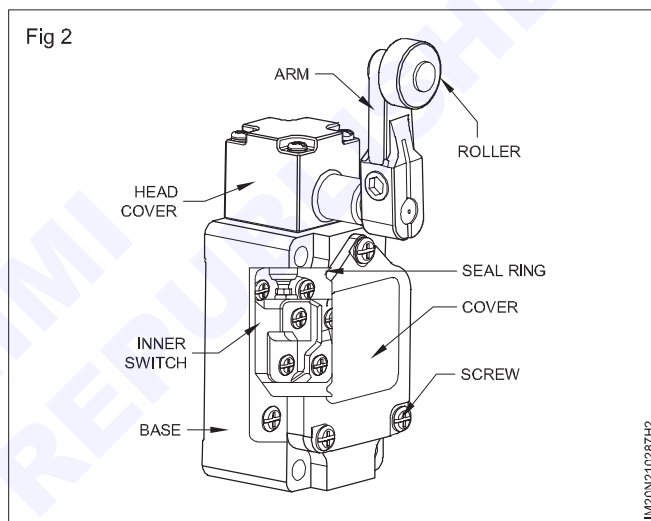
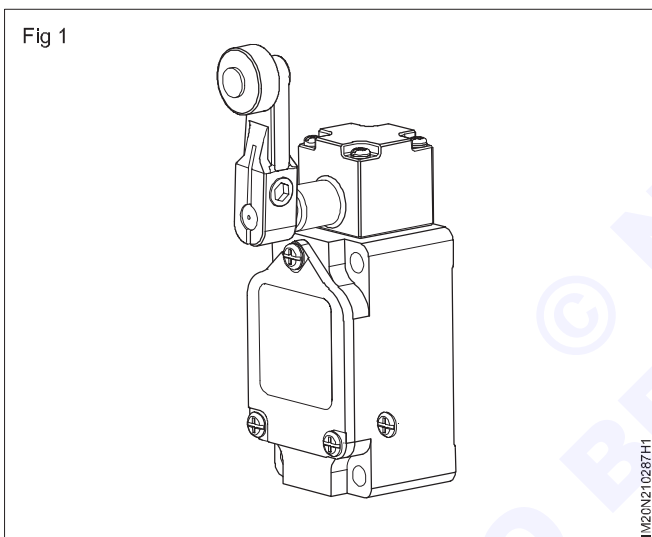
- Mechanical limit switch - 1 No.
- Screw driver - 1 No.
- Lamp - 1 No.

Materials

- Connecting wire - 1 No.

PROCEDURE

- 1 Connect the limit switch with the lamp given.
- 2 Check the changeover of the limit switch when acting the lever of the switch



Installation and testing of capacitive inductive proximity with the load indicator

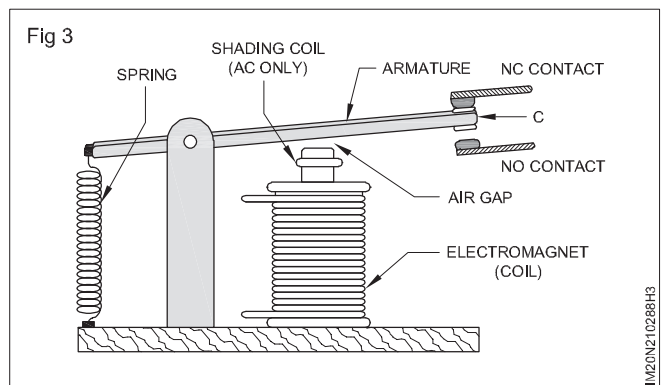
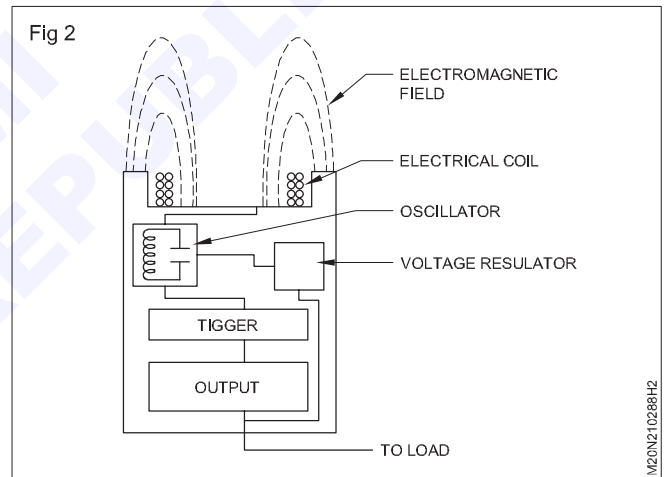
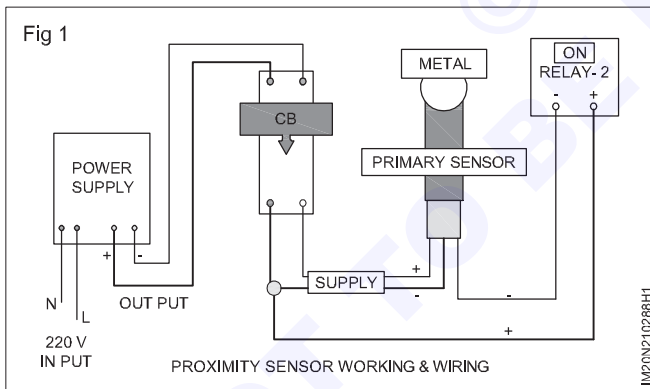
Objectives: At the end of this exercise you shall be able to

- install and test capacitive proximity with the load indicator
- install and test inductive proximity with the load indicator.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Power supply unit -24V DC	- 1 No.
• Wire stripper	- 1 No.	• AC lamp	- 1 No.
• Multimeter	- 1 No.	• Electro-mechanical relay coil supply 24VDC	- 1 No.
Equipment/Machines			
• Proximity switch (inductive/capacitive type-pnp)	- 1 No.	Materials	
		• Connecting wire	- 1 No.
		• Cotton waste	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments.
- 2 Note down the specification of tools and equipment.
- 3 Check the working condition of the equipments.
- 4 Connections are done as per the circuit diagram.
- 5 Place a metal object near to the proximity sensor.
- 6 The relay will energize, turn on the AC lamp.



Proximity switch (ultrasonic/infrared type)-installation and testing

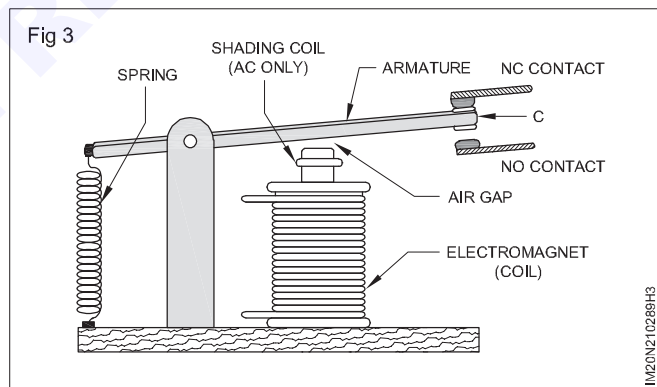
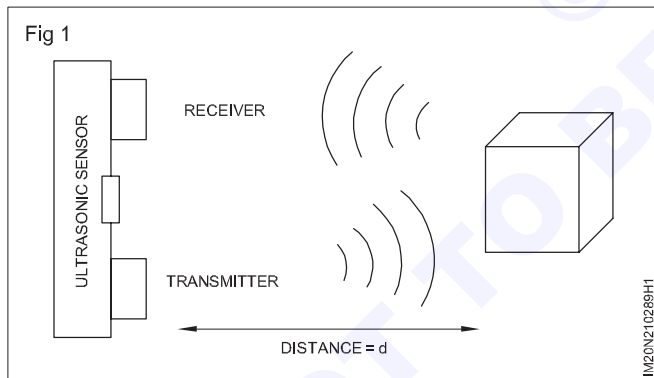
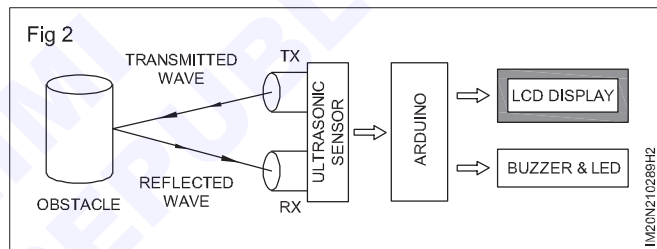
Objectives: At the end of this exercise you shall be able to

- identify the proximity switch (ultrasonic/infrared type)
- understand the installation and testing of proximity switch (ultrasonic/infrared type).

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• LED	- 1 No.
• Wire stripper	- 1 No.	• Electro-mechanical relay coil supply 24VDC	- 1 No.
• Multimeter	- 1 No.		
• Contactor, x motor or lamp	- 1 No.	Materials	
Equipment/Machines			
• Proximity switch (ultrasonic/infrared type)	- 1 No.	• Connecting wire	- 1 No.
• Power supply unit -24V DC	- 1 No.	• Cotton waste	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments.
- 2 Note down the specification of tools and equipment.
- 3 Check the working condition of the equipments.
- 4 Connections are done as per the circuit diagram.
- 5 Place object near to the proximity sensor.
- 6 The relay will energize, turn on the led.



Result :

Installation of proxy with relay and operating high current load (like motor or AC lamp etc

Refer Exercise: 2.10.289

Operate of sequential control and block valves

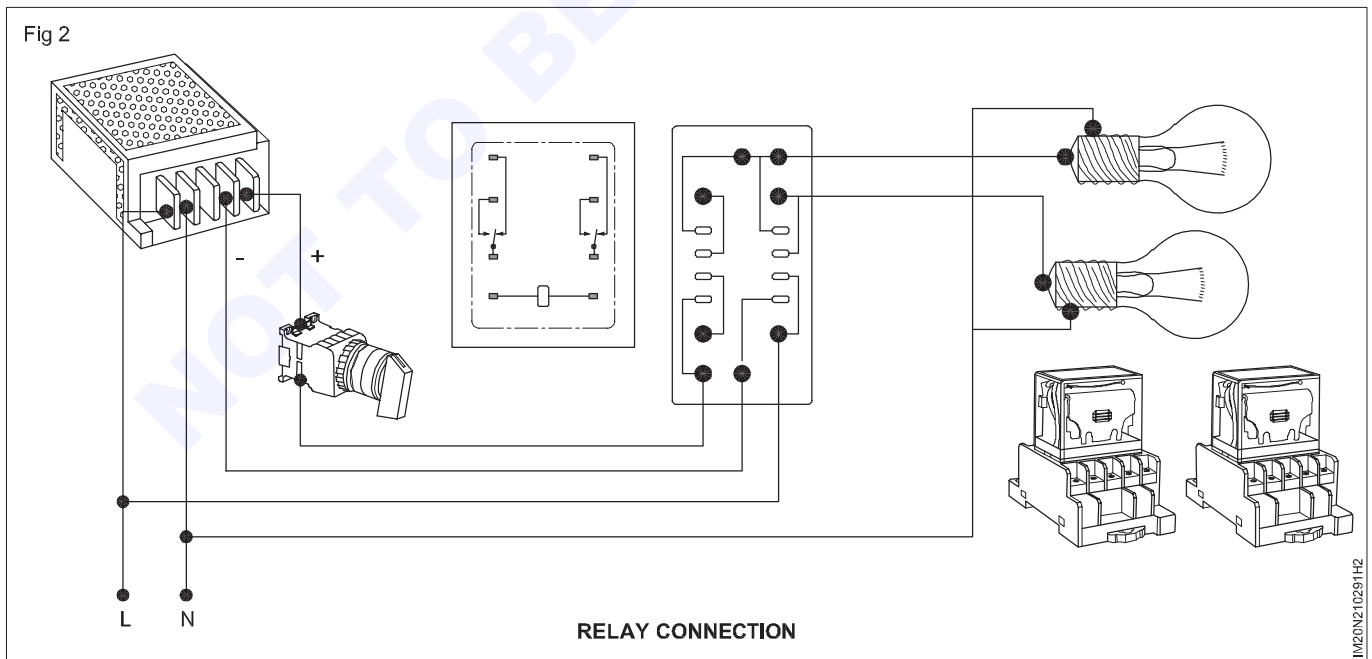
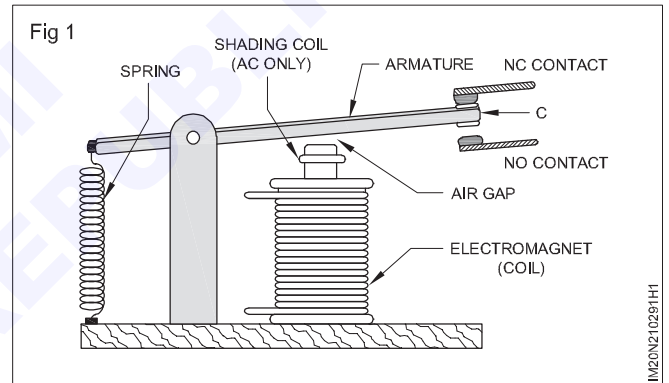
Objectives: At the end of this exercise you shall be able to

- identify the electro-mechanical relay
- understand the operation and servicing of electro-mechanical relay.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Power supply unit -24V DC	- 1 No.
• Wire stripper	- 1 No.	• AC Lamp	- 1 No.
• Multimeter	- 1 No.		
Equipment/Machines			
• Electro-mechanical Relay Coil Supply 24VDC	- 2 Nos.	Materials	
		• Connecting wire	- 1 No.
		• Cotton waste	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments.
- 2 Note down the specification of tools and equipment.
- 3 Check the working condition of the equipments.
- 4 Connections are done as per the circuit diagram.
- 5 Give 24V DC to the coil of the relay.
- 6 The relay will energize, turn ON the AC lamp or motor.



Result:

Operation of electro mechanical solid state relay

Refer Exercise: 2.10.291

Service & test and use electromechanical and solid state relay

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

- servicing of electromechanical solid state relay
- testing of electromechanical solid state relay.

Requirements

Tools/Instruments

- Electro mechanical Relay
- Screw driver
- Multimeter

- 1 No.
- 1 No.
- 1 No.

Materials

- Cotton waste - 1 No.
- Cleaning solution for electrical contacts - 1 No.

PROCEDURE

- 1 Remove the relay cover.
- 2 Inspect for cracks or frame tightness.
- 3 Check the covers and glass.
- 4 Check for loose contacts.
- 5 Check the resistance of the coil.
- 6 Check the no / nc contact charge over where the relay energized.

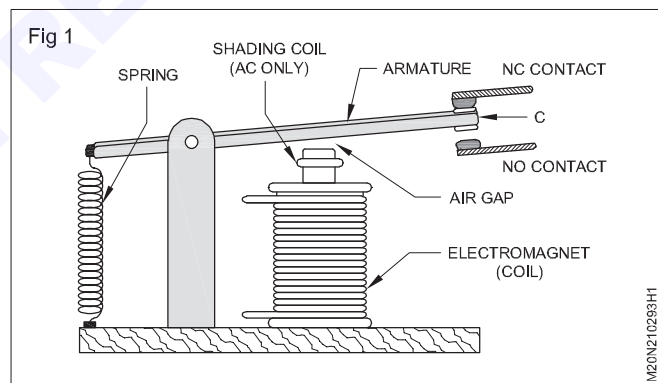
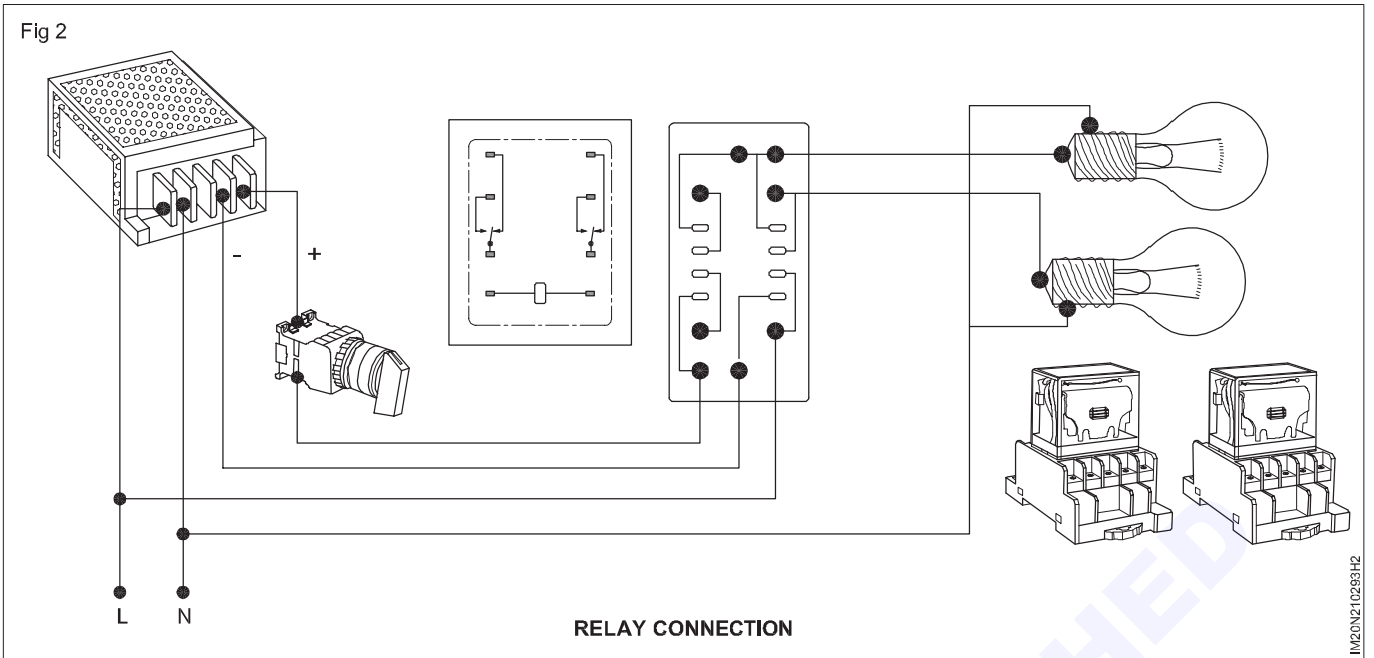


Fig 2



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Result:

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Design and test sequential logic operation using relay

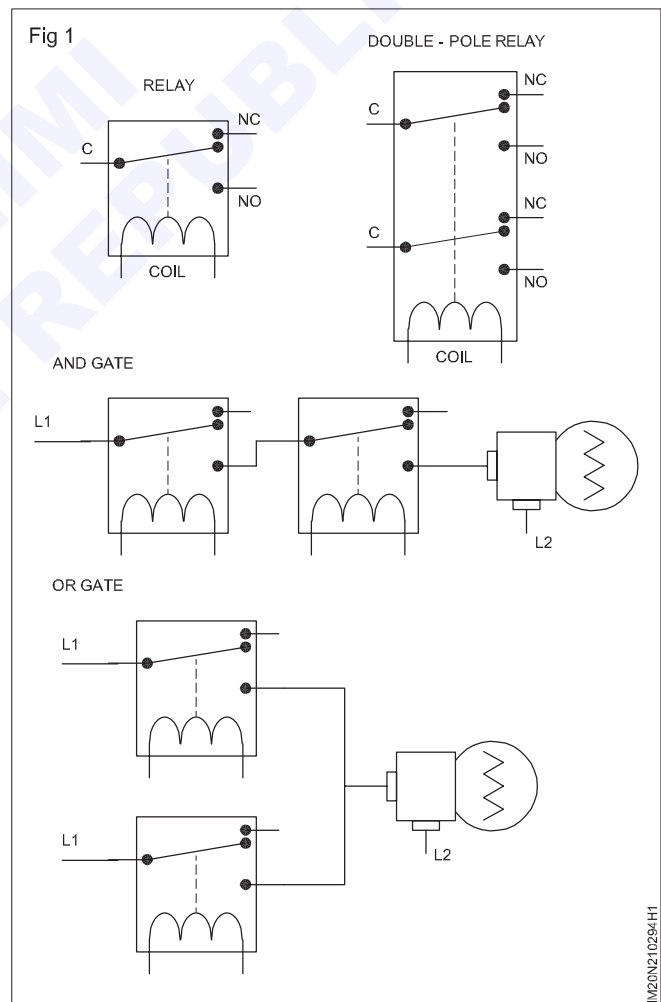
- Objectives:** At the end of this exercise you shall be able to
- design sequential logic operation using electro mechanical relay
 - testing sequential operation.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Power supply unit -24V DC	- 1 No.
• Wire stripper	- 1 No.	• AC Lamp	- 1 No.
• Multimeter	- 1 No.		
Equipment/Machines			
• Electro-mechanical Relay Coil Supply 24VDC	- 2 Nos.	Materials	
		• Connecting wire	- 1 No.
		• Cotton waste	- 1 No.

PROCEDURE

- 1 Connections are done as in circuit diagram for AND & OR gate logic.
- 2 Check the output conditions of the lamp indicator.
- 3 Study the logic for different conditions.

Result:



Install, wire up and test the control operation

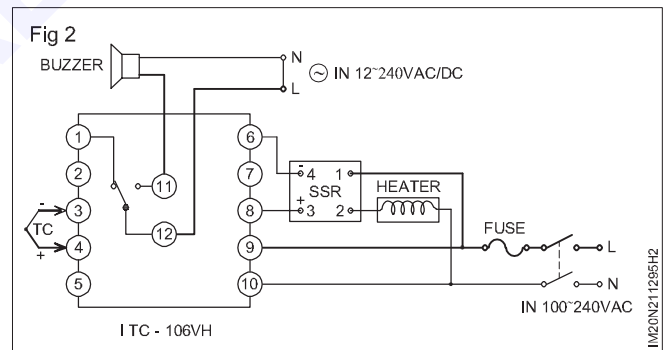
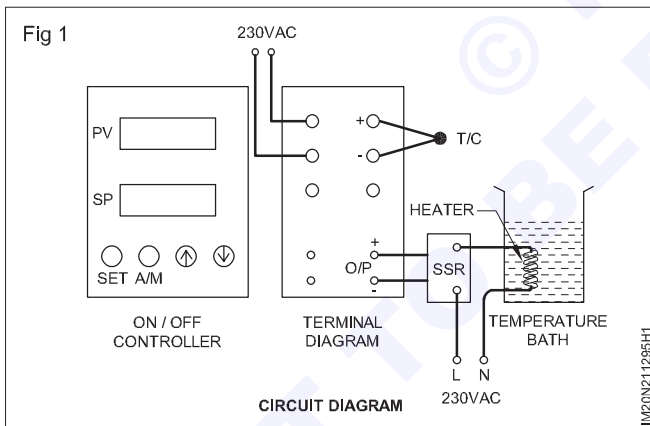
Objectives: At the end of this exercise you shall be able to

- understand the installation and wiring of ON-OFF controller
- understand the operation of ON-OFF controller
- understand the construction of a temperature control loop.

Requirements			
Tools/Instruments		Equipments/Machines	
• Electronic controller (ON-OFF)	- 1 No.	• Screw driver	- 1 No.
• RTD or Thermocouple	- 1 No.	• Wire stripper	- 1 No.
• SSR or contactor	- 1 No.	Materials	
• Heater	- 1 No.	• Connecting wires	- 1 No.
• Temperature bath	- 1 No.	• Water	- as reqd.
		• Cotton waste	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipment's.
- 2 Note down the specification of tools and equipment's after checking their working condition.
- 3 Connections are done as in the circuit diagram.
- 4 Pour water into the temperature bath.
- 5 Switch on the power supply vary the set point using the keypad in the electronic controller.
- 6 Note down the condition of the final control element. Heater (ON or OFF)
- 7 Note down the temperature points at which heater condition changes.



Sl.No.	Set point (SP) in °C	Process variable (PV) in °C	Heater condition
1			
2			
3			

Study construction & operation of on-off electronic / pneumatic controllers

Refer Ex. No. 2.11.295

Service and maintenance of ON - OFF electronic/pneumatic controllers

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

- understand procedure for servicing and maintenance of ON-OFF controllers.

Requirements

Tools/Instruments

- Electronic controller (ON-OFF) - 1 No.
- RTD or Thermocouple - 1 No.
- SSR or contactor - 1 No.
- Heater - 1 No.
- Temperature bath - 1 No.

Equipments/Machines

- Screw driver - 1 No.
- Wire stripper - 1 No.

Materials

- Connecting wires - 1 No.
- Water - as reqd.
- Cotton waste - as reqd.

PROCEDURE

- 1 Identify the type and model of the ON-OFF controller and obtain the relevant documentation, including the manufacturer's instructions and technical data.
- 2 Power off the controller and disconnect it from the rest of the system.
- 3 Inspect the controller housing to ensure that there is no physical damage. Check for dents, scratches, or other signs of wear and tear.
- 4 Inspect electrical connections and ensure they are tight and free from corrosion. Tighten any loose connections.
- 5 Clean the controller using a soft, dry cloth and compressed air to remove any dust or debris that may have accumulated.
- 6 Check the condition of the sensors and actuators connected to the controller. Replace any damaged components.
- 7 Conduct a functional check of the ON-OFF controller by connecting it to a test setup. Verify that the controller responds correctly to input signals and that its output is as expected.
- 8 Check and calibrate the set points and other parameters according to the manufacturer's instructions and guidelines.
- 9 Load the appropriate firmware or software updates as needed to ensure the latest versions are installed.
- 10 Conduct a performance test to confirm that the ON-OFF controller is functioning correctly. Measure the response times and other metrics and compare them to the manufacturer's specified values.
- 11 Reconnect the controller to the system and monitor the system's operation to ensure there are no issues.
- 12 Schedule a regular maintenance program for the ON-OFF controller to ensure it's always functioning correctly. This can include periodic inspection, calibration, and functional testing.

Install, wire up, test and monitor the performance of control operation using on-off electronic and pneumatic controllers

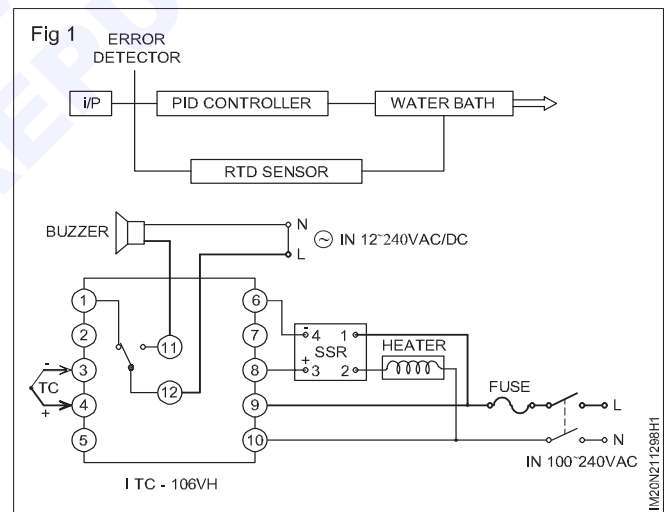
- Objectives:** At the end of this exercise you shall be able to
- understand the installation and wiring of PID controller(Electronic)
 - understand the construction of a PID controller loop.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Thermal bulb	- 1 No.
• Wire stripper	- 1 No.	• FRL unit	- 1 No.
• Multimeter	- 1 No.	• Thermocouple/RTD	- 1 No.
Equipments/Machines			
• Pneumatic PID controller	- 1 No.	• Heater	- 1 No.
• Electronic PID controller	- 1 No.	Materials	
• Temperature bath	- 1 No.	• Connecting wires	- 1 No.
• Solid state relay (SSR)	- 1 No.	• Compensating cable	- as reqd.
		• Cotton waste	- as reqd.

PROCEDURE

TASK 1: Installation, testing and operation of PID on-off controller (Electronic)

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connections are done as per the circuit diagram
- 5 Pour the water into the temperature bath
- 6 Switch on the power supply, vary the set point and PID parameters using the keyboard in the PID controller
- 7 Note down the output of the PID controller in the observation column.

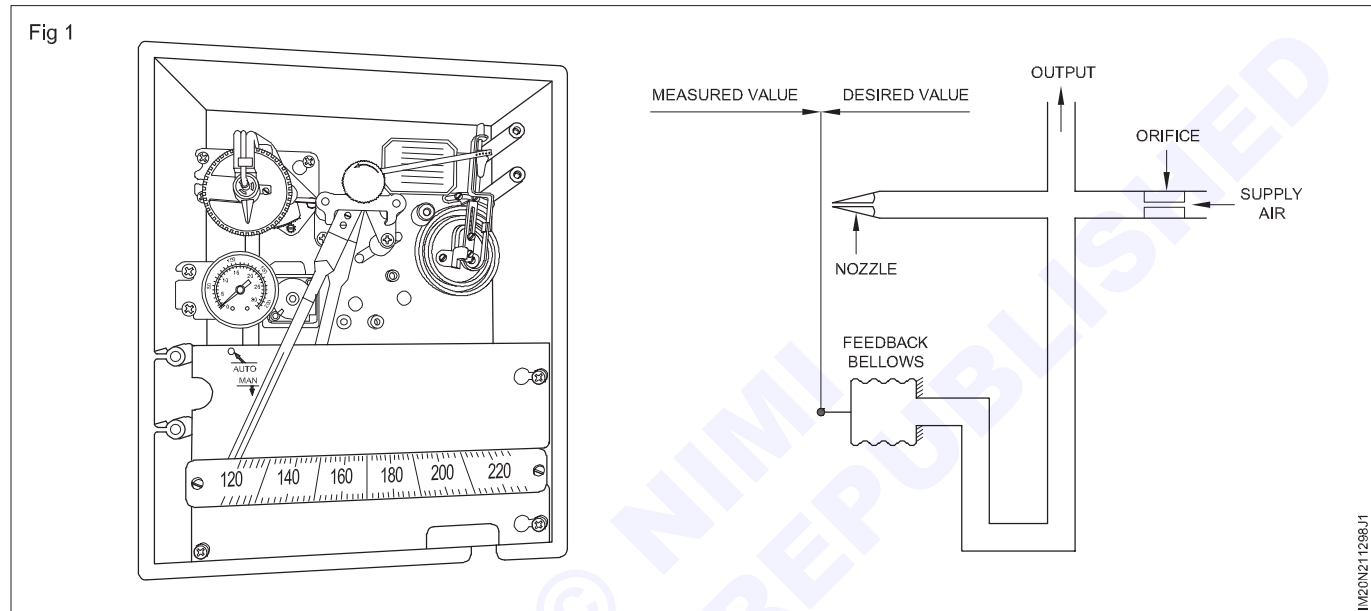


Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

TASK 2: Installation, testing and operation of PID controller (Pneumatic)

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connect the thermal bulb to the temperature bath
- 5 Pour the water into the temperature bath
- 6 Connect the output of FRL unit to the input of the controller
- 7 Note down the output of the PID controller in the observation column

Sl.No.	Setpoint °C	Process Variable (PV)	Controller Output (%)



Practical on PID controller trainer on various process parameters

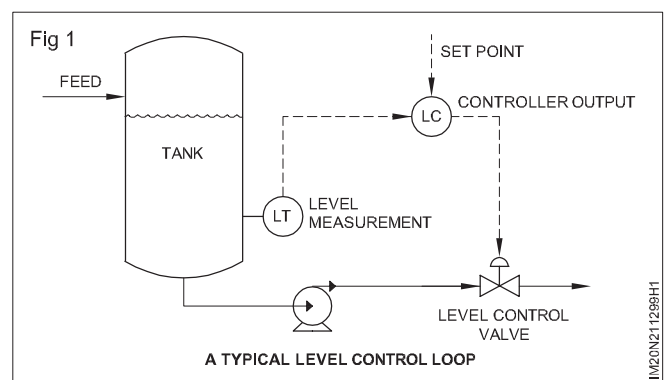
Objectives: At the end of this exercise you shall be able to

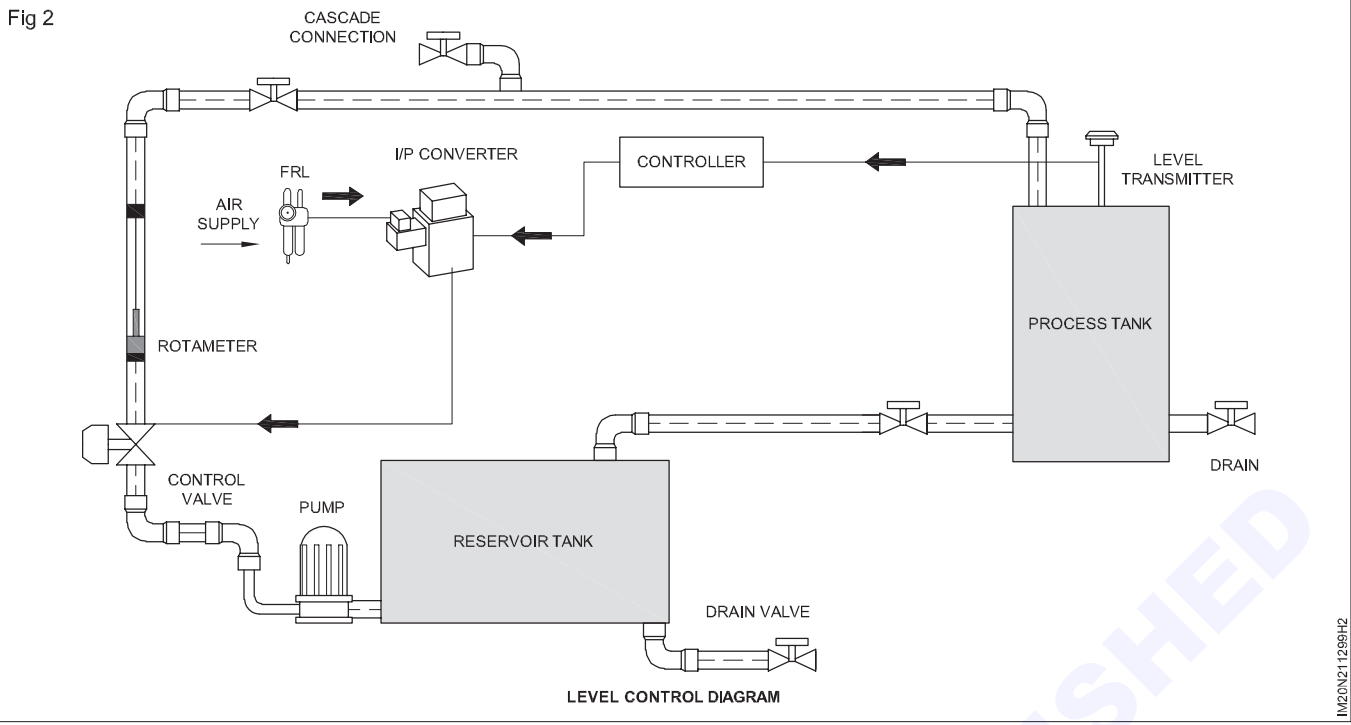
- study the behaviour of PID controller on various process parameters
- understand the configuration of PID controller trainer.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• 1 to P Converter	- 1 No.
• Wire stripper	- 1 No.	• Level transmitter	- 1 No.
• Multimeter	- 1 No.	• Compressor	- 1 No.
Equipments/Machines		Materials	
• Electronic PID controller	- 1 No.	• Connecting wires	- 1 No.
• Level tank	- 1 No.	• Cotton waste	- as reqd.
• Control valve with electro-pneumatic positioner FRL	- 1 No.	• PU tube	- as reqd.
		• Cotton waste	- as reqd.

PROCEDURE

- 1 Set up the PID controller trainer and connect it to a suitable process simulator. The process simulator can be a water flow system, temperature control system, level control system, or any other suitable process.
- 2 Configure the PID controller trainer for the desired control mode, such as P, PI, PD, or PID. Set the parameters according to the process being studied.
- 3 Introduce a disturbance to the process. For example, in a water flow system, changing the flow rate can cause a disturbance.
- 4 Observe the behavior of the PID controller and the process. Measure process parameters such as flow rate, temperature, or level, and monitor the response of the PID controller to the disturbance.
- 5 Vary the proportional gain of the PID controller and observe its effect on the system response. Keep the integral and derivative gains constant.
- 6 Vary the integral gain of the PID controller and observe how it affects system performance. Keep the proportional and derivative gains constant.
- 7 Vary the derivative gain of the PID controller and observe how it affects system performance. Keep the proportional and integral gains constant.
- 8 Study the effect of changing the set point on system response. Observe how the PID controller responds to different reference values.
- 9 Test the performance of the PID controller under steady-state conditions, and measure parameters such as overshoot, settling time, and steady-state error.
- 10 Record and analyze the data gathered during the training exercise. Compare the results of different tests and evaluate the performance of the PID controller under different conditions.





SI.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

Study the construction and operation of PID controller (Digital)

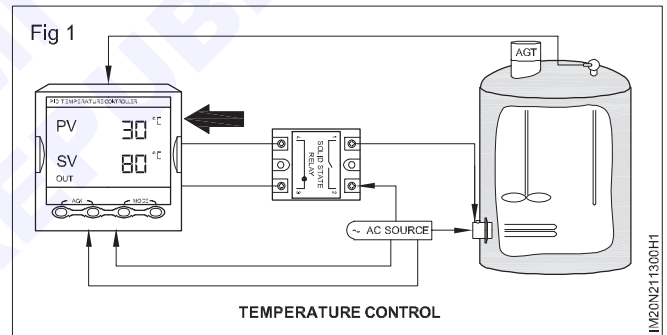
Objectives: At the end of this exercise you shall be able to

- understand the construction and wiring of pid controller(digital)
- understand the construction of a PID controller loop.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Thermocouple/RTD	- 1 No.
• Wire stripper	- 1 No.	Materials	
• Multimeter	- 1 No.	• Connecting wires	- 1 No.
Equipments/Machines		• Compensating cable	- as reqd.
• Electronic PID controller	- 1 No.	• Cotton waste	- as reqd.
• Temperature bath	- 1 No.		
• Solid state relay (SSR)	- 1 No.		

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connections are done as per the circuit diagram
- 5 Pour the water into the temperature bath
- 6 Switch on the power supply, vary the set point and PID parameters using the keyboard in the PID controller
- 7 Note down the output of the PID controller in the observation column



Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

Service and maintenance of PID controllers

Objectives: At the end of this exercise you shall be able to
• understand service and maintainance of PID controllers.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Thermocouple/RTD	- 1 No.
• Wire stripper	- 1 No.	Materials	
• Multimeter	- 1 No.	• Connecting wires	- 1 No.
Equipments/Machines			
• Electronic PID controller	- 1 No.	• Compensating cable	- as reqd.
• Temperature bath	- 1 No.	• Cotton waste	- as reqd.
• Solid state relay (SSR)	- 1 No.		

PROCEDURE

- 1 Review the manufacturer's user manual to understand the recommended maintenance schedule and procedures.
- 2 Power off the controller and disconnect it from the power source before servicing or cleaning it.
- 3 Visually inspect the controller for any signs of wear and tear, loose connections, or other damage. Replace any damaged parts immediately.
- 4 Clean the controller and surrounding area using appropriate cleaning solutions and tools. Avoid using abrasive materials and solvents that may damage the controller.
- 5 Check the wiring connections and ensure that they are secure and free from corrosion or other damage. Clean the wiring connections if necessary.
- 6 Calibrate the controller periodically to ensure that it is functioning accurately. Follow the manufacturer's instructions for calibration.
- 7 Test the controller periodically to ensure that it is working properly. Check the output signals, temperature readings, and other functions.
- 8 Replace the controller's batteries annually or as recommended by the manufacturer.
- 9 Keep a record of all maintenance and servicing activities performed on the controller.

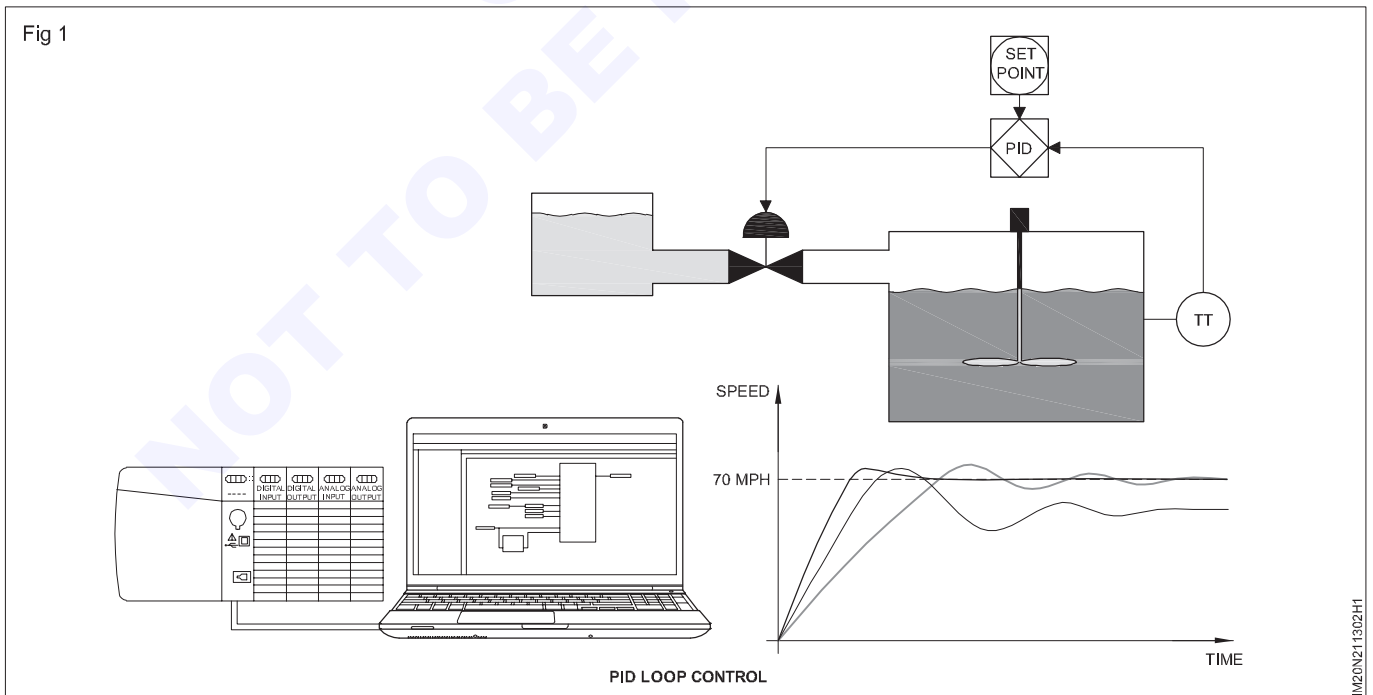
Install, wire up, configure test the control operation using PID electronic/digital controllers

- Objectives:** At the end of this exercise you shall be able to
- understand the installation and wiring of PID controller(digital)
 - understand the construction of a PID controller loop.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Compressor	- 1 No.
• Wire stripper	- 1 No.	• Temperature transmitter	- 1 No.
• Multimeter	- 1 No.	• Thermocouple/RTD	- 1 No.
Equipments/Machines		Materials	
• Electronic PID controller	- 1 No.	• Connecting wires	- 1 No.
• Temperature bath	- 1 No.	• Compensating cable	- as reqd.
• Control valve	- 1 No.	• Cotton waste	- as reqd.
• 1 to P Converter	- 1 No.		

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connections are done as per the circuit diagram
- 5 Pour the water into the temperature bath
- 6 Switch on the power supply, vary the set point and PID parameters using the keyboard in the PID controller
- 7 Note down the output of the PID controller in the observation column



Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

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Verify the steady state and transient response of PID electronic/digital controllers

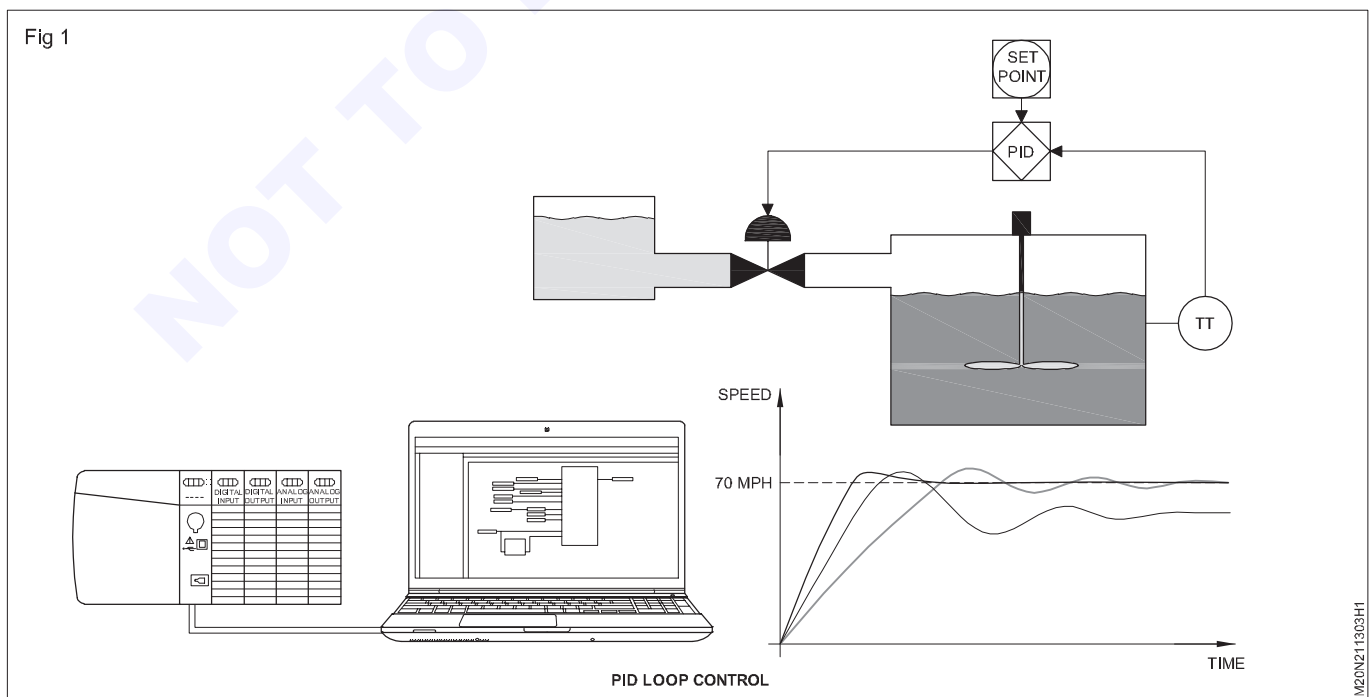
Objectives: At the end of this exercise you shall be able to

- understand steady state and transient response of electronic pid controller.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Compressor	- 1 No.
• Wire stripper	- 1 No.	• Temperature transmitter	- 1 No.
• Multimeter	- 1 No.	• Thermocouple/RTD	- 1 No.
Equipments/Machines		Materials	
• Electronic PID controller	- 1 No.	• Connecting wires	- 1 No.
• Temperature bath	- 1 No.	• Compensating cable	- as reqd.
• Control valve	- 1 No.	• Cotton waste	- as reqd.
• 1 to P Converter	- 1 No.		

PROCEDURE

- 1 Set up the PID controller with the appropriate settings for the mode being tested (P, PI, PD, or PID). These settings usually include gain, integral and derivative time constants, and set point values.
- 2 Apply a step change to the input signal to simulate a disturbance.
- 3 Observe the output signal for the controller's transient response. The response time can be measured from the time when the set point is changed until the output signal reaches steady state.
- 4 Calculate the response time, overshoot, and settling time of the controller. These parameters can help evaluate the controller's transient response and determine if any adjustments are needed.
- 5 Once the controller enters stable or steady-state operation, evaluate its steady-state performance. This will typically involve measuring the output signal's response to changes in the set point.
- 6 Repeat the tests for all the modes of the PID controller (P, PI, PD, and PID) to compare their performance.
- 7 Analyze the test results to determine the most effective mode of the PID controller for the specific application.



Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

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Install, connect pneumatic signal, align and test the control operation using PID pneumatic controller

- Objectives:** At the end of this exercise you shall be able to
- understand operation of PID controller (pneumatic)
 - understand the construction of a PID controller loop.

Requirements

Tools/Instruments

- Screw driver - 1 No.
- Adjustable spanner - 1 No.

- FRL unit - 1 No.
- Control valve - 1 No.

Equipments/Machines

- Pneumatic PID Controller - 1 No.
- Temperature bath - 1 No.
- Thermal bulb - 1 No.

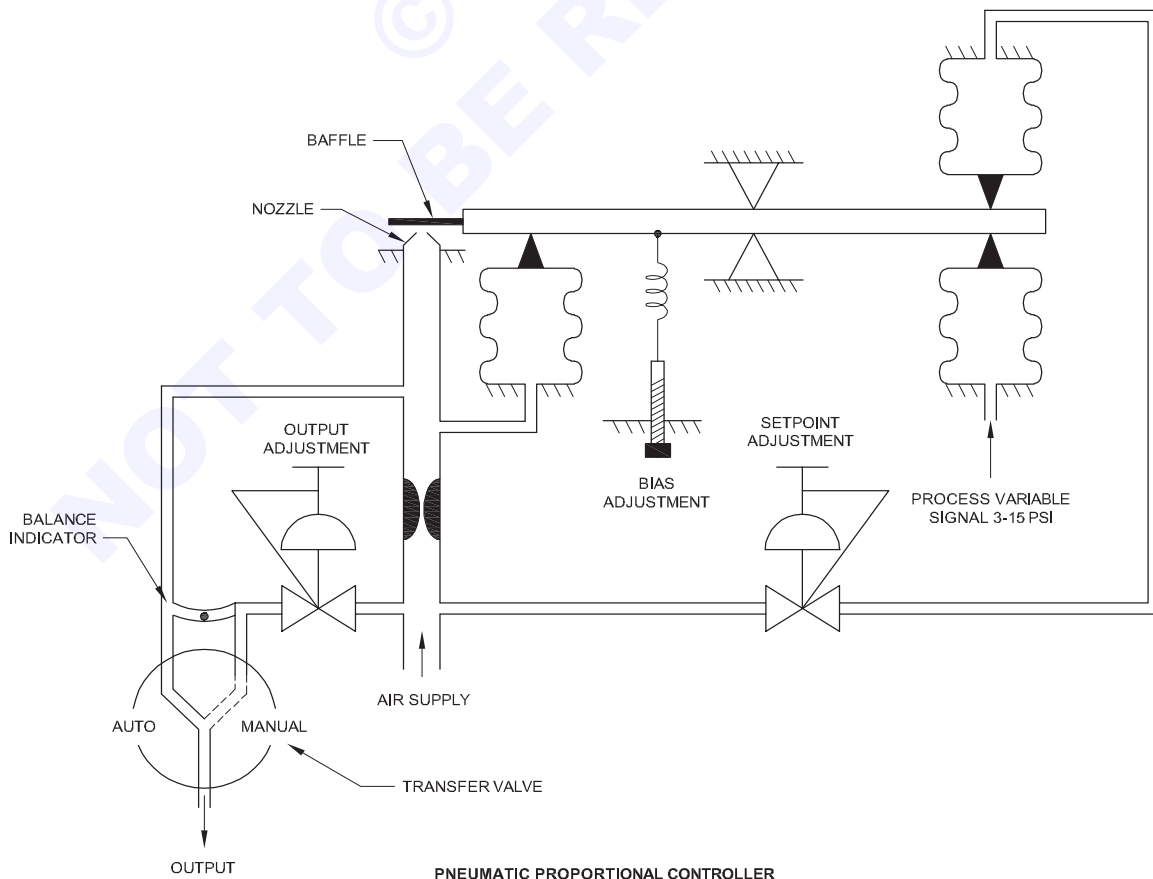
Materials

- Cotton waste - as reqd.
- One touch fitting - as reqd.
- Polyurethane tube - as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connect the thermal bulb to the temperature bath
- 5 Pour the water into the temperature bath
- 6 Connect the output of FRL unit to the input of the controller
- 7 Note down the output of the PID controller in the observation column

Fig 1



INV20N211304/H1

Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

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Verify the steady state and transient response of PID electronic/digital controllers

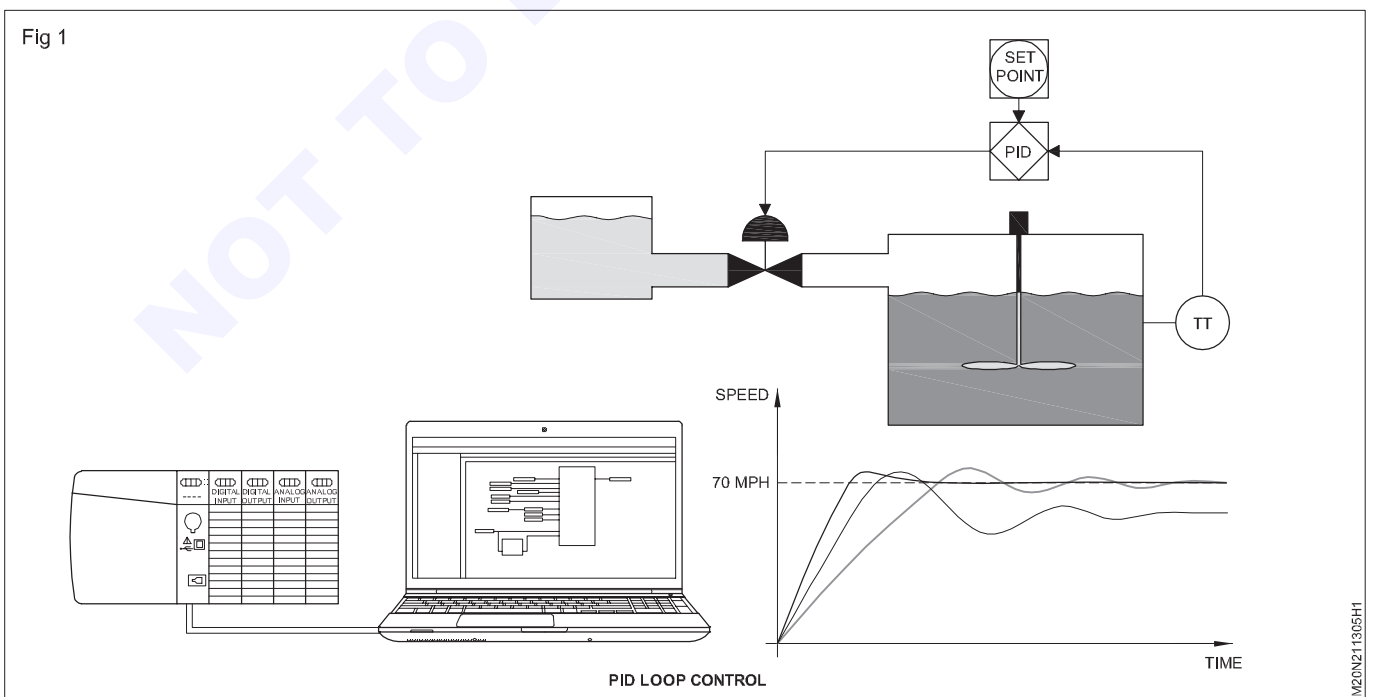
Objectives: At the end of this exercise you shall be able to

- understand steady state and transient response of pneumatic PID controller.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• FRL unit	- 1 No.
• Adjustable spanner	- 1 No.	• Control valve	- 1 No.
Equipments/Machines		Materials	
• Pneumatic PID Controller	- 1 No.	• Cotton waste	- as reqd.
• Temperature bath	- 1 No.	• One touch fitting	- as reqd.
• Thermal bulb	- 1 No.	• Polyurethane tube	- as reqd.

PROCEDURE

- 1 Ensure that the pneumatic PID controller is set up correctly with the appropriate settings for the mode being tested (P, PI, PD, or PID). These settings usually include proportional, integral, and derivative gains, and set point values.
- 2 Apply a step change to the input signal to simulate a disturbance. This can be done by adjusting the valve position or pressure.
- 3 Monitor the output signal of the controller using a pressure transducer or other appropriate measuring instruments. Observe the controller's transient response and calculate the response time, overshoot, and settling time of the controller.
- 4 Monitor the stability and accuracy of the controller's steady-state response using the same instruments. Evaluate how the output signal responds to changes in the set point.
- 5 Repeat the tests for all the modes of the PID controller (P, PI, PD, and PID) to compare their performance.
- 6 Analyze the test results to determine the most effective mode of the PID controller for the specific application.



Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

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Instrument Mechanics - Controllers Modes and Tuning

Perform the control operation in manual and automatic mode

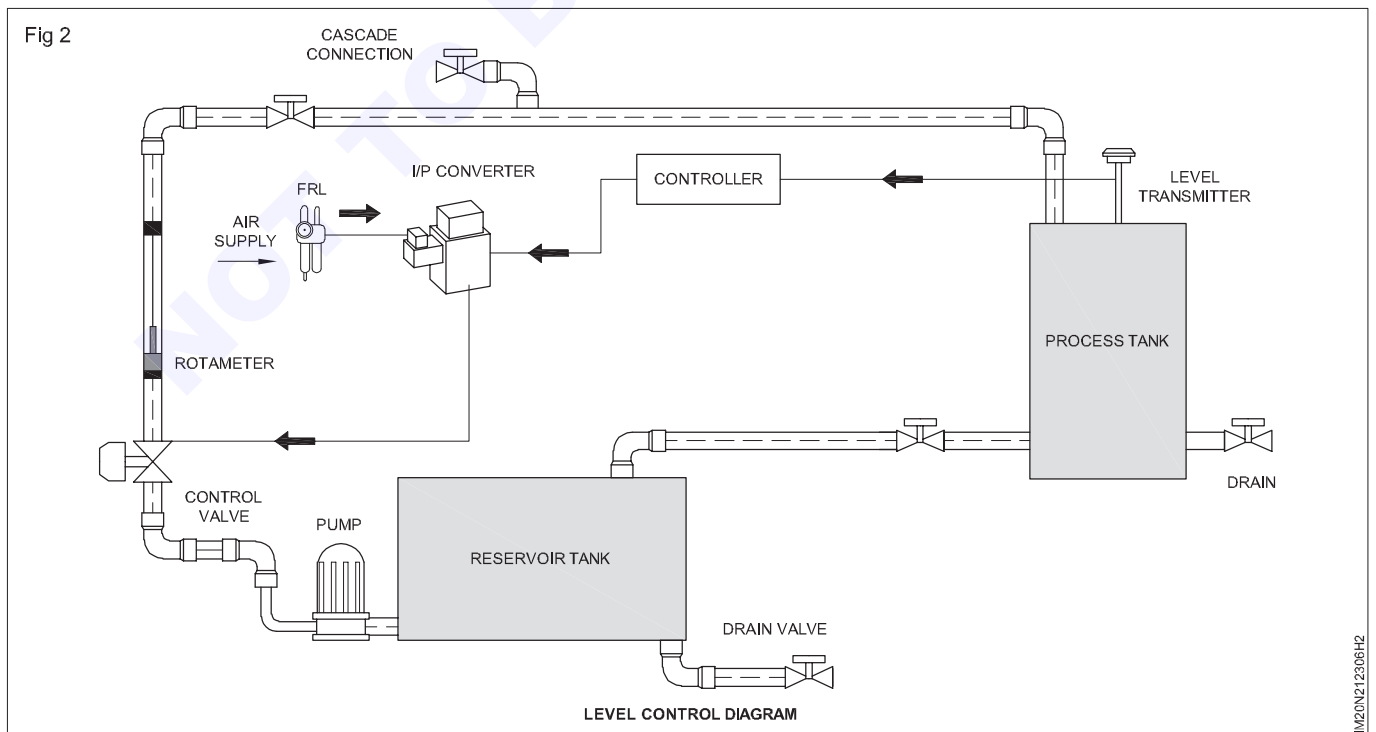
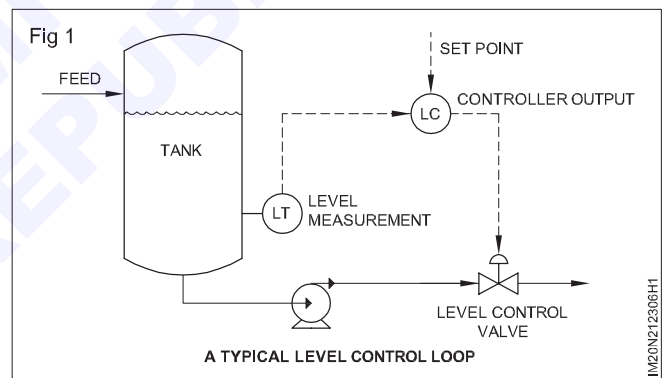
Objectives: At the end of this exercise you shall be able to

- understand the installation and wiring of electronic PID controller (manual and auto mode)
- understand the construction of a PID controller loop.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• 1 to P Converter	- 1 No.
• Wire stripper	- 1 No.	• Level transmitter	- 1 No.
• Multimeter	- 1 No.	• Compressor	- 1 No.
Equipments/Machines		Materials	
• Electronic PID controller	- 1 No.	• Connecting wires	- 1 No.
• Level tank	- 1 No.	• Cotton waste	- as reqd.
• Control valve with electro-pneumatic positioner FRL	- 1 No.	• PU tube	- as reqd.
		• Cotton waste	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments.
- 2 Note down the specification of tools and equipment.
- 3 Check the working condition of the equipments.
- 4 Connections are done as per the circuit diagram.
- 5 Pour the water into the sump tank.
- 6 Switch on the power supply, vary the set point and PID parameters using the keyboard in the PID controller.
- 7 Note down the output of the PID controller in the observation column.



Sl.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

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Instrument Mechanics - Controllers Modes and Tuning

Set optimum setting for unit process in PID controller

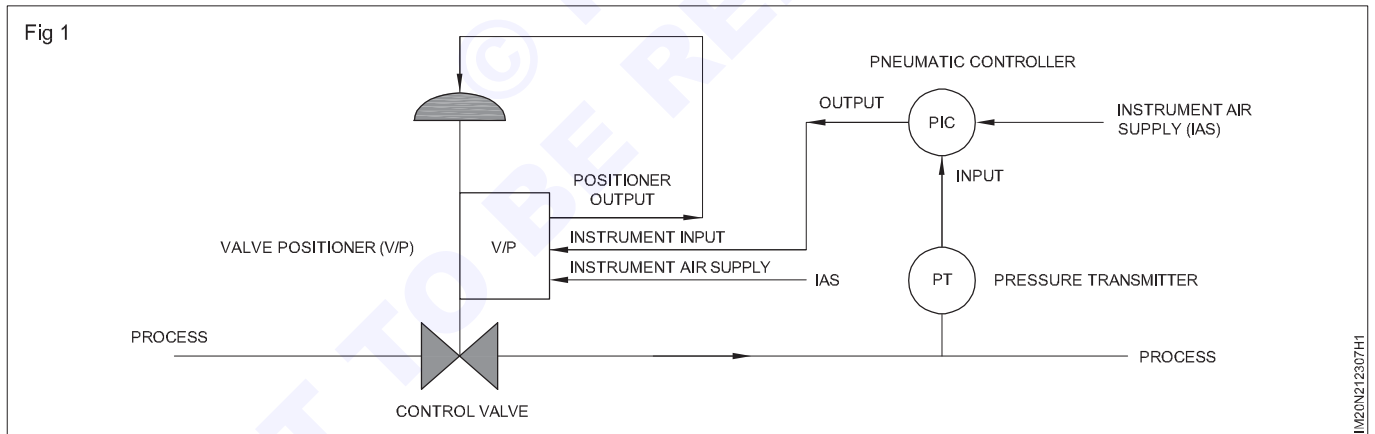
Objectives: At the end of this exercise you shall be able to

- understand the installation and wiring of pneumatic pid controller (manual and auto mode)
- understand the optimum setting for the unit process in pid controller.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Control valve with positioner	- 1 No.
• Adjustable spanner	- 1 No.	• Compressor	- 1 No.
Equipments/Machines		Materials	
• Pneumatic PID Controller	- 1 No.	• Cotton waste	- as reqd.
• Pressure control setup	- 1 No.	• One touch fitting	- as reqd.
• FRL unit	- 1 No.	• Polyurethane tube	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of tools and equipment
- 3 Check the working condition of the equipments
- 4 Connect the tapping of the pressure tank to the bourdon tube of the pneumatic controller
- 5 Give the instrument air supply to the input of the positioner
- 6 Connect the output of the positioner to the control valve
- 7 Note down the output of the PID controller in the observation column.



SI.No.	Setpoint °C	Process Variable (PV)	Proportional Gain (P)	Integral Time (I)	Derivative Parameter (D)	Controller Output (%)

Instrument Mechanic - Programmable Logic Controllers

Connection of field devices to the I/O module of PLC

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

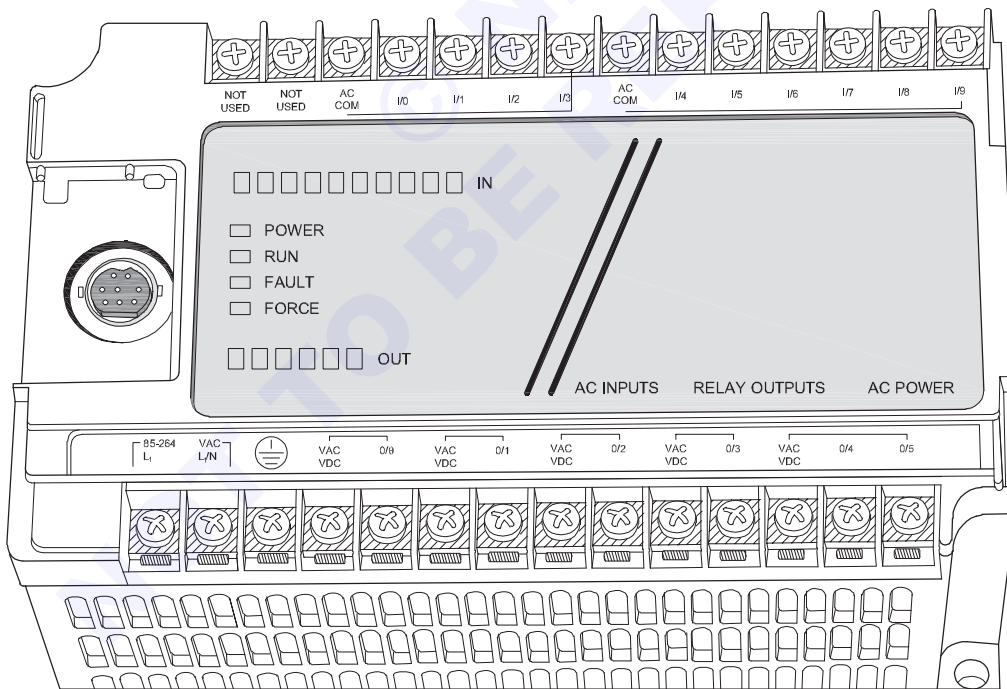
- understand the wiring and connection of I/O devices to the I/O module.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• I/O Devices	- 1 No.
• Wire stripper	- 1 No.	• SMPS	- 1 No.
• Multimeter	- 1 No.		
Equipments/Machines			
• Personal Computer	- 1 No.	Materials	
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• Connecting wire	- 1 No.
		• PLC Communication Cable	- as reqd.

PROCEDURE

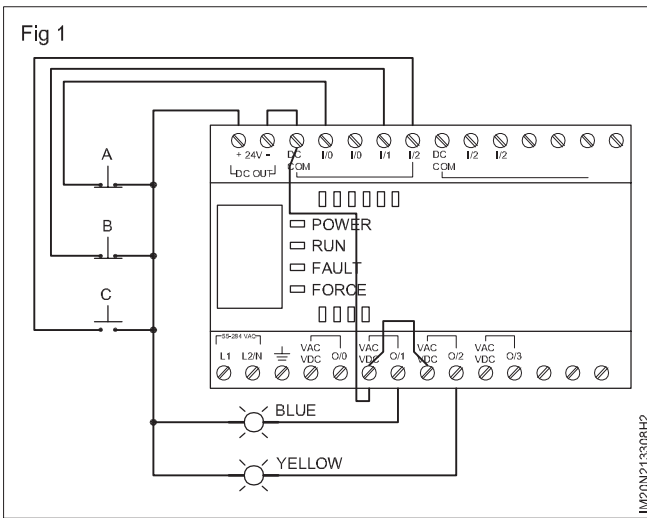
- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC.
- 3 Connect the i/o devices to the PLC I/O module.
- 4 Verify the output voltage of SMPS (24VDC).
- 5 Verify all the connections before switch on the power supply.

Fig 1



IMP20N212308H1

Fig 1



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Install PLC Programming software and establish communication with PC and PLC

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

- understand the installation of PLC software
- establish communication with PC & PLC.

Requirements	
<p>Tools/Instruments</p> <ul style="list-style-type: none"> • RS logix 500 software - 1 No. • RS linux classic - 1 No. <p>Equipments/Machines</p> <ul style="list-style-type: none"> • Personal computer - 1 No. • PLC (Allen Bradley, Micrologix 1000 Series) - 1 No. 	<p>Materials</p> <ul style="list-style-type: none"> • PLC communication cable (RS232/485) - as reqd.

PROCEDURE

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Collect all tools and equipments. 2 Note down the specification of PLC and programming software. | <ol style="list-style-type: none"> 3 Install the programming software. 4 Establish the communication between PC and PLC. |
|---|--|

Hardware configuration and prepare the input and output addresses for each slot

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

- state hardware configuration and preparation of I/O addresses for I/O modules.

Requirements			
Tools/Instruments			
• Screw driver (100 mm)	- 1 No.	• I/O Devices	
• Wire stripper	- 1 No.	• SMPS	
• Multimeter	- 1 No.	Materials	
Equipments/Machines		• Connecting wire	- 1 No.
• Personal Computer	- 1 No.	• PLC Communication Cable	- as reqd.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.		

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software.
- 3 Connect the i/o devices to the PLC I/O module.
- 4 Establish the communication between PC & PLC.
- 5 Start the programming software / RS logix 500 and select the PLC CPU model (Micrologix 1000).
- 6 Construct the ladder diagram and prepare/assign addresses for each I/O devices connected to the I/O module.
- 7 Verify the results.

NOT TO BE REPRODUCED

Instrument Mechanic - Programmable Logic Controllers

Prepare and download ladder programs for various switching gates

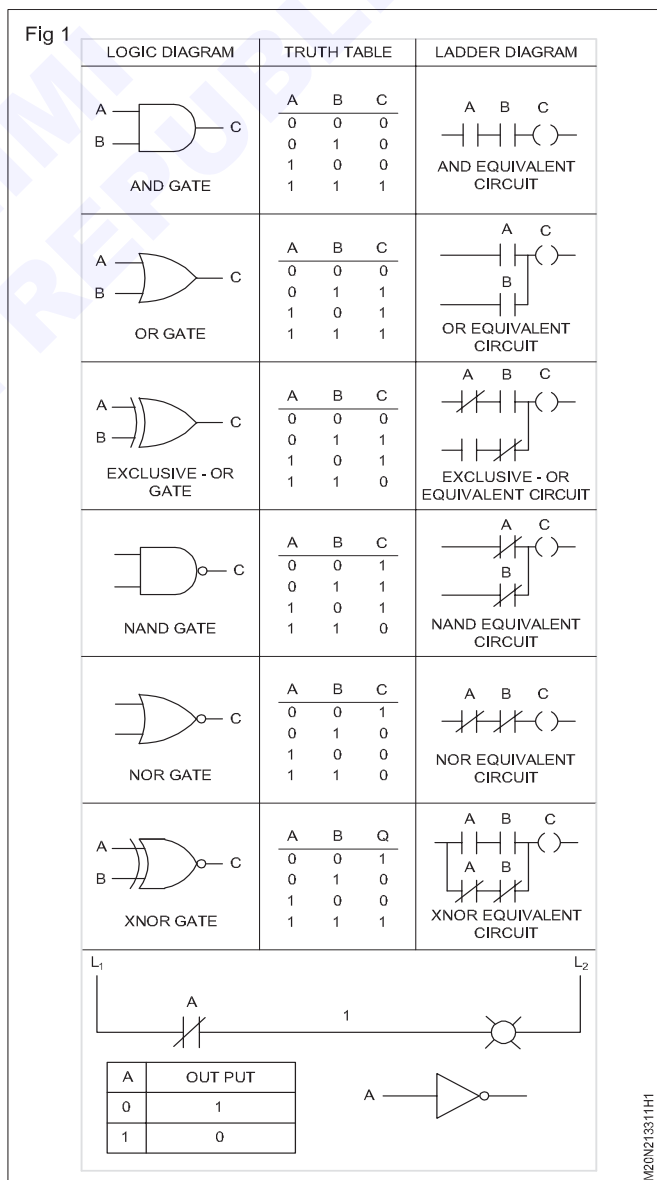
Objectives: At the end of this exercise you shall be able to

- understand the wiring hardware configuration and preparation of input-output addresses for I/O modules
- understand the preparation of ladder diagram for various logic gates (AND, OR, NOT, NAND, NOR, XOR & XNOR).

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
• Wire stripper	- 1 No.	• I/O Devices	- 1 No.
• Multimeter	- 1 No.	• SMPS	- 1 No.
Equipments/Machines			
• Personal computer	- 1 No.	Materials	
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• Connecting wire	- 1 No.
		• PLC communication cable	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the i/o devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC.
- 7 Establish the communication with plc and PC.
- 8 Construct the ladder diagram for different logic gates (AND, OR, NOT, NAND, NOR, XOR & XNOR)
- 9 Address the i/os using the syntax of the allen bradley PLC. i.e., inputs are addressed as I:0/0, I:0/1, I:0/2 etc. and output as O:0/0, O:0/1, O:0/2 etc.
- 10 Download the program into the PLC and verify the truth table for all logic gates (AND, OR, NOT, NAND, NOR, XOR & XNOR).



Write and execute program logic control operation

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

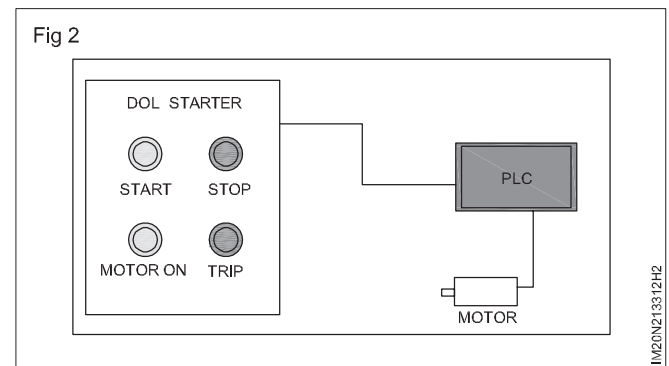
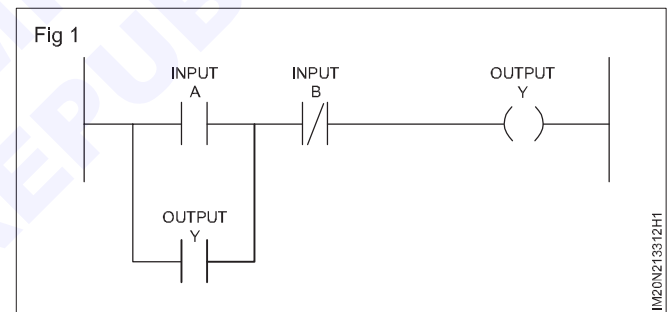
- PLC programming for logical control operation of DOL starter
- understand the preparation of ladder diagram for operation of DOL starter.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
• Wire stripper	- 1 No.	• I/O Devices	- 1 No.
• Multimeter	- 1 No.	• SMPS	- 1 No.
Equipments/Machines		Materials	
• Personal Computer	- 1 No.	• Connecting wire	- as reqd.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for operation of DOL starter
- 9 Two inputs of the DOL starter (Start & Stop) are addressed as I:0/0, I:0/1 and output (Motor or Relay) as O:0/0
- 10 Download the program into the PLC and simulate the program for operation of DOL starter

Ladder diagram for DOL starter



Develop programs using arithmetic/data copy operation and execute

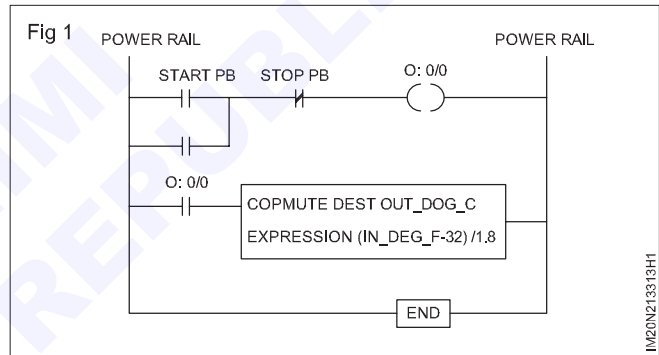
Objectives: At the end of this exercise you shall be able to

- understand the use of arithmetic / data copy instruction.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
• Wire stripper	- 1 No.	• I/O Devices	- 1 No.
• Multimeter	- 1 No.	• SMPS	- 1 No.
Equipments/Machines		Materials	
• Personal Computer	- 1 No.	• Connecting wire	- as reqd.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Verify all the connections before switch ON the power supply.
- 3 Establish the communication between PC & PLC.
- 4 Open the programming software and construct ladder diagram for Fahrenheit to celsius temperature conversion.
- 5 Download and run the program.
- 6 Verify the result.



Write and execute program on sequence control using timers and counters

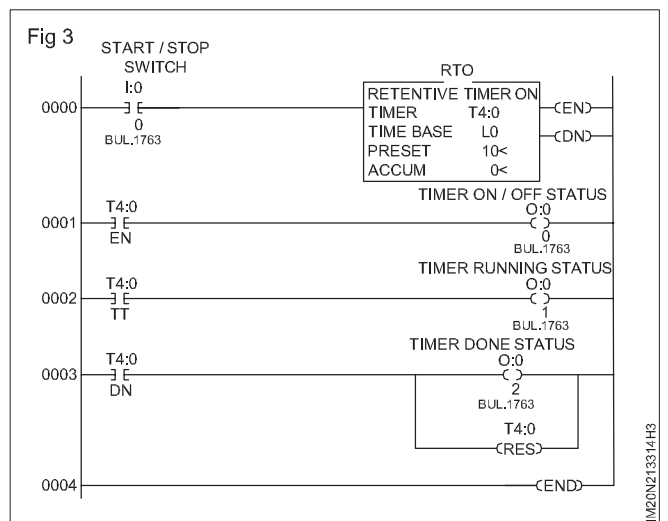
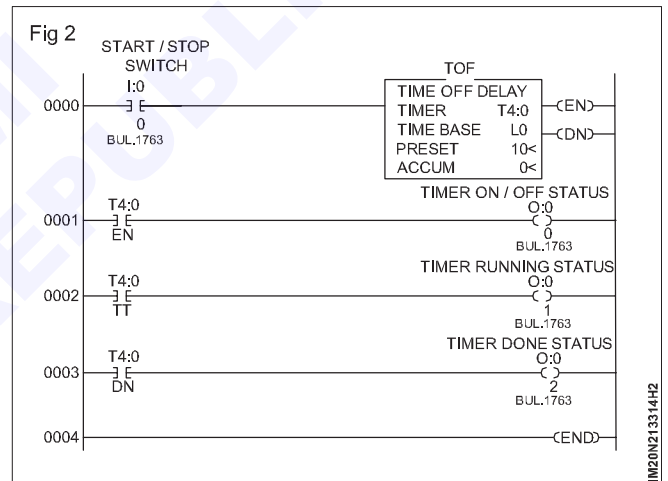
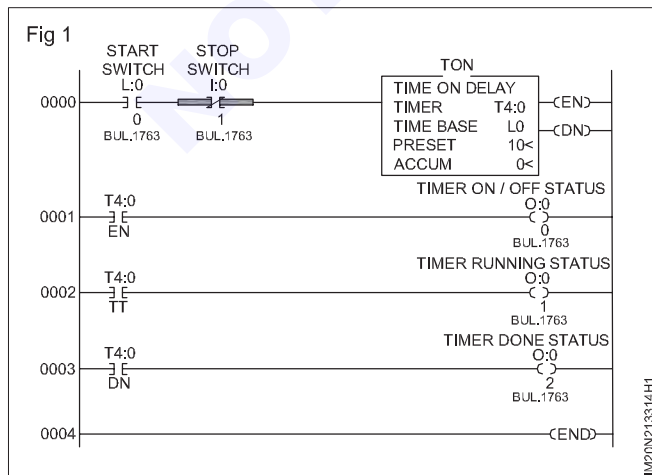
Objectives: At the end of this exercise you shall be able to

- PLC programming for sequence control of timer
- PLC programming for sequence control of counter.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
• Wire stripper	- 1 No.	• I/O Devices	- 1 No.
• Multimeter	- 1 No.	• SMPS	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	Materials	
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• Connecting wire	- as reqd.
		• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the i/o devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with plc and PC
- 8 Construct the ladder diagram for operation of ON -DELAY TIMER, OFF DELAY TIMER & RETENTIVE ON DELAY TIMER.
- 9 Download the program into the PLC and simulate the program for operation of ON -DELAY TIMER, OFF DELAY TIMER & RETENTIVE ON DELAY TIMER.
- 10 Repeat the program execution for UP COUNTER & DOWN COUNTER.



Instrument Mechanic - Programmable Logic Controllers

Develop programs using shift bit operation

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

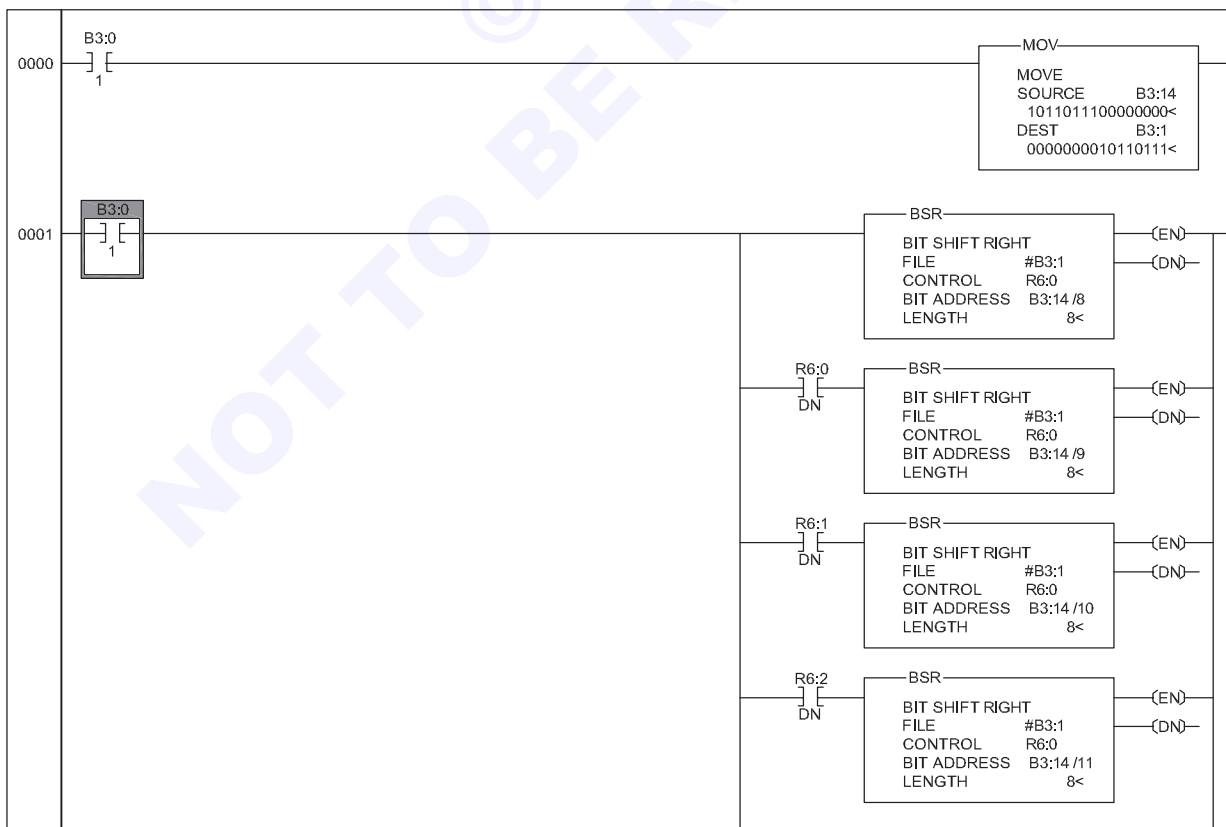
- PLC programming for shift bit operation.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
Equipments/Machines		• I/O Devices	- 1 No.
• Personal Computer	- 1 No.	• SMPS	- 1 No.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	Materials	
		• Connecting wire	- as reqd.
		• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the i/o devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for shift bit operation
- 9 Download the program into the PLC and execute the program for SHIFT BIT OPERATION.

Fig 1



IM20N213315H1

Interface analog o/p module of PLC with actuator, relay

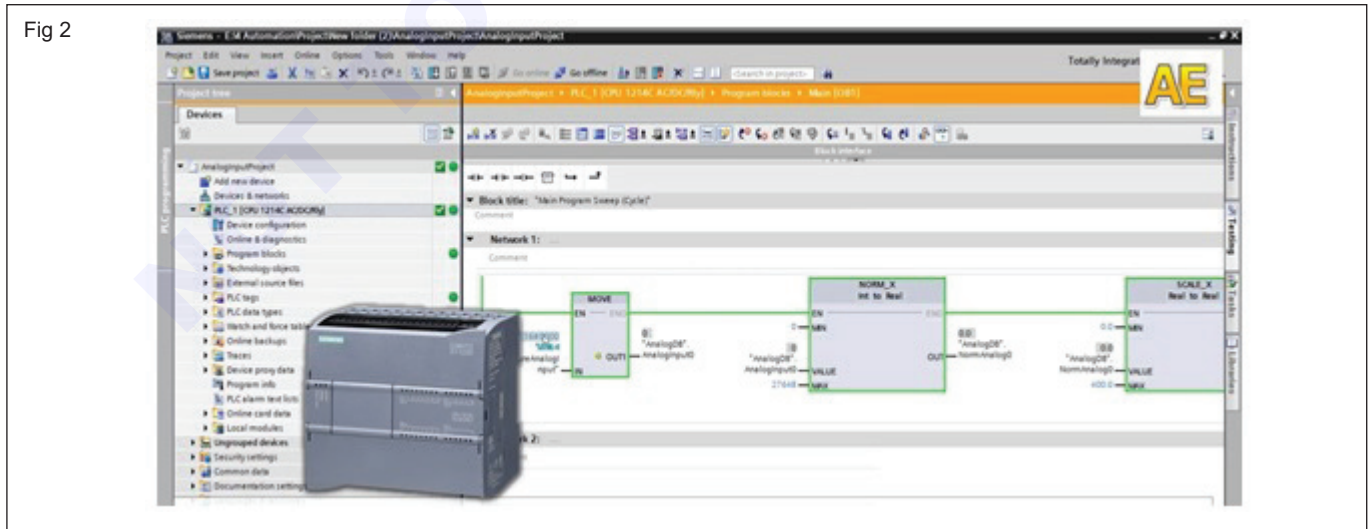
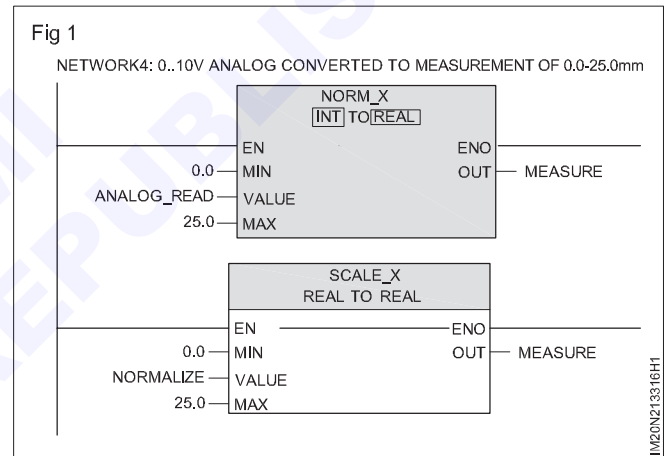
Objectives: At the end of this exercise you shall be able to

- PLC programming for interfacing analog I/Os.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• I/O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• PLC (Siemens, S 1200 series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (Totally integrated automation -TIA)	- 1 No.	• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the i/o devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for analog input interfacing.
- 9 Download the program into the PLC and execute the program for analog input interfacing.



Instrument Mechanic - Programmable Logic Controllers

Prepare programs based on-delay and off-delay timers making on and off of a single LED taking one input and one output

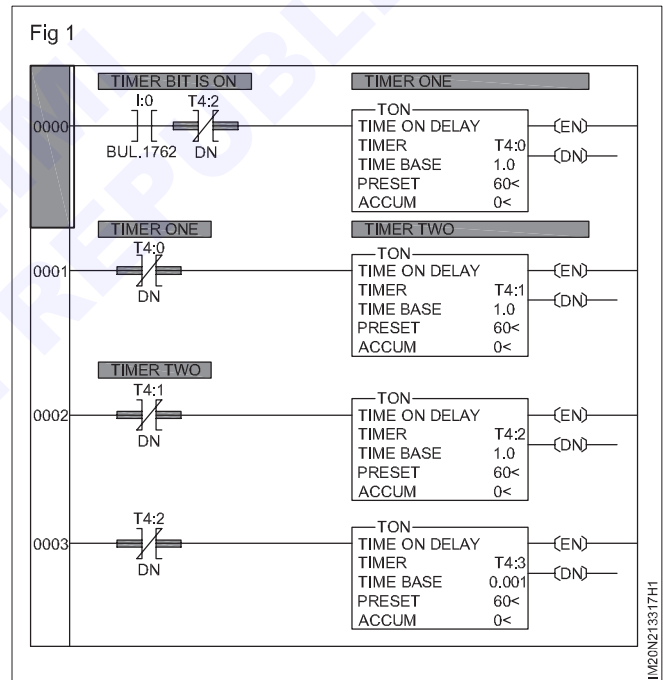
Objectives: At the end of this exercise you shall be able to

- PLC programming on application on-delay/off delay timer.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	• I/O Devices	- 1 No.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• SMPS	- 1 No.
Materials			
		• Connecting wire	- as reqd.
		• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for ring counter
- 9 Download the program into the plc and execute the program of ring counter (Timer execution one after the other)



Two Less on and off using push button as an input

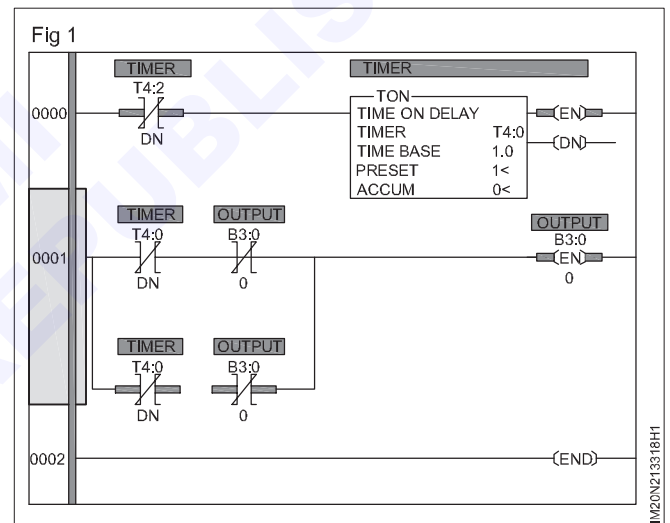
Objectives: At the end of this exercise you shall be able to

- PLC Programming of one output ON-OFF controlled by START-STOP.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	• I/O Devices	- 1 No.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• SMPS	- 1 No.
Materials			
		• Connecting wire	- as reqd.
		• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for blinking circuit.
- 9 Download the program into the PLC and execute the program of blinking circuit (single output on-off).



Instrument Mechanic - Programmable Logic Controllers

Sequencer task using three LEDs as output and two input pushbuttons one as input (NO) for start and other for stop (NO)

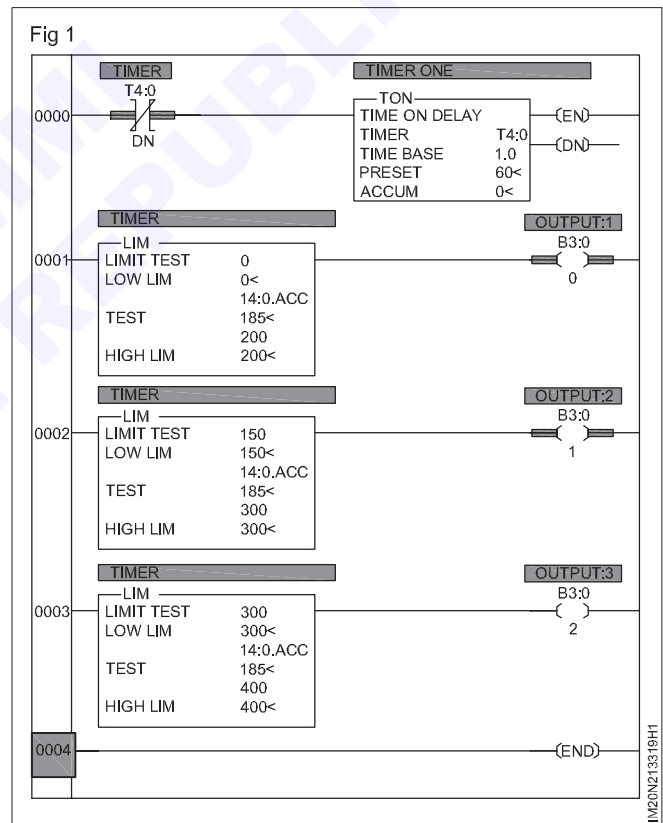
Objectives: At the end of this exercise you shall be able to

- PLC programming on sequencer of task using three output .

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• Programming software (RS logix 500)	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	• I/O Devices	- 1 No.
• PLC (Allen Bradley, Micrologix 1000 Series)	- 1 No.	• SMPS	- 1 No.
Materials			
		• Connecting wire	- as reqd.
		• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for sequencer of task using three outputs
- 9 Download the program into the PLC and execute the program of sequencer of task using three outputs.



Configuring the project using analog input & output instructions

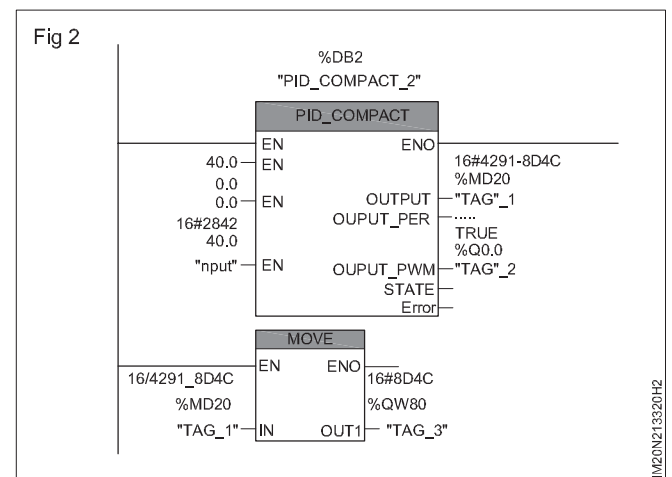
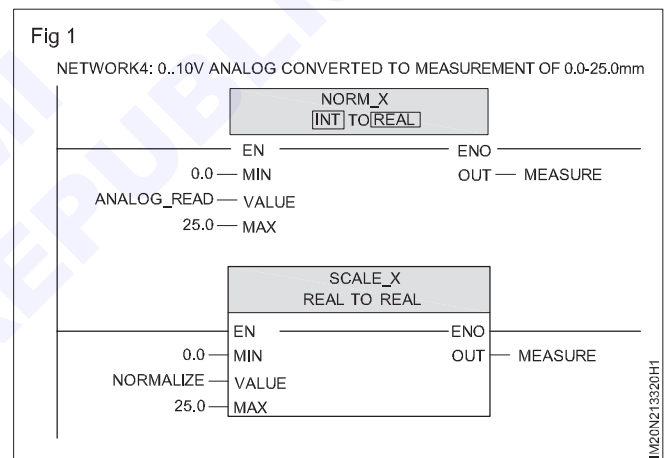
Objectives: At the end of this exercise you shall be able to

- configuring the project using analog input & output instructions.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• I/O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• PLC (Siemens, S 1200 series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (Totally integrated automation -TIA)	- 1 No.	• PLC Communication Cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for configuring the project using analog input & output instructions.
- 9 Download the program into the PLC and execute the program for configuring the project using analog input & output instructions.



Development of ladder logic for task related to timer/counter

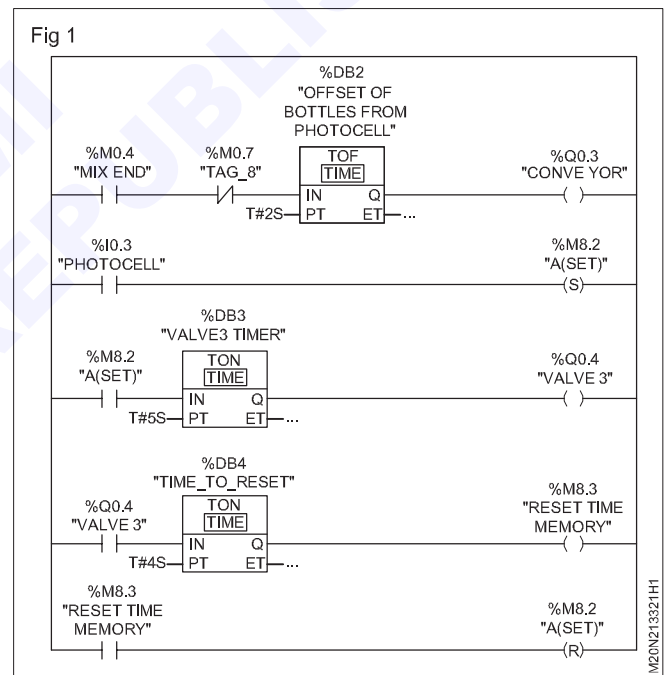
Objectives: At the end of this exercise you shall be able to

- development of ladder logic for task related to timer/counter in progress industry.

Requirements			
Tools/Instruments			
• Screw driver	- 1 No.	• I/O Devices	- 1 No.
Equipment/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• PLC (Siemens, S 1200 series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (Totally integrated automation -TIA)	- 1 No.	• PLC Communication cable	- 1 No.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software to the PC
- 7 Establish the communication with PLC and PC
- 8 Construct the ladder diagram for development of ladder logic for task related to timer/counter in process industry
- 9 Download the program into the plc and execute the program for development of ladder logic for task related to timer/counter in process industry.



Installing and operating HART transmitters / devices (I/O)

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

- install HART transmitters / devices (I/O)
- operation of HART transmitters.

Requirements			
Equipments/Machines		Materials	
• HART Transmitters / devices (Pressure , Level , flow)	- 1 No.	• Pipeline	- 1 No.
		• R & 232 cable , multimeter PC with software	- 1 No.

PROCEDURE

TASK 1: General Procedure for installation

In general, the installation practice for wired HART devices is the same as for conventional 4 – 20 mA instrumentation. Guidelines for a wired HART installation involve:

- Use shielded twisted pair cabling with proper conductor size
- Grounding at one point only
- Ensure a properly specified power supply.
- Stay below the maximum allowable cable length which depends upon the cable capacitance and the number of network devices.

Typical Wiring Connection using a HART Field Device, a PC with a PC based application and a Handheld Terminal. Also shown is a required HART interface or Modem – either RS 232 or USB version.

Installation Procedure For pressure Transmitter

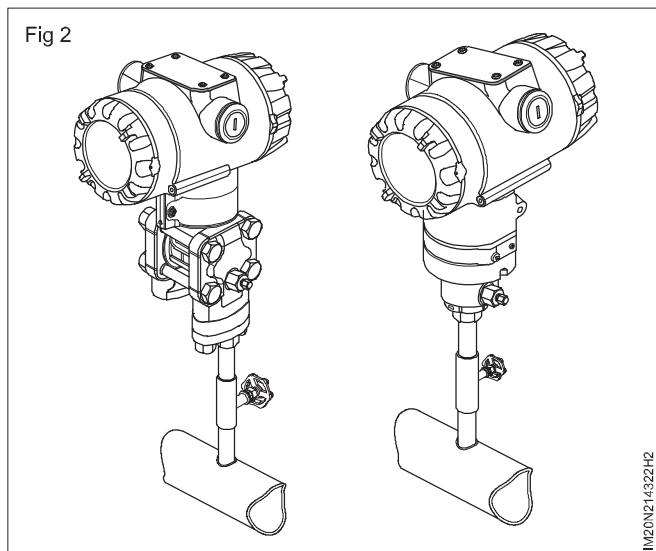
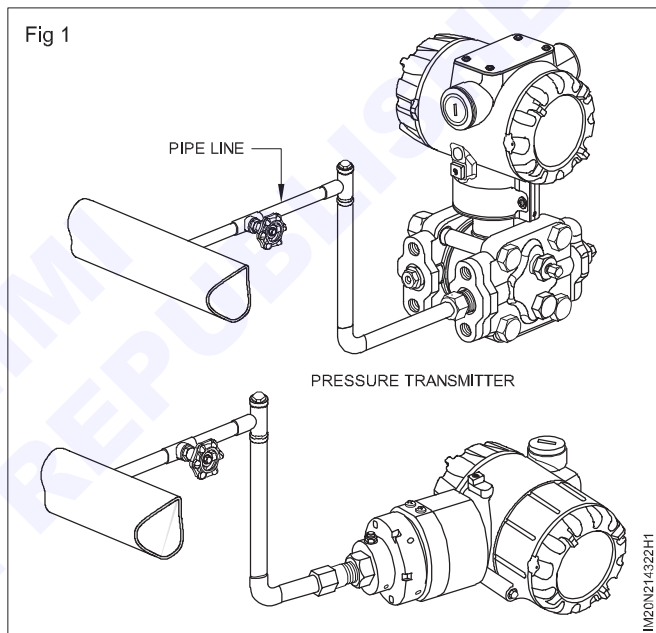
Pressure or absolute pressure measurement of a condensable vapor in a pipe

- Place the tap at the side of the line as shown in Fig 1
- Mount the transmitter (both pressure and differential pressure transmitter) below the tap.
- Connect the + (H) side of the transmitter to the pipe.
- Fill the vertical section of the connecting line to the tap with a compatible liquid through the dedicated filling tee.

Gauge or absolute pressure measurement of condensable vapor. (Fig 1)

Installation of Pressure or absolute pressure measurement of a gas in a pipe

- Place the tap at the top or side of the line.
- Mount the transmitter (both pressure the differential pressure transmitter) beside or above the tap
- Connect the transmitter to the pipe as shown in Fig 2

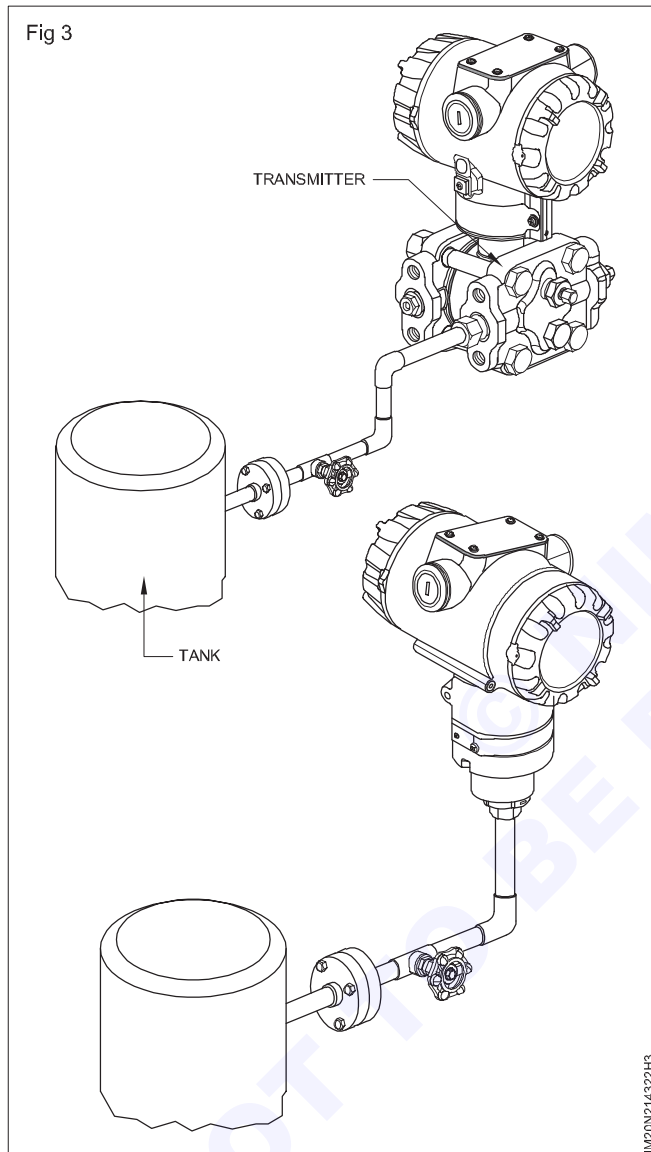


Gauge or absolute pressure measurement setup diagram of gas in a pipe (Fig 3)

Pressure or absolute pressure measurement of a tank

- Place the taps in the upper part of the tank.
- Mount the transmitter above the elevation of the process tap (both pressure and differential pressure transmitter can be used).
- Connect the transmitter to the tank.

Set up diagram of Gauge or absolute pressure measurement on a tank (Fig 3)



Installation of Pressure or absolute pressure measurement of a liquid in a pipe

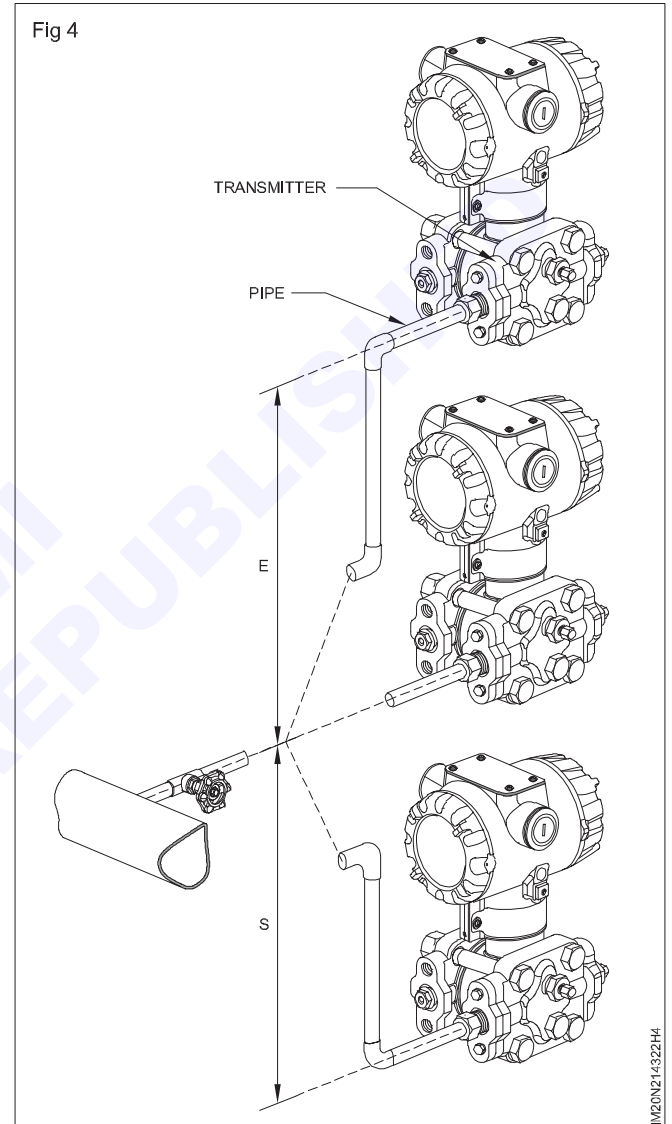
- Place the tap at the side of the line.
- Mount the transmitter (both pressure and differential pressure transmitters) beside or below the tap for clean fluids, above the tap for dirty fluids.
- Connect the + (H) side of the transmitter to the pipe.

Set up diagram of Gauge or absolute measurement of a liquid in a pipe (Fig 4)

For flow Transmitter Installation procedure

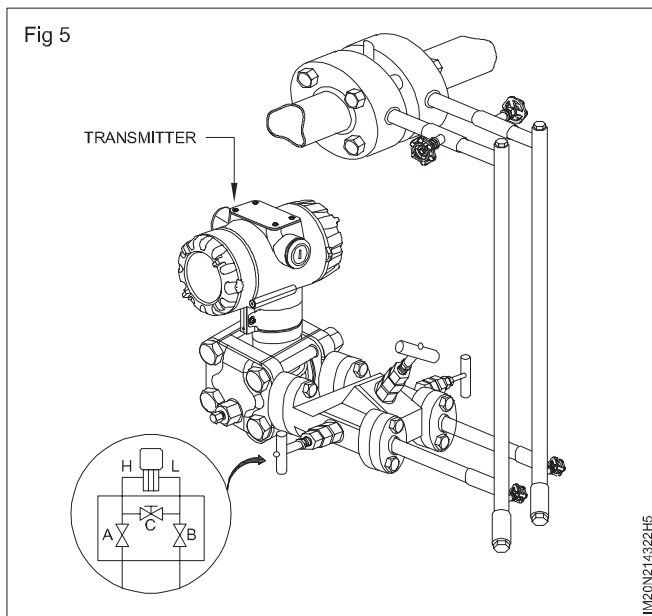
Steam (condensable vapor) or clean liquids flow measurement

- Place taps to the side of the line.
- Mount beside or below the taps.
- Mount the drain/ vent valve upward.
- In case of steam application fill the vertical section of the connecting lines with a compatible fluid through the filling tees.



The process fluid must enter the transmitter primary:

- 1 Open equalizing valve (C)
 - 2 Close low pressure (B) and high pressure (A) valves.
- Open gate valves
- 3 Slowly open high pressure (A) valve to admit process fluid to both sides of primary.
 - 4 Vent or drain the primary unit and then close the valves
 - 5 Open the (B) valve and close the equalizing valve.
- Stream or clean liquids from measurement (Fig 5)



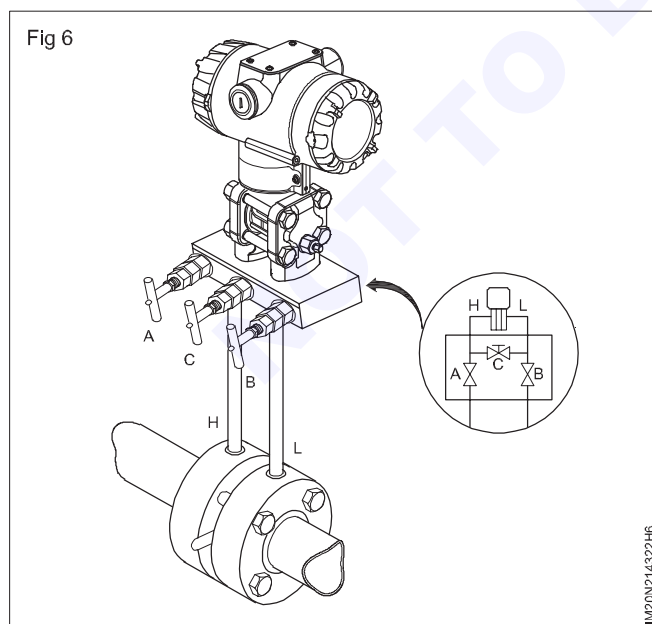
Installation procedure of Gas or liquid (with solids in suspension) flow measurement

- Place the taps to the top or side of the line.
- Mount the transmitter above the taps.

The process fluid must enter the transmitter primary:

- 1 Open equalizing valve (C)
- 2 Close low pressure (B) and high pressure (A) valves.
- 3 Open gate valves
- 4 Slowly open high pressure (A) valve to admit process fluid to both sides of primary.
- 5 Vent or drain the primary unit and then close the valve.
- 6 Open the (B) valve and close the equalizing valve.

Gas or liquid flow measurement (transmitter and manifold) (Fig 6)

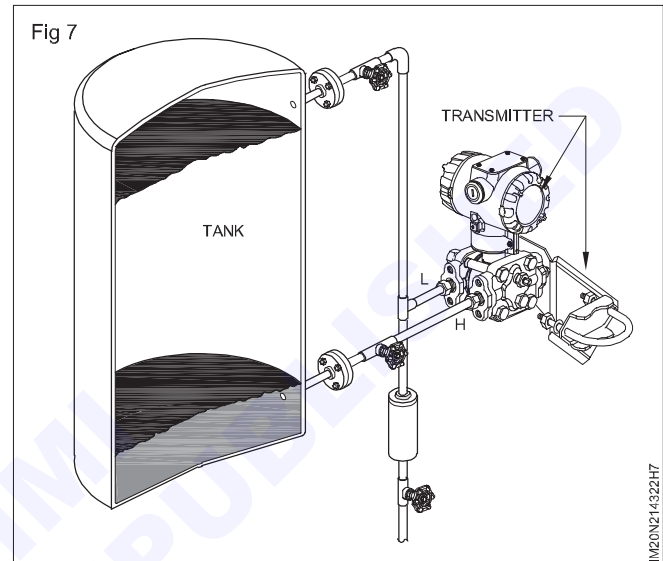


Procedure for Liquid level Transmitter:

Liquid level measurements on closed tanks and non condensable fluids (dry leg)

- Mount the transmitter at the same height or below the lowest level to be measured.
- Connect the + (H) side of the transmitter to the bottom of the tank
- Connect the – (L) side of the transmitter to the upper part of the tank, above the maximum level of the tank.

Setup diagram of Level measurement on closed tank with dry leg (Fig 7)



Liquid level measurement with closed tanks and condensable fluids (wet leg)

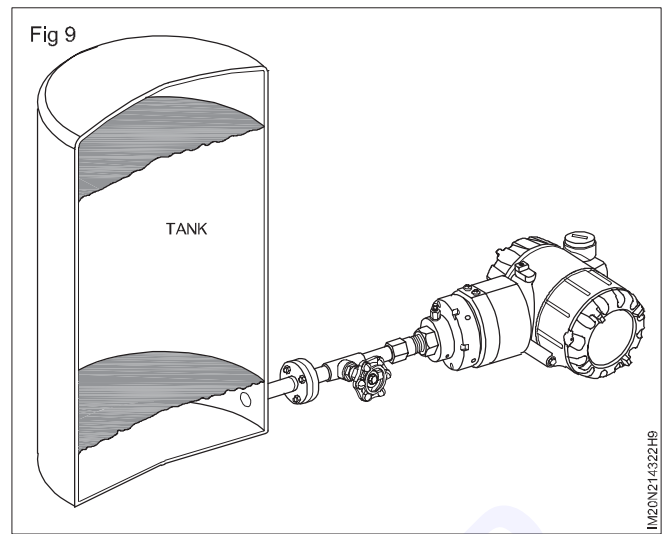
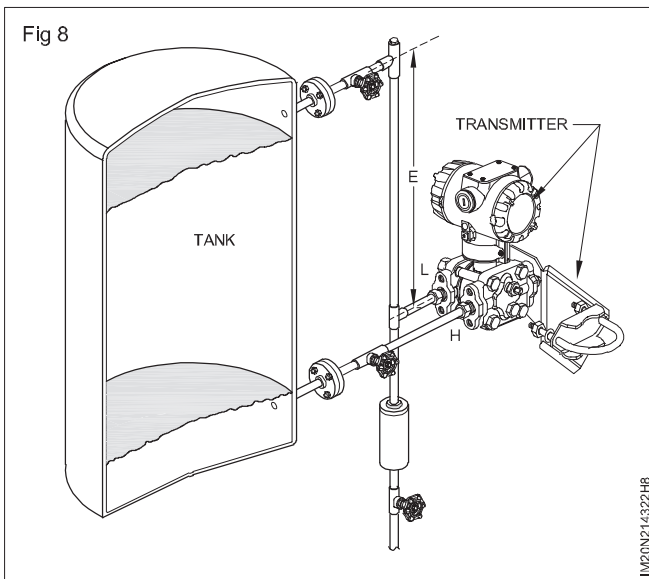
- Mount the transmitter at the same height or below the lowest level to be measured.
- Connect the + (H) side of the transmitter to the bottom of the tank.
- Connect the – (L) side of the transmitter to the upper part of the tank.
- Fill the vertical section of the connecting line to the upper part of the tank with a compatible liquid through the dedicated filling tee.

Setup diagram of Level measurement on closed tank with wet leg (Fig 8)

Liquid level measurement with open tanks

- Mount the transmitter at the same height or below the lowest level to be measured
- Connect the + (H) side to the bottom of the tank.
- Vent the “-“ (L) side of the transmitter to the atmosphere (in this case a gauge pressure is shown: the (L) side is already vented to the atmosphere).

Setup diagram of Level measurement on open tank with P style transmitter (Fig 9)



TASK 2: Operation of HART Transmitter (Temperature (Fig 1))

- 1 First fill the water in the reservoir tank.
- 2 Connect the RS 232 cable from temperature unit to PC
- 3 Switch ON the unit.
- 4 Open the software from PC
- 5 Switch on the pump

SI.No	Voltage (v)	Temperature (c)

- 6 Set the minimum flow rate in rotameter
- 7 Select the "PID" mode option from control menu in the software.
- 8 Switch ON the heater.
- 9 Apply the set point from 0 to 100%

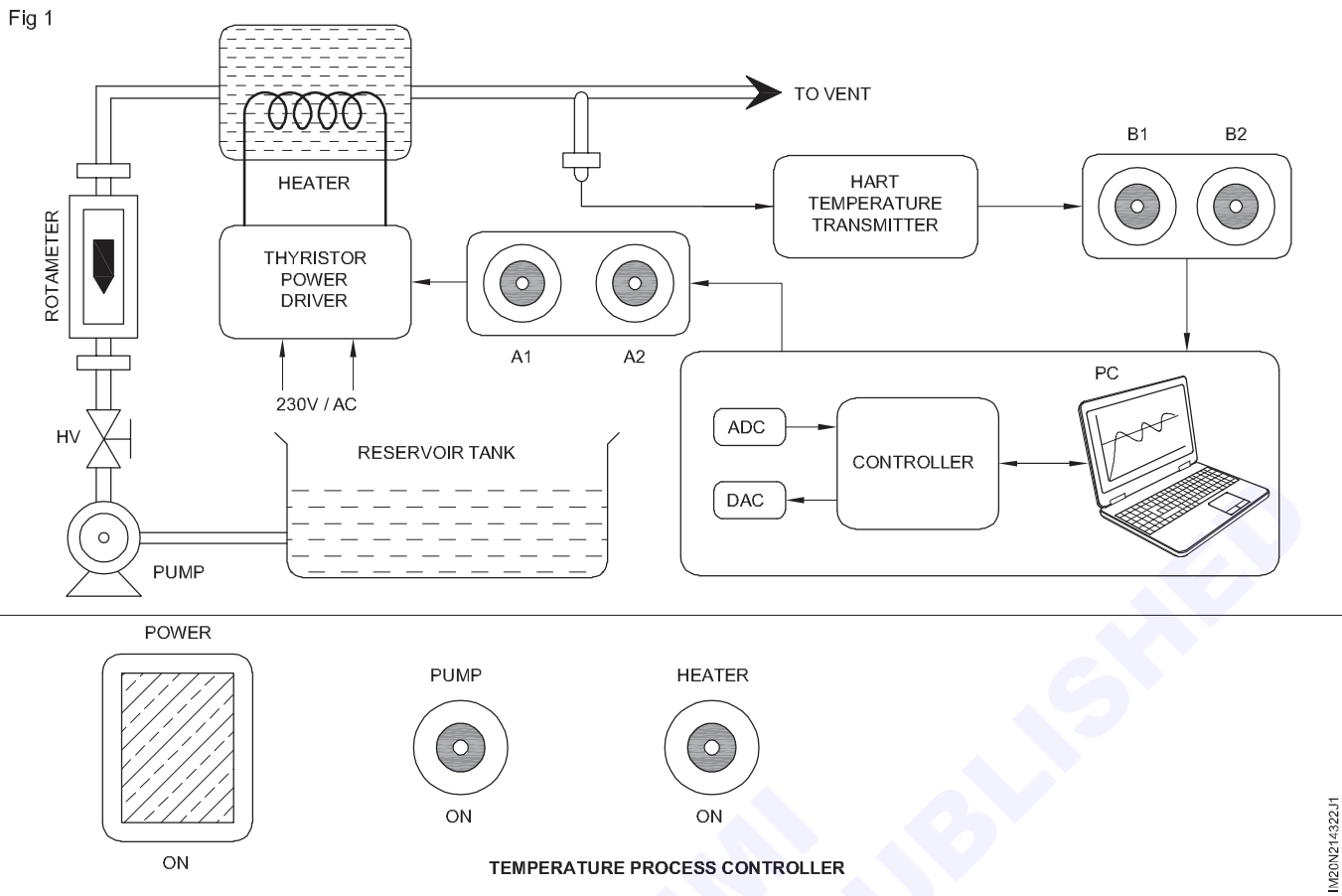
- 10 Change the proportional band, integral time, derivate time and observe the response of the process for each change in settings.
- 11 Note down the reading between temperature and voltage then plot the graph
- 12 Switch off the heater and pump.

Note:

- To change the transmitter range or span value through HART communicator we can create tan and configuring the parameters.
- Details will be explained in EX. NO. 323.

HART Transmitter – Safety Precautions:

- Check the supply voltage.
- Note down cable connection.
- If a transmitter is used for process control using a control valve, then put the PID controller in manual mode.
- Verify transmitter tag number.
- After completing the process remove from line "switch off" the transmitter and clean it.



Creating tag, measuring the parameter, configuring the parameter values in HART transmitter using communicator

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

- able to create tag
- able to change measuring values and configuring parameters.

Requirements			
Equipments/Machines			
• HART Transmitter	- 1 No.	• HART Communicator	- 1 No.

PROCEDURE

TASK 1 : Creating tag

- Clean the working table
- Clean “HART Transmitter” Hart communicator and put on the table.
- Connect 24 vdc to HART transmitter and switch “ON” it.
- Switch on the HART communicator.
- Communicator display shows main menu with some sub menu.
- Double tab “HART Application” from main menu.
- Select Device setup > Basic setup > Tag > device name [enter device name] > Enter.
- Observe the display “Tag with device name”.
- Observe that “tag will be created”.

TASK 2: Measuring the parameter and configuring parameter values

- Clean the working table.
- Clean the HART Transmitter, HART communicator and put on the table.
- Connect 24vdc to HART transmitter and switch on the transmitter.
- Switch on the communicator.
- 4 The device revisions available selected device model is listed.
- 5 Double tap the desired device revision.
- 6 If a warning appears, thoroughly read the warning
- 7 Mark (select) the configurable variables you want sent to the device; Double tap Mark all OK to have all variables marked. Double tap Unmark all OK to clear the marks from all variables.

To start the HART Application:

- 1 Press and hold the Power key until the green light on that key blinks to turn on the 475 Field Communicator.
- 2 Double tap HART Application from the Field Communicator main menu.

HART Diagnostics functions. From HART Application main menu.

HART Application Main menu (Fig 1)

To create a new HART configuration while working offline:

- 1 From the HART Application main menu, double tab Offline.
- 2 The manufactures names of the installed device descriptions are listed.
- 3 Double tap the desired device model to expand the list.

- To mark and edit variables individually:
- a Double – tap Edit individually:
 - b Scroll through the list of variables and select the variable you want to mark or edit. Tap EDIT, change the value, and tap ENTER. A
 - c Symbol appears next to the variable name and the value is highlighted yellow to indicate the change has not been saved.
- To mark the selected variable, tap MARK. A “+” symbol appears next to the value.
- d Repeat these steps for other variables as necessary and tap EXIT when you are finished.
 - 8 To save the configuration, double tap Save us. (The SAVE button brings you to the Save as menu.)

- a To change the location where the configuration is saved, double – tap Location, select an option, and tap Enter.
- b To specify a name for the configuration, double-tap Name, enter the name, and tap ENTER.
- c Tap SAVE.

Online menu displays important information; some sub-menus display the HOME button to return you to the HART Online menu

- Observe communicator online menu with submenu
- Device setup already completed in TASK 1

- Select process variable (PV)
- Press save option to measure process variable.
- Select LRV for setting lower range value and press save option to set the value.
- Select URV for setting upper range value and press save option to set the value.
- To consign parameter values press, save option.

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Preparation network cables and connectors testing network cables

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

- identify the cable types
- identify the network components
- prepare a UTP cross cable ends for making connection to the computer
- test the cable with LAN tester.

Requirements			
Tools/ Equipments/Instruments		Materials	
• Desktop computers	- 2 Nos.	• RJ – 45	- 1 No.
• Crimping tool	- 1 No.	• RJ – 11	- 1 No.
• LAN tester	- 1 No.	• Coaxial cable	- as reqd.
• Modem	- 1 No.	• UTP cable	- as reqd.
• Hub	- 1 No.	• STP / Optical	- as reqd.
• Router	- 1 No.		
• Switch	- 1 No.		

PROCEDURE

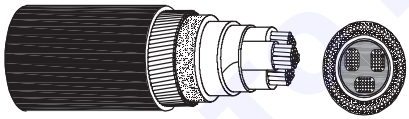
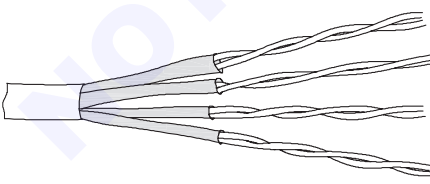
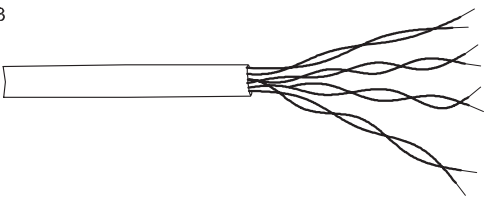
TASK 1 : Identification of different types of cables

- 1 Pick one of the labelled cable form the given lot and identify the types.
- 2 Record the observations in the table 1 (Refer to the Chart -1 to identify the name of the cable).
- 3 Repeat the steps 1 of 2 for remaining labelled cables.
- 4 Get the work checked by the instructor.

Table 1

SI No.	Label No	Type Name	Remarks
1			
2			
3			
4			
5			

Chart 1

Various network cables	Name of the cable
<p>Fig 1</p>  <p>FLAT ARMORED CABLE</p> <p>IM20N214324T1</p>	
<p>Fig 2</p>  <p>IM20N214324T2</p>	
<p>Fig 3</p>  <p>IM20N214324T3</p>	

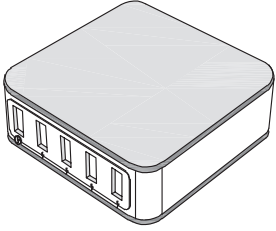
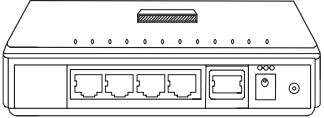
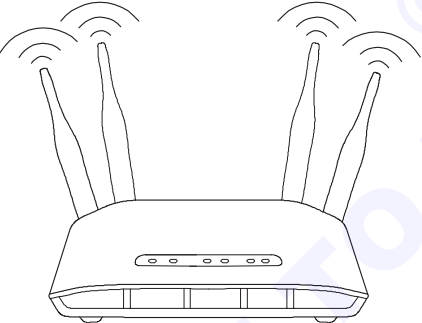
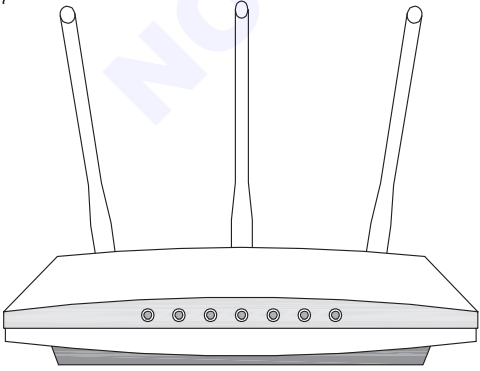
TASK 2: Identification of various devices used in networking

- 1 Follow the steps in TASK 1 (instead of cable use labelled network devices/components)
- 2 Refer chart-2 and record the observation using Table 2
- 3 Repeat the steps for remaining labelled devices.
- 4 Get the work checked by the Instructor

Table 2

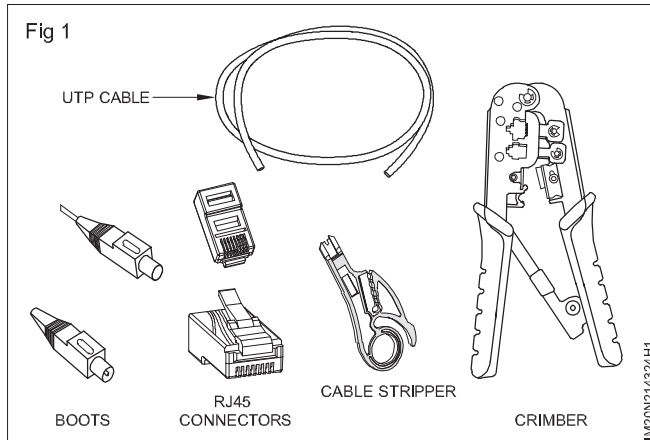
S.I NO.	Label No	Type /Name of device/ components	Remarks
1			
2			
3			
4			
5			

Chart 2

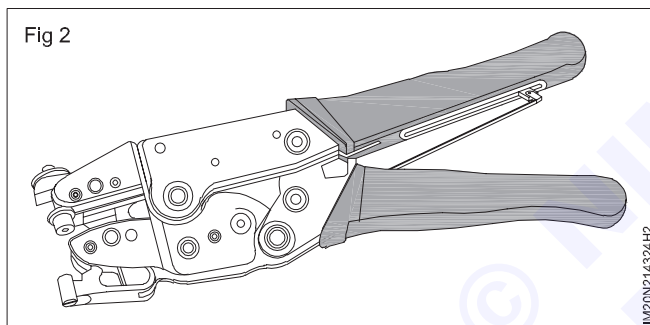
Various network cables	Name of the cable
<p>Fig 4</p>  <p style="text-align: right; font-size: small;">IM20N214324T4</p>	
<p>Fig 5</p>  <p style="text-align: right; font-size: small;">IM20N214324T5</p>	
<p>Fig 6</p>  <p style="text-align: right; font-size: small;">IM20N214324T6</p>	
<p>Fig 7</p>  <p style="text-align: right; font-size: small;">IM20N214324T7</p>	

TASK 3: Prepare a UTP cross cable ends for making connection to the computer

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



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

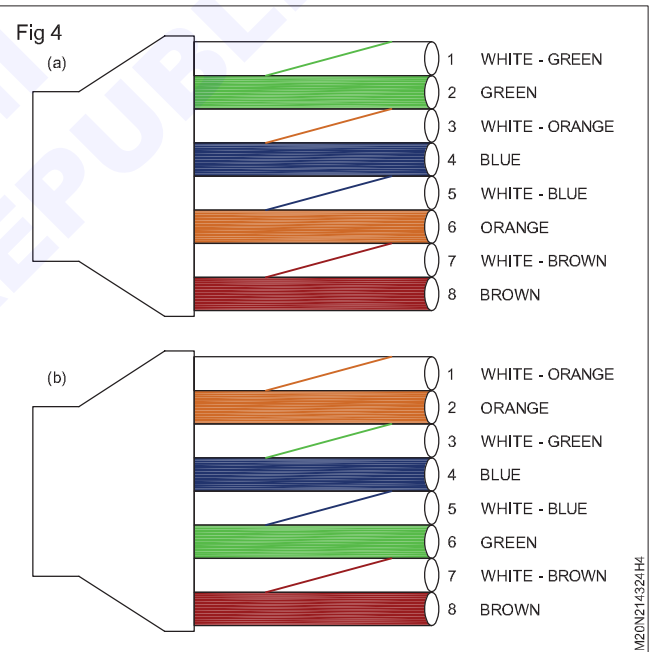
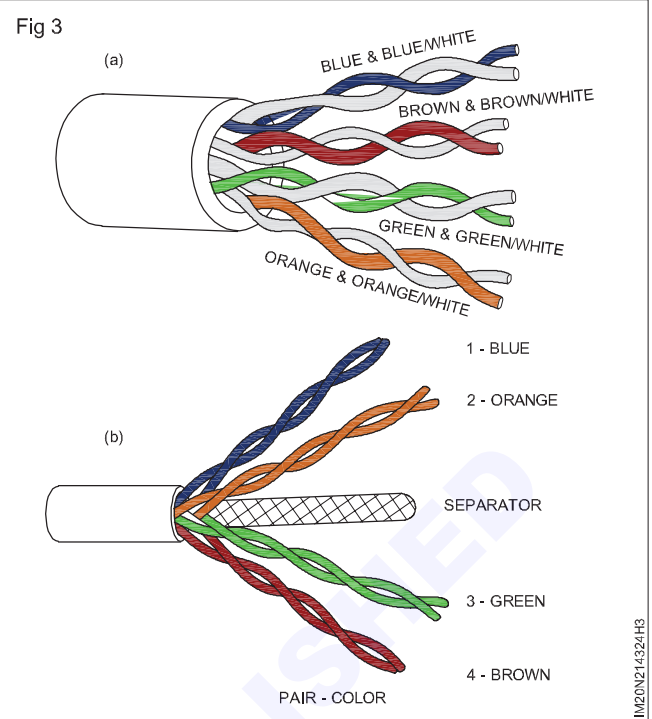


Crimp tools have two blades. One designed to cut the cable and other to strip the jacket. While stripping the cable care should be taken not to cut the internal wires. Remove the jacket insulation about an inch. When the jacket insulation removed you will find eight wires twisted into four pair for CAT 5 cable as in fig 3a and a separator inside the CAT 6 cable as shown in Fig 3b.

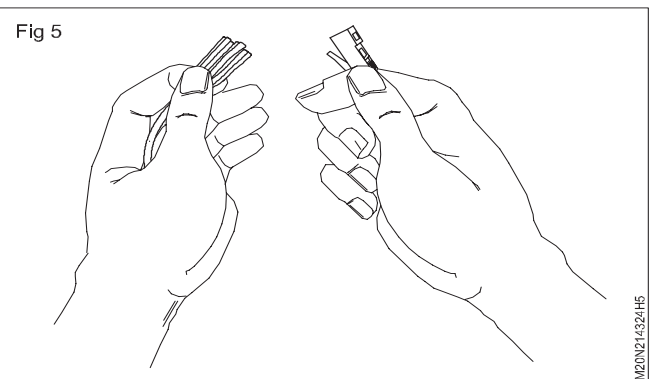
- 2 Cut the separator off and untwist the wires back to within one-eighth inch of the jacket.
- 3 Arrange the wires from left to right in the order they are to be crimped. The normal crimping order for cross cable is shown in fig 4a & fig 4b.

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

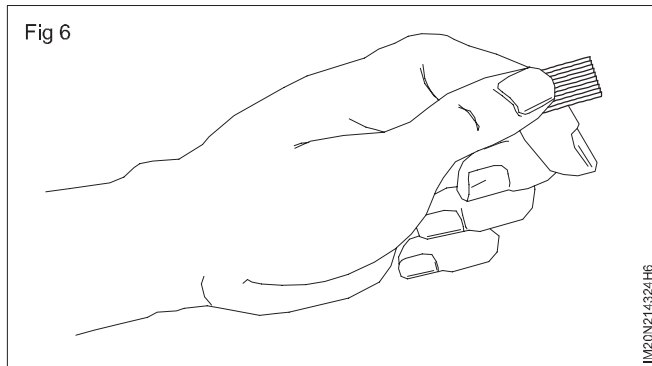
- Cross over cable
 - One end
- 4 Grasp the wires firmly between your fingers and flatten them to remove the curliness



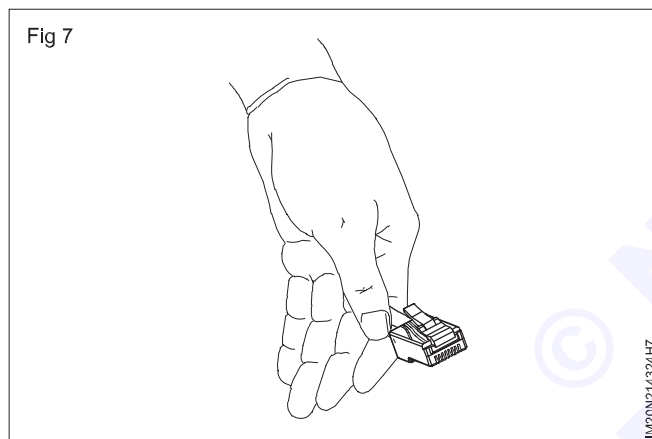
The wires must lay flat and together aligned as closely as possible in order. when finished the cable should look like as shown in Fig 5.



- 5 Cut a few mm while holding them firmly, so they are all of the same length as shown in Fig 6.
- 6 Slide the RJ45 connector on to the wires making sure the wires stay lined up

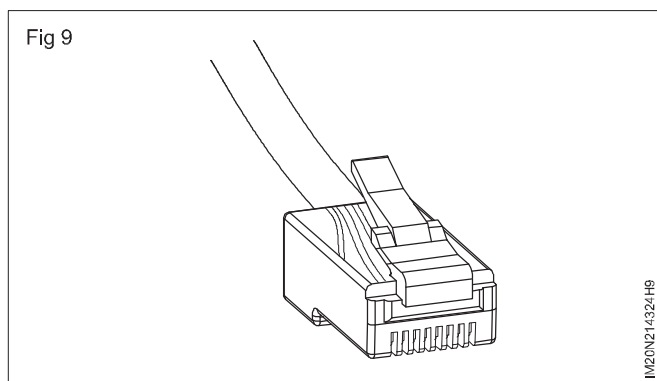
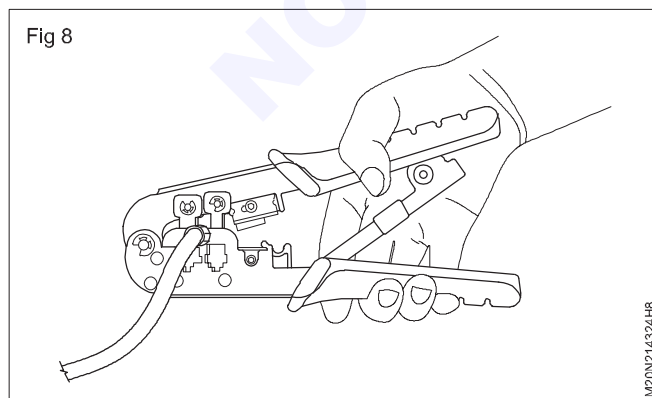


Try to make each wire fits in the slot of the connector and make each wire reach the end of its slot. The cable jacket/insulation should reach just beyond the end of the crimp point as shown in Fig 7.



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

Now half of the work done. The cable should look like as shown in Fig 9. The process must be repeated for the other end of the cable. However, the colour code wiring order changes for cross cable as shown in Fig 10.



Similarly, straight through cable and roll over cable can be prepared with the help of the instructor. The colour code wiring order.

Fig 10

PIN ID	SIDE A	SIDE A
1	ORANGE - WHITE	GREEN - WHITE
2	ORANGE	GREEN
3	GREEN - WHITE	ORANGE - WHITE
4	BLUE	BROWN - WHITE
5	BLUE - WHITE	BROWN
6	GREEN	ORANGE
7	BROWN - WHITE	BLUE
8	BROWN	BLUE - WHITE

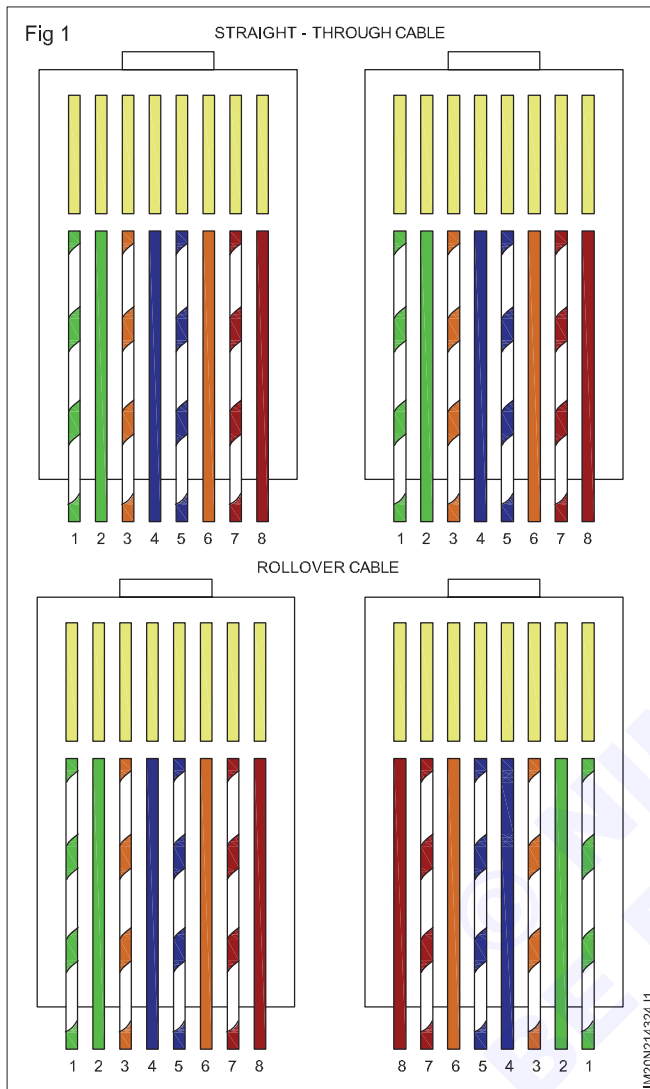
IM20N214324HA

- 1 Green White
- 2 Green
- 3 Orange White
- 4 Blue
- 5 Blue White
- 6 Orange
- 7 Brown White
- 8 Brown

Cross over cable is used to connect between two hosts (PC's). Straight-through cable is used in network when connecting a host to a switch. A rollover cable is used in a networking environment where a outer/switch is to be configured from a computer. One end is wired one way but on the other it is reversed. You would typically use on end into a serial port on a PC and the other into the console port of the switch/router.

TASK 4: Testing the cable with the LAN tester

- 1 Insert one end of the cross cable (prepared in TASK 1) into one socket and other end in another plugged in socket of the LAN tester as shown in Fig 1

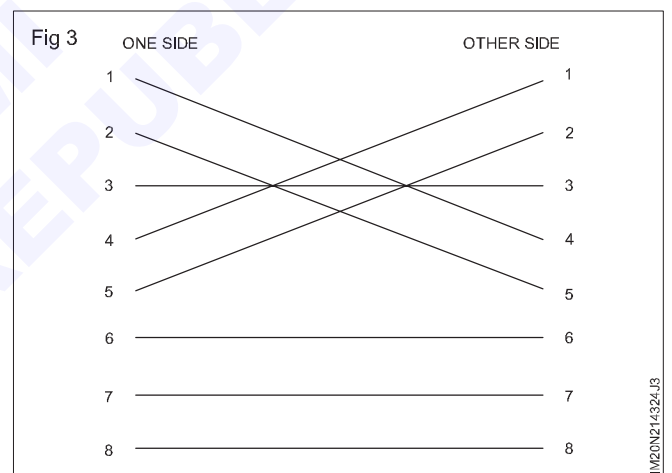
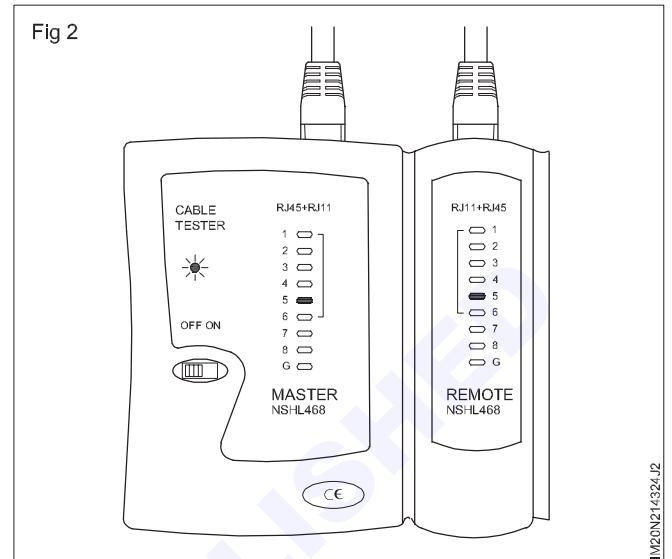


Check for the batteries loaded in cable tester

- 2 Switch 'ON' the LAN tester.

- 3 Note the order in which LED's glowing in both the panel of the LAN tester should correspond to the order shown in Fig 2&3

If the LED's doesn't glow, then there is a break in the cable.



Preparation of network cables – serial (RS232/485 Standards or equivalent) and ethernet

Objectives: At the end of this exercise you shall be able to
 • preparation of network cable R232/RS485 connector and ethernet.

Requirements			
Tools/Instruments		Equipments/ Machines	
• Trainees tool kit	- 1 No.	• Crimping tool	- 1 No.
• RS 232 / RS 485 interface	- 1 No.	• Temperature controlled soldering Station	- 1 No.
• RJ 45 connector	- 2 Nos.	• Solder	- 5 g
• T 568 A cable	- 5 Meter.	• Flux	- as reqd.
• T 568 B	- 5 Meter.	• Cleaning cloth	- as reqd.

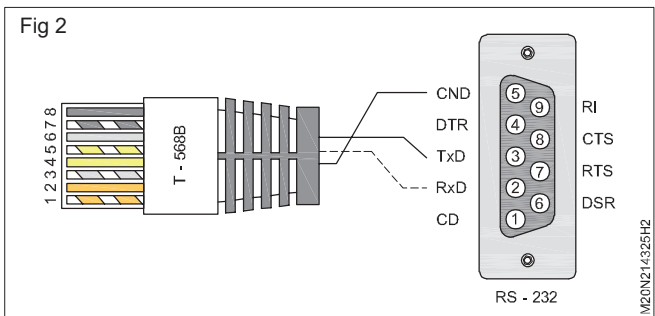
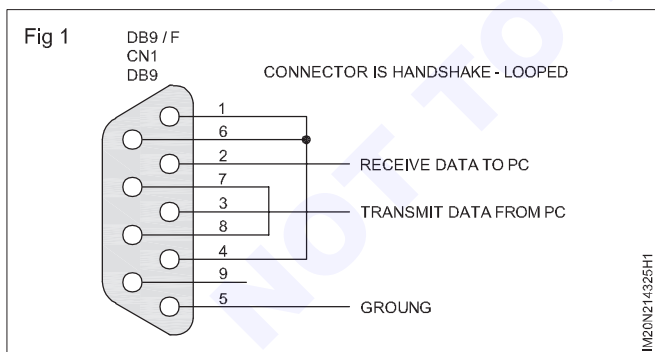
PROCEDURE

TASK 1 : Preparation of network cable R232/RS485 connector and Ethernet

- 1 Study the pin arrangements of RS 232 and T 568 as shown in fig 1
- 2 Prepare the network cable connecting one end with RS 232 connector and other end with RJ 45 connector
- 3 Cut T568B / T568A cable required to connect between DTE and DCE

DTE Data terminating equipment ex pc
DCE Data communication equipment ex Router

The connector on the PC has male pins, therefore the mating cable needs to terminate in a DE9/F (Female pin) connector.



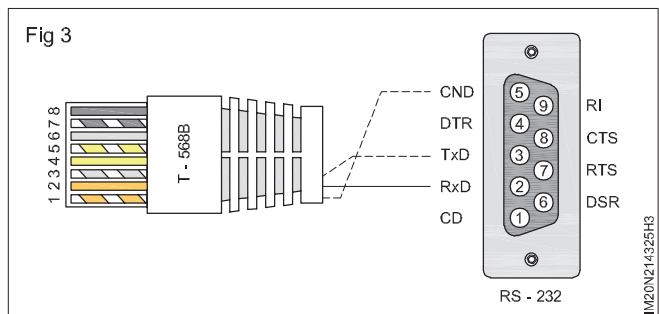
RS232 Pin arrangement (DE9 PC signal set)

Pin 1	Received line signal detector
Pin 2	Received Data
Pin 3	Transmit Data
Pin 4	Data terminal ready
Pin 5	Signal Ground
Pin 6	Data set Ready
Pin 7	Request To send
Pin 8	Clear To send
Pin 9	Ring Indicator

- 4 Identify the pins in RS 232 and solder the cable as shown in fig 2

Precaution: Hold the wires with tweezers and solder immediately to avoid overheating of cable insulation.

Fig 3 shows the pin connections for the COM1 conversion cable from RJ45 'port' into regular DB9 connector



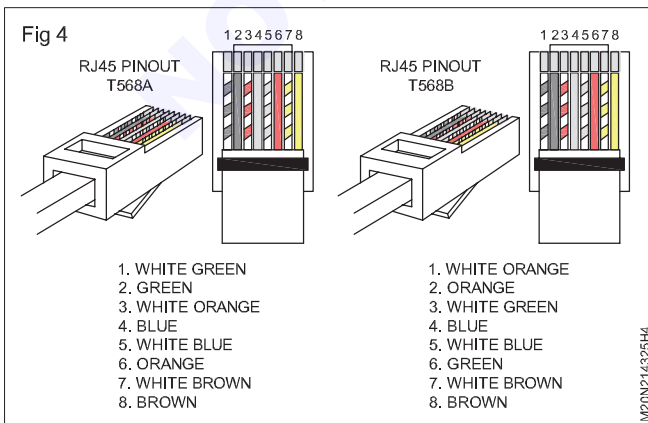
COM 1 (eia/tia-561) PIN layout Diagram with DB 9 connector

RJ 45pin	Pin name	CANON DB 9 PIN	Function
1	GND	Do not use	Do not use
2	R x D	Do not use	Do not use
3	T x D	Do not use	Do not use
4	GND	5	Signal Ground
5	R x D	2	Receive pin
6	T X D	3	Transmit pin
7	A	Do not use	Do not use
8	B	Do not use	Do not use

- 5 Prepare T -568B cable com1 with DB 9 ie. RS 232 connector as shown in fig 3 and other end of this cable must have a RJ 45 male connector
- 6 Prepare T – 568B cable COM 2 with DB 9 ie. RS 232 connector
- 7 Prepare T 568 A cable with Rs 232 connector with the help of instructor
- 8 Fig 4 illustrates the difference between T 568 A and T 568 B
- 9 Follow the procedure in exercise 2.13.324 TASK 4 for preparing RJ 45 connector on the other end of T 568 A / T 568 B cable.
- 10 Check the work done by the instructor.

Com 2 Pin layout diagram with DB 9 connector

RJ 45pin	Pin name	CANON DB 9 PIN	Function
1	GND	5	Signal Ground
2	R x D	2	Receive pin
3	T x D	3	Transmit pin
4	GND	Do not use	Do not use
5	R x D	Do not use	Do not use
6	T X D	Do not use	Do not use
7	A	Do not use	Do not use
8	B	Do not use	Do not use



Connect network connectivity hardware and check for its functioning

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

- check NIC installed
- install NIC CARD
- connect LAN chord
- check functionality of network.

Requirements

Tools/Instruments/ Equipments

- Desktop computer or Laptop - 1 No.
- NIC card installation - 1 No.

PROCEDURE

TASK 1 : Checking whether NIC is installed in Desktop or not

- | | |
|--|--|
| 1 Open whether NIC card is installed in Desktop | 4 Close all the opened windows on successful |
| 2 Click on the Network adapters and check the availability of the NIC card | checking. |
| 3 Right Click on the NIC Card if available and check properties | 5 Get the work checked by the Instructor. |

TASK 2 : Installation of NIC Card if not installed

- | | |
|---|--|
| 1 Insert the CD/DVD containing NIC Card driver Information (or) Download the relevant driver for NIC card from Internet | 5 Check the card is installed properly using Device Manager, as it has no yellow or question mark near the device. |
| 2 Confirm the make of the NIC card and driver using internet checking tools | 6 Re-install using the 'Search for Drivers using Internet' to find a proper driver automatically. |
| 3 Click setup.exe in the drivers folder to install the NIC card. | 7 Get the work checked by the Instructor. |
| 4 Finish on successful installation. | |

TASK 3 : Connecting the LAN card and establish network connection

- | | |
|---|--|
| 1 Plug one end of the NIC Card in the Desktop LAN Port (Ethernet Port). | 3 Confirm the Desktop LAN Port shows a green light, which confirms the connection is successful. |
| 2 Plug the other end into the Switch / Hub / NIC Point available. | 4 Preview the LAN details for TCP/IP settings to access the internet from the LAN using the command in Start -> Run -> command ->ipconfig. |

TASK 4 : Checking the functionality of network

- | | |
|--|---|
| 1 Click on Chrome / Firefox logo to open the browser. | 3 Setup a Local Network to connect with other computers using Setup a Home Network in the control panel-> Network Setup wizard. |
| 2 Type http://www.google .com in the address bar and wait for opening the Google web page. | 4 Create the workgroup setup to connect with the network computers. |
| | 5 Set values for IP address, file sharing options to connect and share the system information. |
| | 6 Get the work checked by the Instructor. |

Note : If the google page appears, internet is connected successfully. If it is not showing and displays as page cannot be displayed, internet is not connected.

Dismantle and assemble the desktop computer system

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

- **dismantle and assemble desktop computer system.**

Requirements

Tools/Instruments/ Equipments

- Identical PCs with labeled ports, Connection cables (could even Be dummy) - as reqd.
- I / O devices such as Keyboard Mouse Monitor Printer Multimedia Speaker CD drive DVD Drive and Microphone - as reqd.
- Screw driver set and Allen key (depending Upon the type of fixing used with connectors - as reqd.
- Sticking labels - as reqd.

PROCEDURE

TASK 1 : Dismantling and assembling the computer system

- 1 Switch off and unplug the power cord from the PC.
- 2 Remove the component connections from the Cabinet ie. USB connections, keyboard Mouse connections, LAN connections, Parallel and serial port connections
- 3 Ensure no power related connection is there with Cabinet
- 4 Unscrew the cover that is opposite to the Mother board section, as the motherboard section closure is fully closed by motherboard base, and remove the cover.
- 5 Remove the SMPS connections to Hard Disk drive, DVD Drive, Motherboard Main power, CPU power, Fan Power Connector PSU connections, inside the Cabinet.
- 6 Remove the connectors from devices like SATA/IDE cables to HDD and DVD, Audio connectors, Cabinet Front USB / Audio Connectors.
- 7 Unscrew the motherboard screws, HDD – DVD screws and other removable items and dismantle.

Note: Don't use any water based cleaner inside the system as it is power conductive and may short – circuit in case of moisture. Keep the parts separated and clean.

- 9 Place the SMPS at right position and screw it.
- 10 Place properly the motherboard on the legs of cabinet. In case any placement problem places the motherboard first and screw it before fixing SMPS.
- 11 Fix the processor and fan, RAM, PCI cards which ever removed at proper places.
- 12 fix the Hard disk, DVD drive, Floppy Drive, Other components that to be screwed with the cabinet.
- 13 Connect the connectors from motherboard to various devices like SATA, IDE, USB Extensions, etc.
- 14 Plug the SMPS connections to Motherboard , CPU PSU, Devices, which are on power required connections.
- 15 Screw up the side cover to close the cabinet.
- 16 Connect the devices and external devices using connectors into motherboard.
- 17 Connect the power chord finally to the Cabinet.

Warning: Do not remove or misplace any jumpers placed across the motherboard, as it will result malfunctioning or dead – error motherboard operation.

Note: Now the PC totally dismantled. Keep a note of all the parts is being dismantled, which will be easier to re assemble the system.

Note: Ensure that all connections are proper Now switch ON the power and switch – ON the system.

- 8 Clean the objects with a soft cotton cloth, mild blower etc. to remove dust and patches on them.

Study the operation of pulse code modulation and demodulation

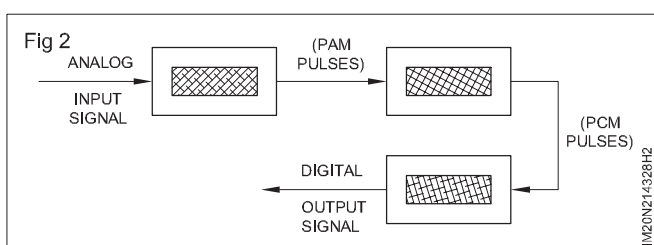
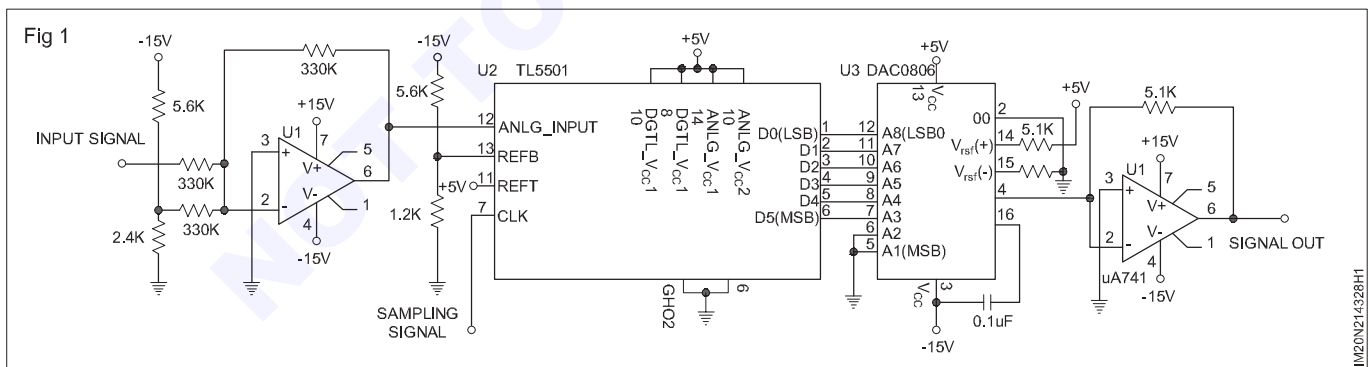
Objectives: At the end of this exercise you shall be able to

- construct the Pulse code modulator/Demodulator.
- study the operation of pulse code modulation and demodulation.

Requirements	
Tools/Instruments	Materials
<ul style="list-style-type: none"> • Wire strippers - 1 No. • Multimeter - 1 No. 	<ul style="list-style-type: none"> • Resistors: <ul style="list-style-type: none"> - 1-1.2 K Ω - 1 No. - 1-2.4 K Ω - 1 No. - 3-5.1 K Ω - 3 No. - 1-5.6 K Ω - 1 No. - 1-100 K Ω - 1 No. - 3-330 K Ω - 3 No. • Capacitors: <ul style="list-style-type: none"> - Determined by circuit • Integrated circuits: <ul style="list-style-type: none"> - TL5501 A/D Converter - 1 No. - DAC0806 D/A Converter - 1 No. - Op-amp uA741 - 2 No. - Connecting wires - as reqd.
Equipments/Machines	
<ul style="list-style-type: none"> • DSO/CRO - 1 No. • DC Supply (5V) - 2 No. • DC Supply 15V - 2 No. 	

PROCEDURE

- 1 Construct the PCM modulator/demodulator shown in Fig 1. The TL5501 has some strict parameters for the input signal, the input can be maximum of 1 Vpp, in the DC range of 4 VDC to 5 VDC
- 2 Using the multimeter, verify that the DC voltage applied to pin 12 of TL5501 is approximately 4.5V and the voltage at pin 13 is about 4.0 V. Use a square wave with an of amplitude 2.5 Vpp, an offset 1.25 V, and a frequency of 50 kHz (all displayed values) as the sampling signal applied to pin 7.
- 3 Connect a sine wave of 350 mVpp(displayed value) to the input. Use channel 2 to observe this signal and channel 1 to observe the reconstructed output signal (at pin 6 of U4). Notice that the signals are approximately 180° out of phase due to the inverter in the input stage.



Instrument Mechanic - Digital Control System and Networking

Connect any one data output of the decade counter to the data inputs of the FSK modulator and measure output waveform

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

- understand the working of FSK modulator
- construct of FSK modulator.

Requirements	
Tools/Instruments	Equipments/Machines
<ul style="list-style-type: none"> • Digital IC trainer - 1 No. • Trainees tool kit - 1 Set. • DC power supply 0 – 30v - 1 No. • Logic probe - 2 Nos. • CRO 20 mhz with instruction Manual probe kit - 1 No. • Function generator - 1 No. Capacitors: <ul style="list-style-type: none"> • 0.01 mf / 25v - 2 Nos. Resistors CR 25 / ¼ w <ul style="list-style-type: none"> • 600 Ω - 1 No. • 500k Ω - 2 Nos. • 4.7 k Ω - 2 Nos. 	<ul style="list-style-type: none"> • Single sheet logic pulser - 1 No. Materials <ul style="list-style-type: none"> • IC – 7490 - 1 No. • IC – 555 - 1 No. • IC base 8 pin - 1 No. • General purpose IC TB/ broad board solder flux - 2 Nos. • as reqd. - as reqd. • Connecting wires - as reqd. • Transistor BC 557 or Equivalent - 1 No.

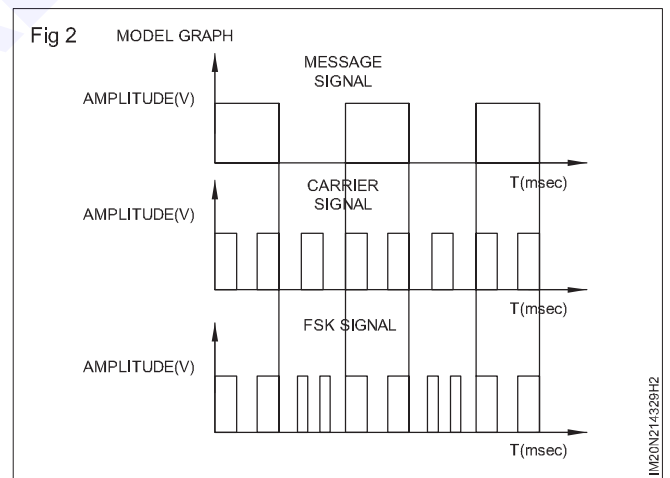
PROCEDURE

TASK 1 : Connect any one data output of the decade counter to the data input of the FSK modulator and measure output wave form

- 1 Collect all the components check them and assemble the decade counter using IC 7490 on the bread board as shown in fig 1

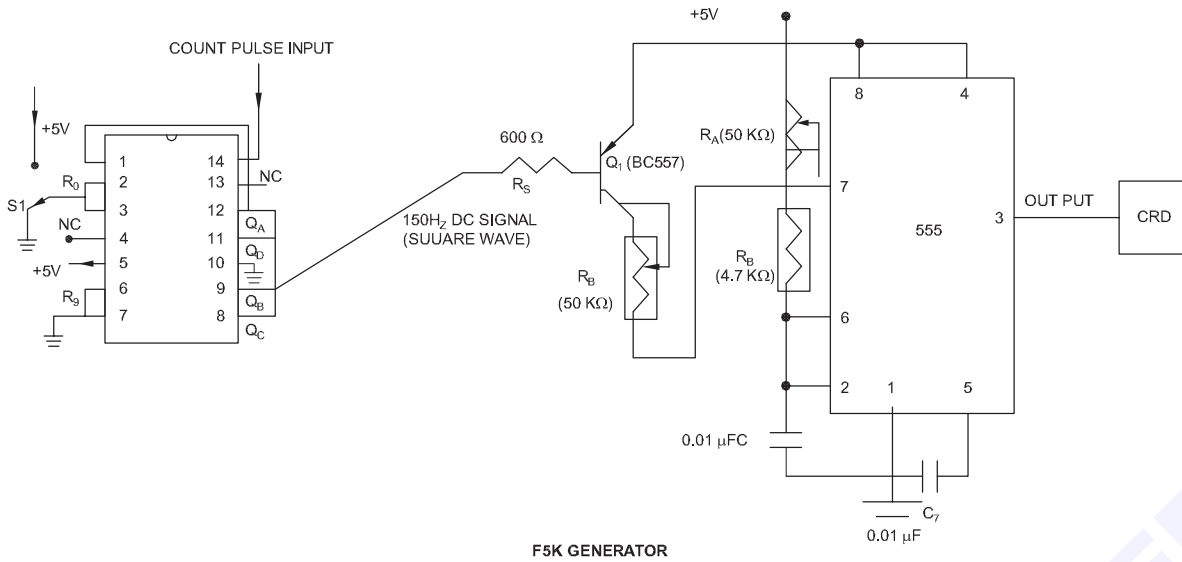
Make use IC base to connect IC 7490

- 2 Reset the counter output by applying logical 1 input momentarily to reset input pins 2 & 3.
- 3 Apply a clock pulse at pin no 14 using single shot logic pulser and note down the output logic levels at Qa, Qb, Qc, & Qd using logic probe.
- 4 Collect the components check and construct FSK modulator as shown in fig 1.
- 5 Check the connections with the help by instructor.
- 6 Connect any one data output of decade counter to FSK modulator data input



- 7 Measure the output waveform of FSK modulator using CRO as shown in fig 2
- 8 Check the work done by the instructor.

Fig 1



IM20N214329HT

Instrument Mechanic - Fundamentals of SCADA & DCS

Wire and connect the I/O Module of DCS to field signals

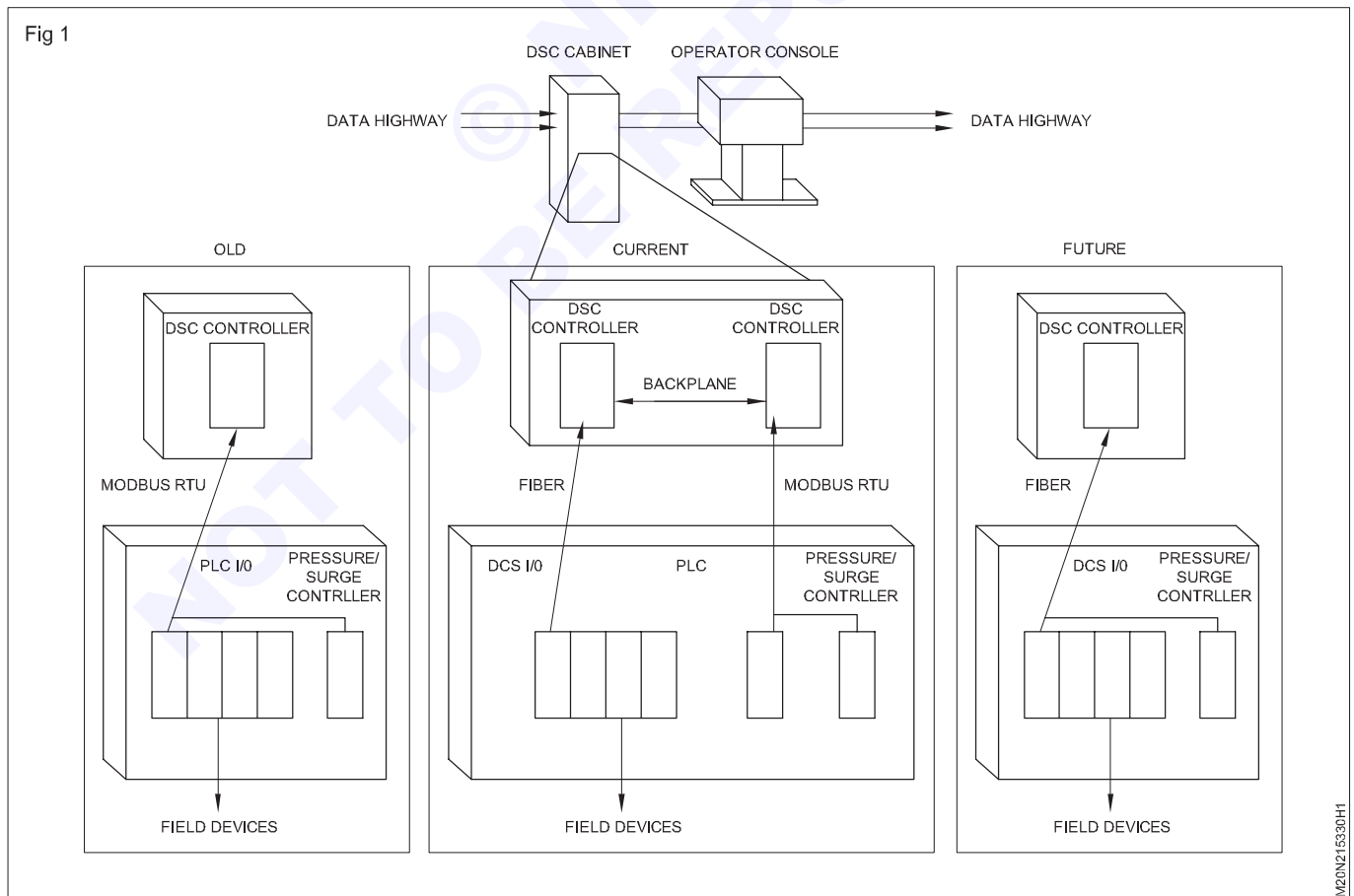
Objectives: At the end of this exercise you shall be able to

- understand the wiring and connection of I/O module of DCS to field signal.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• Programming Software (SIMATIC MANAGER)	- 1 No.
• Wire stripper	- 1 No.	• I/O Devices	- 1 No.
• Multi meter	- 1 No.	• SMPS	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	Materials	
• Distributed control systems (DCS) SIEMENS PCS7, CPU 410	- 1 No.	• Connecting wire	- as reqd.
		• Communication cable	- as reqd.

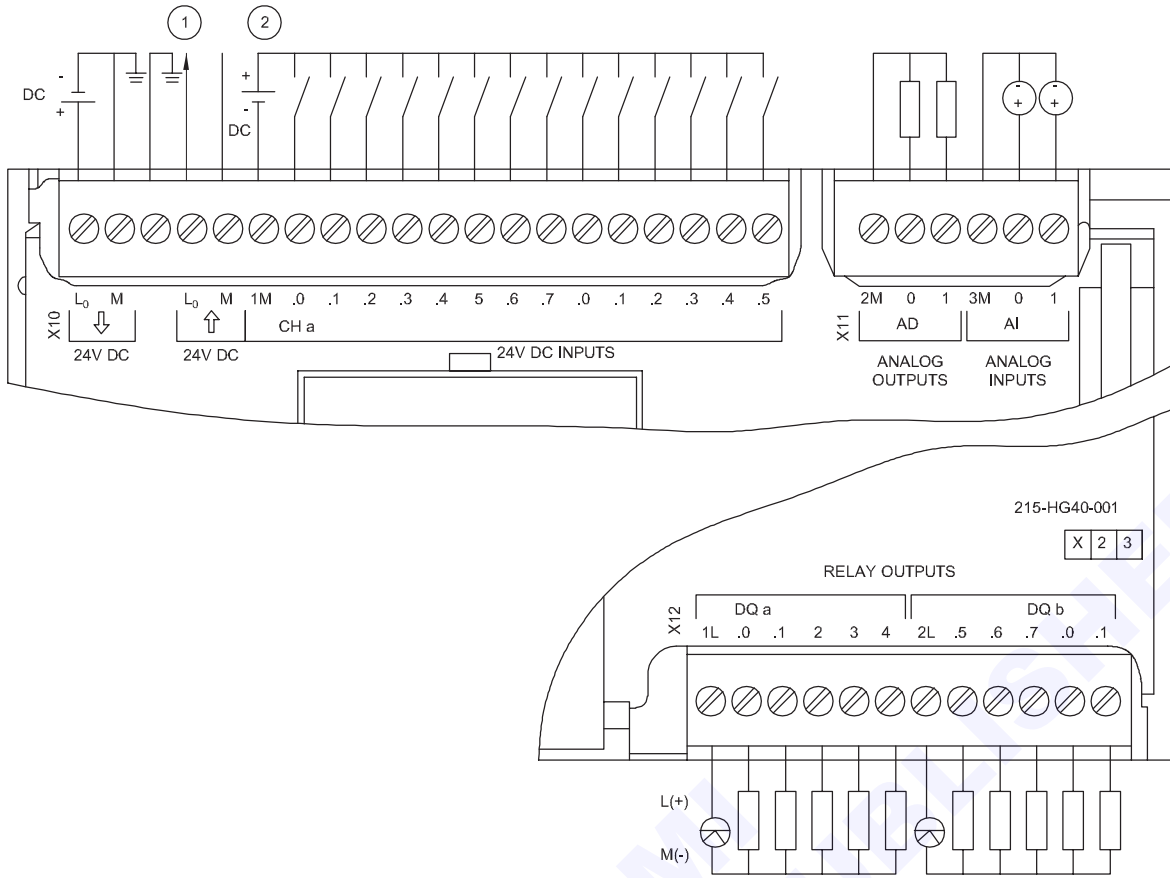
PROCEDURE

- 1 Collect all the tools and equipments.
- 2 Note down the specification of DCS and programming software
- 3 Connect the I/O devices to the DCS I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply



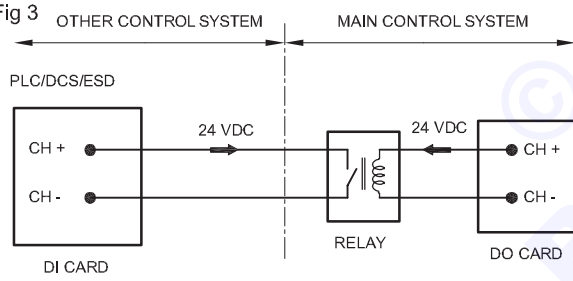
IM20N15330H1

Fig 2



IM20N215330HZ

Fig 3



DIGITAL OUTPUT WITH RELAY - DRY CONTACT INTERFACING WITH OTHER CONTROL SYSTEMS

IM20N215330HZ

Instrument Mechanic - Fundamentals of SCADA & DCS

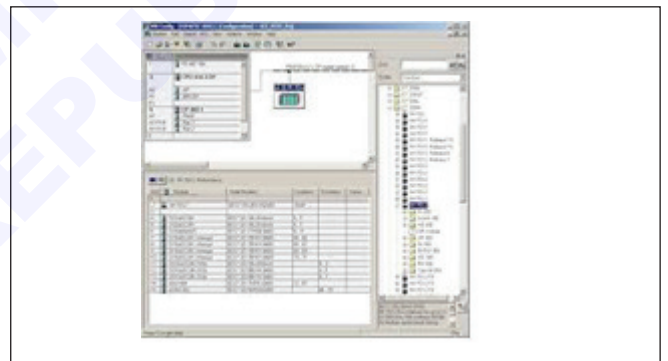
Install DCS Programming software and establish communication with PC and DCS

- Objectives:** At the end of this exercise you shall be able to
- understand the installation of DCS programming software
 - establish communication between PC and DCS.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• Programming Software (SIMATIC MANAGER)	- 1 No.
• Multi meter	- 1 No.	• I/O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• Distributed control systems (DCS) SIEMENS PCS7, CPU 410	- 1 No.	• Connecting wire	- as reqd.
		• Communication cable	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of DCS and programming software
- 3 Connect the I/O devices to the DCS I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the programming software Simatic Manager to the PC
- 7 Establish the communication with DCS and PC



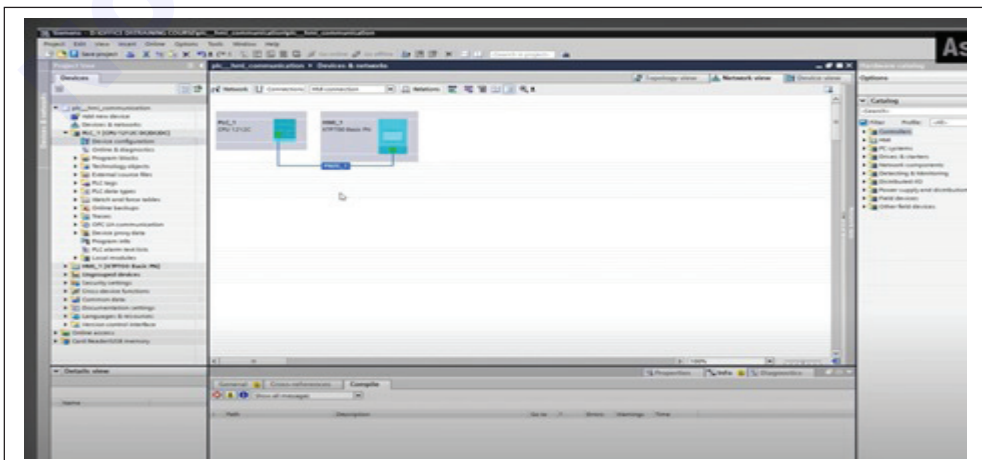
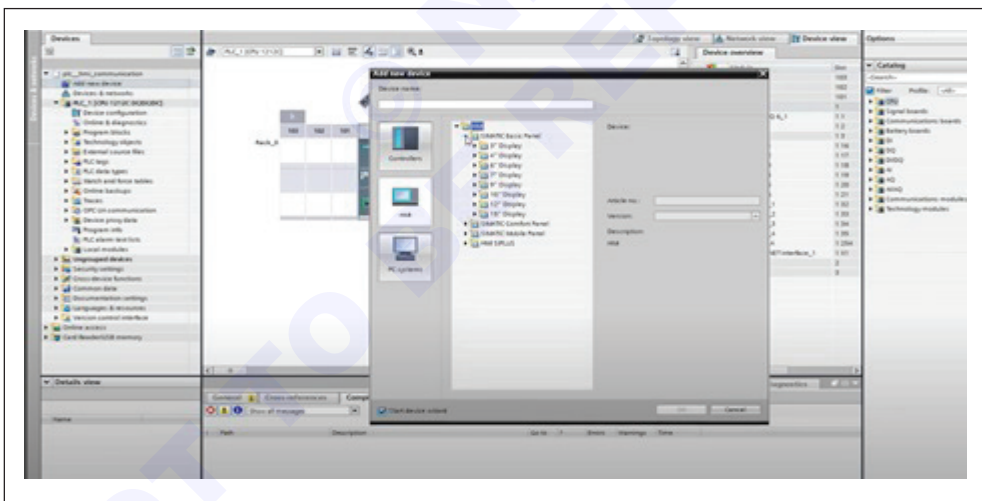
Set the communication between DCS and SCADA System

Objectives: At the end of this exercise you shall be able to
 • communication between DCS and SCADA.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• SCADA Software	- 1 No.
• Multi meter	- 1 No.	• I / O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• Distributed control systems (DCS) SIEMENS PCS7, CPU 410	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (SIMATIC MANAGER)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of DCS and programming software
- 3 Connect the I/O devices to the DCS I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Install the win CC SCADA software to the PC
- 7 Establish the communication with SCADA and PC



Concept of tag/points generation

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

- understand the concept of tag points generation.

Requirements			
Tools/Instruments/Equipments			
• Trainees tool kit	- 1 Set	• SCADA Software	- 1 No.
• Multi meter	- 1 No.	• I /O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• Distributed control systems (DCS)		• Connecting wire	- as reqd.
SIEMENS PCS7, CPU 410	- 1 No.	• Communication cable	- as reqd.
• Programming Software			
(SIMATIC MANAGER)	- 1 No.		

PROCEDURE

- 1 Identify Variables:** Determine the variables or parameters that you want to monitor or control within the SCADA system. These could be physical quantities like temperature, pressure, flow rate, or digital states like on/off status of a device.
- 2 Assign Unique Names:** Assign unique names or identifiers to each variable to create tags or points. These names should be meaningful and descriptive, making it easier to understand the purpose of each tag.
- 3 Define Data Types:** Specify the data type for each tag, such as integer, floating-point, Boolean, string, etc., based on the nature of the variable it represents.
- 4 Determine Addressing:** Determine the addressing scheme for the tags based on the communication protocol used by the SCADA system. This could involve assigning memory addresses, register addresses, or using other addressing mechanisms supported by the protocol.
- 5 Set Tag Properties:** Define additional properties for each tag, such as engineering units, scaling factors, alarm limits, historical data logging settings, and access permissions. These properties provide context and help in data interpretation and system control.
- 6 Configure Communication:** Configure the communication settings for each tag to establish the connection between the SCADA system and the physical devices or data sources. This typically involves specifying the communication protocol, device addresses, polling rates, and other parameters necessary for data acquisition.
- 7 Create Tag Database:** Create a tag database within the SCADA software or configuration tool. This database serves as a repository for all the tags or points, storing their names, data types, addresses, properties, and communication settings.
- 8 Link Tags to Visual Elements:** If you're building a graphical user interface (GUI) for the SCADA system, associate the tags with appropriate visual elements such as meters, gauges, charts, or buttons. This allows for real-time visualization and control of the variables.
- 9 Test and Verify:** Validate the tags and their associated properties by performing thorough testing. Ensure that the tags are correctly reading and writing data, and that the alarms, logging, and control actions associated with the tags are functioning as expected.
- 10 Deploy and Monitor:** Once the tag generation and configuration are complete, deploy the SCADA system in the operational environment. Monitor the system to ensure the tags are acquiring and processing data accurately and reliably. Make any necessary adjustments or updates as the system operates.

Note: The procedure may vary depending on the specific SCADA software or configuration tool being used, as well as the requirements of the application.

Attaching points to the display element

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

- understand the steps for attaching points to the display element in SCADA.

Requirements			
Tools/Instruments/Equipments			
• Trainees tool kit	- 1 Set	• SCADA Software	- 1 No.
• Multi meter	- 1 No.	• I/O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• Distributed control systems (DCS) SIEMENS PCS7, CPU 410	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (SIMATIC MANAGER)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

- 1 Define the data points:** Determine the data points that you want to associate with the display element. These points represent real-time or historical data that will be displayed or controlled by the element. Examples of data points could be temperature, pressure, flow rate, or any other measurable parameter.
- 2 Configure the SCADA system:** Access the configuration or development environment of the SCADA system. This environment may vary depending on the specific SCADA software you are using. Some popular SCADA software options include Ignition, Wonder ware, and Win CC.
- 3 Add or select the display element:** Add a new display element to the SCADA project or select the existing element to which you want to attach the data points. This step involves dragging and dropping the appropriate graphical representation onto the SCADA screen.
- 4 Define the binding or linkage:** Once the display element is selected or created, you need to define the binding or linkage between the element and the data points. This step establishes the connection between the visual element and the real-time or historical data.
- 5 Configure the properties:** Configure the properties of the display element to specify which data points

are associated with it. This typically involves assigning tags or addresses to the element, which correspond to the specific data points in the SCADA system.

Test and verify: After configuring the properties, it's important to test and verify that the display element is correctly linked to the desired data points. Check if the data values are displayed or controlled accurately by the element.

- 6 Repeat for additional elements:** If you have multiple display elements that require data point attachments, repeat the above steps for each element.
- 7 Save and deploy the project:** Once all the display elements are successfully linked to the data points, save the project and deploy it to the SCADA system. This step makes the configuration and attachments available for monitoring and control in the operational SCADA environment.

Note: The exact procedure may vary depending on the SCADA software you are using, as different software platforms have their own specific workflows and terminology. The above steps provide a general guideline for attaching points to display elements in a SCADA system.

Practice HMI, operator panel and touch panel operation and related software

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

- identify and operate HMI Panel.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• HMI	- 1 No.
• Multi meter	- 1 No.	• I/O Devices	- 1 No.
		• SMPS	- 1 No.
Equipments/Machines			
• Personal Computer	- 1 No.	Materials	
• PLC (SIEMENS S7 1200 Series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (TIA)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

1 Familiarize Yourself with the Hardware:

- Obtain the HMI device, operator panel, or touch panel you want to practice with.
- Read the user manual or documentation provided by the manufacturer to understand the hardware's features, specifications, and physical operation.

2 Install the Required Software:

Visit the manufacturer's website or use the provided installation media to download and install the necessary software for programming and configuring the HMI.

Follow the installation instructions carefully to ensure a successful installation.

3 Connect the HMI Device:

Connect the HMI device, operator panel, or touch panel to your computer using the appropriate connection method (e.g., USB, Ethernet).

Ensure that the connection is properly established and that the device is recognized by your computer.

Set up and configure HMI with PLC

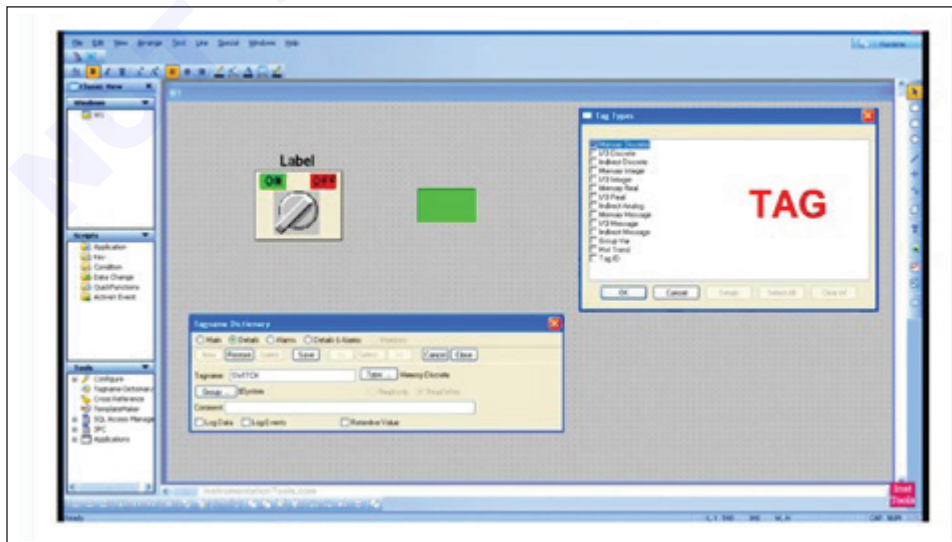
Objectives: At the end of this exercise you shall be able to

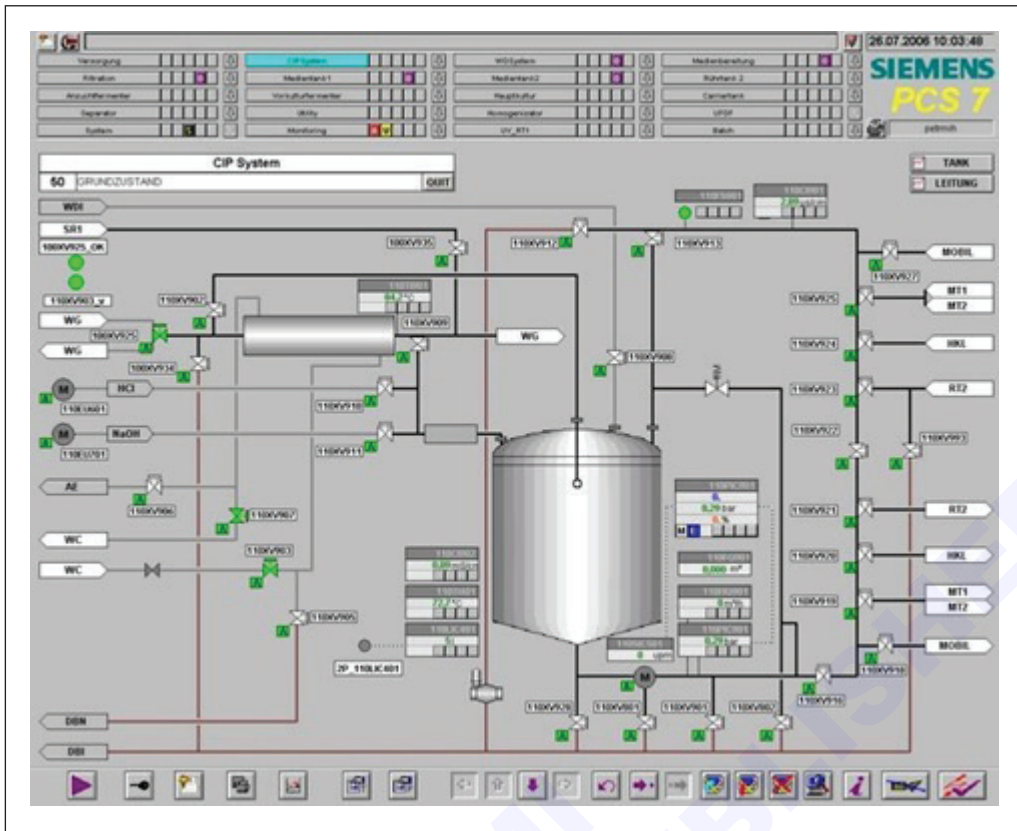
- understand the HMI
- understand the configuration of HMI with PLC.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• HMI	- 1 No.
• Multi meter	- 1 No.	• I /O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• PLC (SIEMENS S7 1200 Series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (TIA)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC, HMI and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Connect the HMI to the PLC
- 7 Establish the communication with SCADA and PC
- 8 Launch the Software :
 - Start the HMI Software
- 9 Create a New Project:
 - Define the project settings, such as screen resolution communication protocols, and target hardware.
- 10 Design the HMI screens:
 - Add button, labels, indicators, input fields and other components.
- 11 Configure Communication:
 - Configure data exchange protocols such as mod bus, Ethernet / IP etc
- 12 Simulate and Test the HMI
 - Use the software simulation mode to test the functionality of HMI screens
- 13 Download and Deploy the project
- 14 Operate and Test the HMI
 - Power on HMI Device, interact with touch panel, verify HMI functions properly





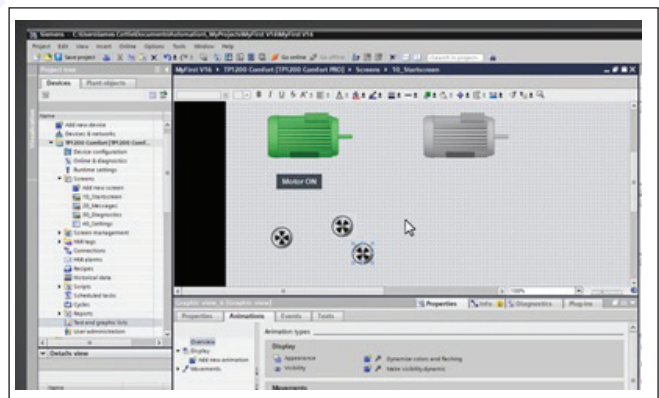
Animate objects on a HMI screen to monitor motor status

Objectives: At the end of this exercise you shall be able to
 • understand the animation of objects on HMI screen.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• HMI	- 1 No.
• Multi meter	- 1 No.	• I/O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Materials	
• PLC (SIEMENS S7 1200 Series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (TIA)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

- 1 Collect all the tools and equipments
- 2 Note down the specification of PLC, HMI and programming software
- 3 Connect the I/O devices to the PLC I/O module
- 4 Verify the output voltage of SMPS (24VDC)
- 5 Verify all the connections before switch on the power supply
- 6 Connect the HMI to the PLC
- 7 Establish the communication with SCADA and PC
- 8 Create Tagging of objects and create address each tag
- 9 **Define Animation triggers:** Define the conditions or events that will trigger the animation.
- 10 **Configure Animation properties:** This include color changes, movement, flashing, rotation, or scaling. Use the HMI software’s animation tool to define these properties based on the tag or variable values.
- 11 **Link Tags to Animation:** Connect the tags or variables to the animation properties. This linkage will enable the animation to reflect the actual motor status.
- 12 **Test and Debug:** Test the HMI screen using the simulation mode provided by the HMI software. Then monitor motor status.



Instrument Mechanic - Fundamentals of SCADA & DCS

Use security features to do tag logging and command execution

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

- use security features to enable tag logging and command execution.

Requirements			
Tools/Instruments/Equipments			
• Screw driver	- 1 No.	• HMI	- 1 No.
• Multi meter	- 1 No.	• I /O Devices	- 1 No.
Equipments/Machines		• SMPS	- 1 No.
• Personal Computer	- 1 No.	Material	
• PLC (SIEMENS S7 1200 Series)	- 1 No.	• Connecting wire	- as reqd.
• Programming Software (TIA)	- 1 No.	• Communication cable	- as reqd.

PROCEDURE

- 1 First, access the security settings of your HMI device. The exact method to access this may vary depending on the type of device you have, so refer to the user manual or contact the manufacturer for guidance.
- 2 Once you have accessed the security settings, create a new user account specifically for tag logging and command execution. This account should have limited privileges that only allow it to perform these tasks.
- 3 Next, enable the Tag Logging feature in the security settings. This will allow you to track changes made to specific tags in your system, including who made the change, when it was made, and what the old and new values were.
- 4 You can also enable the Command Execution feature in the security settings. This will allow you to execute certain commands or functions based on trigger events or predetermined conditions. For example, you could set up a command to turn off a motor if it overheats or has exceeded a certain number of running hours.
- 5 In order to ensure that these security features are effective, you should also configure alarm notifications and/or email alerts for certain events. For example, if a critical tag is changed or an unauthorized command is executed, you should be notified immediately so that you can take appropriate action.
- 6 Finally, you should periodically review your tag logs and command history to identify any potential issues or security breaches. This will help you to continuously improve the security of your HMI system and ensure that it operates safely and efficiently.

Practice symbolic representation of hydraulic components

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

- identify draw & write the shape and symbol of the hydraulic components.

Requirements	
Materials	
• Paper	- 1 No.
• Pen	- 1 No.






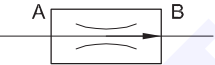
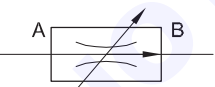
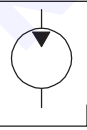


PROCEDURE

TASK 1: To identify, draw and write the shape and symbol of hydraulic component

- 1 Draw the symbol and write the name of the hydraulic components in Table 1 and Table 2.

Note: Trainer should instruct the trainees to draw the symbols of hydraulic components mentioned in tabulation 1 and 2 respectively

Table 1

SI. No.	Symbol	Component
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

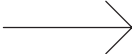
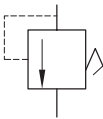

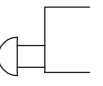

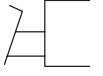

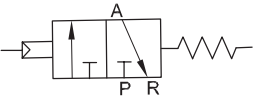

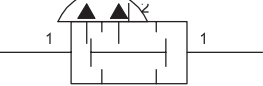
SI. No.	Symbol	Component
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Table 2

S. No.	Component	symbol
1	Single acting cylinder	
2	Pilot line	
3	Lines Crossing	
4	Lines Joined	
5	2/2 DCV	
6	3/2 DCV	
7	5/2 DVC	
8	Double acting cylinder	
9	Filter	
10	Air pump	
11	Pressure Reducing Valve	
12	Accumulator	
13	Strainer	
14	Sequence Valve	
15	5/2 Pilot DCV	
16	Shuttle Valve	
17	Flow control	
18	Throttle Valve	
19	Normally Open	
20	Normally closed	

2 Check the work done with the help of Instructor.

— — — —

Familiar with hydraulic hoses and fitting

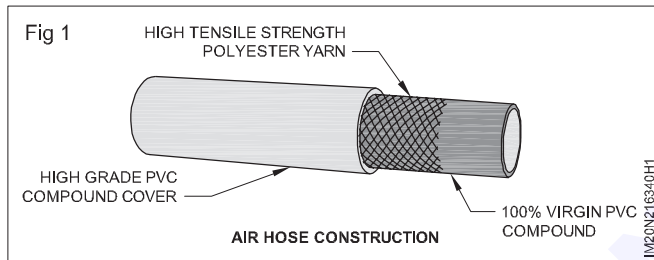
- Objectives:** At the end of this exercise you shall be able to
- construction type and application/use of hydraulic pipes
 - names and symbols of different types of hydraulic pipe fittings.

Requirements	
Materials	
• Different types of fittings	- 1 No.
• Paper	- 1 No.
• Pen	- 1 No.

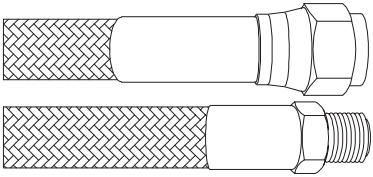
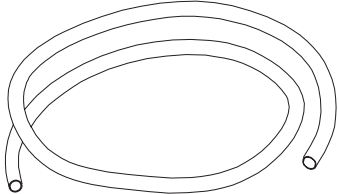
PROCEDURE

TASK 1: Construction, types and application/uses of hydraulic pipes

Fill the parts name in Fig 1.



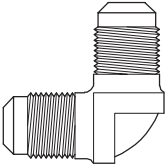
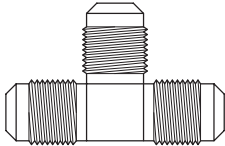
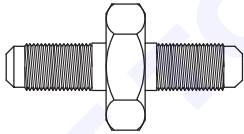
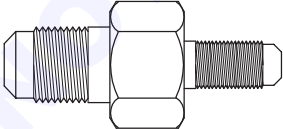
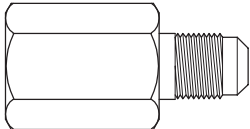
S. No.	Types of Hoses	Application
1	<p>HOSES FOR LOW PRESSURE</p>	
2	<p>STANDARD HOSES FOR HIGH PRESSURE</p>	

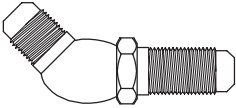
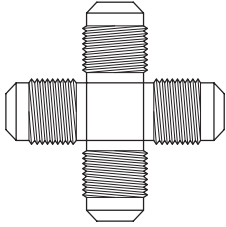
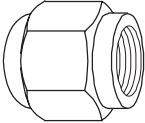
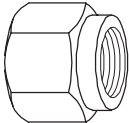
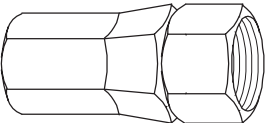
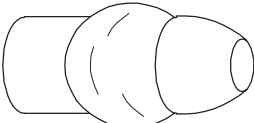
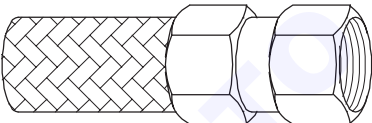
S. No.	Types of Hoses	Application
3	 <p>STANDARD HOSES FOR HIGH PRESSURE</p>	
4	 <p>PLASTIC TUBE</p>	

TASK 2: Name and symbols of different types of hydraulic pipe fittings

1 Write the name of respective fitting in Table 2

Table 2

S. No.	Types of Fitting	Name of the Fitting
1		
2		
3		
4		
5		

6		
7		
8		
9		
10		
11		
12		

2 Draw the symbols of the respective fittings in Table 3.

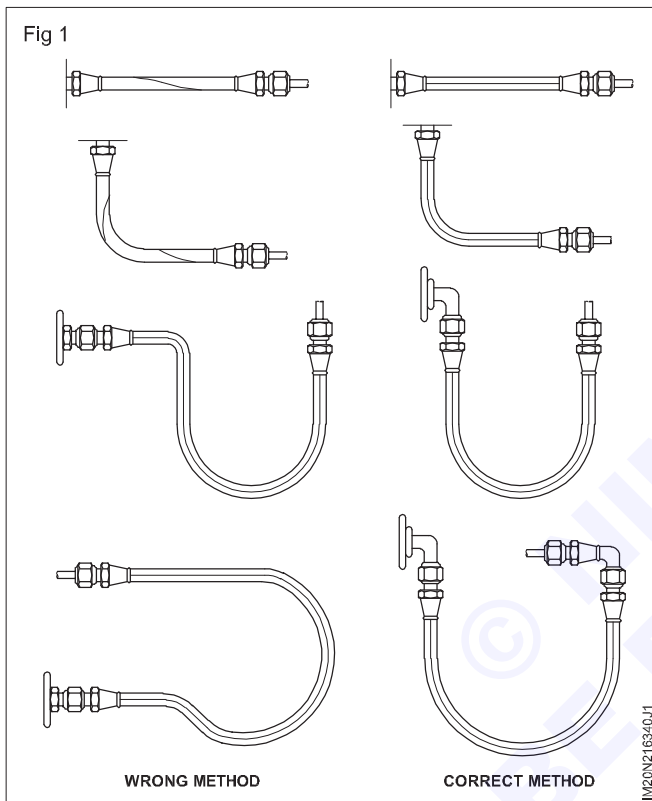
Table 3

S. No.	Name of the fittings	Symbol
1	BEND 90°	
2	BEND	
3	CROSS	
4	ELBOW 90°	
5	ELBOW 45°	
6	TEE	

S. No.	Name of the fittings	Symbol
7	UNION SCREWED	
8	PLUG OR CAP	
9	REDUCER, CONCENTRIC	
10	JOIN/SOCKET	

3 Check the work done with the help of Instructor.

4 Follow the correct method for fixing the Hoses.



Feature and function of hydraulic pump, and power system

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

- different types of hydraulic pumps important parts, method of functioning and its uses
- important components of hydraulic power system, method of functioning and its uses.

Requirements	
Tool/Instruments <ul style="list-style-type: none"> • Different types of pumps • Trainees Tools Kit 	Equipment/Machines <ul style="list-style-type: none"> • Trainer board of hydraulic system • Hydraulic Source Materials <ul style="list-style-type: none"> • Pipe fittings

PROCEDURE

TASK 1: Different types of pumps, important parts, method of functioning and their uses

1 In table 1 write the name of the parts, Function and Features of respective pumps in Table 1.

Table 1

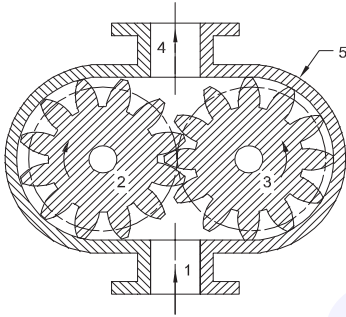
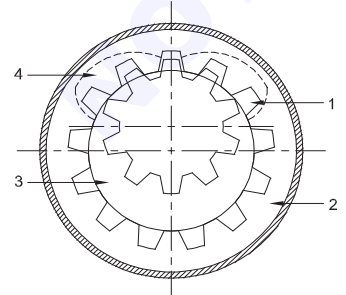
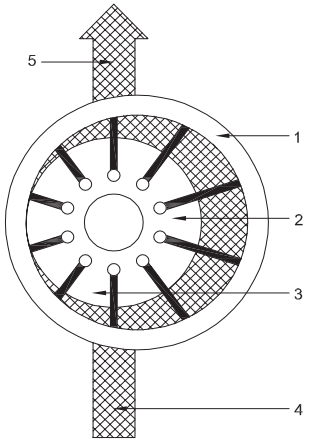
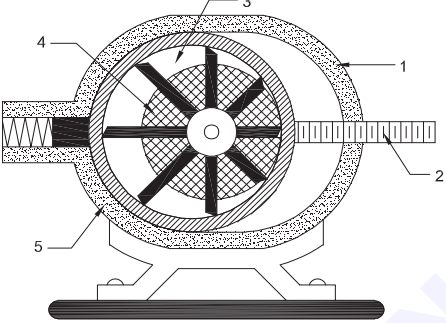
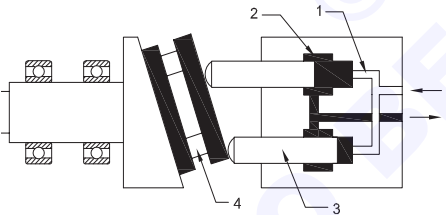
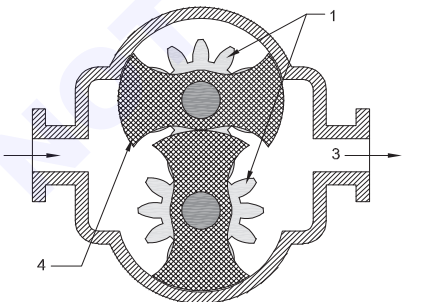
S. No.	Types of Pumps	Name of the parts	Function	Features
1	 <p>EXTERNAL GEAR PUMP</p>	1 2 3 4 5		
2	 <p>INTERNAL GEAR PUMP</p>	1 2 3 4 5		

Table 1

S. No.	Types of Pumps	Name of the parts	Function	Features
3	 <p>VANE PUMP</p>	<p>1 2 3 4 5</p>		
4	 <p>RADIAL PISTON PUMP</p>	<p>1 2 3 4 5</p>		
5	 <p>SWASH PLATE AXIAL PISTON PUMP</p>	<p>1 2 3 4 5</p>		
6	 <p>CLOPE PUMP</p>	<p>1 2 3 4 5</p>		

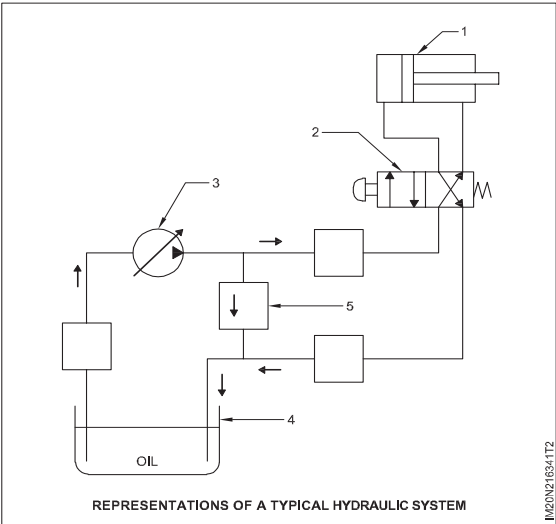
2 Check the work done with the help of Instructor.

— — — —

TASK 2: Important parts of hydraulic power system, method of functioning and uses

- 1 Write the name of the components, function and features of respective hydraulic power system in Table 2.

Table 2

Hydraulic System	Name of the Components	Function	Features
	<p>1</p> <p>2</p> <p>3</p> <p>4</p>		

- 2 Check the work done with the help of Instructor.

Feature and function of hydraulic accumulator

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

- types of hydraulic accumulator, important parts, method of functioning and its uses
- identification of hydraulic components.

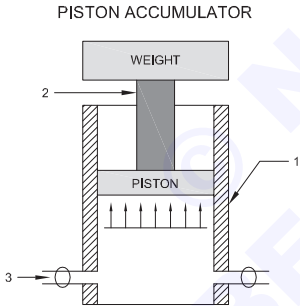
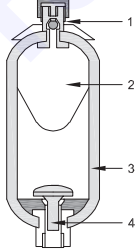
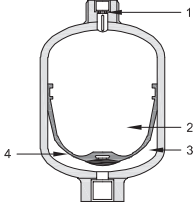
Requirements			
Tools/Instruments		Equipments\Machines	
<ul style="list-style-type: none"> • Different types of pumps • Trainees Tools Kit 	<ul style="list-style-type: none"> - 1 No. - 1 No. 	<ul style="list-style-type: none"> • Trainer board of hydraulic system • Hydraulic Source 	<ul style="list-style-type: none"> - 1 No. - 1 No.
		Materials	
		<ul style="list-style-type: none"> • Pipe fittings 	- 1 No.

PROCEDURE

TASK 1: Types of hydraulic accumulator important parts, method of functioning and its uses

- 1 Write the name of the parts, function and features of respective accumulator in Table 3

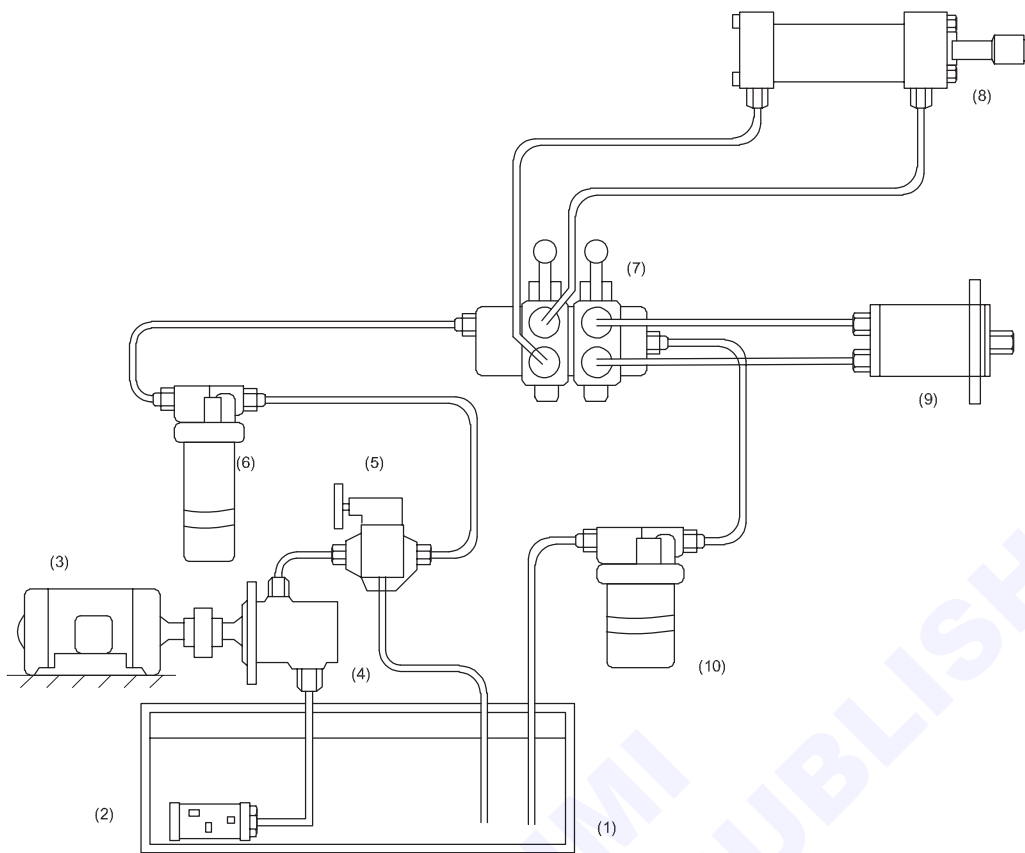
Table 3

S. No.	Types of Accumulator	Name of the parts	Function	Features
1	<p>PISTON ACCUMULATOR</p> 			
2	<p>BLADDER ACCUMULATOR</p> 			
3	<p>DIAPHRAGM ACCUMULATOR</p> 			

- 2 Check the work done with the help of Instructor.

Identification of hydraulic components

Fig 1



IM20N2163/2H1

The instructor must organize and demonstrate the circuit to the trainees

- Study the circuit and record the names of the components in Table 4.

- Draw the symbol of respective component in Table 4.

Table 4

S. No.	Name of the parts	Symbol
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Check the work done with the help of Instructor.

— — — — —

Service and test different types of valves

Objectives: At the end of this exercise you shall be able to
 • service and test different types of hydraulic valves.

Requirements	
Tools/Instruments <ul style="list-style-type: none"> Direction Control Valve Different types of control Valve - 1No. 	Equipments\Machines <ul style="list-style-type: none"> Hydraulic Trainer Kit - as reqd. Hydraulic Source - as reqd. Materials <ul style="list-style-type: none"> PVC Tube - as reqd. Muslin Cloth - as reqd.

PROCEDURE

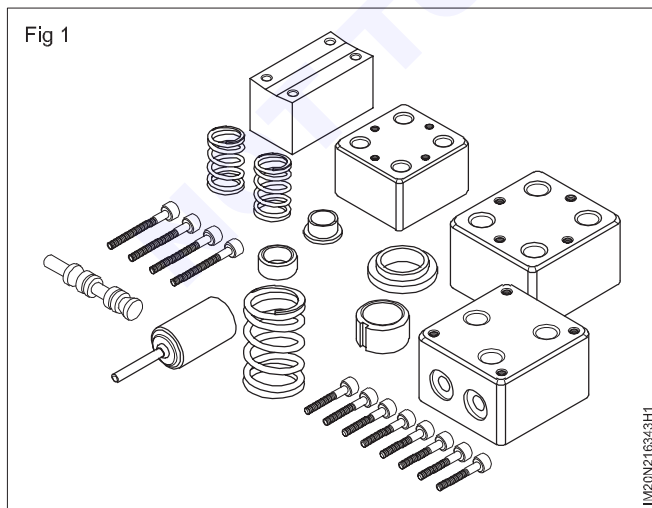
TASK 1: Servicing different types of hydraulic valves

- To Clean the working table.
- Clean the given valves with a cloth and place it on the table.
- Check the valves for any defects if any defects are present then note the defects in Table 1.

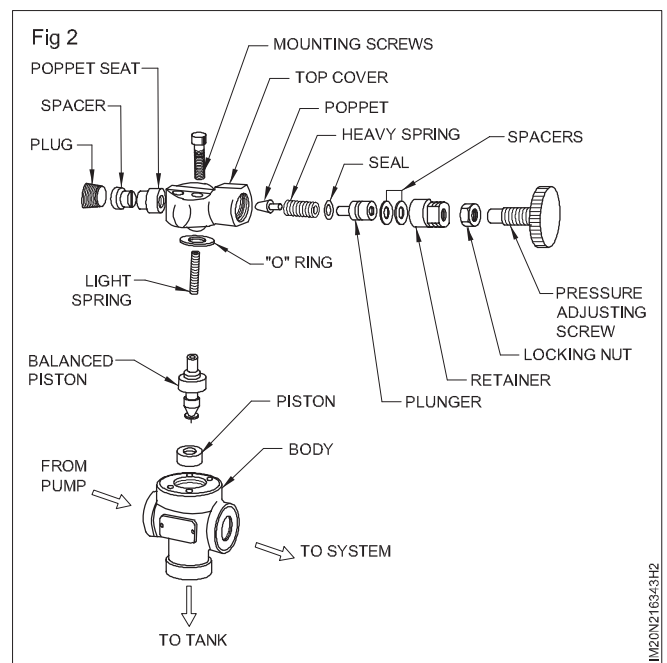
Table 1

S. No.	Name of the valve	Name of the parts	Defects

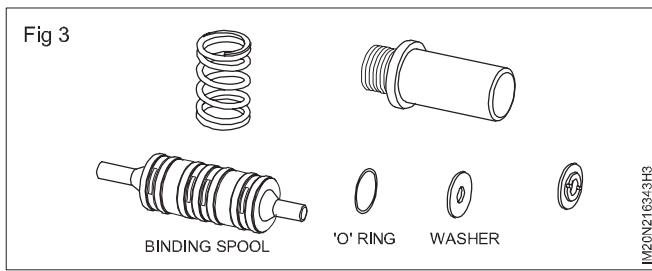
4 Arrange the dismantled parts in order as shown in Fig 1.



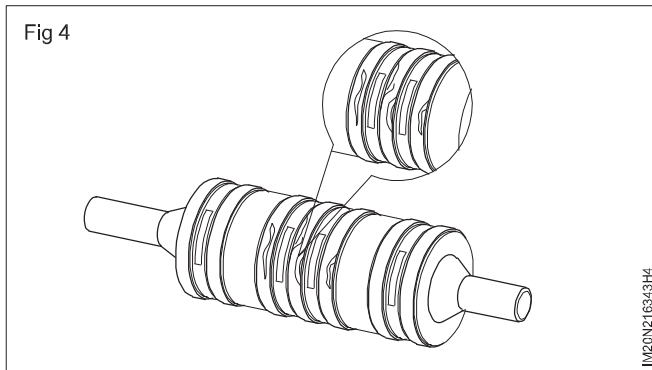
5 Understand study the parts of given valve as shown in Fig 2.



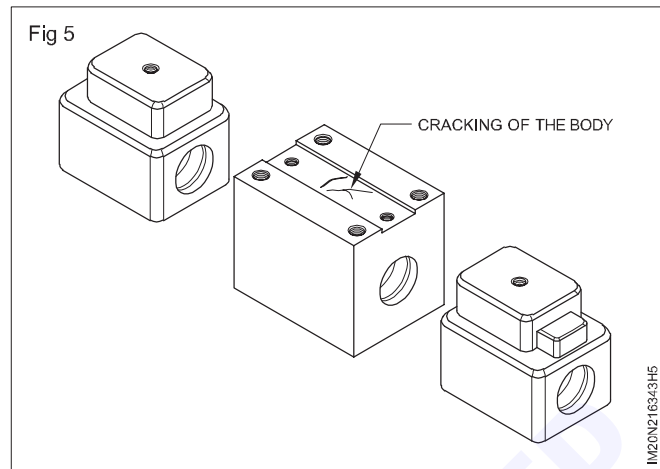
6 Following are the defects that could occur in valves
 Damage of spool (Fig 3)



- Damage of "O" ring (Fig 4)
- Binding of spool (Fig 4)



- Cracking of Body (Fig 5)
- Wearing of washer (Fig 4)

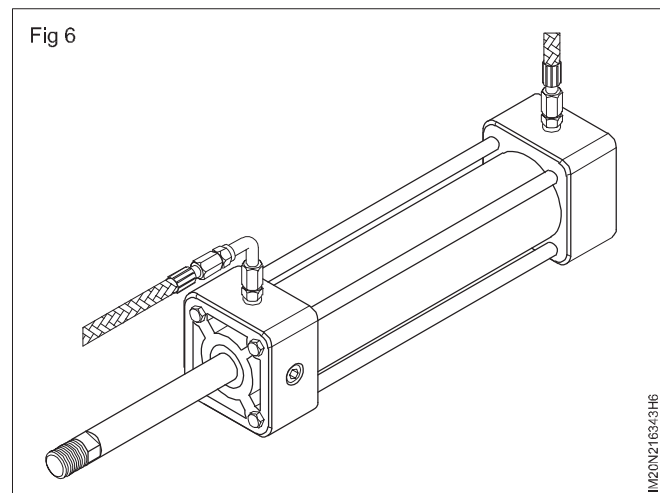


7 Note down the defects in Table 2.

Table 2

S. No.	Name of the valve	Name of the parts	Defect

- 8 Replace the defected parts with the help of the Instructor.
- 9 Assemble the valves in reverse order as shown in Fig 6.
- 10 Do me same procedure for different valves available in yarn lab.
- 11 Check the work done with the help of Instructor.



Design hydraulic circuit for double acting cylinder actuation

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

- select the components, to operate single acting cylinder using 3/2 way valve
- assemble circuit on the trainer board
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments		Materials	
• Trainee board	- 1 No.	• Hydraulic tube with end connection	- as reqd.
• Hydraulic motor	- 1 No.	• Pressure regulator	- as reqd.
• Hydraulic pump	- 1 No.	• Pencil	- as reqd.
• Accumulator	- 1 No.	• Manifold	- 1 No.
• Hydraulic tank	- 1 No.	• 3/2 way DC valve	- 1 No.

PROCEDURE

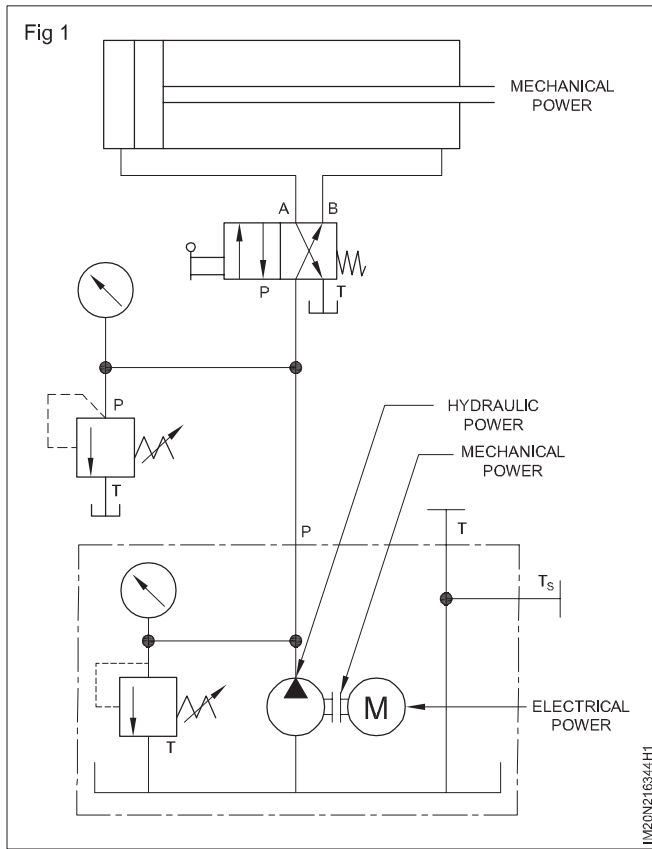
TASK 1: Select and list the components for double acting cylinder actuation in hydraulic circuit

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Hydraulic motor	Single Acting Cylinder
Hydraulic pump	
Pressure relief valve	
Hydraulic tank	
Pressure regulator	
4/2 way CC valve	
Manifold	
Accumulator	

TASK 2: Draw circuit diagram (Fig 1)



1 Draw circuit diagram

TASK 3: Assemble circuit on the trainer board

- 1 Arrange component on trainer board as shown.
- 2 Connect pump to input port 'P' of 4/2 way DC valve
- 3 Connect pump to port 'P' of pressure regulator valve.
- 4 Connect pump to port 'T' of pressure regulation valve.
- 5 Connect output port "A" & "B" of 4/2 way DC valve to input ports of double acting cylinder.
- 6 Connect port 'T' of 4/2 way DC valve to the tank
- 7 Ensure proper connections.
- 8 Switch on the motor.

Pump, motor, tank & pressure regulators are available in single unit

Connect the pump through manifold

Connect properly to avoid oil leaks through joints.

TASK 4: Check function of the circuit as per the table

Action	Expected Result	Confirm Result (Put)
Move the lever to the forward direction	Piston moves forward	
Move the lever to the backward direction	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Double acting cylinder actuation occurred in hydraulic circuit	

Design hydraulic circuit pilot operated check valve

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

- select the components, for design hydraulic circuit using pilot operated check valve
- assemble circuit as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments		Materials	
• Trainee board	- 1 No.	• Hydraulic tube with end connection	- asreqd.
• Hydraulic motor	- 1 No.	• Pilot operated check value	- asreqd.
• Hydraulic pump	- 1 No.	• Manifold	- 1 No.
• Accumulator	- 1 No.	• 4/2 way DC valve	- 1 No.
• Hydraulic tank	- 1 No.	• 3/2 way DC valve	- 1 No.
		• Pressure relief valve	- 1 No.

PROCEDURE

TASK 1: Select and list the components for double acting cylinder actuation in hydraulic circuit

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Hydraulic motor	Single cylinder
Hydraulic pump	
Pressure relief valve	
Hydraulic tank	
4/2 way DC valve	
4/2 way CC valve	
Manifold	
Accumulator	
3/2 way DC valve	

— — — —

TASK 4: Check function of the circuit per the table

Action	Expected Result	Confirm Result (Put)
Move the lever to the forward direction	Piston moves forward	
Move the lever to the backward direction	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Double acting cylinder actuation occurred in hydraulic circuit	

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Design hydraulic circuit using pressure reducing valve

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

- select the components, for design hydraulic circuit using pressure reducing valve
- assemble circuit as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments		Materials	
• Trainee board	- 1 No.	• Hydraulic tube with end connection	- as reqd.
• Hydraulic motor	- 1 No.	• pressure reducing valve 50 bar	- as reqd.
• Hydraulic pump	- 1 No.	• Manifold	- 1 No.
• Accumulator	- 1 No.	• 4/3 way DC valve	- 1 No.
• Hydraulic tank	- 1 No.	• Pressure relief valve 100bar	- 1 No.
		• Pressure gauge	- 1 No.
		• Pressure gauge	- 1 No.

PROCEDURE

TASK 1: Select and list the components for double acting cylinder actuation in hydraulic circuit

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Hydraulic motor	Single Cylinder
Hydraulic pump	
Hydraulic power pack	
Hydraulic tank	
4/3 way DC valve	
Manifold	
Pressure reducing valve	
Pressure relief valve	
Pressure gauge	
Double acting cylinder	

Design hydraulic circuit using pressure relief & pressure regulating valve

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

- select the components, for design hydraulic circuit using pressure reducing valve
- assemble circuit as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments			
• Trainee board	- 1 No.	• Pressure reducing valve 50 bar	- as reqd.
• Hydraulic power pack	- 1 No.	• Manifold	- 1 No.
Materials		• 4/3 way DC valve	- 1 No.
• Hydraulic tube with end connection	- as reqd.	• Double acting cylinder	- 1 No.
		• Check valve	- 1 No.

PROCEDURE

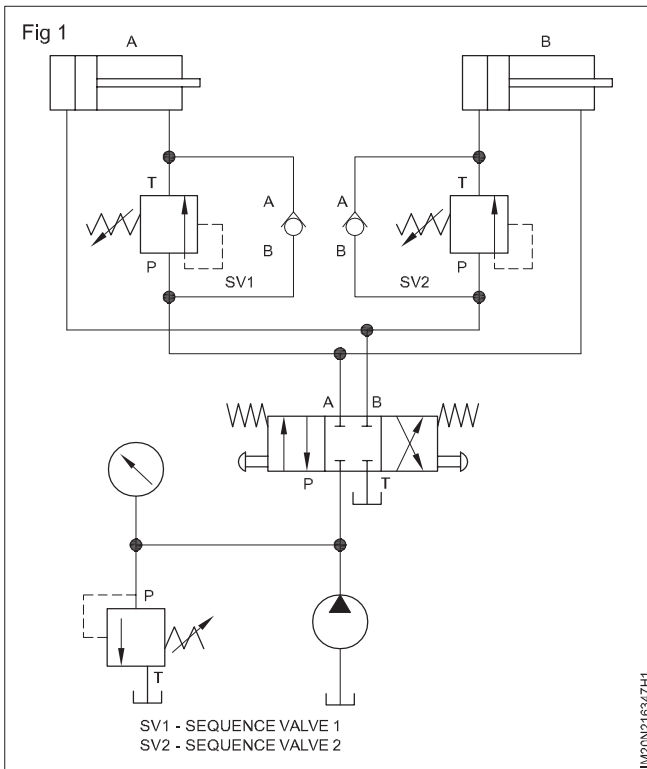
TASK 1: Select and list the components for hydraulic pressure sequencing circuit

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Hydraulic power pack	Single Acting Cylinder
4/3 way DC valve	
Manifold	
Pressure sequencing valve	
Double acting cylinder	
Check valve	

TASK 2: Draw circuit diagram (Fig 1)



1 Draw circuit diagram

TASK 3: Assemble circuit on the trainer board

- 1 Arrange component on trainer board as shown.
- 2 Connect pump port 'P' of 4/3 way DC valve through manifold.
- 3 Connect port 'T' of the 4/3 way DC valve to the tank
- 4 Connect output port 'A' & 'B' of 4/3 way DC valve to input of double acting cylinder as shown in the diagram.
- 5 Connect out port 'B' of 4/3 way DC valve to port 'P' of SV1, check valve 1 & to input of double acting cylinder 2 as shown in the diagram.
- 6 Connect output port of SV1, SV2 & check valve to the input of double acting cylinder as shown in the diagram.
- 7 Connect drain port of SV1 & SV2 to the tank.
- 8 Ensure proper connections
- 9 Switch on the motor.

Pump, motor, tank & pressure regulators are available in single unit

Connect the pump through manifold

Connect properly to avoid oil leaks through joints.

TASK 4: Check function of the circuit per the table

Action	Expected Result	Confirm Result (Put)
Press the push button 'L' of 4/3 the DCV	Piston moves forward & reverse with same pressure	
Press the push button 'R' of 4/3 the DCV	Piston moves forward & reverse with same pressure	

Conclusion

Conclusion drawn	Remarks
When the DCV is shifted into its left envelope mode, the left cylinder extends completely and then the right cylinder extends. If the DCV is shifted into its right envelope mode, the right cylinder retracts fully followed by the left cylinder.	

Design hydraulic pressure sequencing circuit

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

- select the components, for design hydraulic circuit using pressure reducing valve
- assemble circuit as per the diagram
- check function of the circuit.

Refer Exercise No. 2.16.347

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Design Hydraulic circuit using pressure compensated flow control

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

- select the components for design Hydraulic circuit using pressure compensated flow control valve
- assemble circuit as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments			
• Trainee board	- 1 No.	• Manifold	- 1 No.
• Hydraulic power pack	- 1 No.	• 4/3 way DC valve	- 1 No.
		• Double acting cylinder	- 1 No.
Materials			
• Hydraulic tube with end connection	- as reqd.	• Check valve	- 1 No.
• Pressure compensated flow control valve	- as reqd.	• Pressure relief valve	- 1 No.
		• Pressure gauge	- 1 No.

PROCEDURE

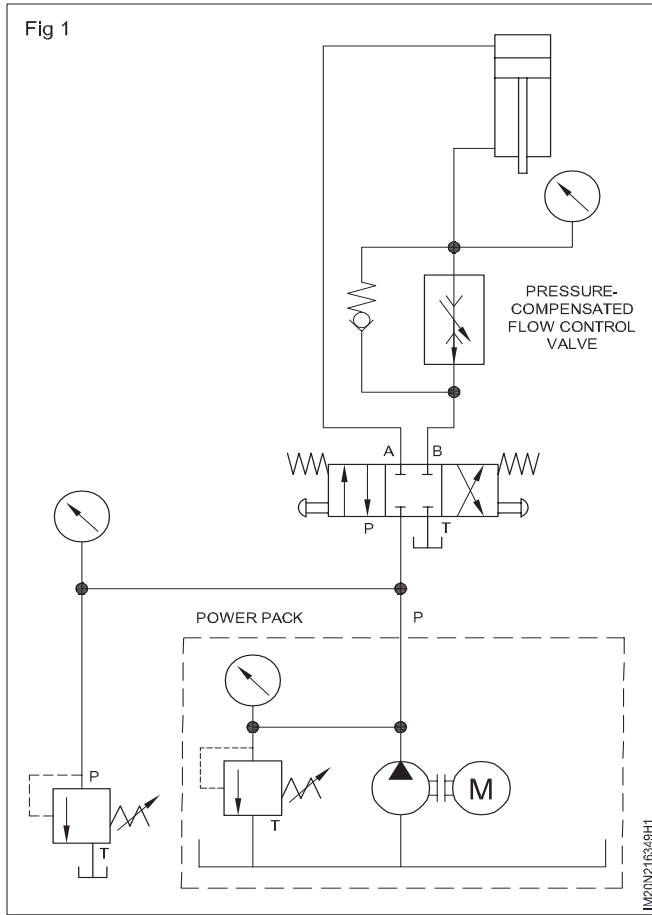
TASK 1: Select and list the components for hydraulic circuit using pressure compensated flow control valve

- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned

Component	Symbol
Hydraulic power pack	Single Cylinder
4/3 way DC valve	
Manifold	
Pressure sequencing valve	
Double acting cylinder	
Check valve	

TASK 2: Draw circuit diagram (Fig 1)



1 Draw circuit diagram

TASK 3: Assemble circuit on the trainer board

- 1 Arrange component on trainer card as shown.
- 2 Connect Pump to port P of 4/3Way DC valve & Pressure relief valve through Manifold.
- 3 connect port T of the 4/3Way DC valve & Pressure relief valve to the Tank
- 4 Connect to output port A of the 4/3Way DC valve to output of double acting cylinder as shown in the diagram.
- 5 Connect to output port B of the 4/3 Way DC valve to Pressure compensated flow control valve & check valve as shown in the diagram
- 6 Connect another part of Pressure compensated flow control valve & check valve to the input of double
- 7 Connect Pressure gauges shown in the diagram.
- 8 Ensure proper connections
- 9 Switch on the motor.

Pump, motor, tank & pressure regulators are available in single unit

Connect the pump through manifold

Connect properly to avoid oil leaks through joints.

TASK 4: Check function of the circuit per the table

Action	Expected Result	Confirm Result (Put)
Actuate the 4/3 DC valve	The cylinder will move with constant speed	

Conclusion

Conclusion drawn	Remarks
Pressure-compensated flow control valve provided a constant volume flow rate independent of the pressure drop across the valve	

Study construction operated & used of air compressor and fitter regulator and lubricators

Objectives: At the end of this exercise you shall be able to
 • identify the various parts of this air compressor.

Requirements			
Tools/Instruments			
• Workshop tools	- 1 Set.	• FRL unit	- 1 No.
• Special tools	- 1 Set.	• Pressure regulator	- 1 No.
Equipments/Machines		Materials	
• Compressor 0 – 7 kg/cm ² ½ HP	- 1 No.	• PVC tube	
		• Ferrule	- 1 Set.
		• Nut	- 1 Set.

PROCEDURE

TASK 1: Identify the various parts of reciprocating piston air compressor

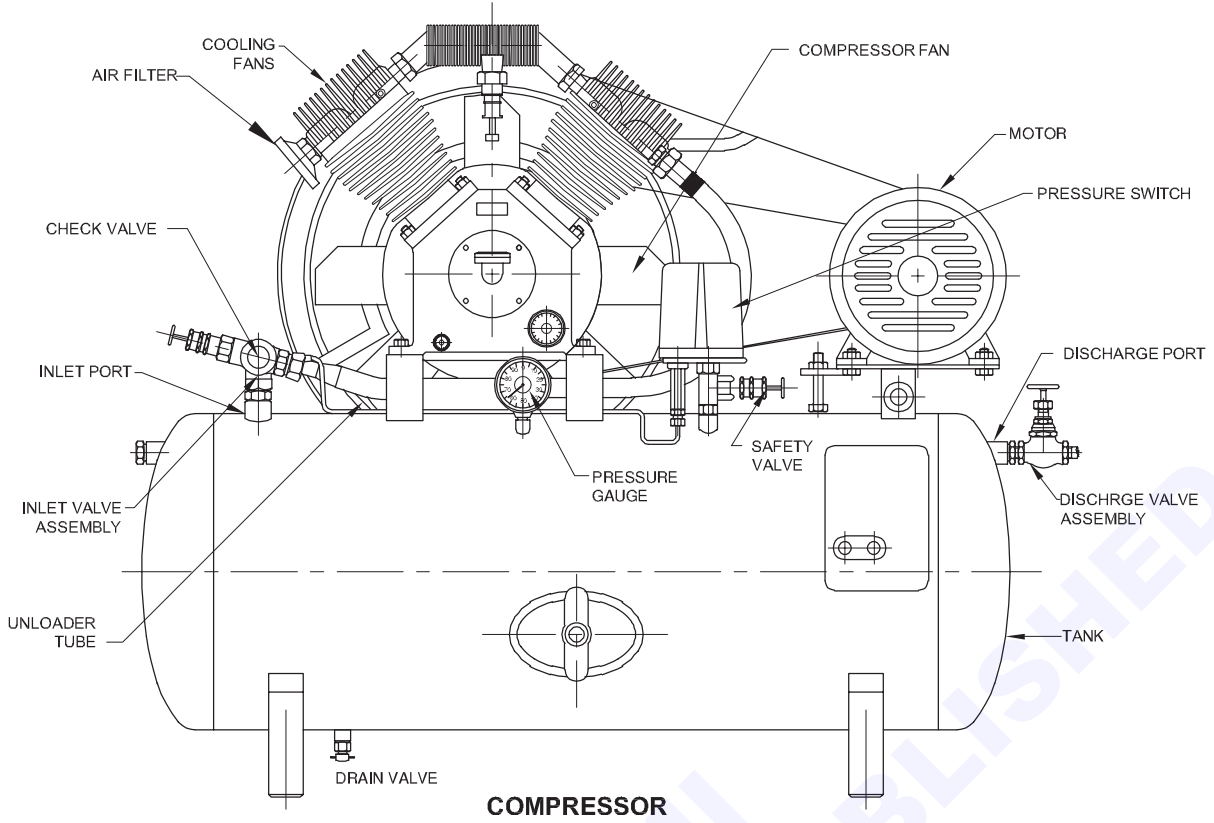
Instructor shall monitor the trainees and give demo explaining all the parts. Ask the trainees to record in in the table 1.

- Observe the various parts of compressor.
- Identify the parts.
- Record the parts name in the Table 1.
- Connect the compressor with 230V AC supply.

Table 1

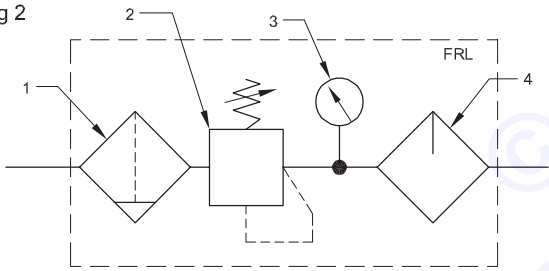
Sl. No.	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Fig 1



IM20N217350H1

Fig 2



IM20N217350H2

Identify various parts of FRL unit

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

- identify the various parts of FRL unit.

Requirements			
Tools/Instruments			
• Workshop tools	- 1 Set.	• FRL unit	- 1 No.
• Special tools	- 1 Set.	• Pressure regulator	- 1 No.
Equipments/Machines		Materials	
• Compressor 0 – 7 kg/cm ² ½ HP	- 1 No.	• PVC tube	
		• Ferrule	- 1 Set.
		• Nut	- 1 Set.

PROCEDURE

Instructor shall arrange and show the compressor to trainees and give demo explaining all the parts. Ask the trainee to record in the table 1.

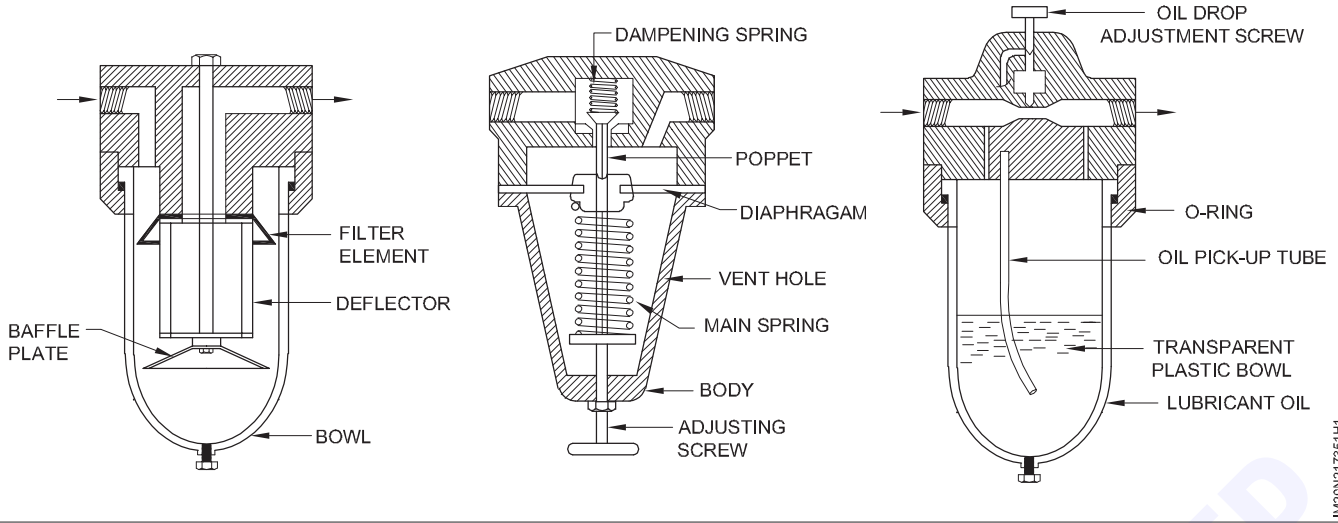
- Observe the FR2
- Identify the parts
- Record the parts name in Table 1.
- Connect the FRL unit with compressor and turn it on.
- Observe and note the pressure gauge reading.

Table 1

Serial No	Name of the parts
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

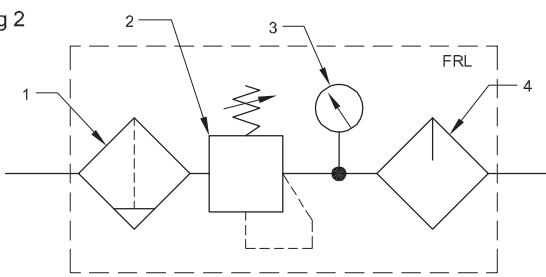
- Get it checked by your instructor.

Fig 1



IM20N217351H1

Fig 2



IM20N217351H2

Practice and use of pneumatics piping, tubing and filling (metallic and non – metallic) and setup a system to provide 20 PSI output from compressor

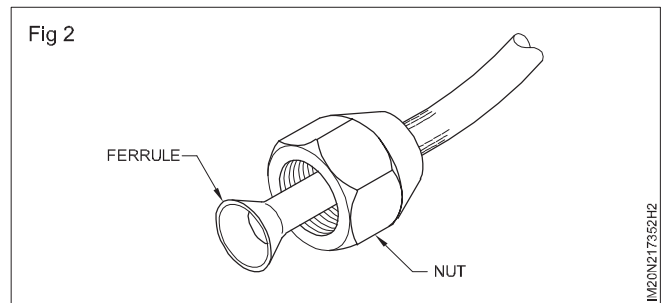
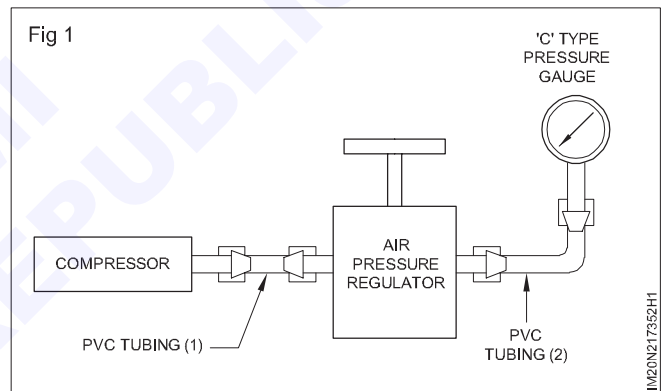
Objectives: At the end of this exercise you shall be able to

- practice and use of pneumatic piping, tubing and fitting (metallic and nonmetallic) setup a system to provide 20 psi output from compressor.

Requirements	
Tools/Instruments	
• Compressor (0 -7) Kg/cm ²	- 1 No.
• Air pressure (0-100) psi regulator (0-30) psi	- 1 No.
• Double ended spanner	- 1 No.
• Flat file 8"	- 1 No.
Materials	
• C- type Pressure gauge (0.30) psi	- 1 No.
• PVC tube 6mm	- 5m
• Metallic pipe 6mm	- 5m

PROCEDURE

- 1 Cut the PVC tube as per dimension given by the instructor as shown Fig 1.
- 2 Fit the ferrule and nut at the two ends of PVC tube as shown in Fig 2
- 3 Connect PVC tubing 1 between output of air pressure regulator and pressure gauge.
- 4 Check the leaks in the connection with the help of instructor
- 5 Check the leaks in the connection with the help of instructor.
- 6 Switch on the compressor
- 7 Set 20m psi pressure in air pressure regulator by regulating the knob.
- 8 Check whether the psi pressure is readout in the pressure gauge.
- 9 Repeat the same procedure by changing the tube from PVC to metallic tube with the help instructor.



Set up a system to provide pneumatic (air) supply of 20 psi output from the available compressor

For Exercise 2.17.253 Refer Exercise 2.17.352

Build a pneumatic circuit of a single acting cylinder being controlled by 3 way 2 position directional control valves

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

- select the components, to operate single acting cylinder using 3/2 DC push button valve
- assemble circuit on the trainer board as per the diagram
- check function of the circuit.

Requirements		
Tools/Instruments/Equipments		Materials
<ul style="list-style-type: none"> • Trainer board • Pneumatic source 	<ul style="list-style-type: none"> - 1 No. - 1 No. 	<ul style="list-style-type: none"> • P U Tube • Single Acting Cylinder • 3/2 way valve • FRL
		<ul style="list-style-type: none"> - as reqd. - 1 No. - 1 No. - 1 No.

PROCEDURE

TASK 1: List the components, to operate Single Acting cylinder using 3/2 way valve.

- 1 Identify the components and list using ISO 1219 symbol in the table.

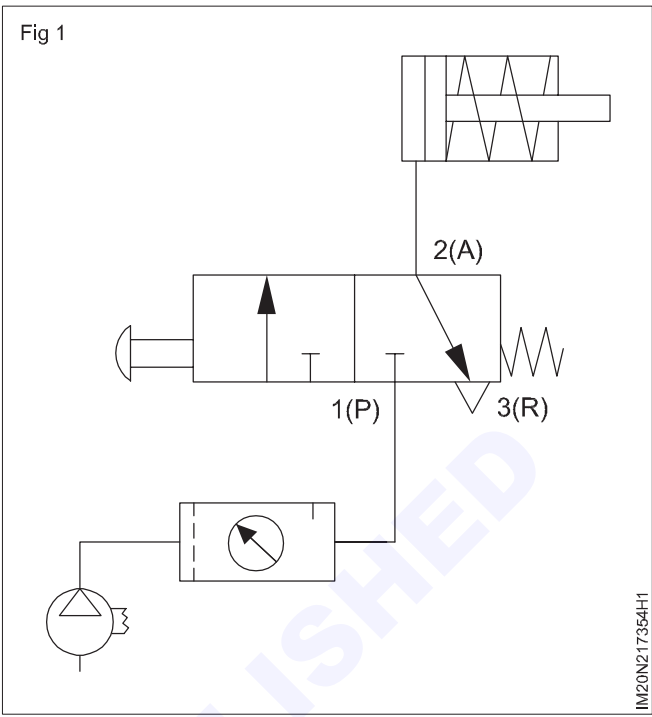
The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Single Acting Cylinder	
3/2 Way valve	
FRL	

TASK 2: Assemble circuit on the trainer as per the circuit diagram

- 1 Arrange component on trainer board as shown fig 1.
- 2 Connect source to FRL
- 3 Connect FRL to input port of 3/2 DC push button valve
- 4 Connect output port 2 of 3/2 DC push button valve to input port of single acting cylinder.
- 5 Ensure proper connections
- 6 Supply air.

Correct the assembly if air leaks through joints



TASK 3: Check function of the circuit as per the table

Action	Expected Result	Confirm Result (Put)
Press Push Button	Piston moves forward	
Release push Button	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Motion of Single Acting cylinder can be controlled by 3/2 Way valve.	

Build a pneumatic circuit of a double acting cylinder being controlled by 5 way 2 position directional control valve

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

- select the components, to operate double acting cylinder using 5/2 DC push button valve
- assemble circuit on the trainer board as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments/Equipments		Materials	
• Trainer board	- 1 No.	• P U Tube	- as reqd.
• Pneumatic source	- 1 No.	• Double Acting Cylinder	- 1 No
		• 5/2 push button valve	- 1 No
		• FRL	- 1 No

PROCEDURE

TASK 1: Select and list the components, to operate Double Acting cylinder using 5/2 DC Push button valve

- 1 Identify the components and list using ISO 1219 symbol in the table.

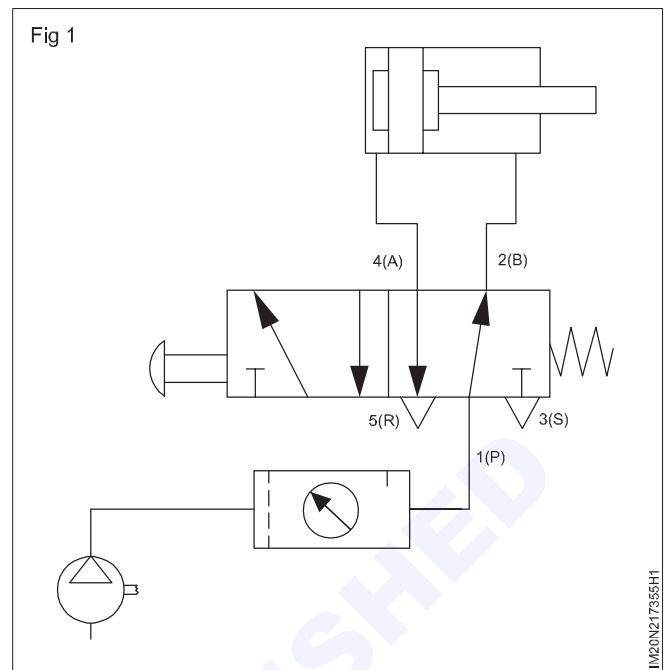
The instructor shall arrange trainer board with components mentioned

Component	Symbol
Pneumatic Source	
Single Acting Cylinder	
5/2 Push button valve	
FRL	

TASK 2: Assemble circuit on the trainer board as per the circuit diagram

- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL.
- 3 Connect FRL to input port "1" of 5/2 DC push button valve.
- 4 Connect output port "2(B)" & "4(A)" of 5/2 DC valve, to input port of double acting cylinder as shown.
- 5 Ensure proper connections.
- 6 Supply air.

Correct the assembly if air leaks through joints.



TASK 3: Check function of the circuit

Action	Expected Result	Confirm Result (Put)
Press Push Button	Piston moves forward	
Release push Button	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Motion of Double Acting cylinder can be controlled by 5/2 DC Push button valve.	

Build a pneumatic AND, OR circuit by 3 way 2 position directional control valves to operate a double acting cylinder

- Objectives:** At the end of this exercise you shall be able to
- select the component to build pneumatic AND&OR circuit
 - assemble the pneumatic AND circuit on the trainer board
 - check the function of the circuit.
 - assemble the pneumatic OR circuit on the trainer board
 - check the function of the circuit.

Requirements			
Tools/Instruments			
• Trainer board	- 1 No.	• 5/2 DC valve pneumatically operated spring return	- 1 No.
• Pneumatic source	- 1 No.	• FRL	- 1 No.
Materials			
• PU Tube	- as reqd.	• 3/2 DC Push button valve	- 2 Nos.
• Double acting cylinder	- 1 No.	• Two pressure valve	- 1 No.
		• Shuttle valve	- 1 No.
		• One way flow control valve	- 2 Nos.

PROCEDURE

TASK 1: Select and list the components, for pneumatic AND & OR circuit to operate double acting cylinder

- 1 Identify the components and list using ISO 1219symbol in the table.

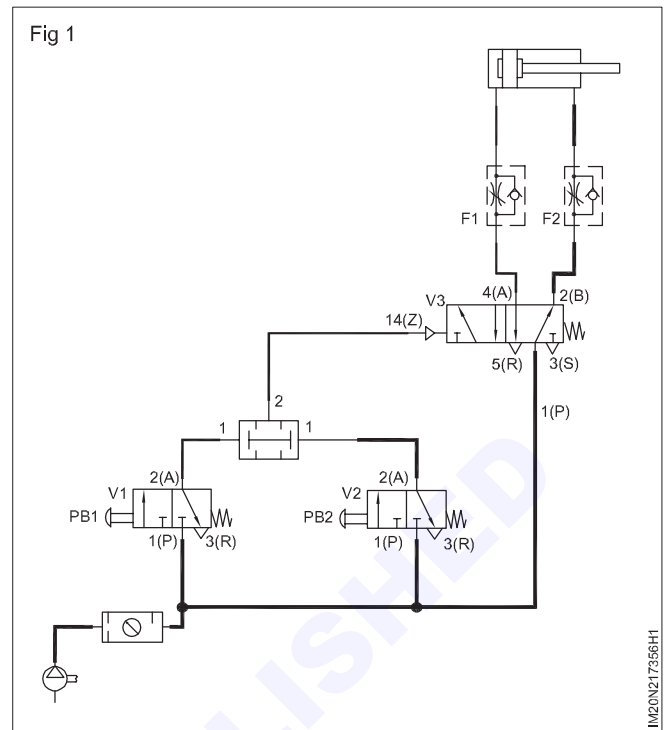
The instructor shall arrange trainer board with components mentioned.

Component	Symbol
Pneumatic Source	
Double acting cylinder	
3/2 DC Push button valve	
FRL	
5/2 valve, pneumatically operated spring return	
Two pressure valve	
Shuttle valve	
One way flow control valve	

TASK 2: Assemble pneumatic AND circuit as per the diagram and check function of the circuit (Fig 1)

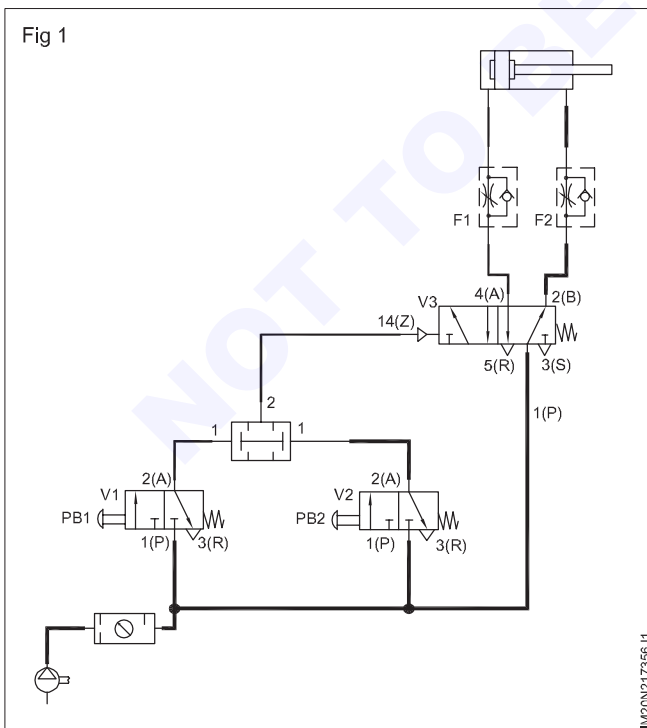
- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL
- 3 Connect FRL to input port "1" of both 3/2 DC Push button valves and 5/2 DC valve, pneumatically operated spring return.
- 4 Connect output port "2" of both 3/2 DC push button valve to the port "1" (each side) of the two pressure valve
- 5 Connect output port "2" of the two pressure valve to pressure port "14" of the 5/2DC valve, pneumatically operated spring return
- 6 Connect output port "2(B)" & "4(A)" of 5/2 DC pneumatically operated spring return valve to input port of double acting cylinder via one way flow control valve as shown.
- 7 Ensure proper connections.
- 8 Supply air.

Correct the assembly if air leaks through joints



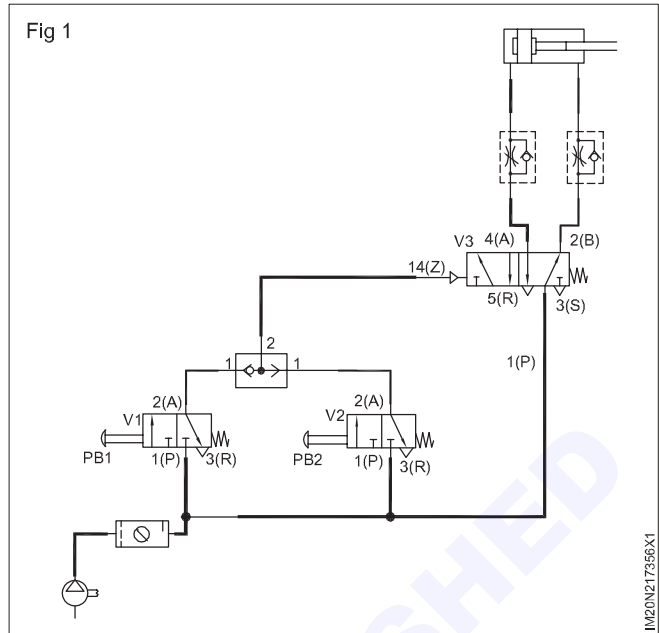
TASK 3: Check function of the circuit. (Table 1)

Action	Expected Result	Confirm Result (Put)
Press any one push button	Piston not moves forward	
Press both the push button	Piston moves forward	
Release push button	Piston retracts	



TASK 4: Assemble pneumatic OR circuit as per the diagram as per the diagram (Fig 1)

- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL
- 3 Connect FRL to input port “1” of both 3/2 DC Push button valves and 5/2 DC valve, pneumatically operated spring return.
- 4 Connect output port “2” of both 3/2 DC push button valve to the port “1” (each side) of the shuttle valve.
- 5 Connect output port “2” of the shuttle valve to the pressure port “14” of the 5/2 DC valve, pneumatically operated spring return.
- 6 Connect output port “2(B)” & “4(A)” of 5/2 DC pneumatically operated spring return valve to input port of double acting cylinder via one way flow control valve as shown.
- 7 Ensure proper connections.
- 8 Supply air.



Correct the assembly if air leaks through joints.

TASK 5 : Check function of the circuit (Table 2)

Action	Expected Result	Confirm Result (Put)
Not press push button	Piston not moves forward	
Press any/all push button	Piston moves forward	
Release push button	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Motion of Double Acting cylinder can be do based on logic AND & OR principle.	

Build a pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way 2 position directional control valve and 5 way 2 position valve

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

- select the components, to build pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way 2 position directional control valve and 5 way 2 position valve
- assemble the circuit on the trainer board as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments		Materials	
• Trainer board	- 1 No.	• PU Tube	- as reqd.
• Pneumatic source	- 1 No.	• Double acting cylinder	- 1 No.
		• 3/2 DC push button valve	- 1 No.
		• 3/2 DC valve, pneumatically operated	- 2 Nos.
		• FRL	- 1 No.

PROCEDURE

TASK 1 : Select and list the components, to build pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way 2 position directional control valve and 5 way 2 position valve

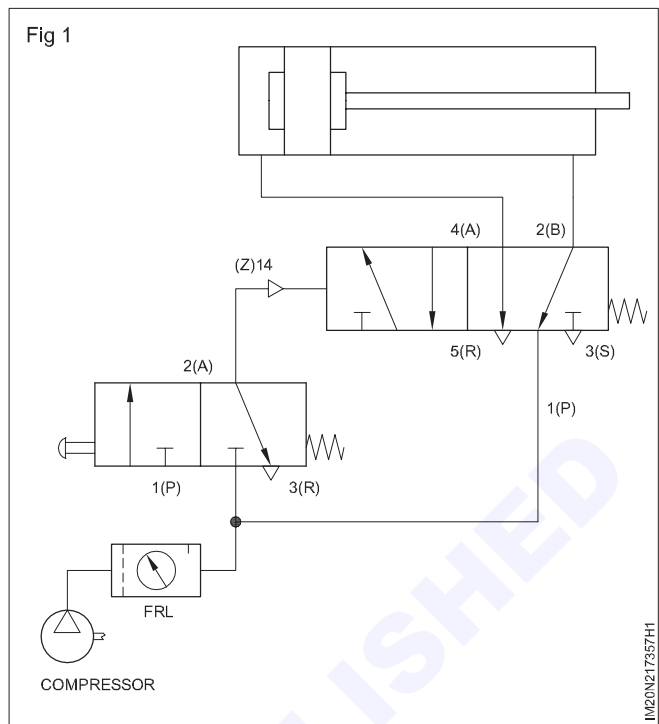
- 1 Identify the components and list using ISO1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned.

Component	Symbol
Pneumatic source	
Double acting cylinder	
5/2 DC valve, pneumatically operated	
3/2DC push button valve	
FRL	

TASK 2: Assemble the circuit on trainer board as per the diagram (Fig 1)

- 1 Arrange component on trainer board as shown.
- 2 Connect source to FRL
- 3 Connect FRL to input port “1” of both 3/2 DC Push button valves and 5/2 DC valve, pneumatically operated spring return.
- 4 Connect output port “2” of both 3/2 DC push button valve to the port “1” (each side) of the two pressure valve
- 5 Connect output port “2” of the two pressure valve to pressure port “14” of the 5/2DC valve, pneumatically operated spring return
- 6 Connect output port “2(B)” & “4(A)” of 5/2 DC pneumatically operated spring return valve to input port of double acting cylinder via one way flow control valve as shown.
- 7 Ensure proper connections.
- 8 Supply air.



Correct the assembly if air leaks through joints.

TASK 3: Check function of the circuit

Action	Expected Result	Confirm Result (Put)
Press Push Button	Piston moves forward	
Release push Button	Piston retracts	

Conclusion

Conclusion drawn	Remarks
Motion of Double Acting cylinder can be controlled by 5/2 DC Push button valve.	

Build a pneumatic circuit to test logical latch circuit by 5 way 2 position, 3 way 2 position direction control valves

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

- select the components, build a pneumatic circuit to test logical latch circuit by 5 way 2 position 3 way 2 position direction controlled valves
- assemble circuit on the trainer board as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments			
• Trainer board	- 1 No.	• Double acting cylinder	- 1 No.
• Pneumatic source	- 1 No.	• 5/2 DC double pilot valve	- 1 No.
Materials		• Throttle check valve	- 2 Nos.
• PU Tube	- as req	• 3/2 DC push button valve	- 1 No.
		• FRL	- 1 No.

PROCEDURE

TASK 1: List the components to operate double acting cylinder using 5/2 DC push button valve

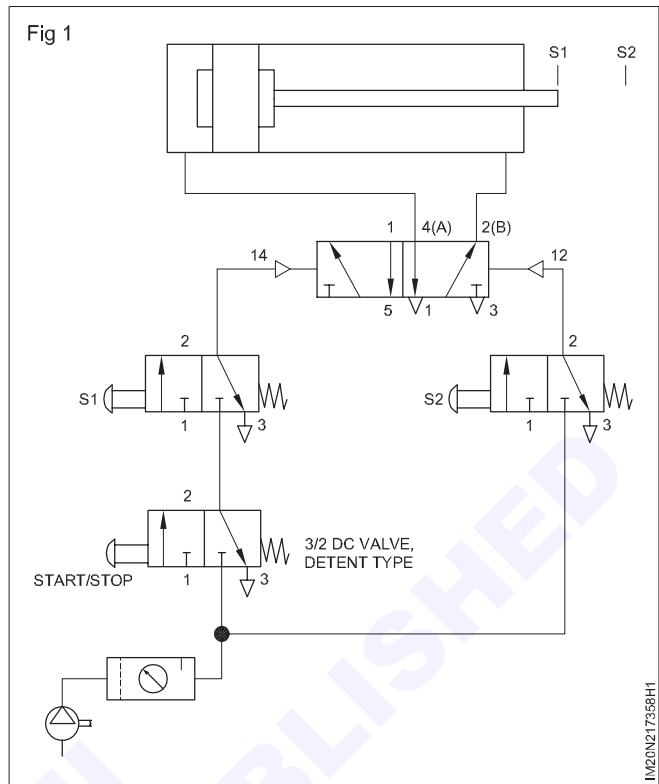
- 1 Identify the components and list using ISO 1219 symbol in the table.

The instructor shall arrange trainer board with components mentioned.

Component	Symbol
Pneumatic source	
Double acting cylinder	
5/2 DC Double pilot valve	
3/2 DC push button valve	
Throttle check valve	
FRL	

TASK 2: Assemble circuit on the trainer board as per the circuit diagram.

- 1 Arrange components on trainer board as shown in Fig 1
- 2 Connect source to FRL
- 3 Connect FRL to input port "1" of both 3/2 DC push button valves and 5/2 double pilot valve
- 4 Connect output port "2(B)" & "4 (A)" of 5/2 double valve, to input port of double acting cylinder through throttle check valve as shown in Fig 1.
- 5 Connect output port 2B & 4A of 5/2 double pilot valve, to input port of double acting cylinder through through check valve as shown
- 6 Ensure proper connections.
- 7 Supply air.



Correct the assembly if air leaks through joints.

TASK 3: Check function of the circuit as per the table

Action	Expected Result	Confirm Result (Put)
Press Push Button 1	Piston moves forward	
Press Push Button 2	Piston moves backward	

Conclusion

Conclusion drawn	Remarks
Motion of double acting cylinder can be matched by 3/2 DC push button valves and 5/2 DC pilot valve.	

Build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way 2 position direction control valves

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

- select the components, build pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way 2 position direction control valves
- assemble circuit on the trainer board as per the diagram
- check function of the circuit.

Requirements			
Tools/Instruments			
• Trainer board	- 1 No.	• Double acting cylinder	- 1 No.
• Pneumatic source	- 1 No.	• 5/2 DC double pilot valve	- 1 No.
Material/component		• 3/2 DC push button valve detent type	- 1 No.
• PU Tube	- as reqd.	• 3/2 DC roller valve	- 2 Nos.
		• FRL	- 1 No.

PROCEDURE

TASK 1: List the components to build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way 2 position direction control valves

- 1 Identify the components and list using ISO 1219 symbol in the table.

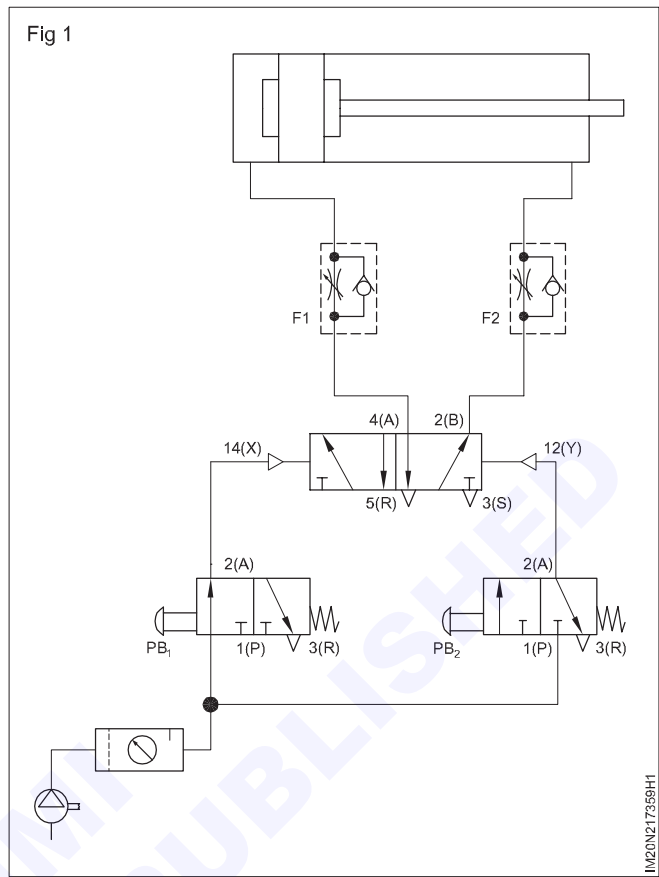
The instructor shall arrange trainer board with components mentioned.

Component	Symbol
Pneumatic source	
Double acting cylinder	
5/2 DC double pilot valve	
3/2 DC push button valve	
3/2 DC push button valve detent type	
FRL	

TASK 2: Assemble circuit on the trainer board as per the circuit diagram

- 1 Arrange components on trainer board as shown in Fig 1.
- 2 Connect source to FRL.
- 3 Connect FRL to input port “1” of 3/2 DC roller valve (S2) , 3/2 DC valve (detent type)and 5/2 DC double pilot valve”.
- 4 Connect output port “1”of 3/2 DC push button valve (detent type)to input port “1” of 3/2 DC roller valve (S1).
- 5 Connect output port “2” of 3/2 DC Roller valve (S1) to pressure port “14 & 12” of 5/2 DC double pilot valve.
- 6 Connect output port “2(B)” & 4(A) of 5/2 DC Double pilot valve, to input port of double acting cylinder as shown in Fig 1.
- 7 Ensure proper connections.
- 8 Supply air.

Correct the assembly if air leaks through joints.



TASK 3: Check function of the circuit as per the table

Action	Expected Result	Confirm Result (Put)
Press Push Button	Piston moves forward & Backward continuously	
Release push button	Piston moves backward	

Conclusion

Conclusion drawn	Remarks
Double acting cylinder is continuously moving forward and backward when the push button press and stops while release.	

Cut the metallic tube using tube cutter and bend using pipe bender

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

- measure mark and cut the metallic tube using tube cutter.

Requirements

Tools/Instruments

- Mallet or plastic hammer - 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
- Nylon or rubber hammer - 1 No

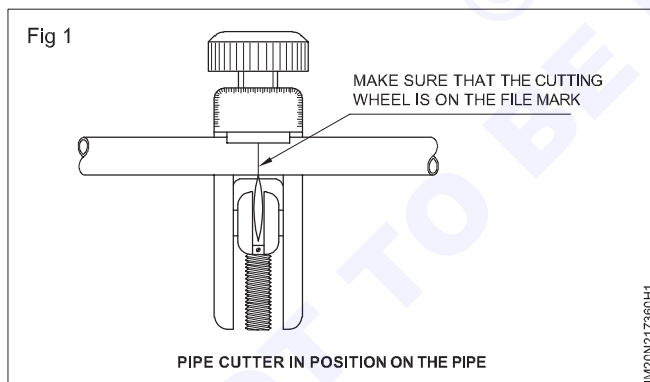
Materials

- Copper tube \varnothing 6mm - 1 coil
- Cotton waste - as reqd.
- A small quantity of oil - as reqd.
- Copper tube two pieces (6mm OD) - 2 Nos.

PROCEDURE

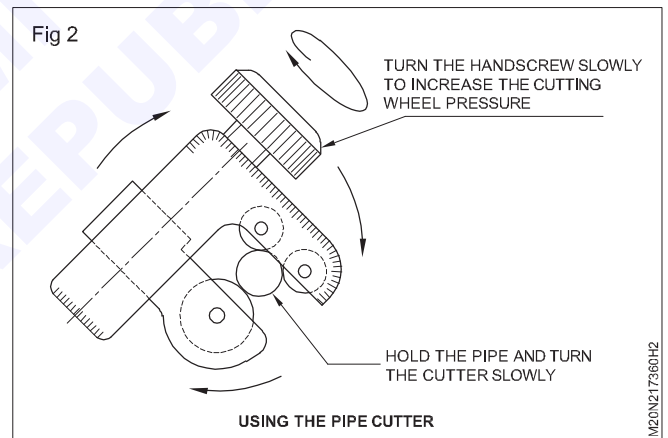
TASK 1: Measure mark and cut the metallic using tube cutter

- 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 1)

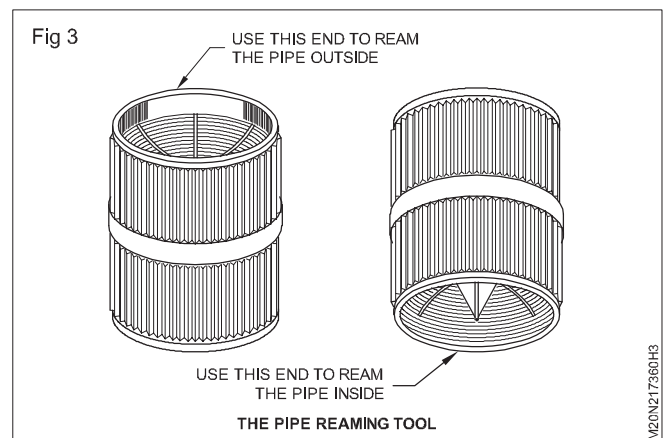


- 4 Tighten the hand screw until the cutting wheel just touches the outside of the pipe.
- 5 Turn the pipe cutter slowly around the pipe so that the cutting wheel cuts gradually into the outside.
- 6 Turn the hand screw to increase the pressure of the cutting wheel and then turn the cutter around the pipe again. (See Fig 2).
- 7 Continue the cutting by gradually increasing the pressure of the cutting wheel. Work slowly and carefully.

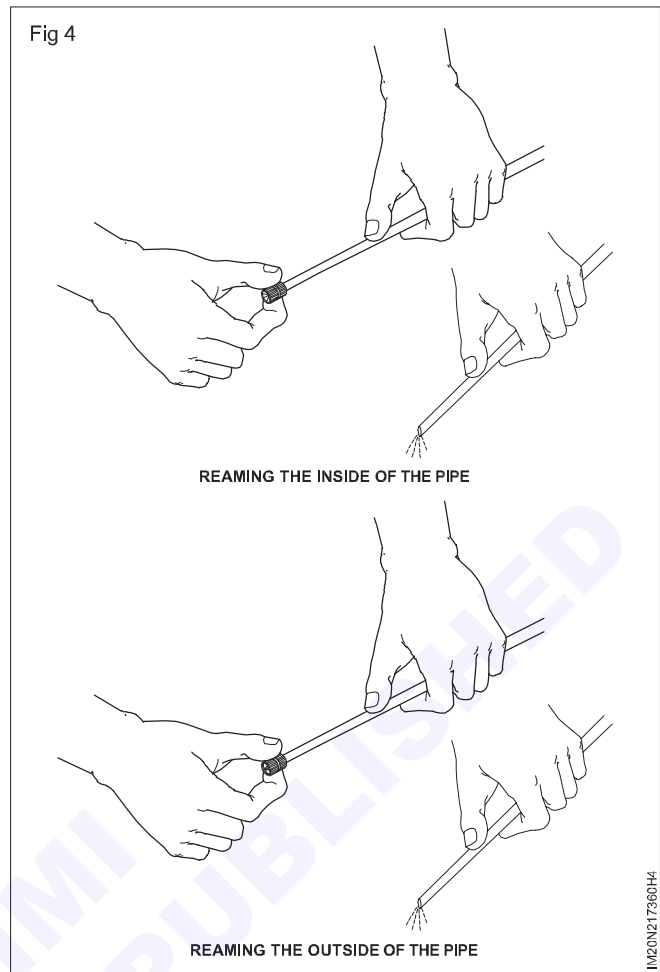
Do not use too much pressure or you may damage the pipe.



- 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 3)



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 4)



Bend the metallic tube using tube bender

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

- bend the metallic tube using pipe bender.

Requirements

Tools/Instruments

- Mallet or plastic hammer - 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
- Nylon or rubber hammer - 1 No

Materials

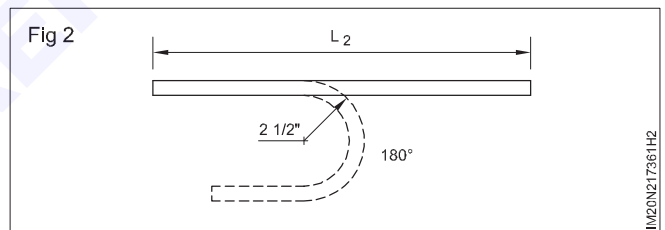
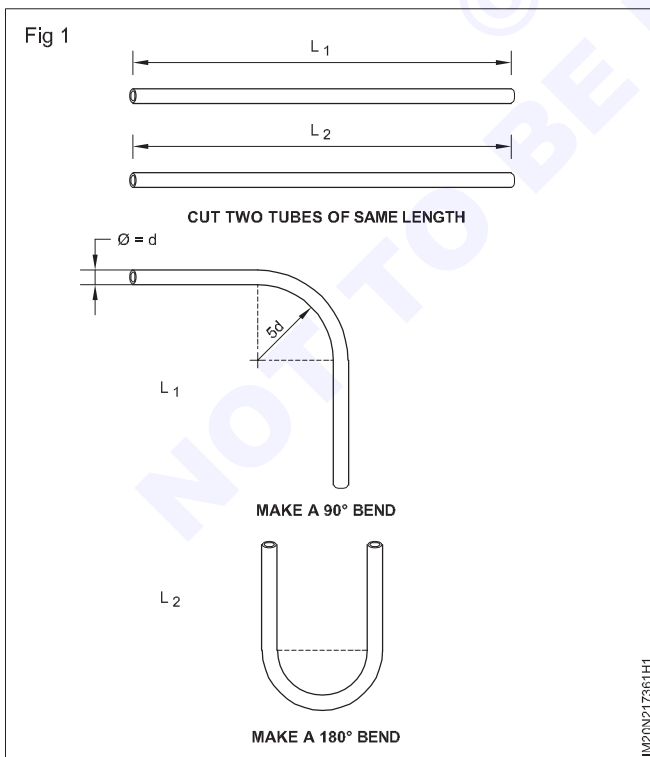
- Copper tube ϕ 6mm - 1 coil
- Cotton waste - as reqd.
- A small quantity of oil - as reqd.
- Copper tube two pieces (6mm OD) - 2 Nos.

PROCEDURE

TASK 1: Bend the metallic tube using tube bender

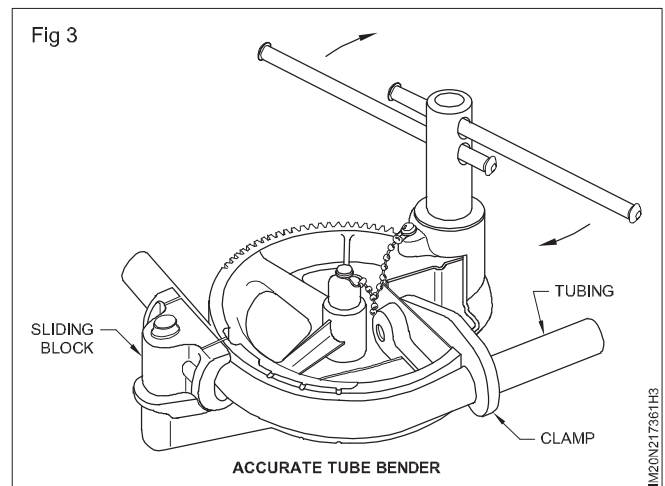
- 1 Metallic pipe is soft and can be bent by hand. Because it is soft it can be easily damaged when bending.
- 2 If the pipe is hard and will not bend easily, it must be annealed before use.
- 3 Push a bending spring onto the outside of the pipe (see drawing) (Fig 1). This helps the pipe to bend evenly.

- 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 2) Not less than 5 times of its diameter.



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

- 6 Bend the pipe so that it fits onto the connection easily (see drawing). (Fig 3)
- 7 Check the work done with the help of instructor.

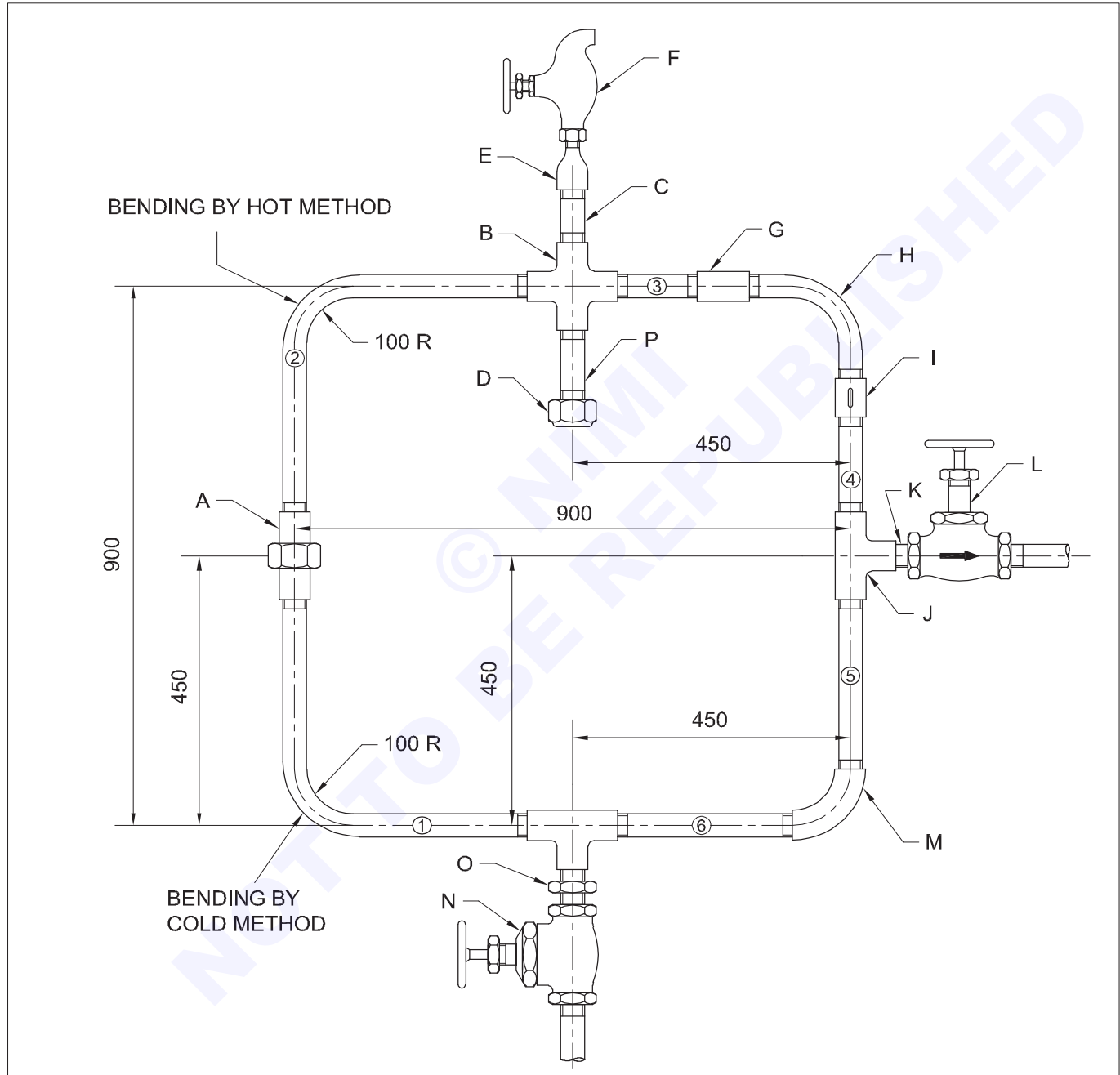


- 4 Bend the pipe a little at a time using your thumbs (see drawing). (Fig 2) Do not try to complete the bend with one movement. This will cause the pipe to buckle.

Installation of simple piping

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

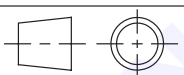
- fit the elbow with G.I. pipe
- fit the union with G.I. pipe
- fit valves with G.I. pipe
- assemble pipe with standard fittings.



-	-	-	-	-	-	07
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS					DEVIATIONS ±	
<p style="text-align: center;">ASSEMBLY OF G.I. PIPES WITH STANDARD PIPE FITTING</p>					TIME 10h	
					CODE NO. IM20N217362E1	

PROCEDURE

- 1 Join pipe No. 2 with the 4-way cross. (B)
- 2 Fit pipe No.3 with the 'cross'.
- 3 Join plain coupling (G) to the other end of the pipe No. 3.
- 4 Assemble G.I. bend (H) to the plain coupling.
- 5 Fit the ribbed coupling (I) to the other end of the bend.
- 6 Join pipe No. 5 to the opposite end of 'T'.
- 7 Assemble elbow (M) with pipe No. 5,
- 8 Fit pipe No. 6 with the other end of the elbow.
- 9 Join 'T' with pipe No. 6.
- 10 Fit pipe No. 1 with the opposite end of 'T'.
- 11 Join pipe Nos. 1 & 2 with union. (A)
- 12 Fit 150mm barrel nipple (P) to the left side of the 'cross' and put cap (A) for it.
- 13 Put another 100mm barrel nipple (C) to the right side of the cross.
- 14 Join the reducer (E) to the barrel nipple.
- 15 Assemble the bib-cock (F) to the other end of the reducer.
- 16 Put the hexagonal nipple (O) to the left side 'T'.
- 17 Assemble the gate-valve to the nipple.

1	25 x 150 mm	BRASS NIPPLE	G.I.	P	P	
1	25 x 25 mm	HEXAGONAL NIPPLE	G.I.	O	O	
1	25 mm	GATE VALVE	COPPER ALLOY	N	N	
1	25 mm	ELBOW	G.I.	M	M	
1	25 mm	GLOBE VALVE	COPPER ALLOY	L	L	
1	25 x 100 mm	BARREL NIPPLE	G.I.	K	K	
2	25 mm	TEE	G.I.	J	J	
1	25 mm	RIBBED COUPLING	G.I.	I	I	
1	25 mm	BEND 90°	G.I.	H	H	
1	25 mm	PLAIN COUPLING	G.I.	G	G	
1	1/2 INCH	BIB COCK	BRASS	F	F	
1	25 x 15 mm	REDUCER	G.I.	E	E	
1	25 mm	CAP	G.I.	D	D	
1	25 x 100 mm	BARREL NIPPLE	G.I.	C	C	
1	25 mm	CROSS	G.I.	B	B	
1	25 mm	UNION (WITH WASHER)	G.I.	A	A	
1	Ø25 x 4.05 - 405	PIPE (CLASS B)	G.I.	6	6	
1	Ø25 x 4.05 - 410	PIPE (CLASS B)	G.I.	5	5	
1	Ø25 x 4.05 - 290	PIPE (CLASS B)	G.I.	4	4	
1	Ø25 x 4.05 - 300	PIPE (CLASS B)	G.I.	3	3	
2	Ø25 x 4.5 - 820	PIPE (CLASS B)	G.I.	1 & 2	1 & 2	7
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS		ASSEMBLY OF G.I. PIPES WITH STANDARD PIPE FITTING			DEVIATIONS	TIME
					CODE NO. MM1307E2	

Operation of pH meter, conductivity meter and dissolved oxygen meter

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

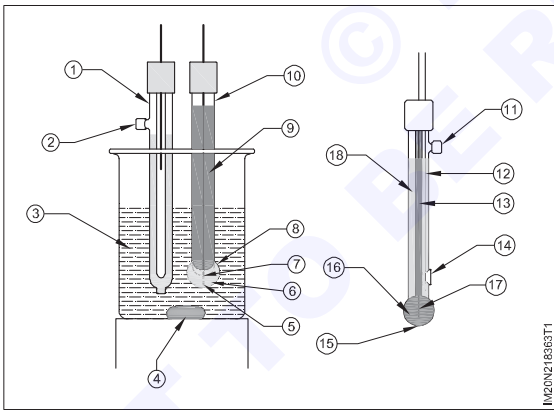
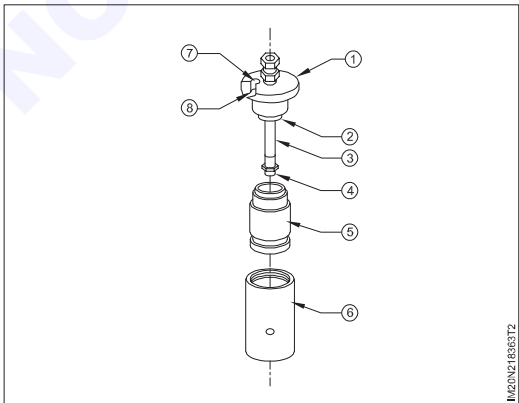
- operation of pH meter, conductivity meter and dissolved oxygen meter.

Requirements			
Materials			
• pH Meter	- 1 No.	• Mullmull cloth	- as reqd.
• Conductivity meter	- 1 No.	• Power supply (230V/AC)	- 1 No.
• Dissolved oxygen meter	- 1 No.		

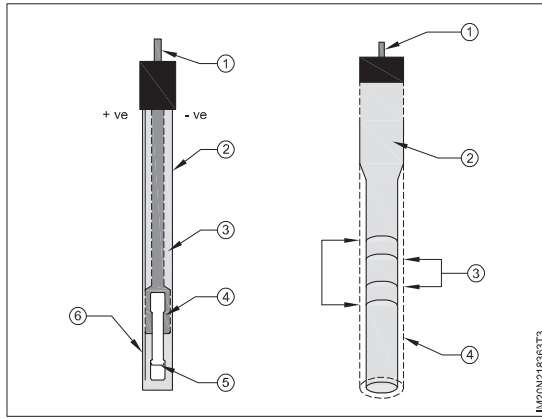
PROCEDURE

- 1 Take pH meter, conductivity meter and dissolved oxygen meter on working table.
- 2 Clean the above instruments using mullmull cloth.
- 3 Identify the parts name and operation of the above instrument with the help of instructor and tabulate in tables.

Table 1

Sl.No.	Name of the instrument	Part name	Operation
1			
2			

3



Instructor should explain trainees the above instrument in R.T.for Ex.No.2.17.363

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Wire up pH meter electrode to pH meter

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

- wire up pH meter electrode to pH meter
- determination of pH.

Requirements			
Tools/Instruments		Equipments/Machines	
• pH trainer kit	- 1 No.	• Power chord	- 1 No.
• pH meter	- 1 No.	Materials	
• pH electrode filled with KCL solution	- 1 No.	• Clean beakers	- as reqd.
• Buffer solution of pH4 and pH7 & pH 9.2	- 1 No.	• Tissue Papers	- as reqd.
• Thermometer		• Distilled water	- as reqd.
		• Buffer capsule	- as reqd.

PROCEDURE

TASK 1: Wire up pH meter electrode to pH meter

- 1 Study the front panel and back panel pH measurement trainer as illustrated below.

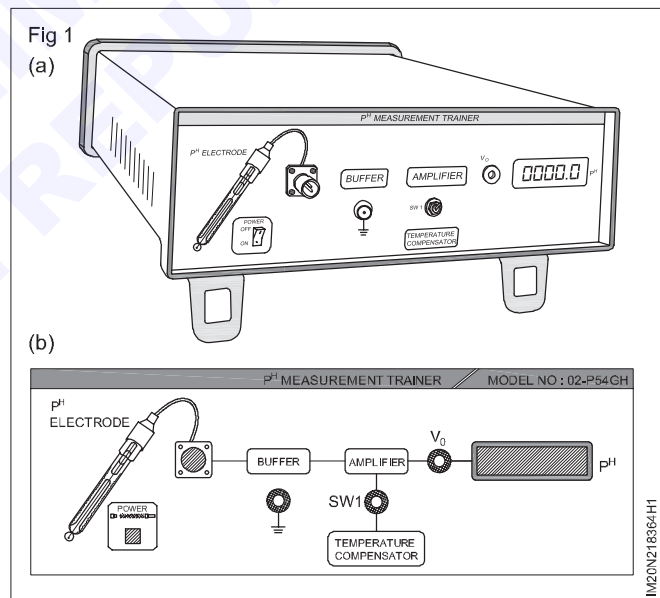
pH Measurement Trainer

Front Panel Description

- Power ON/OFF switch : Switch ON/OFF the unit.
- Electrode plug point : Connect the pH electrode.
- V_o : Measure the output voltage (0-5) V
- 3.5 Display : Display the pH value (0 . 14) pH
- SW1 Switch : Select with temperature compensation or without temperature compensation.
- GND : Ground terminal.

Back Panel Description

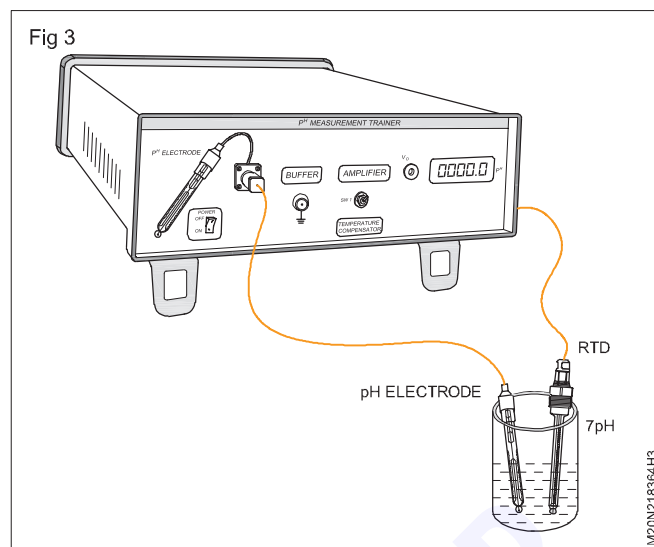
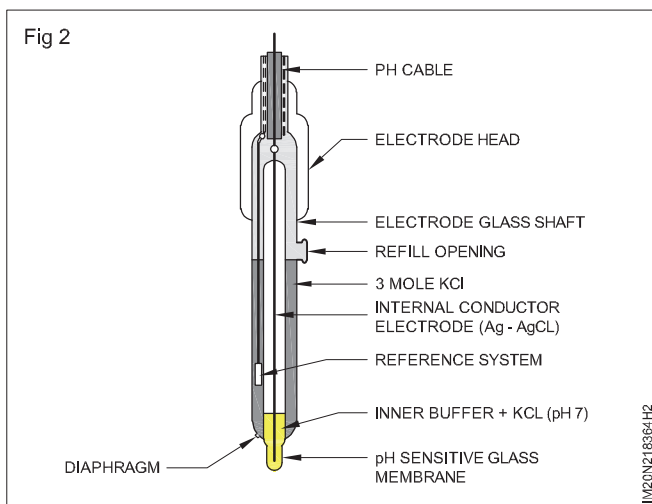
- 230V AC/50HZ Power chord : Connect the 230V AC/50HZ supply.
- RTD : Connect the RTD sensor.
- 2 Identify and study the front panel view of pH measurement trainer as shown in Fig.1 (a) and Fig 1 (b)



pH Measurement Trainer

Front Panel Diagram

- 3 Fig 2 shows the combination electrode used to measure the pH of the solution under test.
- 4 Wire up the electrode and RTD as shown in Fig 3
- 5 Check the connection with the help of the instructor.



TASK 2 : Determination of pH

- 1 Plug in the pH meter to power source and let it warm up for 5 to 10 minutes.
- 2 Wash the glass electrode with distilled water and clean slowly with a soft tissue.
- 3 Select the temperature compensation selector switch 'ON' position, to remove the electrode error.

Note : The error is removed by an automatic temperature compensator consists of RTD immersed in the solution in which resistance changes with temperature to change the PH meter amplifier gain to compensate the temperature rise and change in pH value is rectified by using temperature compensation networks.

- 4 Prepare test solution by taking 100ml of distilled water in the beaker.
- 5 Add one buffer capsule and stir the distilled water.
- 6 Connect the electrode in the electrode plug point terminal in the front panel as shown in Fig 1.

Note : For using different test solution using different PH value buffer capsule (4pH, 7pH,9.2pH)

To take 200ml of distilled water (Add 2 buffer capsule) in the beaker for fully immersing the pH electrode sensor.

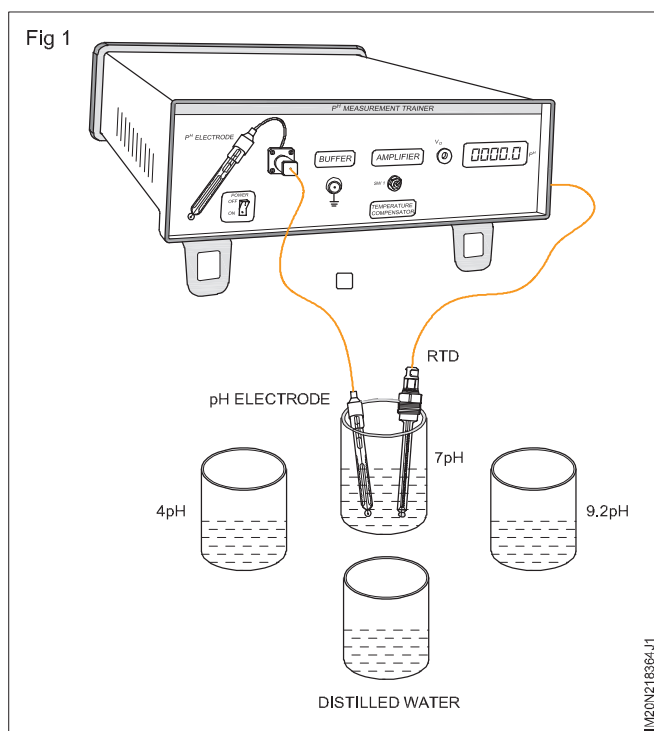
- 7 Connect the RTD temperature sensor to temperature compensation terminals.
- 8 Switch 'ON' the display.

Note : Wash the pH sensor tip with the help of distilled water for every change of test solution.

- 9 Immerse the electrode in the test solutions.
- 10 Connect the multimeter across GNP and VO terminals.
- 11 Note the pH value and output voltage for different test solutions (4pH, 7pH,9.2pH)
- 12 Calculate the percentage of error different test solutions using the formula.

$$\% \text{ of error} = \frac{\text{Actual value} - \text{Displayed value}}{\text{Actual value (Standard value)}}$$

Note down the readings and tabulated them. and check it with the help of the instructor



Sl.No.	Output voltage	Displayed pH value	Actual pH value	% of error

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Calibrate pH meter using buffer solution

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

- calibrate pH meter using buffer solution.

Requirements

Tools/Instruments

- pH measurement trainer – 1 No.
- pH electrode – 1 No.
- Beaker 200ml – 1 No.
- Power chord – 1 No.

Materials

- Distilled water – as required – as reqd.
- Buffer capsule - 4pH, 7pH,9.2pH – as reqd.

PROCEDURE

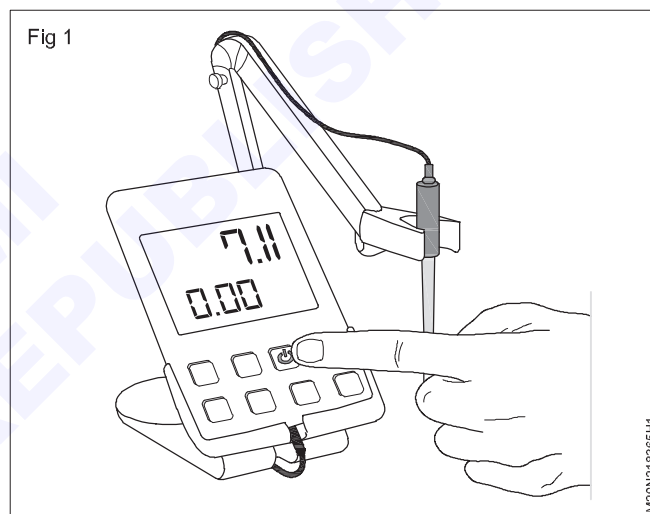
Preparing for calibration

- 1 Turn on your pH meter. Before you begin to calibrate and use your pH meter you will first need to turn it on and allow adequate time for the meter to warm up. This should generally take around 30 minutes, but check your pH meter's operating manual for exact times.
- 2 Clean the electrode. Take the electrode out of its storage solution and rinse it with distilled water under an empty waste beaker. Once rinsed, wipe it with a soft cloth.
 - Be Sure to rinse the electrode in a waste beaker that is different from the beaker you will be calibrating in.
 - Avoid rubbing the electrode as it has a sensitive membrane around it.
 - If you find the electrode to be particularly dirty consult your operating manual for recommended cleaning solutions.
- 3 Prepare your buffers. You will generally need more than one buffer for calibrating a pH meter. The first will be a "neutral" buffer with a pH of 7, and the second should be near the expected sample pH. Either a PH of 4 or 9.21. Buffers with a higher pH (9.21) are best for measuring bases, whereas buffers with a low pH (4) are best for measuring acidic samples. Once you have chosen your buffers allow them to reach the same temperature as the pH meter because pH readings are temperature dependent. Pour your buffers into individual beakers for calibration. (Fig 1)

Note: Check with your pH meter manufacturer, or current educational or professional institution, about acquiring pH buffer solutions.

Buffers should be kept in a beaker for no longer than two hours.

Fig 1

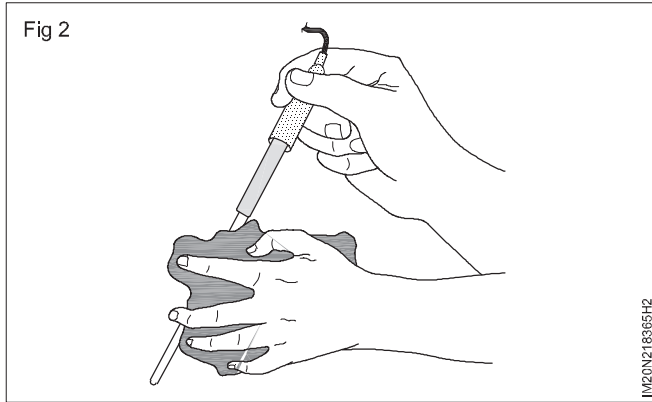


Discard the buffer when you are finished. Do not return it to its original container.

Calibrating pH meter

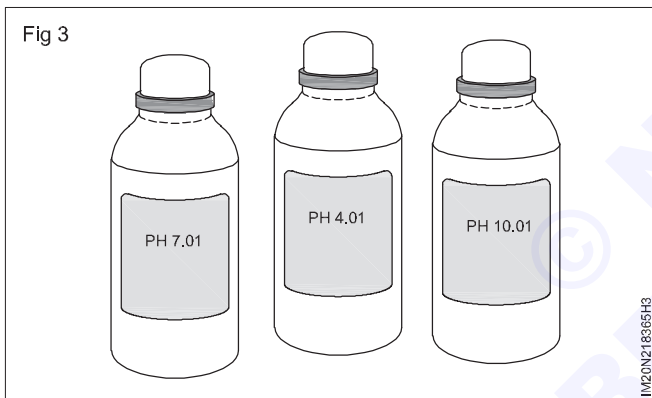
- 1 Place your electrode in the buffer with a pH value of 7 and being reading "measure or calibrate button to begin reading the pH once your electrode is F buffer.
 - Allow the pH reading to stabilize before letting it sit for approximately 1 – 2 min
- 2 Place the electrode in your sample and begin reading. Once the electrode is placed in your samples press the measure button and leave the electrode in your sample for approximately 1 – 2 minutes.
- 3 Set your pH level. Once the reading has stabilized, press the measure button. This is the pH level of your sample.
- 4 Clean the electrode after use. Rinse the electrode with distilled water and wipe it with a soft cloth. You may store your pH meter once clean and dry.

- Consult your operation manual for optimal storage practices for your specific pH meter. (Fig 2)



- 5 Immerse the electrodes into different test solutions
- 6 Calculate the percentage error for different test solution. (Fig 3)

Wash the pH sensor tip with the help of distilled water for every change of test solution



Tabulate the readings

Tabulation

Displayed pH value

Actual pH value

% error

- 6 **Rinse your electrode:** You can use distilled water to rinse. Use a lint – free tissue, like Kimwipes or Shurwipes. In between buffers to dry the electrode. (Fig 4)



Determination of pH of a sample solution

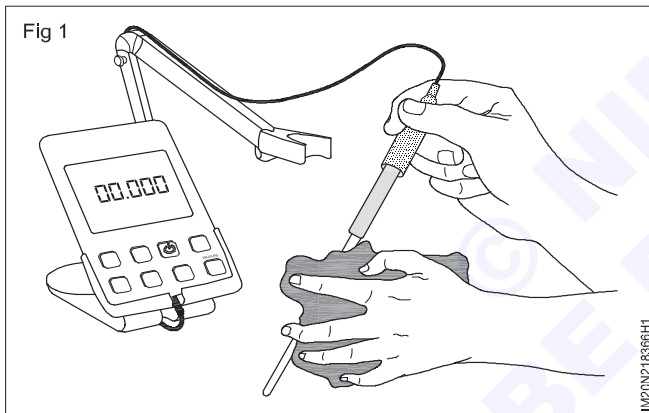
Objectives: At the end of this exercise you shall be able to
 • **determination of pH by pH meter.**

Requirements			
Tools/Instruments		Materials	
• pH measurement trainer	– 1 No.	• Distilled water – as required	– as reqd.
• pH electrode	– 1 No.	• Buffer capsule - 4pH, 7pH,9.2pH	– as reqd.
• Beaker 200ml	– 1 No.	• sample solution	– as reqd.
• Power chord	– 1 No.		

PROCEDURE

Calibrate pH meter using buffer solution

- Place the electrode in your sample and begin reading. Once the electrode is placed in your samples press the measure button and leave the electrode in your sample for approximately 1 – 2 minutes. (Fig 3)



- Set your pH level. Once the reading has stabilized, press the measure button. This is the pH level of your sample.
- Clean the electrode after use (Fig 1) Rinse the electrode with distilled water and wipe it with a soft cloth. You may store your pH meter once clean and dry.
 - Consult the operation manual for optimal storage practices for your specific pH meter.

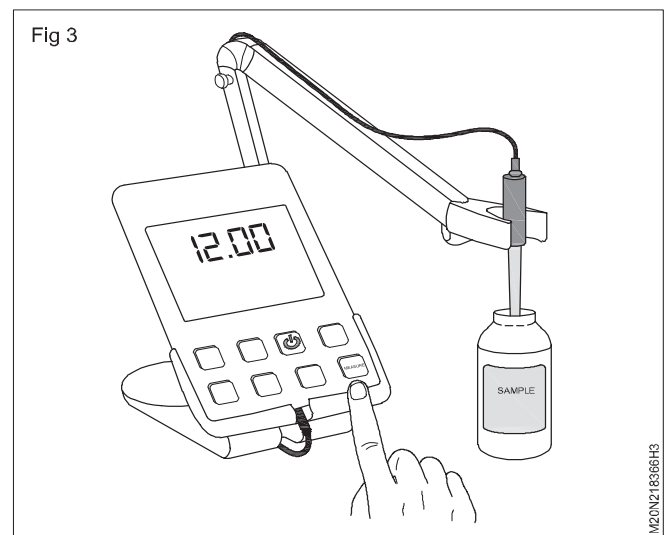
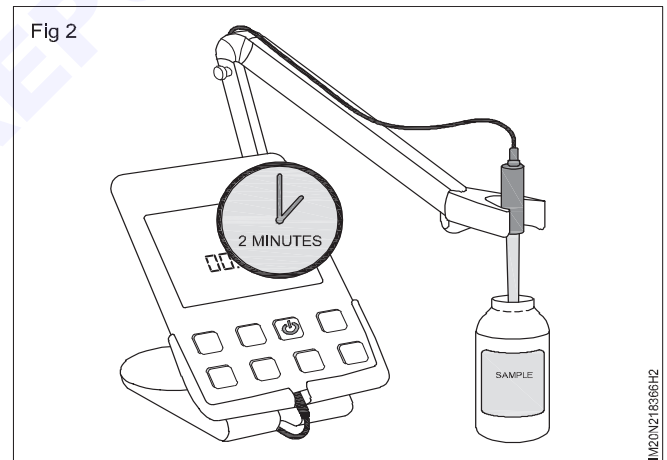
- Immerse the electrodes into different test solutions
- Calculate the percentage error for different test solution.

Wash the pH sensor tip with the help of distilled water for every change of test solution

Tabulate the readings

Tabulation
 Displayed pH value
 Actual pH value
 % error

- Rinse your electrode:** You can see distilled water to rinse. Use a lint – free tissue, like Kimwipes or Shurwipes. In between buffers to dry the electrode. (Figs 2 & 3)



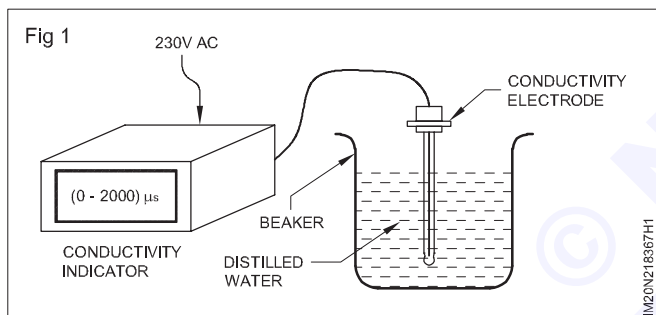
Wire up conductivity meter to electrode and find the electrolytic conductivity of solution

Objectives: At the end of this exercise you shall be able to
 • up conductivity meter to electrode and find electrolytic conductivity.

Requirements			
Tools/Instruments		Materials	
• Conductivity measurement trainer	– 1 No.	• Salt	– as reqd.
• Beaker 200ml	– 1 No.	• Distilled water	– as reqd.
• Power chord	– 1 No.		

PROCEDURE

- 1 Take conductivity trainer on working table and clean it.
- 2 Wire up conductivity meter to electrode as shown in Fig 1



- 3 Clean the beaker initially with water
- 4 Give required supply to conductivity trainer. Conductivity probe is sensitive and must be calibrated before measuring.
- 5 Pour the distilled water into the beaker.
- 6 Immerse the sensor (Conductivity electrode) to the water which is kept in the beaker.

Note : The conductivity electrode should not be touch the bottom of the beakers.

- 7 Add 1g of salt in 100 ml of distilled water.
- 8 Record the conductivity values from display (0 – 2000) micro siemens in table 1

Table 1

Sl.No	Salt Content Gram	Conductivity (in micro Siemens/centimeter)

- 9 Do the same procedure for tap water and record it in table 2

Electrical conductivity of water

Table 2

		Conductivity (in micro Siemens/centimeter)
Distilled water		
Tap water		

Service and maintenance of conductivity meter and dissolved oxygen meter

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

- service and maintenance of conductivity meter
- service and maintenance of dissolved oxygen meter.

Requirements			
Tools/Instruments			
• Dissolved oxygen meter	– 1 No.	• Cleaning cloth	– as reqd.
• Conductivity meter	– 1 No.	• Distilled water	– as reqd.
• Trainees tool kit	– 1 set.		

PROCEDURE

TASK 1 : Service and maintenance of conductivity meter.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1 Take conductivity meter and kept it on the working table. 2 Clean the instrument with cleaning cloth. 3 Follow the trouble shooting guide to service the conductivity meter. <ul style="list-style-type: none"> • A DVM will help to check for electrical continuity from the measuring electrode to its connector and to measure resistance between the conductive pins to see if a short circuit is present. • Verify that the temperature sensor in the electrode is working based on resistance reading at room temperature. | <ul style="list-style-type: none"> • Between measurements rinse the cell with de-ionized water. • Rinse thoroughly with distilled water after cleaning. • Store the conductivity cell carefully. • Handle cells carefully. |
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Conductivity Electrode Troubleshooting

Check electrode in conductivity calibration/standard solutions. Compare results to those on the following table.

Conductivity standard solution output	Possible cause	Corrective Action
No output	<ol style="list-style-type: none"> a Conductivity sensor not connected to instrument. b Bad Connection at connector. c Break in cable or internal connection broken in sensor. 	<ol style="list-style-type: none"> a Check all connections from electrode to instrument. b Check for electrical continuity from conductivity pin to connector using Ohms setting on DVM (should be < 1 Ohm) c clean the sensor
Output in standard solution is more than 10 % different than value of solution.	<ol style="list-style-type: none"> a Solution is not fresh, contaminated, or labeled wrong. b Electrode is dirty. c Standard solution is outside of cell range. 	<ol style="list-style-type: none"> a Use fresh solutions. b Clean electrode per instruction manual. Do not abrade measuring surface. c Pick standards based on ranges shown below

Unstable or drifting reading	Bubbles in electrode or flow cell	<p>a Shake or stir electrode to remove bubbles if testing solution in beaker.</p> <p>b Mount electrode horizontally so bubbles rise up and away from electrode.</p>
Readings not getting	<p>a Electrode not completely immersed in process fluid.</p> <p>b Electrode not connected to controller.</p>	<p>a Check installation fittings and make sure sensor is completely installed.</p> <p>b Check wiring to instrument.</p>

Maintenance of conductivity meter

- 1 Do not completely submerge the sensor. The handle is not waterproof.
- 2 If taking readings at temperature below 15° C above 30° C allow more time for the temperature comparison to adjust and provide a stable conductivity range.
- 3 After the experiment clean the conductivity probe with distilled water and keep it dry.
- 4 If the probe cell surface is contaminated soak it in water with a mild detergent for 15 mins. Then soak it in a dilute and solution for another 15 minutes.
- 5 Burn inside and outside of the electrode cell dry to avoid water droplets diluting or contaminating the sample to be tested.
- 6 Be sure the electrode surfaces in the elongated cell are completely submerged in the liquid and that are no bubbles around the electrode surface.

TASK 2: Service and maintenance of dissolved oxygen meter.

- 1 Take dissolved oxygen meter and keep it on the working table.
- 2 Clean the instrument using proper cleaning material.
- 3 Follow the trouble shooting guide and service the given dissolved oxygen meter.

Troubleshooting Guide

Fault	Probable cause	Action
No Power	Battery failure. Battery polarity incorrect.	Replace batteries refit batteries
Unstable display	DO ₂ probe defective. Probe not fitted correctly. Calibration to 100% with zero solution.	Replace DO ₂ probe check connections repeat zero calibration procedure with fresh zero solution. Calibrate the probe to 100% in air.
Display permanently under or over range	Intermittent or no connection DO ₂ probe defective contaminated solutions. Calibration on low oxygen concentration	Check electrode connection to instrument. Replace DO ₂ probe replace solutions recalibrate with the probe in air.
Temp value incorrect.	DO ₂ probe defective	Replace DO ₂ probe.
I/O switch not working.	I/O key not held down long enough batteries not fitted.	Retry holding key for 2 seconds fit batteries
Keys not working	Operating in incorrect mode	Refer to operation section of manual.

Back light not on/goes out.	10 seconds time elapsed/normal function.	Recheck.
Unable to adjust manual temperature.	Incorrect mode of operation	Reselect mode.
Unable to calibrate – Erratic or slow response.	Sensor tip may be furnished (Ag or Au). Air bubbles inside the membrane cap membrane damaged coating of membrane due to use in oils or slurries, strong solvents , acids or alkalls. DO ₂ probe defective.	Clean the tip, replace membrane module refill or replace membrane Replace membrane. Replace membrane. Replace DO ₂ probe.
Inaccurate calibration – Erratic or slow response.	Zero solution will absorb oxygen if left open.	Use fresh zero solution and recalibrate.
Measurements errors.	Incorrect salinity calibration error contaminated solution incorrect standards incorrect barometric pressure.	Reset salinity values recalibrates instrument replace solution replace standards reset barometric pressure.

Maintenance of dissolved oxygen meter

- 4 Oxygen probe become sluggish due to contamination of the gold cathode silver anode or membrane. So oxygen probe must be cleaned and tested periodically.

Ensure the probe is rinsed in deionized water after each test

- 5 When replacing the membrane ensure no air bubbles are trapped in the electrolyte fill solution and that the membrane is not creased or damaged after tilling.

Ensure the membrane is kept wet at all rinses

- 6 When using the probe in liquids sludges or polymers a coating may be deposited on the membrane causing slow response or drifting.

- 7 If the probe is not to be used for 24 hours store with the protective sheath fitted to present the electrolyte from drying out due to evaporation through the membrane which is possible with water vapour as well as oxygen.

Prior to using the chemicals please refer to the health and safety information at the near of the manual

- 8 To enable immediate use it is recommended that the sensor should be permanently connected to the instrument.
- 9 If the sensor is to kept in extended storage the membrane cap should be removed and rinsed with water also clean the sensor tip.