

PLUMBER

NSQF LEVEL - 3

TRADE THEORY

SECTOR : PLUMBING

(As per revised syllabus July 2022 - 1200 hrs)



Directorate General of Training

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



**NATIONAL INSTRUCTIONAL
MEDIA INSTITUTE, CHENNAI**

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

Sector : Plumbing

Duration : 1 Year

Trade : Plumber - Trade Theory - NSQF Level - 3 (Revised 2022)

Developed & Published by



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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 **Plumber - Trade Theory - 1 year - NSQF Level - 3 (Revised 2022) in Plumbing Sector under Annual pattern**. The NSQF Level - 3 (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 - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (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 Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

SHRI. ATUL KUMAR TIWARI., I.A.S.,
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PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under 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 Theory**) for the trade of **Plumber - NSQF Level - 3** (Revised 2022) under the **Plumbing** 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 **Plumber** 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 - 3 (Revised 2022) syllabus are covered.

The manual is divided into Twelve modules.

- Module 1 - Safety**
- Module 2 - Hand Tools**
- Module 3 - Fitter**
- Module 4 - Welder**
- Module 5 - Mason**
- Module 6 - Plumber**
- Module 7 - Piping System**
- Module 8 - Pumps and PVC Joints**
- Module 9 - Drainage Systems**
- Module 10 - Water Supply System**
- Module 11 - Bending and Systems of Water Supply**
- Module 12 - Tank Installation, Test and Maintenance**

The skill training in the shop floor is planned through a series of practical exercises centred around some practical object. 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

This manual consists of theoretical information for the course of the **Plumber - NSQF Level - 3** (Revised 2022). The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the 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 indicating about the corresponding practical exercise are given in every sheet of this manual.

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

The 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 atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not 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

S.No.	Learning Outcome	Ref.Ex.No
1	Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy following safety precautions.[Basic fitting operation - marking, Hacksawing, Chiseling, Filing, Drilling, Taping, Threading and Grinding etc. Accuracy: $\pm 0.25\text{mm}$] (NOS:PSC/NO133v1.0) (NOS:PSC/NO132) (NOS:PSC/NO134) (NOS:PSC/NO135) (NOS:PSC/N9901 v 1.0)	1.1.01 - 1.2.13
2	Perform Inner & Outer Thread cutting on Metal & Studs and thread cutting on different types of pipes & fittings accessories. (NOS:PSC/NO133)	1.3.14 - 1.3.17
3	Carry out cutting of Pipes of Different dia in different angle and Joining of pipes by gas welding, Soldering and Brazing. (NOS:PSC/NO133)	1.4.18 - 1.4.20
4	Construct Masonry brick wall and RCC casting. Brick wall cutting for concealing pipe line. (NOS:PSC/NO133) (NOS:PSC/NO134) (NOS:PSC/NO134)	1.5.21 - 1.5.28
5	Carry out Cutting and Bending of Pipes using Plumber's tools and equipment. (NOS:PSC/NO133)	1.6.29 - 1.6.35
6	Join Various type of PVC pipe by heat process or Welding. (NOS:PSC/NO133)	1.6.36 - 1.6.40
7	Construct complete pipe line circuit with different types of Joints and fixing Cocks & valve on Pipe line. (NOS: PSC/NO133)	1.6.41 - 1.6.46
8	Carry out Cutting of Different Types of PVC Pipe, joining and laying. (NOS: PSC/NO133)	1.6.47 - 1.6.50
9	Perform Water analysis test, Water Pressure test and Water distribution system by using Pipe line. (NOS:PSC/NO133)	1.6.51 - 1.6.59
10	Align and lay humid asbestos pipe line of different dia. and fitting & maintenance of drainage pipe line. (NOS: PSC/NO135)	1.7.60 - 1.7.66
11	Install and maintain different Electric pumps. (NOS: PSC/NO135)	1.8.67 - 1.8.71
12	Join fittings for different purposes on PVC pipe line. (NOS:PSC/NO133)	1.8.72 - 1.8.76
13	Construct inspection chamber, manhole, gutter, septic tank, socket etc. (NOS: PSC/NO135)	1.9.77 - 1.9.78
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14	Perform removal of leakage in pipe line. (NOS: PSC/NO133)	1.10.83 - 1.10.86
15	Install, fix & maintain different valve & cock and sensor system of sanitary fittings. (NOS: PSC/NO136)	1.10.87 - 1.10.91
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17	Demonstrate method of bending for different materials & different pipe joint. (NOS: PSC/NO133)	1.11.98 - 1.8.101
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19	Carry out fitting, fixing & laying installation of hot & cold water pipe line and symbolizing. (NOS:PSC/NO133)	1.11.107 - 112
20	Perform repairing & reconditioning of waste pipe line. (NOS: PSC/NO133)	1.12.113 - 116
21	Perform repairing & reconditioning, scraping & painting of sanitary fittings pipe line. (NOS: PSC/NO133)	1.12.117 - 122

SYLLABUS FOR PLUMBER

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 100Hrs; Professional Knowledge 18Hrs	Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check for dimensional accuracy following safety precautions.[Basic fitting operation - marking, Hacksawing, Chiseling, Filing, Drilling, Taping, Threading and Grinding etc. Accuracy: $\pm 0.25\text{mm}$] (NOS:PSC/NO133v1.0) (NOS:PSC/NO132) (NOS:PSC/NO134) (NOS:PSC/NO135) (NOS:PSC/ N9901 v 1.0)	<ol style="list-style-type: none"> 1 Importance of trade training, List of tools & Machinery used in the trade.(08hr) 2 Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (5hrs) 3 First Aid Method and basic training.(08hrs) 4 Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (05hrs) 5 Hazard identification and avoidance. (2 hrs) 6 Safety signs for Danger, Warning, caution & personal safety message.(06hr) 7 Preventive measures for electrical accidents & steps to be taken in such accidents.(04hrs) 8 Use of Fire extinguishers.(7 hrs) 9 Practice and understand precautions to be followed while working in the trade. (04hrs) 10 Safe use of tools and equipment used in the trade. (1 hr) 	<ul style="list-style-type: none"> • Importance of safety and general precautions required for the trade. • Importance of the trade. • Types of work to be done by trainees in the institute. • Scope of a plumbing work. • Types of services have to plan. • Basic Bench fitting (04hrs)
		<ol style="list-style-type: none"> 11 Use Steel rule and Steel Tape for measuring, Use Scriber and Divider formarking on raw materials.(10hrs) 12 Demonstrate use of different types of Vice:- Bench vice, Pipe vice, Chain Vice, Hand vice, Chain Wrench. (20 hrs) 13 Demonstrate use of various Hand Tools:- Different Files, Hammer, Centre Punch, Hacksaw, Chisel, Callipers, Pipe Wrench, Stock & Dies, Taps and Holders. (20hrs) 	<ul style="list-style-type: none"> • Plumber's common hand tools - names, description and material from which they are made. • Description, types and uses of holding device, hammers & cold chisels, cutting tools. • Description of simple fitting operations hack sawing, punching and filing. • Types of files used commonly. • Marking instruments and their use of simple drilling machine. • Method of using drills. • Description of simple bench drilling Machine. • Description of Grinding and Chisel. • Description of different types of locking and fastening devices. (14 hrs)
Professional Skill 15Hrs; Professional Knowledge 06Hrs	Perform Inner & Outer Thread cutting on Metal &Studs and thread cutting on different types of pipes&fittings accessories. (NOS:PSC/NO133)	<ol style="list-style-type: none"> 14 Thread Inner on M.S. flat by using Tap.(5hrs) 15 Use various locking device.(5hrs) 16 Outer thread on Pipe by using Die. (3hrs) 17 Fixing of different Pipe fittings in different position of Pipe. (2hrs) 	<ul style="list-style-type: none"> • About different types of pipes-GI, CI, DI, PVC/CPVC, PPR, AC and HDPE etc. • About different Types of Pipe Fittings:- Socket, Elbow, Tee, Union, Bend, Cap, Plug, Cross, Ferrule etc. • About different types of Thread cutting. (06hrs)

Professional Skill 20Hrs; Professional Knowledge 06Hrs	Carry out cutting of Pipes of Different dia in different angle and Joining of pipes by gas welding, Soldering and Brazing. (NOS:PSC/NO133)	18 Cutting different diameter of MS pipes in different angles. (10 hrs) 19 Joining of Pipe in same dia by gas welding. (05hrs) 20 Joining of Pipes in different dia by gas welding. (05hrs)	Gas Welding :- <ul style="list-style-type: none"> • Purpose of Gas welding. • Method of gas welding • Safety precautions to be observed - Methods of soldering and brazing - fluxes used & Types of fluxes precautions to be observed. • Hard & soft solders - their properties, composition and uses. (06hrs)
Professional Skill 35Hrs; Professional Knowledge 06Hrs	Construct Masonry brick wall and RCC casting. Brick wall cutting for concealing pipe line. (NOS:PSC/NO133) (NOS:PSC/NO134) (NOS:PSC/NO134)	21 Demonstrate proper handling of Mason's hand tools:- Straight edge, Spirit level, Plumb bob, Square, Trowel etc. (5 hrs) 22 Setting out work with Tape, Rule, Square, Line pin and level as per drawing. (5hrs) 23 Prepare Cement mortars in different proportions to suit various purposes. (5 hrs) 24 Prepare Plane Cement Concrete and RCC in different proportions to suit various purposes. (5 hrs) 25 Benching and Channelling of base plate. (5 hrs) 26 Damp proofing. (2 hrs) 27 Plastering the walls. (3 hrs) 28 Cutting of Masonry wall for concealing with Electric Cutting Tools. (5 hrs)	Mason's works :- <ul style="list-style-type: none"> • Names and description of Mason's hand tools and their uses. • Method of making holes in walls and floors. • Types of tools used and various Processes. • Concept of bricks, lime and cement. • Preparation of mortars with various materials of varying composition. • Common brick joints. • Description of bonds. • Scaffolding & plastering. • Define Plain cement concrete, RCC and its proportion, • Grades of coarse aggregate and fine aggregate, • Knowledge of waterproofing compound. • Knowledge of Building Plan and Cross section of wall. • Identify plumbing services required for each type of building according to usage. (06hrs)
Professional Skill 40Hrs; Professional Knowledge 10Hrs	Carry out Cutting and Bending of Pipes using Plumber's tools and equipment. (NOS:PSC/NO133)	29 Demonstrate proper handling of Plumber's Tools & Equipment. (05hrs) 30 Use and care of Plumber's Tools and Equipment. (05hrs) 31 Cutting of G.I Pipes of different Diameter and Sizes by cutting tools. (05hrs) 32 Cutting of C.I Pipe of different Diameter and Sizes by cutting tools. (05hrs) 33 Cutting of all kinds of PVC Pipe of different Diameter and Sizes by cutting tools. (05 hrs) 34 Bending of G.I Pipe as per drawing using Bending Machine up to 50 mm dia. (10hrs) 35 Bending of PVC Pipe as per drawing using heat process up to 50 mm dia. (5 hrs)	<ul style="list-style-type: none"> • Description of plumber tools and Equipment- Ratchet brace, Threading die, Pipe wrench, sliding wrench, Spanner set, Chain Wrench etc. and their safety. • Care & use of tools. • Pipes of different kinds • Method of Pipe bending in different dia. • Plumbing Symbols and Code for Tools & Materials on water line. (10hrs)
Professional Skill 25Hrs;	Join Various type of PVC pipe by heat process or Welding. (NOS:PSC/NO133)	36 Preparation of PVC pipe & Fittings in different dia. (1 hr) 37 Preparation and precaution of Electric Hot Plate. (1hr)	<ul style="list-style-type: none"> • Equipment and tools for hot gas welding and electric hot plate for PPR pipe joints. (08hrs)

Professional Knowledge 08Hrs		38 PVC Pipe welding various dia, using welding machine.(13hrs) 39 Weld various type of PVC Pipe with various dia, using welding machine. (5hrs) 40 PPR pipe welding joint various dia of pipe using welding machine.(5hrs)	
Professional Skill 25Hrs; Professional Knowledge 08Hrs	Construct complete pipe line circuit with different types of Joints and fixing Cocks & valve on Pipe line. (NOS:PSC/NO133)	41 CI/HCI Pipe Flange joint with Bend and Tee.(5hrs) 42 Socket joint of CI Pipes with lead. (5hrs) 43 Detachable joint of AC pressure Pipe. (5 hrs) 44 Titan/Socket & Spigot joint of Ductile Iron (DI) Pipe with Rubber ring.(4hrs) 45 Prepare and Study the drawing of Pipe line circuit and schedule use of Tools and accessories.(2hrs) 46 Make a Pipe line circuit on GI Pipe with Socket, Elbow, Bend, Flange, Tee, Union etc. And Fixing Cocks & Valves as per drawing. (4hrs)	<ul style="list-style-type: none"> Types of fittings for different joints & different pipes.:- CI,HCI,AC,AC Pressure, DI, GI Pipes. Joints:- Flange joint, Socket joint with lead, Detachable joint, Socket & Spigot joints etc. Description of pipe fittings. Methods of joining and their uses. Precautions to be taken while fixing (08hrs)
Professional Skill 25Hrs; Professional Knowledge 08Hrs	Carry out Cutting of Different Types of PVC Pipe, joining and laying. (NOS:PSC/NO133)	47 PVC pipe cutting & shaping in various dia, using Hacksaw and Pipe cutters. (10 hrs) 48 Preparation of PVC pipe and Fittings with emery paper.(5hrs) 49 Use & fixing of PVC fittings use Solvent Cement etc. (5hrs) 50 Layout of PVC pipe according to drawing. (5hrs)	<ul style="list-style-type: none"> Different kinds of Joints, Fittings and Materials in joining pipes:- PVC/CPVC, PPR and HDPE etc. (08hrs)
Professional Skill 25Hrs; Professional Knowledge 08Hrs	Perform Water analysis test, Water Pressure test and Water distribution system by using Pipe line. (NOS:PSC/NO133)	51 Preparation of Water and Water analysis kit. (1 hr) 52 Water Analysis Test by Analysis Kits. pH, TDS, Temperature etc. (4hrs) 53 Preparation of Hydraulic Pressure Test Machine. (1 hr) 54 Static water pressure test by Hydraulic Pressure Test Machine apply on Plastic Water bottle.(4hrs) 55 Static water pressure test by Hydraulic Pressure Test Machine apply on Cistern and Tank.(4hrs) 56 Steps of simple pipe line connection as per drawing. (3 hrs) 57 Make a pipe line for water distribution as per drawing. (4hrs) 58 Make a pipe line for OHR water distribution system as per drawing. (02hrs) 59 Installation of water hammer arrester. (02 hrs)	<p>Composition of Water:-</p> <ul style="list-style-type: none"> Sources of water Hard & Soft water, temporary hardness & permanent hardness. Impurities of water - organic and inorganic impurities. Water purification stages and methods. Static water pressures and measurement of pressures. Bursting pressure, Expansion of water on freezing and heating. Bernoulli's principles Pascal's law. Pressure of water on the sides of cistern or tank. Water hammer in pipes. Description and working of water hammer arrester. (08hrs)

Professional Skill 45Hrs; Professional Knowledge 10Hrs	Align and lay humid asbestos pipe line of different dia. and fitting & maintenance of drainage pipe line. (NOS:PSC/NO135)	60 Interpret drawing of sanitary plumbing. (08hrs) 61 Lay & align hummed pipe. (05hrs) 62 Demonstrate use of specific dia in different location. (04hrs) 63 Use various sanitary fitting. (06hrs) 64 Use various fitting of different materials. (06hrs) 65 Use joining materials of pipe. (10hrs) 66 Join pipe as per laid down Procedure. (06hrs)	<ul style="list-style-type: none"> Use of hummed and asbestos pipes of different sizes. Method of laying out pipes alignment and joining. (05hrs) Description of various pipe joints-straight, Branch, Taft and blow, Expansion joints. Solders and fluxes used in joints. (05hrs)
Professional Skill 60Hrs; Professional Knowledge 10Hrs	Install and maintain different Electric pumps. (NOS:PSC/NO135)	67 Demonstrate use of different pump. (10 hrs) 68 Demonstrate installation of electric pump (10 hrs) 69 Demonstrate maintenance of electric pump. (10 hrs) 70 Demonstrate working process of centrifugal, reciprocating, submersible pump. (15 hrs) 71 Demonstrate delivery of water to overhead tank through pump, presser head, delivery pipe, suction pipe, etc, (15 hrs)	<ul style="list-style-type: none"> Description of Plumber's materials Lead, tin, Zinc, solder, copper, red lead etc. and their uses. Water supply system of a small town. Description and types of pumps viz. suction pump, Centrifugal pump etc. Contamination of water in a well. (10hrs)
Professional Skill 30Hrs; Professional Knowledge 06Hrs	Join fittings for different purposes on PVC pipe line. (NOS:PSC/NO133)	72 Produce BSP thread on pipe. (05 hrs) 73 Produce Internal and external thread on PVC pipes of different dia. (05 hrs) 74 Join PVC pipe with thread. (05hrs) 75 Join PVC pipe with solvent cement and heat process(05hrs) 76 Join PVC pipe as per layout. (10hrs)	<ul style="list-style-type: none"> Description of pipe dies, their uses, care and precaution. Metric specification of various pipes. Standard pipe threads. Method employed for bending, Joining and fixing PVC pipe. Joining material for water and gas pipes. Use of blow lamp. (06hrs)
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Construct inspection chamber, manhole, gutter, septic tank, socket etc. (NOS:PSC/NO135)	77 Demonstrate inspection chamber, manhole, gully trap, septic tank, soak pit. (04 hrs) 78 Construct inspection chambers, cesspool, septic tank, soak pit etc. (21 hrs)	<ul style="list-style-type: none"> Inspection chamber, septic tank, description of drains, cesspools, soak pits etc. Types of traps layout of drainage system (07 hrs)
Professional Skill 25Hrs; Professional Knowledge 05Hrs	Test pipe line as per site drainage pipe line layout. (NOS:PSC/NO135)	79 Demonstrate drawing layout of drainage pipe line. (06 hrs) 80 Perform testing for smoke test, water test, smell test, ball test mirror test. (10 hrs) 81 Join heavy cast iron socket pipe. (03 hrs) 82 Sealing of heavy cast iron pipe joint with lead & caulking tools. (06 hrs)	<ul style="list-style-type: none"> Method of bending pipes by hot and cold process. Method of testing drainage lines (05hrs)
Professional Skill 25Hrs; Professional Knowledge 04Hrs	Perform removal of leakage in pipe line. (NOS:PSC/NO133)	83 Identify location of leakage pipe. (06 hrs) 84 Removing out leakages pipe. (10 hrs) 85 Removing of air locks (06 hrs) 86 Demonstrate rain water harvesting system. (03 hrs)	<ul style="list-style-type: none"> Method of dismantling and renewal of the valves and pipes. Leaks in pipes and noises in plumbing. Installation of water meters. Air lock in pipes and its removal. (04hrs)

Professional Skill 75Hrs; Professional Knowledge 10Hrs	Install, fix & maintain different valve & cock and sensor system of sanitary fittings. (NOS:PSC/NO136)	87 Demonstrate different cocks & valves including materials. (10hrs) 88 Employ cocks & valves at different place. (20 hrs) 89 Employ different cock& valve with sensor system. (20 hrs) 90 Demonstrate maintenance of different cocks & valves. (15 hrs) 91 Demonstrate use of packing washer gasket of different cock & valve. (10 hrs)	<ul style="list-style-type: none"> • Description of cocks & valves-their types, materials & advantages for particular work. • Description of different type of diverts i.e. two way and three way • Sensor system for urinals and wash basin etc.(10hrs)
Professional Skill 75Hrs; Professional Knowledge 14Hrs	Install & maintain water meter and water supply for different fixtures. (NOS:PSC/NO133)	92 Demonstrate location of meter. Fitting of water meter, bath tub, wash basin. (10 hrs) 93 Install water metre, bath tub, hand wash basin, water closet urinal, sink etc with sensor system. (20 hrs) 94 Demonstrate maintenance of water metre, bath tub, hand wash basin, water closet urinal, sink etc. (15 hrs) 95 Demonstrate testing of water metre, Bath Tub, Hand wash basin. (10 hrs) 96 Demonstrated rain water and drainage pipe system. (10hrs) 97 Installation of concealed flushing cistern. (10 hrs)	<ul style="list-style-type: none"> • Erecting rain water and drainage pipe system, • Installation of sanitary fittings, inspection and testing of water supply system. • -Pipe alignment and slope. -Prevention of water hammer. • Storage tanks for general water supply propose. • Test for water supply pipes. • Description of sanitary fittings, general points to be observed when choosing sanitary. • Description of concealed flushing cistern (14hrs)
Professional Skill 50Hrs; Professional Knowledge 05Hrs	Demonstrate method of bending for different materials & different pipe joint. (NOS:PSC/NO133)	98 Demonstrate bending of pipes in bending machine. (08 hrs) 99 Bend GI pipe of different diameter in different angle. (14 hrs) 100 Bend G.I. pipe as per drawing and measurement. (14 hrs) 101 Bend PVC pipe of different diameter in different angle with dry sand by heating. (14 hrs)	Method of bending galvanized mand other heavy pipes. (05hrs)
Professional Skill 50Hrs; Professional Knowledge 05Hrs	Perform fitting and maintenance of Fixture at different place. (NOS:PSC/NO136)	102 Demonstrate process of C.I pipe cutting & joining. (12 hrs) 103 Process of C.I. pipe fitting for waste pipe line in different section. (08 hrs) 104 Employ Process of fixing of external soil pipe. (12 hrs) 105 Demonstrate process of fixing of rain water gutter outlet and ground pipe. (10 hrs) 106 Demonstrate process of measurement of waste pipe line. (08 hrs)	<p>Domestic drainage system: General layout, one pipe system, specifications of Materials required. Method of testing leakage. Different types of traps, ventilation, anti-siphonage and sinks. About Fire hydrants and their fittings. (05hrs)</p>
Professional Skill 25Hrs; Professional Knowledge 06Hrs	Carry out fitting, fixing & laying installation of hot & cold water pipe line and symbolizing. (NOS:PSC/NO133)	107 Demonstrate working of solar water heating system. (02 hrs) 108 Analyse temperature of water (hot and cold). (02 hrs) 109 Layout pipe line for hot and coldwater distribution as per drawing. (04 hrs) 110 Install pipe line for distribution of hot & cold water. (08 hrs)	<p>Concept of heat and Temperature. Method of transmission of heat. Heating system by different thermal units. Domestic hot and cold water. General layout,specification of materials required and Connection of pipes to mains. Tracing leakage. Repairs to service main. Domestic boilers and Geysers.</p>

		<p>111 Install hot water system & solar water heating system. (08 hrs)</p> <p>112 Symbolise distribution of hot & cold water pipe line. (01 hr)</p>	<p>Method of ventilating pipe. Precaution against air Poisoning.</p> <p>Fixing of solar water system. (06hrs)</p>
<p>Professional Skill 25Hrs;</p> <p>Professional Knowledge 06Hrs</p>	<p>Perform repairing & reconditioning of waste pipe line. (NOS:PSC/NO133)</p>	<p>113 Perform repairing of different trap, valve, cistern etc. (03 hrs)</p> <p>114 Demonstrate construction of over head tank as per measurement. (08 hrs)</p> <p>115 Maintenance and recondition pipe line. (10 hrs)</p> <p>116 Perform smoke test for waste pipe line. (04 hrs)</p>	<p>Plumbing and sanitary symbols and plumbing codes for all tools and materials (06hrs)</p>
<p>Professional Skill 20Hrs;</p> <p>Professional Knowledge 02Hrs</p>	<p>Perform repairing & reconditioning, scraping & painting of sanitary fittings pipe line. (NOS:PSC/NO133)</p>	<p>117 Demonstrate cleaning of sanitary pipe line. (02 hrs)</p> <p>118 Perform cleaning of sanitary pipe line. (02hrs)</p> <p>119 Remove corrosion from pipe line. (02hrs)</p> <p>120 Demonstrate scraping & painting. (02 hrs)</p> <p>121 Perform scraping & painting of pipe line. (02hrs)</p> <p>122 Maintenance of broken or cracked sanitary fitting. (05 hrs)</p> <p>123 Estimate and work out abstract cost of plumbing work as per drawing/layout. (05 hrs)</p>	<p>Corrosion - causes and remedies, prevention. Corrosion due to electrolytic action. Effect of water and frost on materials. Layout of pipes as per drawing. Analysis quantity measurement and abstract rate of plumbing and sanitary work.</p> <p>Bill of Quantity and Estimation :-</p> <ul style="list-style-type: none"> • Preparation of bill of quantity • Preparation of Estimation(02hrs)

Importance of safety and general precautions required for the trade

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

- state the importance of safety
- state the importance of first aid
- state the general precautions and safety measures.

Importance of safety for Trainees

Safety is of utmost importance in an industrial organisation big or small.

There are a large number of workers engaged in work in an industrial organisation.

The property of building, machines, tools and equipments etc is invested.

In the event of the accident like fire, there is possible of loss of human life and property in an industrial organisation.

A minor mistake by a careless worker may put the organisation to huge loss, several workers may receive injury or die.

Basic rule for safety

The safety rules to prevent accidents in the factories.

Workers and management in industrial organisations should ensure

Self safety

Safety of machines

Safety of work

Safety for fire.

The ideal motto of every industrial organisation should be 'Safety First' and Safety throughout

Precaution to be taken against fire

Fire in a workshop is very harmful.

The requisite arrangement made to prevent fire.

First aid

To attend immediate medical help to injury person according to accident.

After first aid, the injury person taken to nearest hospital for proper treatment.

Causality

A causality is serious injury to a person in a accident, war or disaster.

Respiration

Your respiration is your breathing to measure the depth of his sleep by the rate of his respiration.

Treatment of a burn

Applying a soothing ointment.

Covering the burn with sterile dressing.

Incace of drowned causality

Turn the victim upside down to drain water from the lungs.

To stop the bleeding

Apply direct pressure to the bleeding point

Elevate the limb and lie the victim down.

Foreign bodies

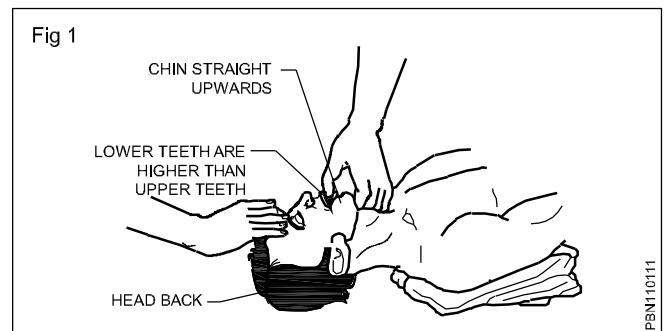
Removed from a wound.

If you find someone who has stopped breathing, what can you do to save his/her life?

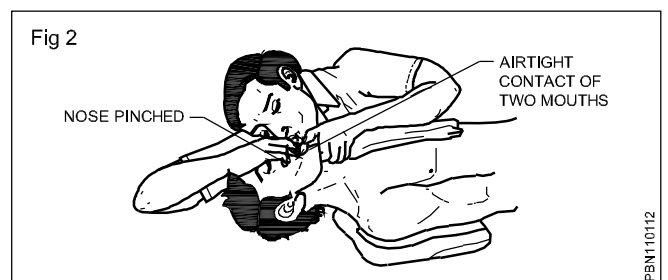
Read the following instructions to find out

Mouth-to-mouth respiration

Remove any obvious obstructions over the face and loosen any thing tight around the neck. Open the airway and remove any debris seen in the mouth and throat. (Fig 1)



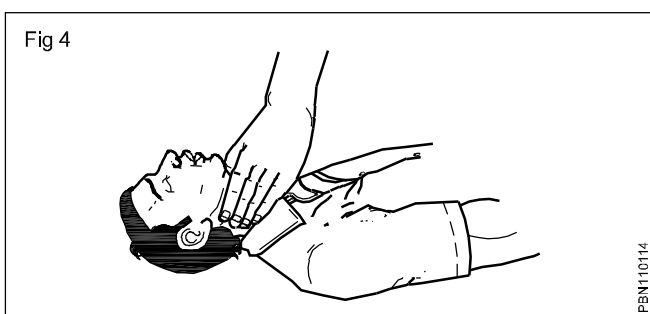
Open your mouth wide and take a deep breath. Pinch the casualty's nostrils together with your fingers and seal your lips around his mouth. (Fig 2)



Blow into the casualty's lungs, looking along his chest. Keep blowing until you can see his chest rise to maximum expansion. (Fig 3)



Remove your mouth well away from the casualty's. Breathe out any excess air while watching his chest fall. Take a deep breath. Repeat inflation. (Fig 4)



After two inflations, check the pulse to make sure the heart is beating.

If the heart is beating and a pulse is felt, continue to give inflations at a rate of 12-16 times per minute until natural breathing is restored. Assist it when necessary and adjust it to the casualty's breathing rate. When the casualty is breathing independently, place him in the Recovery position.

If the heart is not beating you must perform External chest compression immediately.

General precautions and safety measures

The general precautions to be observed in a masonry yard or workshop.

Accidents are quite frequent in the building industry.

These accidents often result in lost time or the job, partial or total disability or even loss of life.

Accidents can be reduced if each person works safely and uses the precautions that the nature work requires.

Safety precautions can be classified

- 1 Safety for self
- 2 Safety for colleague and others
- 3 Safety for tools and equipment's
- 4 Safety for materials.

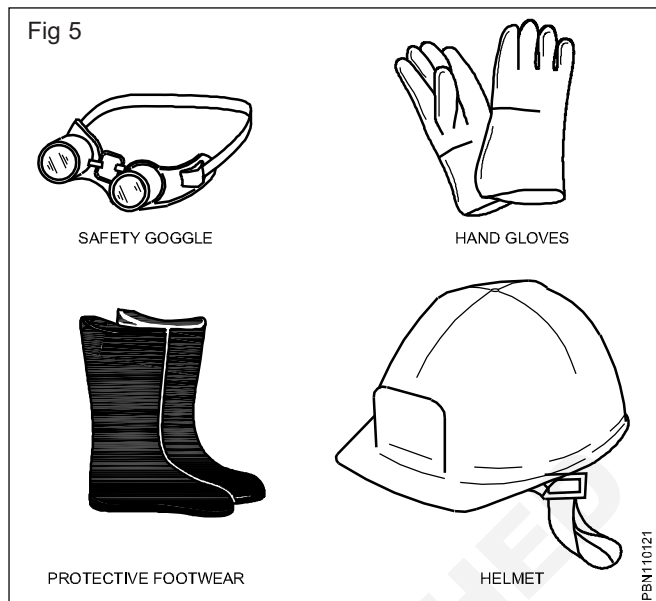
1 Safety for personal

- Always avoid loose clothing.
- Wear goggles while grinding the tools.

2

Plumbing : Plumber (NSQF Revised 2022) - R.T. for Exercise : 1.1.01 - 1.1.06

- Wear the safety shoes. (Fig 5)



- Do not through any sharp instruments.
- Do not through brick or brick bats from top.
- Check the scaffolding before you clamp up.

2 Safety for college and others

- Give caution before lifting heavy units.
- Lifting heavy units by crow bar put some lever underneath the crow bar.
- Combined job is carried out give caution time to time and do safe work.

3 Safety for tools and equipment

- Use proper tools for proper work.
- Do not throw any tools either from top or at bottom.
- All the tools should be washed and oiled after use.
- All the tools should be cleaned and washed and kept in a safe place.

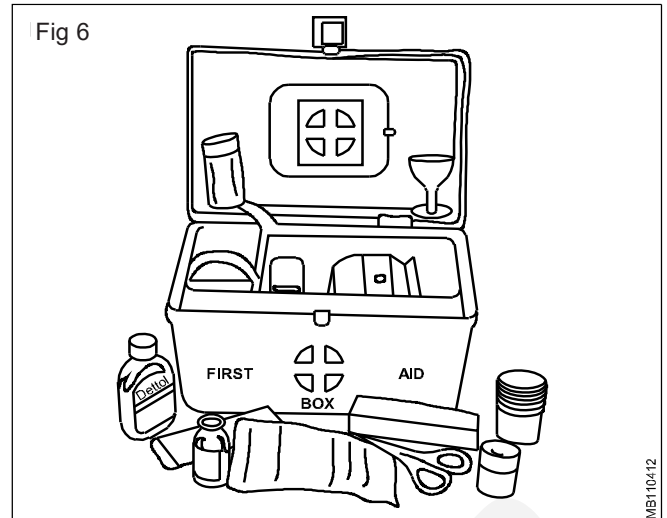
4 Safety for materials

- Bricks should be stacked properly and bricks should not be allowed to be scattered on the work place.
- Cement bags are staked properly on the wooden planks placed on the floor.
- Provide sufficient space say 0.5 meter away from wall and place cement bags.
- Cement go down should be free from air tight, otherwise cement may get spoiled.

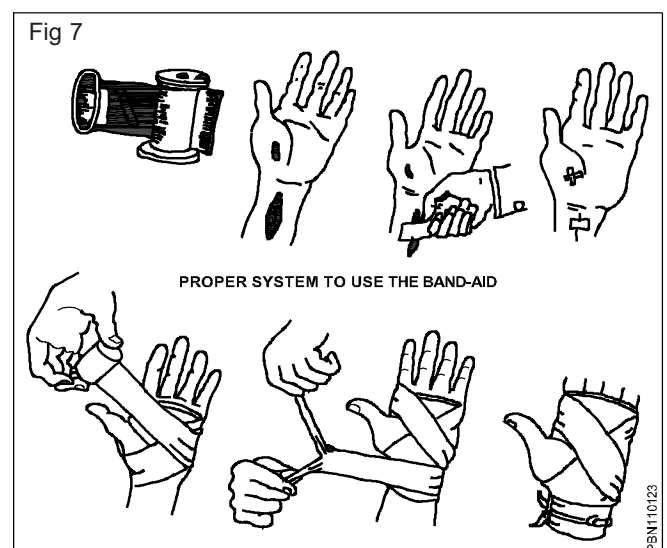
General safety measures

- Electric wire / cables
- High tension / low tension electric line passing near by the slab, care should be taken while placing reinforcement by working persons.
- While placing concrete it may affect working persons.

- Throwing of waste materials bricks bats, broken blocks may lead to injury to persons working below.
- Scaffolding should be erected firmly and properly braced.
- Walking on parapet wall may fall down due to in balance condition.
- Take more care while using the ladders because it may slip and fall down.
- The lift pit is left unguarded the children of workers may fall in the resulting in fatal accident.
- Bar bending work helpers of bar benders to follow short cut method throw surplus steel pieces form top floor to ground and may cause fatal injuries.
- Do not use faulty tools and equipment. Repair or replace these tools.
- Keep the working area clean, many accidents are caused by litter underfoot.
- Personal safety protective kit
- Protecting workmen from injury during the execution job, safety precautions play a vital role.
- Safety gloves: Used for material handling welding machine, gas cutter etc.
- Safety Helmets: Use where site work is going on at different levels.
- Gumboots: For cutting hard rock, concreting works, Asphaltting etc.
- Safety Belt: Used for workmen working on height, on outer sides of the building.
- Safety Goggles: Used for while grinding for gas welding, breaking of pavements etc as shown in figure.
- Site or work spot should have a list of following emergency telephone numbers.
- Fire 101
- Ambulance 108
- Police 100
- Nearest doctor xxxxx
- First Aid
- First aid is an immediate and temporary care given to the victim of an accident, or sudden illness till the treatment from the doctor is made available.
- First aid kit (Fig 6)
- Cotton dressing
- General medicine
- Triangular bandage
- Potassium permanganate
- Pocket of cotton wool
- Roller bandage 25 mm
- Roller bandage 75 mm

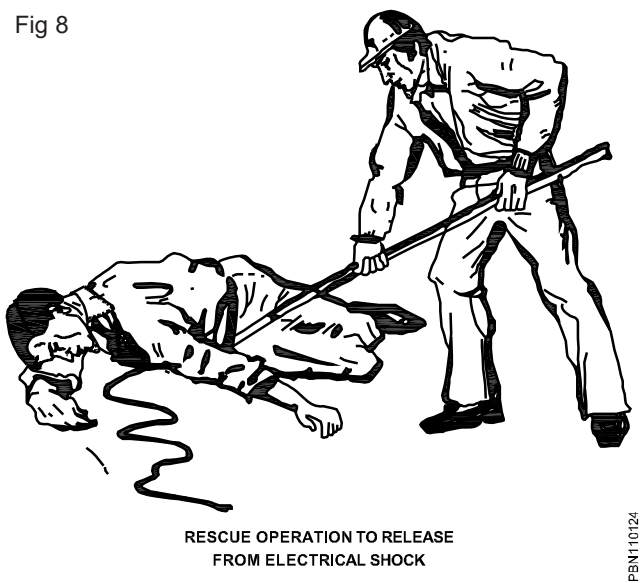


- Iodine bottle
- Dettol
- Safety pins
- Scissors
- Knife
- Blade.
- Major possible injuries at site
- In construction work major injuries may cause in the following
- Bleeding
- Sudden stoppage of respiration
- Fracture.
- Bleeding
- Usually bleeding can be controlled by direct pressure applied to the wound with a sterile dressing or any cloth. (Fig 7).



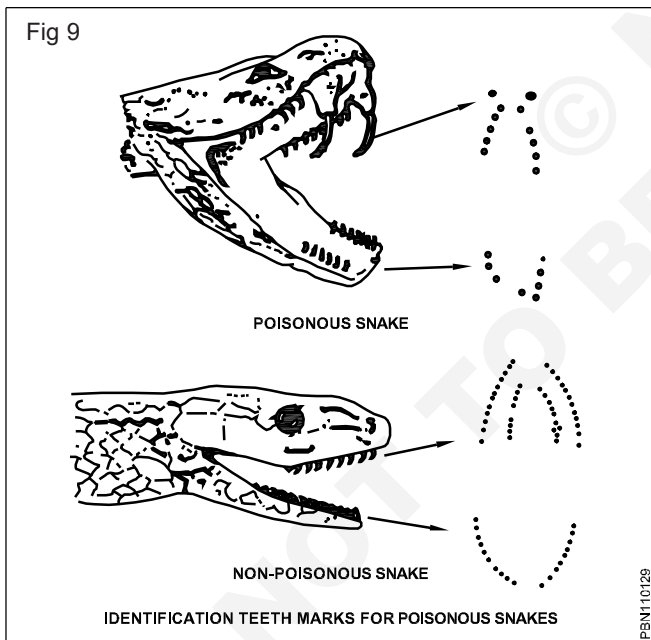
- Sudden Respiratory Blockage
- In the case of electric shock, gas poisoning, suffocation etc, where breathing is stopped immediate action is necessary. (Fig 8).

Fig 8



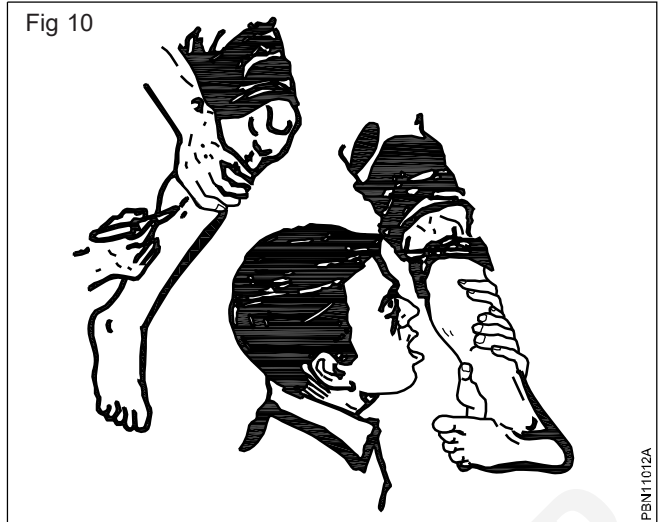
- Excavation of soil for column footings and for deep trenches.
- Poisonous Snake
- Only two prominent.
- Marks of the fangs can be seen after the bite.
- Non - Poisonous Snake
- Two rows of marking of small teeth can be seen after biting as shown in (Fig 9).

Fig 9



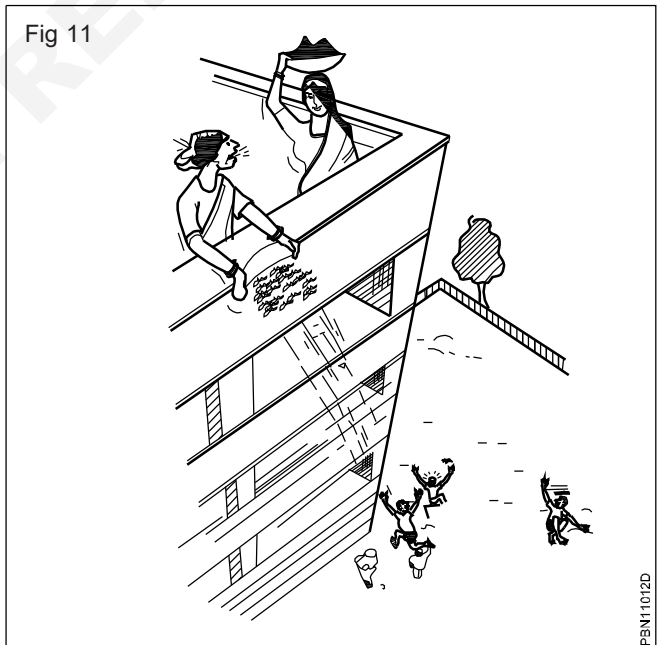
- First Aid treatment on snake bite
- Tie a cloth immediately around the patient in resting position.
- Do not allow the affected portion of the body to move.
- Wash the wound with clear water.
- Take for medical treatment as shown in (Fig 10).
- Scorpion stings

Fig 10



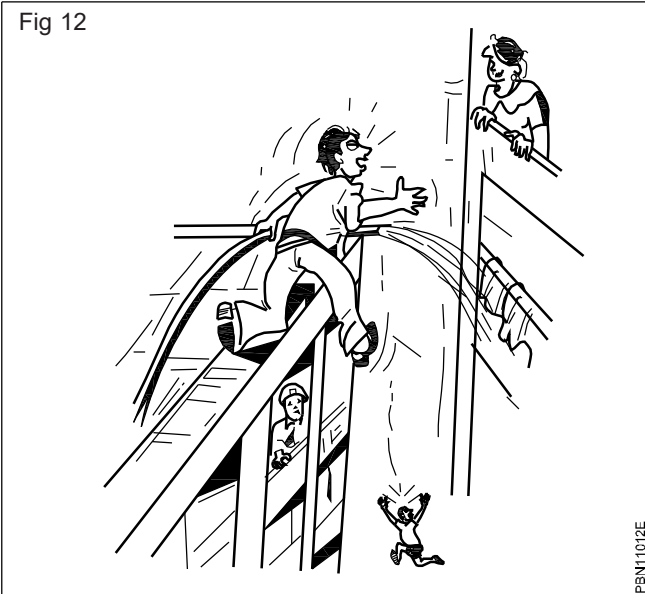
- Usually two types of scorpions red and black.
- Tie the cloth immediately upper portion.
- Take for medical treatment nearest doctor.
- Accidents during slab concreting
- Column reinforcement cage may collapse.
- Lift scaffolding means vertical probes not fixed well may collapse while concreting.
- In construction site the waste materials such as broken brick bats, waste concrete or other debris should not be thrown from top to the bottom of the ground. Otherwise accidents may cause as shown in (Fig 11).

Fig 11



- Careless way of curing may cause accidents as shown in (Fig 12).
- Working on ladder may slip and painter may fall.
- Use safety belt anchored to hooks.
- Co-worker to hold the ladder firmly.

Fig 12



Importance of housekeeping

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

- list the steps involves in house keeping
- state good shop floor practices followed in industry.

Housekeeping

The following activities to be performed for better up keep of working environment:

- 1 **Cleaning of shop floor:** Keep clean and free from accumulation of dirt and scrap daily
- 2 **Cleaning of Machines:** Reduce accidents to keep machines cleaned well
- 3 **Prevention of Leakage and spillage:** Use splash guards in machines and collecting tray
- 4 **Disposal of Scrap:** Empty scrap, wastage, sward from respective containers regularly
- 5 **Tools Storage:** Use special racks, holders for respective tools
- 6 **Storage Spaces:** Identify storage areas for respective items. Do not leave any material in gangway
- 7 **Piling Methods:** Do not overload platform, floor and keep material at safe height.
- 8 **Material handling:** Use forklifts, conveyors and hoist according to the volume and weight of the package.

Good shop floor practices followed in industry

Good Shop floor practices are motivating action plans for improvement of the manufacturing process.

- All workers are communicated with daily target on manufacturing, activities.

- Informative charts are used to post production, quality and safety results compared to achievements.
- Workers are trained on written product quality standards.
- Manufactured parts are inspected to ensure adherence to quality standards.
- Production processes are planned by engineering to minimize product variation.
- 5s methods are used to organize the shop floor and production lines.
- Workers are trained on plant safety practices in accordance with Occupational Safety Health (OSH) standards.
- Workers are trained on "root cause" analysis for determining the causes of not following.
- A written preventive maintenance plan for upkeep of plant, machinery & equipment
- Management meets with plant employees regularly to get input on process improvements.
- Process Improvement Teams are employed to implement "best practices"

Disposal of waste material

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

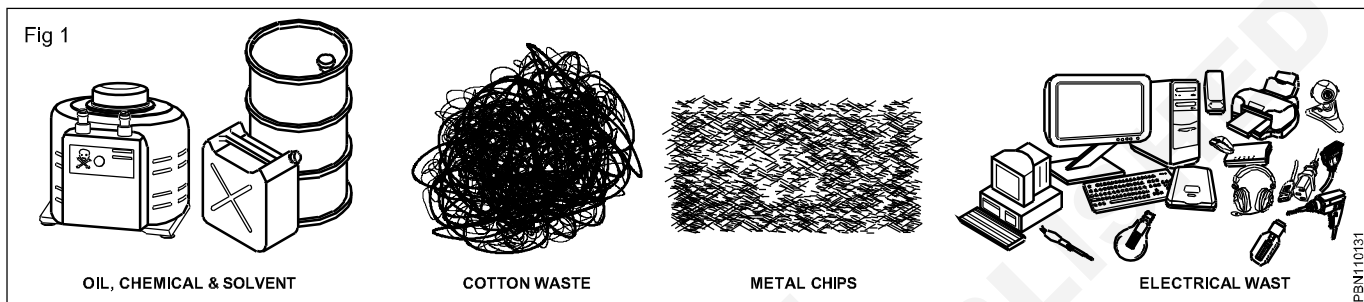
- state what is waste material
- list the waste materials in a work shop
- explain the methods of disposal of waste material.
- state advantage of disposal of waste material.
- state colour code for bins for waste segregation.

Waste material

industrial waste is the waste produced by industrial activity such as that of factories, mills and mines.

List of waste material (Fig 1)

- Cotton waste



Precautions observed in the trade

The following precaution should be followed while doing plumbing work.

All the tools should be properly checked for their proper working condition.

Only standard materials should be used, because sub-standard materials may cause leakage in the pipe lines, taps.

Correct threading should be done on the pipes.

All the joints should be made by water tight.

Over screwing should not be done, because it may split or crack the parts of fittings.

While measuring the length of pipes for cutting, due allowance for the space of fittings should be made, otherwise the length of the pipes may be more or less.

All the pegs should be fixed with their broader end inside the wall and smaller size in face of the wall.

The required size of hole should be made in the wall for fixing of peg, brackets etc.

- Metal chips of different material.
- Oily waste such as lubricating oil, coolant etc.
- Other waste such electrical, glass etc.

While fixing the pipe in the pipe - vice, it should not be over tightened, because the pipe may be deshape.

While bending the pipes on the bending machine care should be taken, it may press the pipe and give more bend than desired.

The cutting of the pipes should be done properly it should be at right angles to the axis of the pipe.

The pipe should be fixed with pipe hooks at proper place. These hooks should be driven in the masonry joints.

In case of accidents first - aid facilities should be available.

Proper tools should be used for doing the job.

The handles of hammers must be rigidly connected. They should not be loose.

Screws should never be hammered like nails.

Screw driver of correct length and size should be used.

Importance of the trade and types of work to be done by trainees in the institute, scope of a plumbing work, types of services have to plan

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

- state the work done by the trainees and scope
- state the safety observed in the trade
- state the safety rules on electrical equipments
- state the uses of fire extinguishers
- state the types of fire extinguishers.

Different types of trade training in different trades are under going for the country 's trade development.

Plumber trade training is used for giving different types of water supply to the different buildings.

Also used for rain water removal from the buildings.

Importance of this trade.

- Distribution of safe and purified water supply.
- Different type of pipe fixtures, faucets and water purification plants installing
- Sanitary channels sanitary appurtenances installation and maintenance
- Installation of different fixtures, waste water removal and maintenance
- Installation and maintenance of sanitary fittings in commercial buildings and shopping malls
- Laying of sanitary pipes in different type of residential buildings and apartments
- Installation of rain water removal and harvesting structures
- Different types of fittings, faucets, metal and metal pipes valves taps fixing and maintenance.
- Different types of pumps installation and maintenance
- The above said works are all done by the plumbers.
- Thus public sanitation and public health are protected.
- Water borne diseases are prevented.

By this way this trade is very important for country's public sanitation, drinking water supply safe soil water disposal and rain water removal.

Types of work done by the trainees in the institute.

For supply of water to varous sanitary fittings.

For collection of waste water from the sanitary fittings.

For collection of rain water from the roofs, house and courtyard wastings.

Plumbing operation

Fixing of brackets, hooks etc. for fixing of sanitary fittings.

Fixing of sanitary appliances.

Layout of meter pipe line.

Giving connections to various fitting

Laying of pipelines for collection of waste water from sanitary appliances.

Laying of rain water pipes, gas pipes and their connections to floors for collection of house washing water.

Scope of a plumbing work

The above mentined works carried out in the domestic, commerical, public buildings, auditoriums, theatres, malls, hospitals etc. are all the scope of plumbers in the plumbing work.

Types of services

Fixing of brackets

The brackets of wash basin, sinks, flushing cistern geysers, etc. are fixed in the walls at proper positions.

Fixing of sanitary appliances

The sanitary fittings are fixed on the brackets, when the joints of the brackets with walls are cured.

Laying of pipe lines

All the length of the pipes are cut to size, screwed at both the ends.

All the joints should be made water - tight.

Recreation, medical facilities and other extra - curricular activities of the institution

The trainees after taking admission in the institution should have complete knowledge about the recreational, medical, sports, debates, chart making competitions, model making competitions etc. facilities and activties of the institution.

In the prospectus of some of the institutions, details regarding various facilities available in the institution are given.

The trainees should take active part in all the activities of the institution.

Safety rules on electrical equipments

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

- explain the necessity of adopting the safety rules
- list the safety rules and follow them.

Safety rules

- Only qualified persons should do electrical work
- Keep the workshop floor clean, and tools in good condition.
- Do not work on live circuits, if unavoidable, use rubber gloves rubber mats, etc.
- Use wooden or PVC insulated handle screwdrivers when working on electrical circuits.
- Do not touch bare conductors.
- Replace or remove fuses only after switching off the circuit switches.
- Use accessories like sockets, plugs and switches and appliances only when they are in good condition and be sure they have the mark of BIS (ISI). (Necessity using BIS (ISI) marked accessories is explained under standardisation.

- Never extend electrical circuits by using temporary wiring.
- Position the ladder, on firm ground.
- While using a ladder, ask the helper to hold the ladder against any possible slipping.
- Always use safety belts while working on poles or high rise points.
- Use always earth connection for all electrical appliances along with 3-pin sockets and plugs.
- Do not meddle with inter locks of machines/switch gears
- Do not connect earthing to the water pipe lines.
- Do not use water on electrical equipment.
- Discharge static voltage in HV lines/equipment and capacitors before working on them.

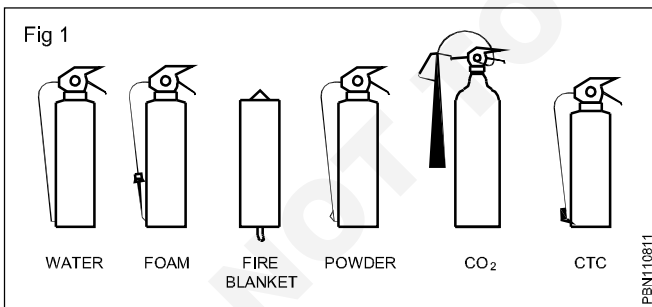
Types of fire extinguishers

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

- distinguish different types of fire extinguishers
- determine the correct type of fire extinguisher to be used based on the class of fire
- describe the general procedure to be adopted in the event of a fire.

A fire extinguisher, flame extinguisher or simply extinguisher is an active fire protection device used to extinguish or control small fires, often in emergency situation. It is not intended for use on and out of control fire.

Many types of fire extinguishers are available with different extinguishing 'agents' to deal with different classes of fires. (Fig 1)

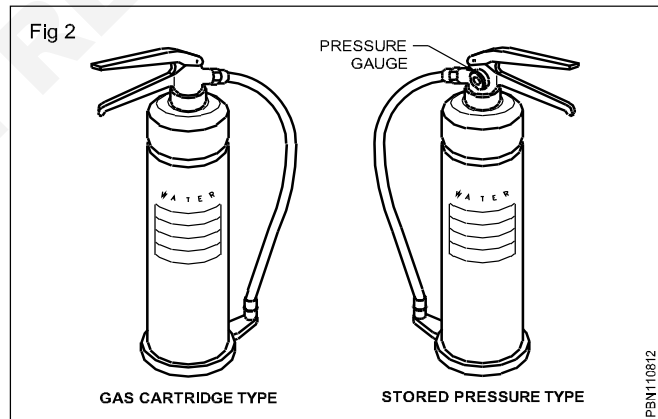


Water-filled extinguishers

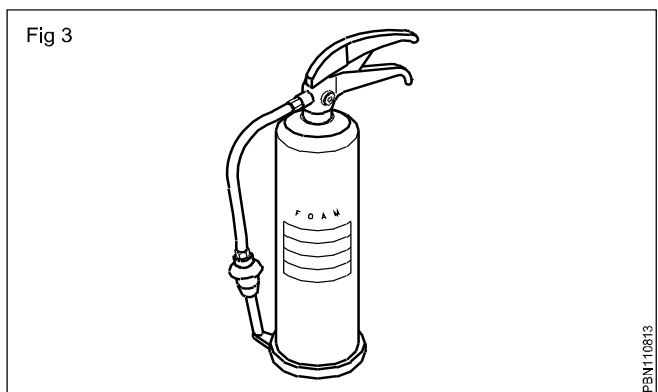
There are two methods of operation. (Fig 2)

- Gas cartridge type
- Stored pressure type

With both methods of operation, the discharge can be interrupted as required, conserving the contact and preventing unnecessary water damage.



Foam extinguishers (Fig 3)



These may be of stored pressure or gas cartridge types.

Always check the operating instructions on the extinguisher before use.

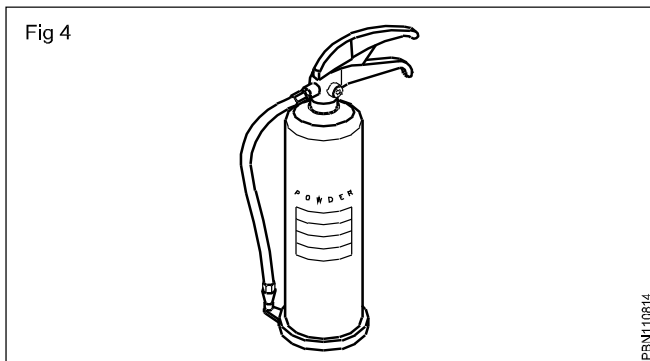
Foam extinguishers are most suitable for:

- flammable liquid fires
- running liquid fires

Must not be used where electrical equipment is involved.

Dry powder extinguishers (Fig 4)

Extinguishers fitted with dry powder may be of the gas cartridge or stored pressure type. Appearance and method of operation is the same as that of the water-filled one. The main distinguishing feature is the fork-shaped nozzle. Powders have been developed to deal with class D fires.



Carbon dioxide (Co₂)

This type is easily distinguished by the distinctively shaped discharge horn. (Fig 5)

Before use, available with different gadgets of operation such as -plunger, lever trigger etc.



Working on fire extinguishers

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

- state about the selection of the fire extinguishers according to the type of fire
- state the method of operation of the fire extinguishers
- explain how to extinguish the fire.

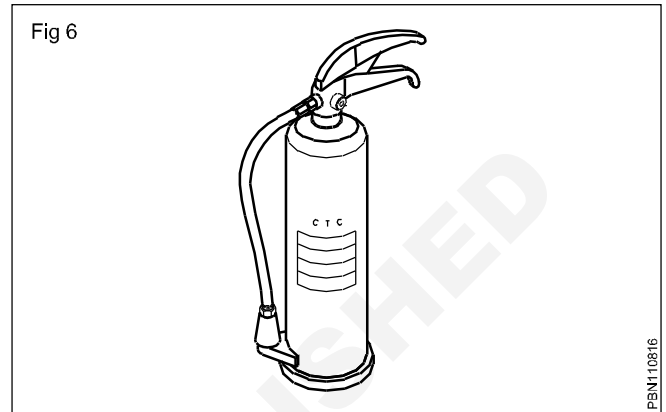
- Alert people surrounding by shouting fire, fire, fire when observe the fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exit and ask them to go away.
- Put "off" electrical power supply.

Halon extinguishers (Fig 6)

These extinguishers may be filled with carbon tetrachloride and bromochlorodifluoro methane (BCF).

They may be of either gas cartridge or stored pressure type.

They are more effective in extinguishing small fires involving pouring liquids. These extinguishers are particularly suitable and safe to use on electrical equipment as the chemicals are electrically non-conductive.



The fumes given off by these extinguishers are dangerous, especially in confined space.

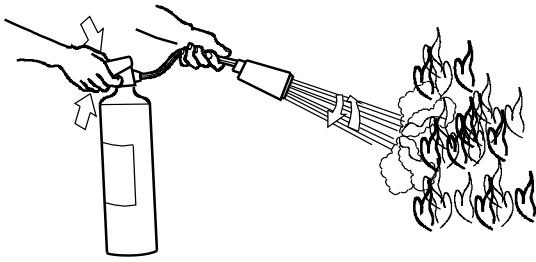
General procedure to be adopted in the event of a fire to be adopted.

- Raise an alarm.
- Turn off all machinery and power (gas and electricity).
- Close the doors and windows, but do not lock or bolt them. This will limit the oxygen fed to the fire and prevent its spreading.
- Try to deal with the fire if you can do so safely. Do not take risk, getting in trapped.
- Anybody not involved in fighting the fire should leave calmly using the emergency exits and go to the designated assembly point. Failure to do this may mean that some person is unaccounted for and others may have to put themselves to the trouble of searching for him or her at risk to themselves.

Don't allow people to go nearer to the fire.

- Squeeze the handle lever slowly to discharge the agent (Fig 1)
- Sweep side to side approximately 15 cm over the fuel fire until the fire is put off (Fig 1)

Fig 1



PSN110622

Fire extinguishers are manufactured for use from the distance.

Caution

- While putting off fire, the fire may flare up
- Do not be panicked before it is put off promptly.

- If the fire doesn't respond well after you have used up the fire extinguisher move away yourself away from the fire point.
- Do not attempt to put out a fire where it is emitting toxic smoke leave it for the professionals.
- Remember that your life is more important than property. So don't place yourself or others at risk.

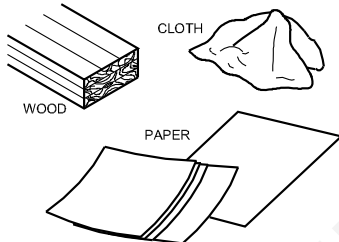
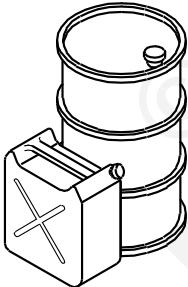
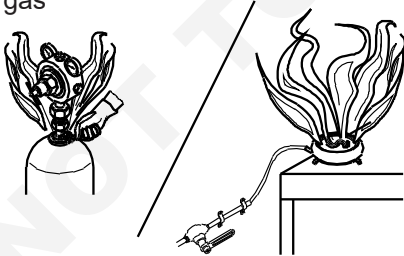

In order to remember the simple operation of the extinguisher, remember P.A.S.S. This will help you to use the fire extinguisher.

P for Pull

A for Aim

S for Squeeze

S for Sweep

Fuel	Extinguishing
<p>CLASS 'A' Fire Wood, paper, cloth etc Solid materials</p> 	<p>Most effective i.e. cooling with water. Jets of water should be sprayed on the base of the fire and then gradually upwards.</p>
<p>CLASS 'B' Fire Flammable liquid. liquefiable solids</p> 	<p>Should be smothered. The aim is to cover the entire surface of the burning liquid. This has the effect of cutting off the supply of oxygen to the fire.</p> <p>Water should never be use on burning liquids.</p> <p>Foam, dry powder or CO² may be used on this type of fire.</p>
<p>CLASS 'C' Fire Gas and liquefied gas</p> 	<p>Extreme caution is necessary in dealing with liquified gases. There is a risk of explosion and sudden spreading of fire in the entire vicinity. If an appliance fed from a cylinder catches fire - shut off the supply of gas. The safest course is to raise an alarm and leave the fire to be dealt with by trained personnel.</p> <p>Dry powder extinguishers are used on this type of fire.</p> <p>Special powders have now been developed which are capable of controlling and/or extinguishing this type of fire.</p>
<p>CLASS 'D' Fire Involving metals</p> 	<p>The standard range of fire extinguishing agents is inadequate or dangerous when dealing with metal fires.</p> <p>Fire on electrical equipment.</p> <p>Carbon dioxide, dry powder and vapourising liquid (CTC) extinguishers can be used to deal with fires in electrical equipment. Foam or liquid (e.g Water) extinguisher must not be used on electrical equipment under any circumstances.</p>

Basic bench fittings

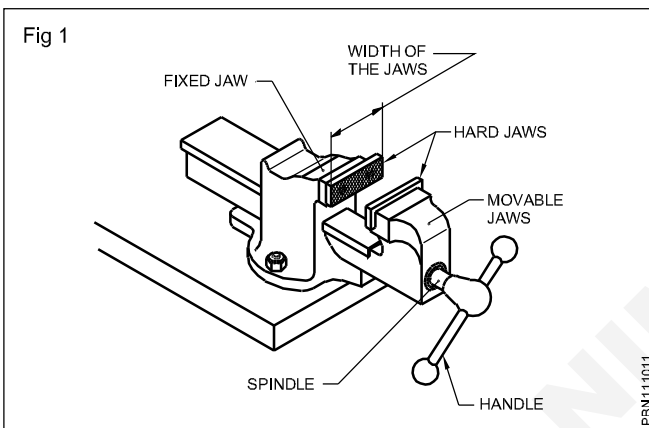
Objectives: At the end of this lesson you shall be able to

- state the construction and advantage of a bench vice and quick releasing vice
- state the uses of pipe vice, tools makers vice, bench grinder
- state the uses of pipe bending machine
- state the uses of bench drilling machines.

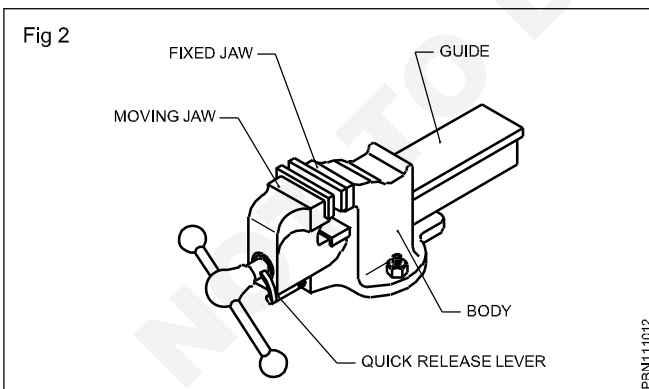
Parts of a bench vice (Fig 1): The following are the parts of a vice.

Fixed jaw, movable jaw, hard jaws, spindle, handle, box-nut and spring are the parts of a vice.

The box-nut and the spring are the internal parts.



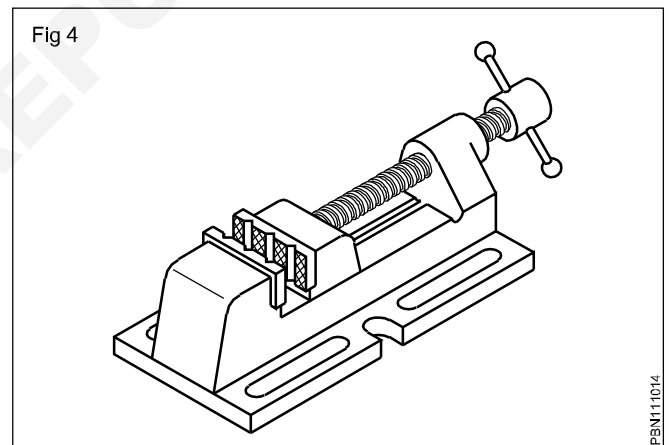
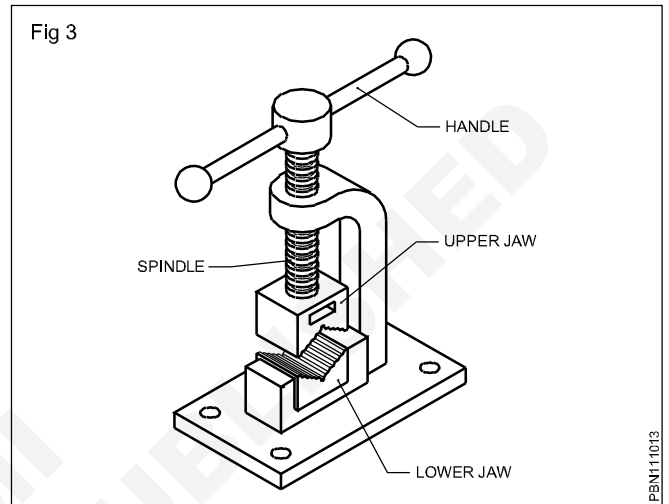
Quick releasing vice (Fig 2): A quick releasing vice is similar to an ordinary bench vice but the opening of the movable jaw is done by using a trigger (lever). If the trigger at the front of the movable jaw is pressed, the nut disengages the screw and the movable jaw can be set in any desired place quickly.



Pipe vice (Fig 3): A pipe vice is used for holding round sections of metal, tubes and pipes. In this vice, the screw is vertical and movable. The jaw works vertically.

The pipe vice grips the work at four points on its surface. The parts of a pipe vice are shown in (Fig 3).

Toolmakers' vice (Fig 4): The toolmakers' vice is used for holding small work which requires filing or drilling and for marking of small jobs on the surface plate. This vice is made of mild steel.



Toolmakers' vice is accurately machined.

Bench grinding is the operation of removing material which does not require great accuracy in size or shape. This is carried out by pressing the work piece by hand against a grinding wheel.

Bench grinding is performed for rough grinding of jobs and resharping of

Scribers

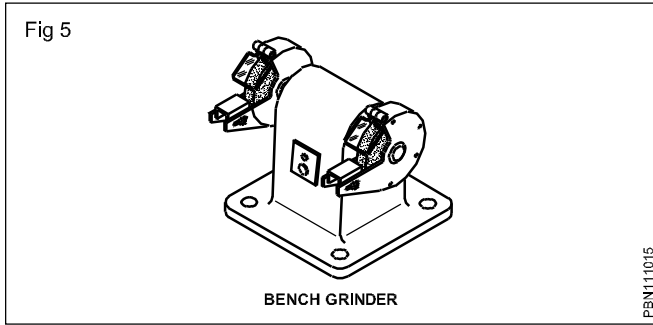
Punches

Chisels

Twist drills

Single point cutting tools etc.

Bench grinding is performed with a bench or pedestal grinder. (Fig 5)



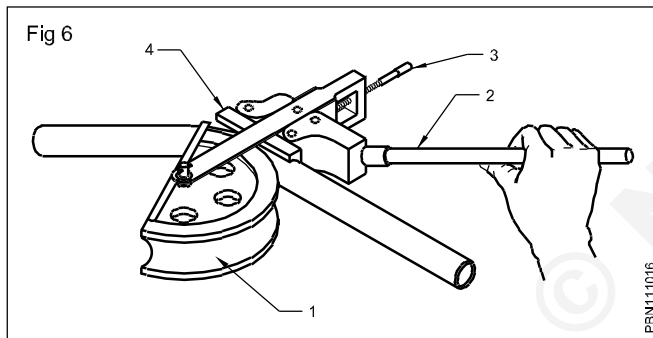
Bench grinders

Bench grinders are fitted to a bench or table, and are useful for light duty work.

Bench type hand operated pipe bender (Fig 6)

This consists of the following parts. It is used for bending galvanized iron and steel pipes.

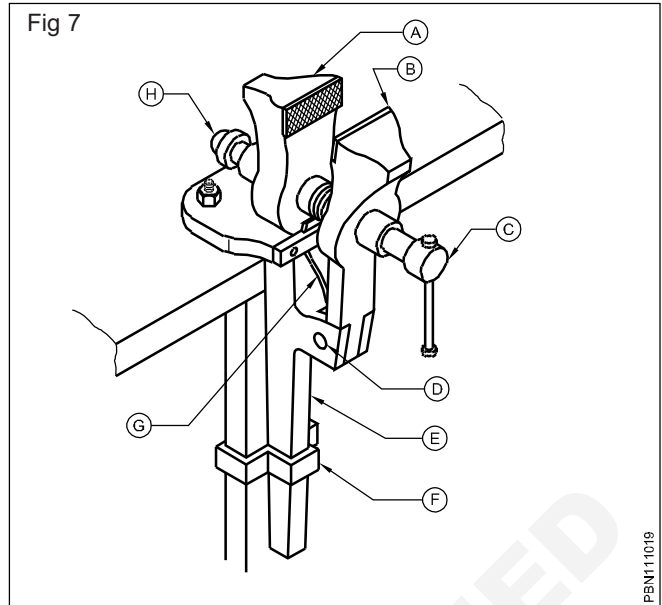
- 1 Innerformer.
- 2 Lever or handle
- 3 Adjusting screw with lock nut.
- 4 Pipe guide.



Main parts of a leg vice (Fig 7)

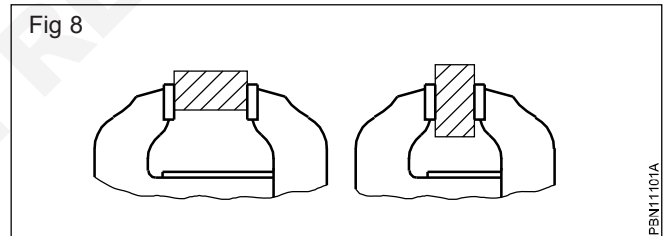
The following are the main parts of a leg vice.

- 1 Solid jaw
- 2 Movable jaw
- 3 Threaded jaw



- 4 Spindle
- 5 Spring
- 6 Pivot
- 7 Leg
- 8 Clamp

Since the hinged jaw moves in a radial path, the job held in this vice is not gripped properly because of the line contact. (Fig 8) Hence a work which can be carried out on a bench vice is not held on a leg vice. Jobs which require hammering only are held on a leg vice.



Plumber common hand tools - Names, description and material from which they are made description, types and uses of holding device, hammers & cold chisels, cutting tools

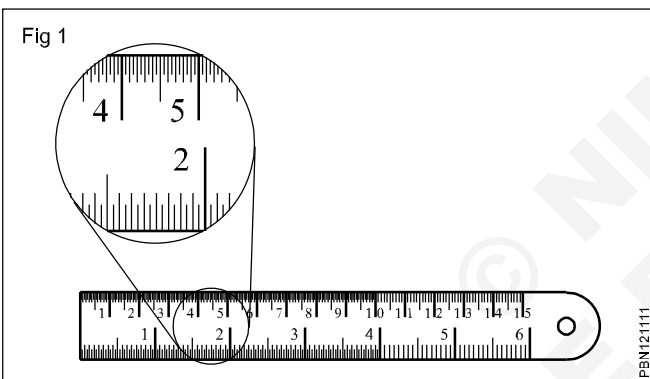
Objectives: At the end of this lesson you shall be able to

- state the purpose of a steel rule, steel tape, calipers, scriber, punches, try square, dividers, hand vice, pin vice
- state the uses of an plumb bob and hack saw frame with blade
- state the uses of an rawl jumper and hammer
- state the uses of BSP die - set pipe wrench and chain wrench
- state the different types of chisel and their uses
- state the use of pipe cutter.

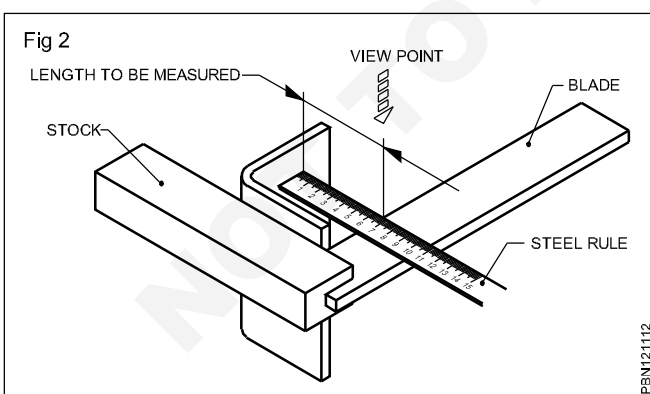
Steel rule

Engineers' steel rules (Fig 1) are used to measure the linear dimensions of workpieces.

Steel rules are made of spring steel or stainless steel. These rules are available in lengths of 150 mm, 300 mm and 600 mm. The reading accuracy of the steel rule is 0.5 mm.



For accurate readings it is necessary to read vertically to avoid errors arising out of parallax. (Fig 2)

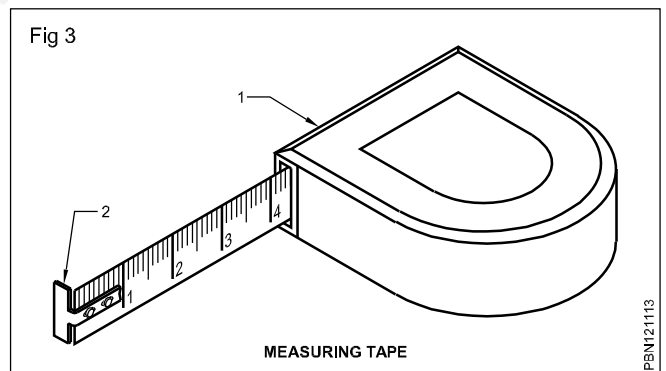


For maintaining the accuracy of a steel rule, it is important to see to it that its edges and surfaces are protected from damage and rust.

Do not place a steel rule with other cutting tools. Apply a thin layer of oil when not in use.

Steel tape

- The steel tape is a measuring tool and consists of a hood casting a rectangle steel strip with division markings. (Fig 3)
- Standard lengths available - 3m, 5m, 15m, 30m
- 3m and 5m are called as 'Pocket Tapes.'
- Tapes are used for Lengthier, linear measurements.
- Tapes should be carefully preserved without scratch, distortion and damage.
- Tapes should be cleaned with soft cloth to remove dust.
- Tapes should be maintained dry without contact with water/moisture to avoid rusting.



Types of calipers

Calipers are indirect measuring instruments used for transferring measurements from a steel rule to a job, and vice versa.

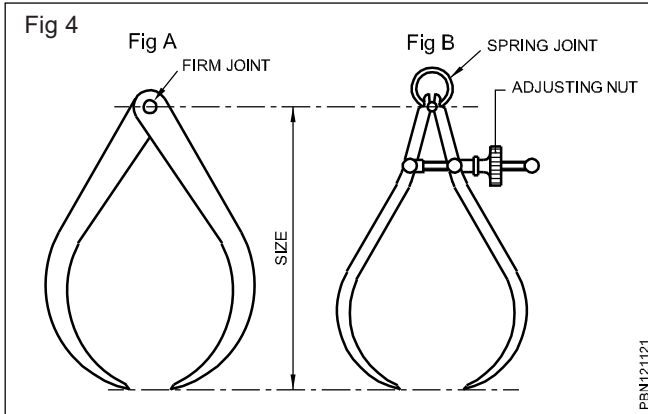
Calipers are classified according to their joints and their legs.

Joints

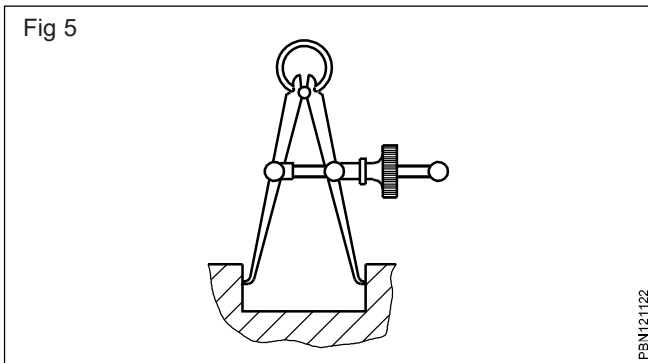
- Firm joint calipers (Fig 4)
- Spring joint calipers (Fig 5)

Legs

- Outside caliper for external measurement. (Fig 4)

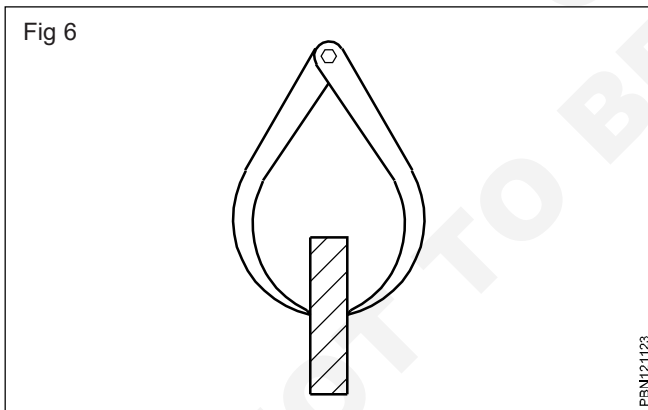


- Inside caliper for internal measurement. (Fig 5)



Spring joint calipers have the advantage of quick setting with the help of an adjusting nut.

For setting a firm joint caliper, tap lightly on a wooden surface. (Fig 6)

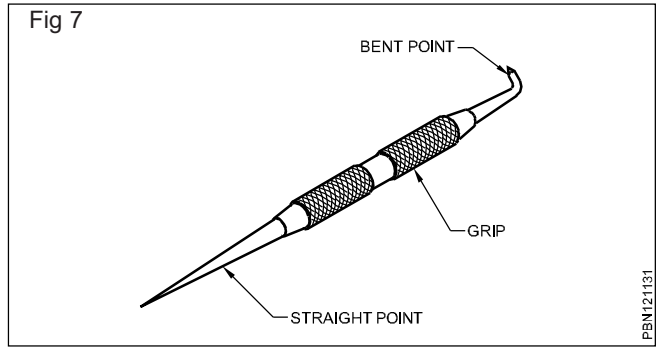


Scribers

In layout work it is necessary to scribe lines to indicate the dimensions of the workpiece to be filed or machined. The scriber is a tool used for this purpose. It is made of high carbon steel and is hardened. For drawing clear and sharp lines, the point should be ground and honed frequently for maintaining its sharpness.

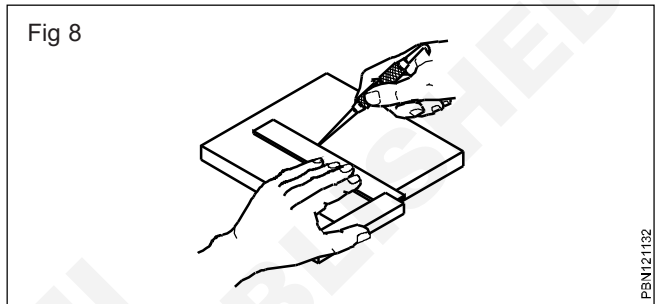
Scribers are available in different shapes and sizes. The most commonly used one is the plain scriber. (Fig 7)

While scribing lines, the scriber is used like a pencil so that the lines drawn are close to the straight edge. (Fig 8)



Scriber points are very sharp; therefore, do not put the plain scriber in your pockets.

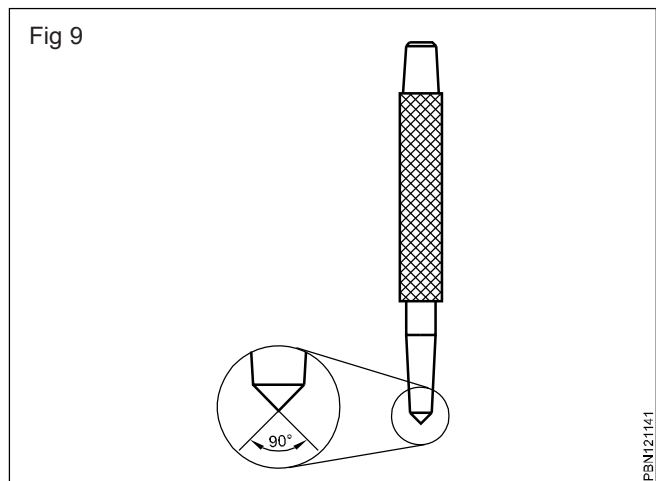
Place a cork on the point when not in use to prevent accidents.



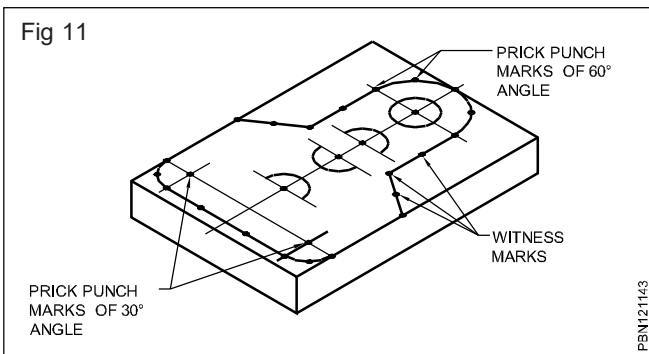
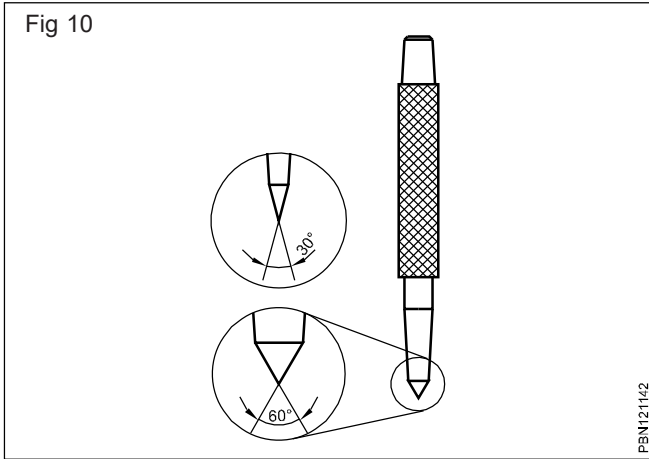
Marking punches

Punches are used in order to make certain dimensional features of the layout permanent. There are two types of punches. They are centre punch and prick punch.

Centre punch: The angle of the point is 90° in a centre punch. The punch mark made by this is wide but not very deep. This punch is used for locating holes. The wide punch mark gives a good seating for starting the drill. (Fig 9)



Prick punch: The angle of the prick punch is 30° or 60° . (Fig 10) The 30° point punch is used for making light punch marks needed to position the dividers. The divider leg will get a proper seating in the punch mark. The 60° prick punch is used for marking witness marks. (Fig 11)

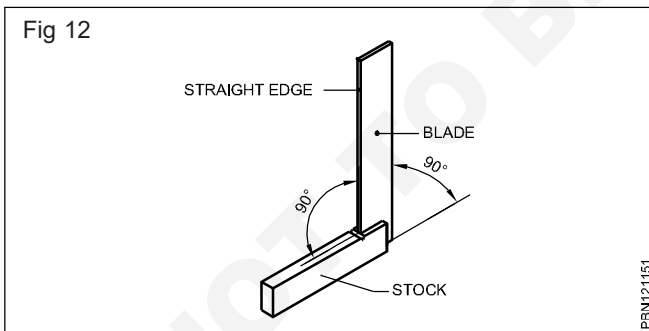


The witness marks should not be too close to one another.

These punches are made of high carbon steel and the points are hardened and tempered. The commercial sizes are 100 mm, 150 mm and 200 mm.

Try square

The try square (Fig 12) is a precision instrument which is used to check squareness (angles of 90°) of a surface.



The accuracy of measurement by a try square is about 0.002 mm per 10 mm length, which is accurate enough for most workshop purposes. The try square has a blade with parallel surfaces. The blade is fixed to the stock at 90°.

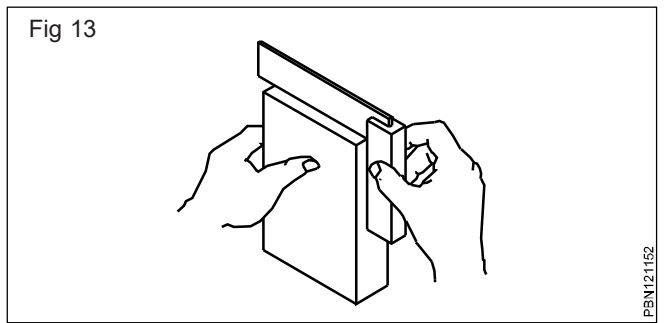
Try squares are made of hardened steel.

Try squares are specified according to the length of the blade i.e. 100 mm, 150, 200 mm.

Uses

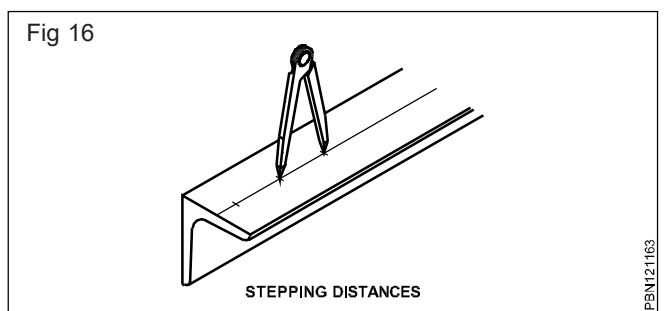
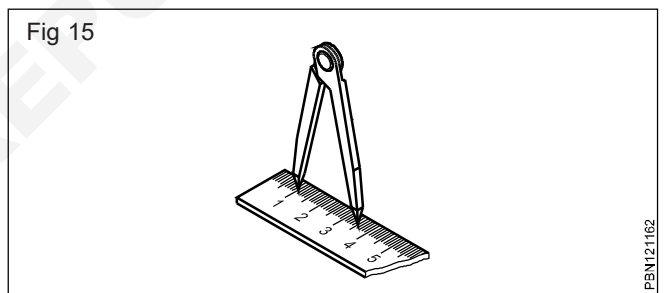
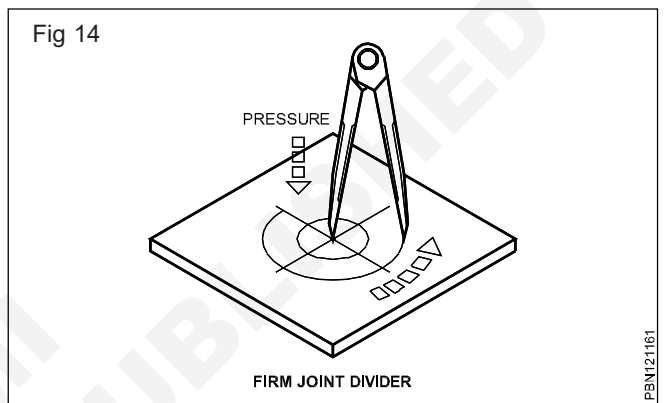
The try square is used to:

- check the squareness. (Fig 13)



Dividers

Dividers are used for scribing circles, arcs and for transferring and stepping off distances. (Fig 14, 15 & 16)



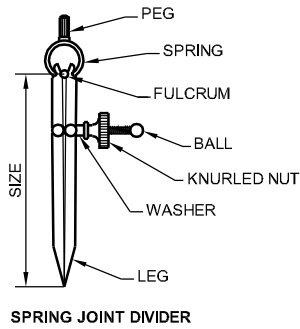
Dividers are available with firm joints and spring joints. (Figs 14 & 17). The measurements are set on the dividers with a steel rule.

The sizes of dividers range between 50 mm to 200 mm.

The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 17)

For the correct location and seating of the divider point prick punch marks of 30° are used.

Fig 17



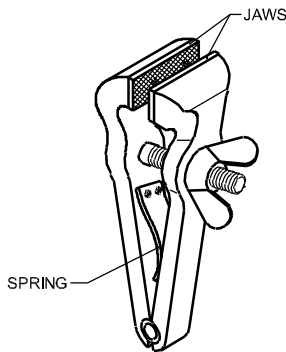
SPRING JOINT DIVIDER

PBN121164

Hand vice (Fig 18)

Hand vices are used for gripping screws, rivets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. A hand vice is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 to 44 mm. The jaws can be opened and closed using the wing nut on the screw that is fastened to one leg, and passes through the other.

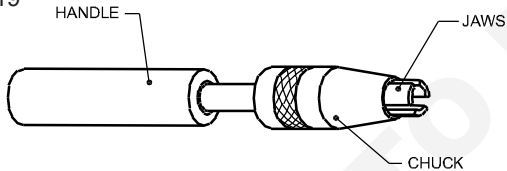
Fig 18



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Pin vice (Fig 19)

Fig 19



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The pin vice is used for holding small diameter jobs. It consists of a handle and a small collet chuck at one end. The chuck carries a set of jaws which are operated by turning the handle.

Plumb bob

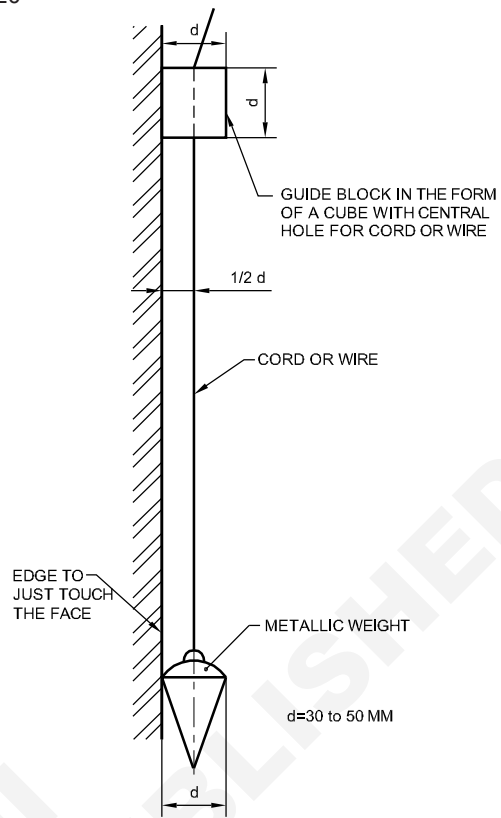
Plumb bob set is a brass or mild steel cone of 30 to 50 mm over all diameter as shown in (Fig 20).

A piece of cord (usually nylon) passes centrally to the conical weight.

Suspended wood piece in the shape of cube, or a metal piece in the shape of a rod and of side dimension equal to the diameter to the plumb bob

The wood or metal piece will have a central hole through which the cord is threaded.

Fig 20



PLUMB BOB SET AND ITS SUSPENSION

PBN121171

The main use of plumb bob set is for checking the plumpness or verticality of wall face.

Also used to transfer plumb points down vertically in layout marking.

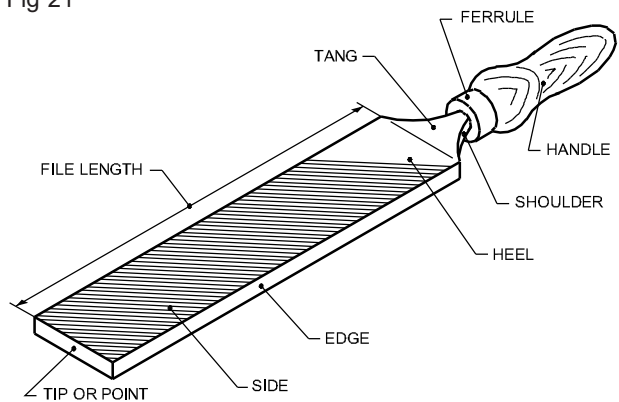
Parts of a file (Fig 21): The illustration above will help you in learning the parts of a file.

Files are specified according to their (1) length (2) grade (3) cut and (4) shape.

The length of a file is the distance from the tip to the heel.

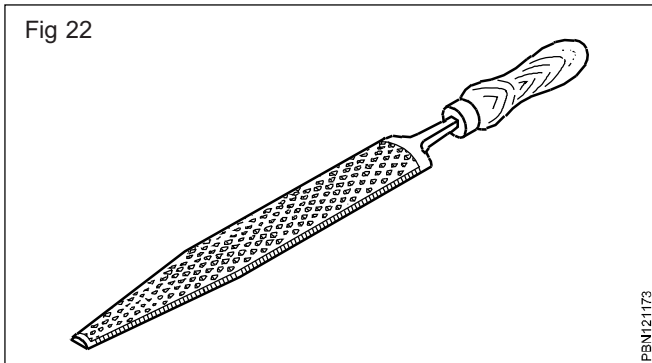
File grades are determined by the spacing of the teeth.

Fig 21



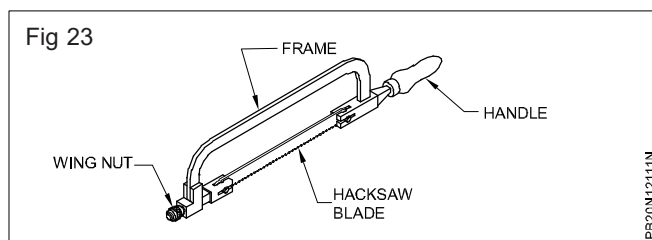
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Rasp cut files are useful for filing wood, leather and other soft materials and are available only in half round shape. (Fig 22)

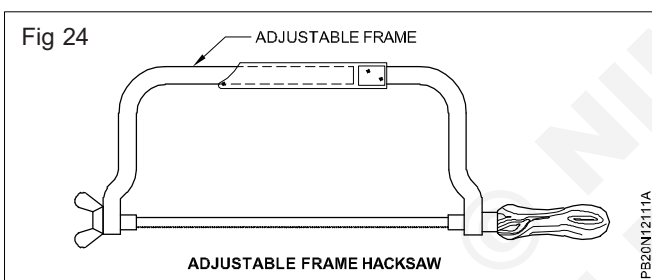


Types of hacksaw frames

Solid frame (Fig 23): Only a blade of a particular standard length can be fitted to this frame.



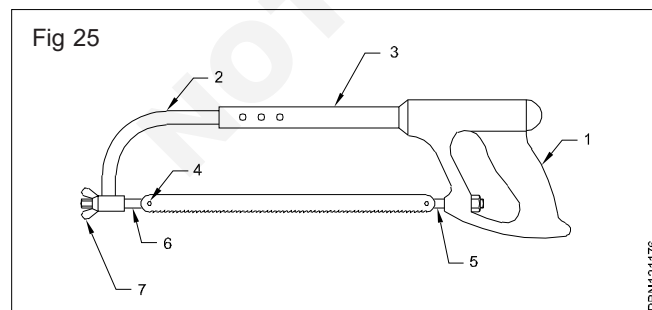
Adjustable frame (flat type) (Fig 24): Different standard lengths of blades can be fitted to this frame.



Adjustable frame (tubular type) (Fig 25): This is the most commonly used type. It gives a better grip and control while sawing.

For proper working, it is necessary to have frames of rigid construction.

The hand hacksaw is used along with blade to cut metals of different sections. It is also used to cut slots and contours. See (Fig 25) to identify parts.



Parts of a hacksaw frame

- 1 Handle
- 2 Frame
- 3 Tubular frame with holes for length adjustment
- 4 Rotating pins
- 5 Fixed blade holder
- 6 Adjustable blade holder
- 7 Wingnut

Hack saw blades

A hacksaw blade is a thin narrow steel band with teeth with two phones at the ends. It is used along with a hacksaw frame. The frame is made of either low alloy steel (LA) or high speed steel (HB) and is available in standard lengths of 250 mm and 300 mm.

Types of hacksaw blades

All hard blade: The full length of the blade between the pins is hardened and it is used for harder metals such as tool steel, die steel and HCS.

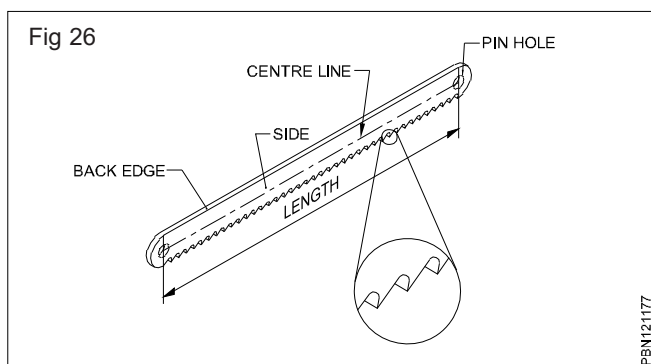
Flexible blade: Only the teeth are hardened. Because of their flexibility, these blades are useful for cutting along curved lines. Flexible blades should be thinner than all hard blade.

Pitch of the blade: The distance between adjacent tooth is known as the 'Pitch' of the blade.

Pitch of the blade:

Classification	Pitch
Coarse	1.8mm
Medium	1.40mm and 1,0mm
Fine	0.80mm

Parts of a hacksaw blade (Fig 26)



- 1 Back edge
- 2 Side
- 3 Centre line
- 4 Pin holes

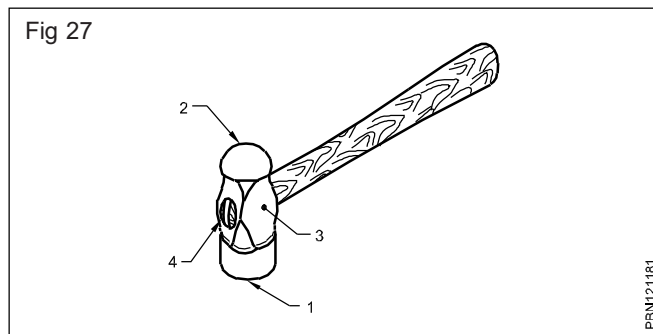
Hammer

An engineer's hammer is a hand tool used for striking purposes while punching, bending, straightening, chipping, forging or riveting.

Major parts of a hammer: The major parts of a hammer are a head and a handle.

The head is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

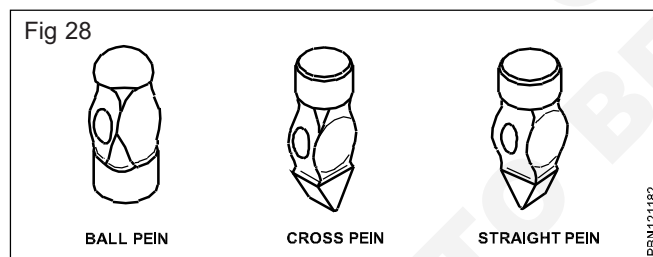
The parts of a hammer - head (Fig 27) are the face (1) pein (2) cheek (3) and the eyehole (4).



Face: The face is the striking portion. A slight convexity is given to it to avoid digging of the edge. It is used for striking while chipping, bending, punching, etc.

Pein: The pein is the other end of the head. It is used for shaping and forming work like riveting and bending. The pein is of different shapes such as:

- ball pein
- cross-pein
- straight pein. (Fig 28)

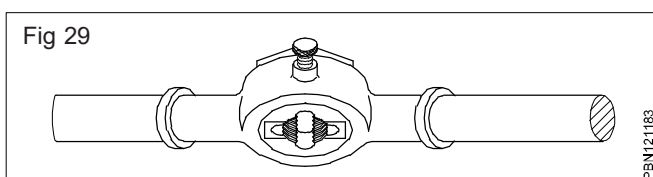


Adjustable Screw Plate Die (Fig 29): This is another type of a two piece die similar to the half die.

This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading.

When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held.



The die pieces can be adjusted, using the adjusting screws on the collar. This type of die stock used is called quick cut diestock.

This B.S.P diesel is commonly used for cutting external threads in the metal and nonmetal pipes.

Pipe wrenches: These are adjustable pipe wrenches with different shapes. They are used for:

- holding and gripping pipes
- assembling and dismantling of pipes and fittings.

The Stilton pipe wrench (Fig 30) is designed as a heavy duty tool to withstand rough handling and heavy work. The jaws give an immediate and positive grip.

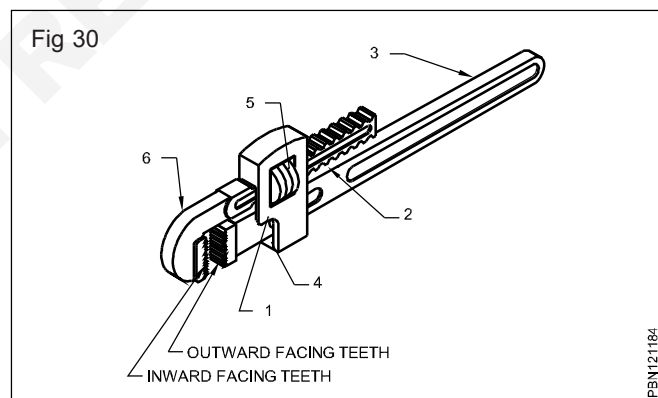
It may be used for all pipes with 15mm to 50mm diameters. Pipe wrenches are selected according to the pipe size.

Parts (Fig 30)

The Stillson pipe wrench consists of the following parts

- 1 Pivot
- 2 Spring
- 3 Handle or lever
- 4 Spring
- 5 Adjusting nut
- 6 Moveable jaw.

While using this pipe wrench, the jaws must be placed over the workpiece to their full depth and tightened by means of the adjusting nut.

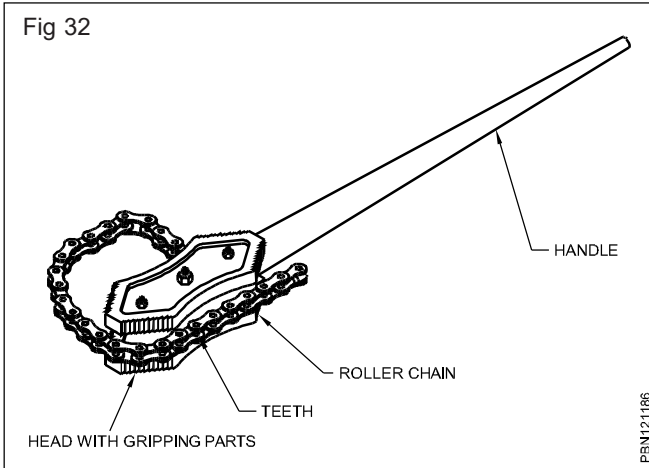
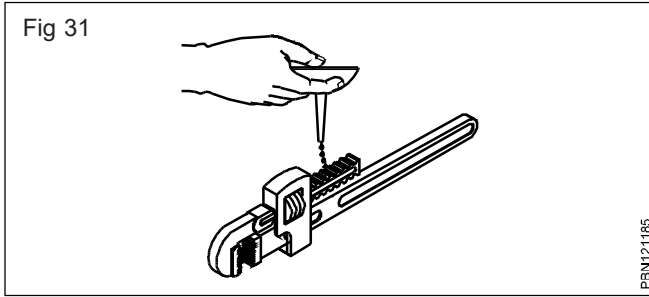


Care and maintenance : The ability of the pipe wrench to grip the pipe is directly related to the condition of the teeth.

Cleaning the teeth and sharpening them with a triangular file can restore some wrenches to useful condition.

Oil should be applied to the adjustment nut periodically to prevent rutting. (Fig 31)

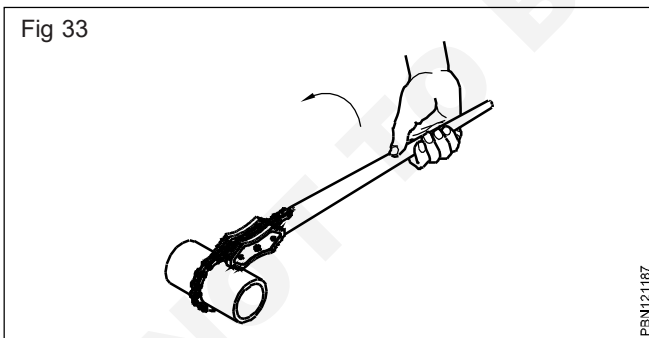
Chain pipe wrench (Fig 32): Chain pipe wrenches are used for pipes with diameters of 50mm to 150mm. They may be used for gripping cylindrical or irregular objects.



Application of chain pipe wrench: To use a chain pipe wrench, the head is placed on the pipe and the chain pulled round the circumference of the pipe. The chain is then engaged with the large teeth in the centre of the head.

The movement of the lever in the direction indicated by the arrow in the figure caused the serrated edges of the head to wedge firmly against the pipe giving a firm grip. (Fig 33)

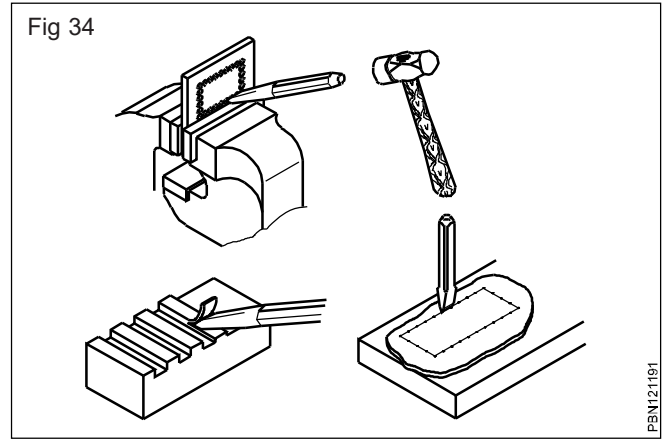
The chain pipe wrench is a heavy gripping tool and should not be used for pipes with less than 50mm diameter.



Chisel

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig 34)

Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.



Parts of chisel (Fig 35)

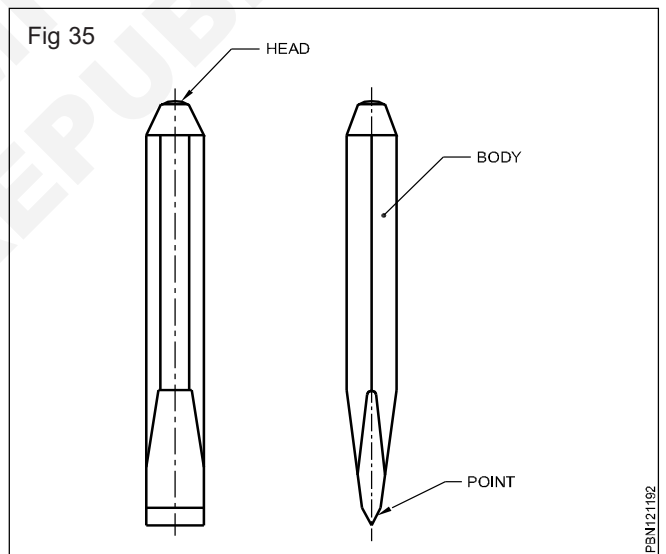
A chisel has the following parts.

Head

Body

Point or cutting edge

Chisels are made from high carbon steel or chrome vanadium steel. The cross - section of chisels is usually hexagonal or octagonal. The cutting edge is hardened and tempered.



Common types of chisels

There are four common types of chisels.

Flat chisel

Cross - cut chisel

Half - round nose chisel

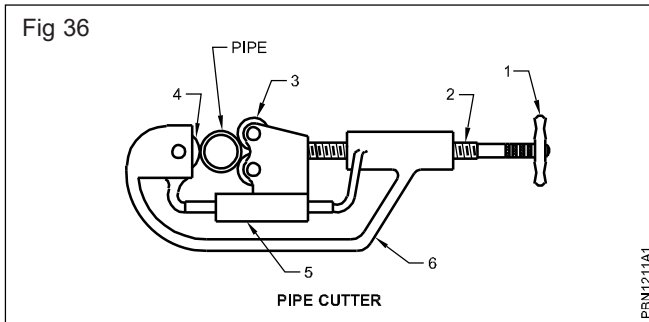
Diamond point chisel

Flat chisels

They are used to remove metal from large flat surfaces and chip excess metal off weld joints and castings.

Pipe cutter

It is used for cutting the pipes. Generally, cutter consists of three wheels. These wheels are fixed at 120° apart. Out of these three, one is cutter and two are roller fixed on base. (Fig 36)

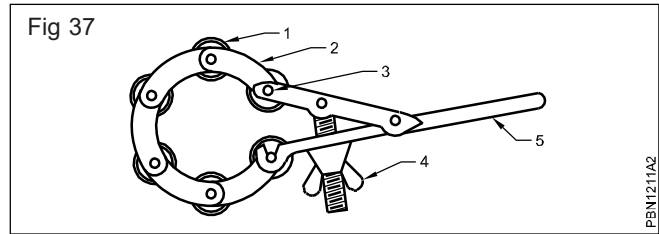


Parts of pipe cutter

- 1 Handle
- 2 Jacking screw
- 3 Cutting wheels
- 4 Roller wheel(Fixed) to face
- 5 Moving reel base
- 6 Frame

Jacking screw is hardened mild steel. Frame is of cast iron. Cutters are of hardened and temperate metal.

By rotating handle, wheels can be brought close to pipe or away from pipe. G.I. pipe, lead pipe and copper pipe can be cut easily with pipe cutter than other instruments. But there will be burr at cut edges as such it is used only for limited purpose at places where hacksaw cannot be used. (Fig 37)



Multi-wheel chain pipe cutter: A multi-wheel chain pipe cutter can be adjusted to cut any diameter of pipe by adding on extra wheels and links. (Fig 2) The type and the size of the cutter is selected according to the diameter of pipe to be cut.

It consists of the following parts

- 1 Hardened cutting wheels
- 2 Links
- 3 Screw for joining links and wheels
- 4 Tension adjustment screw
- 5 Cutter handle

Care and maintenance of pipe cutters: Before using the cutter check the wheels, pins and links for any damage. Replace the wheels, pins and links if damaged.

After cleaning, apply a light oil on all moving parts, links and wheels for easy cutting operation and to prevent rust forming on the tool.

Store the cutter and protect the wheels from possible damage when not in use.

Description of simple fitting operations hacksawing, punching and filing

- Objectives :** At the end of this lesson you shall be able to
- state the causes for corrosion and surface protection
 - state the hacksawing process
 - state the hacksawing to the given dimensions
 - state sawing of different sections.

Corrosion and surface protection

Corrosion or Rusting

When a metal is exposed to air, the oxygen in the air combines with the metal to form a chemical film over the surface of the metal. This chemical film is called oxide of the metal. The chemical reaction between the oxygen in the air and the metal is called oxidation. This is generally known as corrosion or rusting. Corrosion takes place on the surfaces of uncoated iron and steel. The rusting of metal is more severe in wet atmosphere.

Surface protection

The surface protection is classified according to the durability of coating to protect the surfaces from corrosion. This protection can be divided into three groups. They are (1) Temporary (2) Semi - permanent (3) Permanent.

1 Temporary treatment

A Applying oil or grease

This type of surface treatment is done very easily by coating lubricating oil or grease on the surface of the metal.

B Applying Enamels and Lacquers

A coloured or transparent finish can be done with enamels or lacquers.

Before applying opaque enamels or lacquers to metal, you must use a primer, or first coat. It will bind and adhere to the metal, providing a good base.

A Zinc chromate primer is good for exterior finishing.

Methods of applying lacquer

- 1 Make sure that the object is clean and spots are removed.
- 2 Make sure that the surface is completed.
- 3 Now use a clean paper or cloth to handle the project.
- 4 Warm the metal in an oven if possible, because heating makes the lacquer flow smoothly.
- 5 Use a good brush and apply lacquer a little at a time.
- 6 Don't pass over an area again i.e second time.
- 7 Allow the object to dry for an hour or two.

8 Apply a second coat.

9 Clean the brush in lacquer thinner which is the solvent for lacquer.

Methods to apply enamel

- 1 Clean the job carefully.
- 2 Apply primer and allow it to dry.
- 3 Brush on enamel with even strokes.
- 4 Allow it to dry for many hours.
- 5 Apply second and third coats as needed.
- 6 Clean the brush in paint thinner or lacquer thinner, because both are good solvent for enamels.

C Painting

This type of surface treatment is done by painting surface to prevent direct contact of air and moisture and to give a good appearance. It is an easy and quick process. The paint may be applied by brush or by spraying. A complete paint system consists of (1) primer (2) Putties or fillers (3) Under coats (4) Finished or top coats.

2 Semi - permanent treatment

A Galvanising

Galvanising is a process of giving a protective coating of zinc or iron sheets and components to protect the surface from corrosion. The thickness of coating is 0.002 inch.

Process

The article to be galvanised should be cleaned properly either by mechanical or chemical process to avoid dust, oil and grease. The work is dipped into a pickling solution containing 30% sulphuric acid with water. Then the work is fluxed with Zinc Chloride if the base metal is iron or with suitable flux depending on the metal to be galvanised and then dipped in a molten bath of zinc, kept at 450° C to 460° C. After dipping, it is taken out, and brushed to remove extra deposit and washed with water.

B Tinning

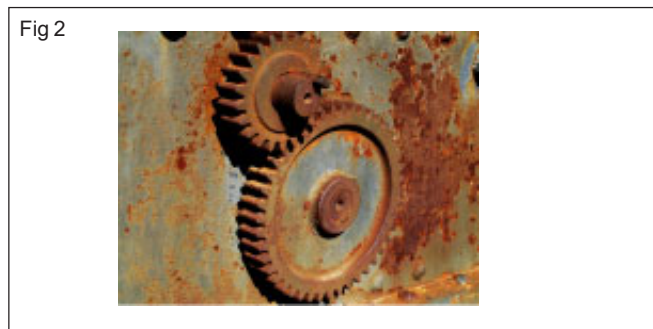
It is similar to that of galvanising. The only difference is that the metal to be tinned is dipped in a molten bath of tin. Tinning is done to save both ferrous and non - ferrous metals from corrosion or rusting.

Visual inspection of raw material for rusting, scaling, corrosion etc.

Rusted components (Fig 1)



Corroded gears (Fig 2)



Scaled part (Fig 3)



Hacksawing (Holding-pitch selection)

Holding the workpiece

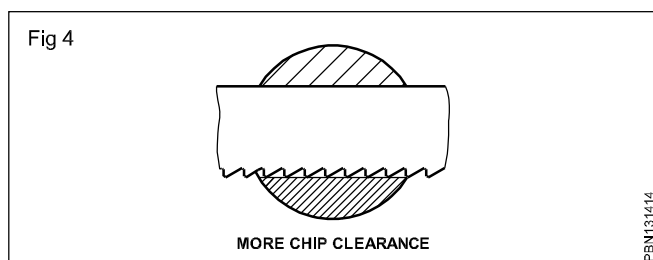
Position the metal to be cut according to the cross-section for hacksawing.

As far as possible the job is held so as to be cut on the flat side rather than the edge or the corner. This reduces the blade breakages.

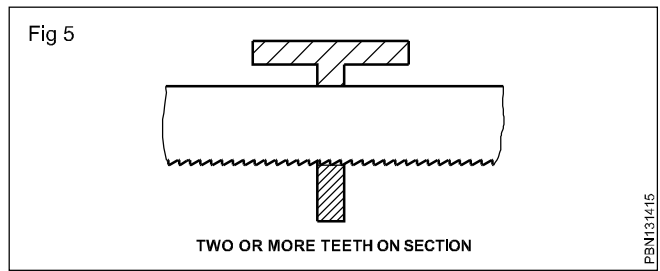
The selection of the blade depends on the shape and hardness of the material to be cut.

Pitch Selection

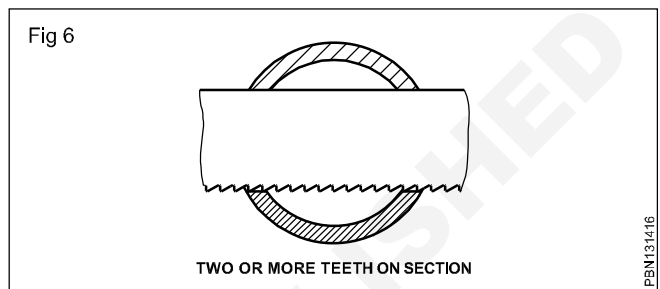
For soft materials such as bronze, brass, soft steel, cast iron, heavy angles etc. use a 1.8mm pitch blade. (Fig 4)



For tool steel, high carbon, high speed steel etc. Use a 1.4 mm pitch. For angle iron, brass tubing, copper, iron pipe etc. Use a 1mm pitch blade. (Fig 5)



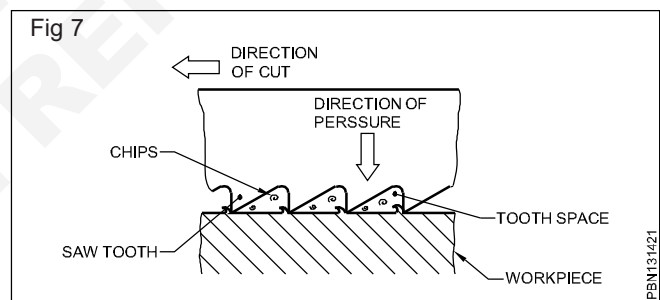
For conduit and other thin tubing, sheet metal work etc. use a 0.8mm pitch. (Fig 6)



Hacksawing

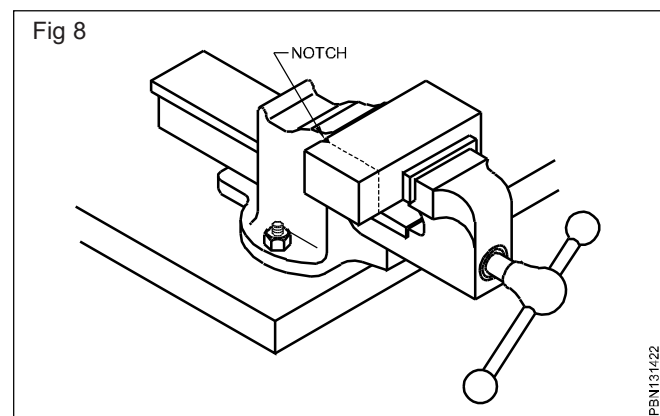
Fixing of Hacksaw Blades

The teeth of the hacksaw blade should point in the direction of the cut and away from the handle. (Fig 7)



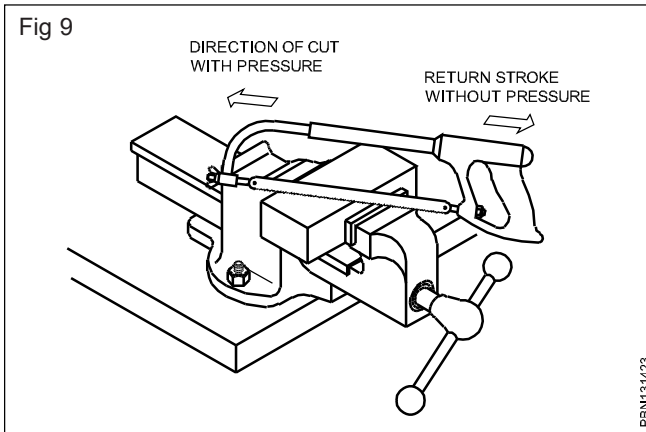
The blade should be held straight, and correctly tensioned before starting.

While starting the cut make a small notch. (Fig 8)



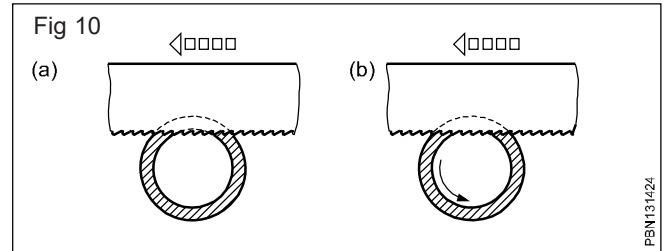
The cutting movement should be steady and the full length of the blade should be used.

Apply pressure only during the forward stroke. (Fig 9)



At least two to three teeth should be in contact with the work while cutting. Select a fine pitch blade for thin work. (Fig 10 a)

Turn and changed the position of the pipe while hacksawing. (Fig 10 b)



Normally, a coolant is not necessary while hacksawing.

Do not move the blade too fast. While finishing a cut, slow down to avoid breakage of the blade and injury to yourself and others.

Types of files used commonly

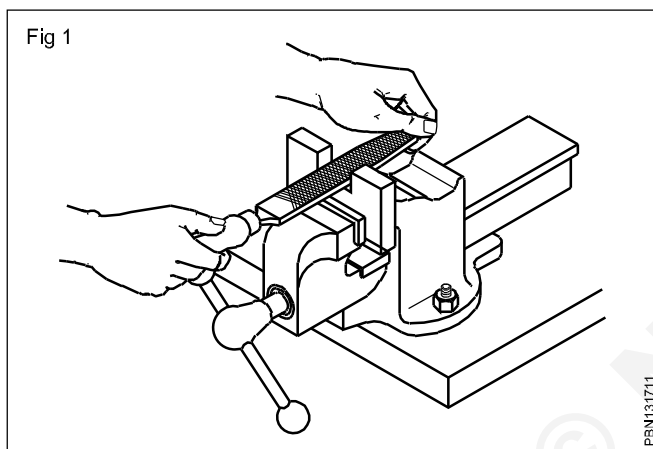
Objectives: At the end of this lesson you shall be able to

- state the elements of a file
- state the shapes of different files
- state the pinning of files and method of removing with file card
- state the checking process of flatness and squareness using try square.

Elements of a file

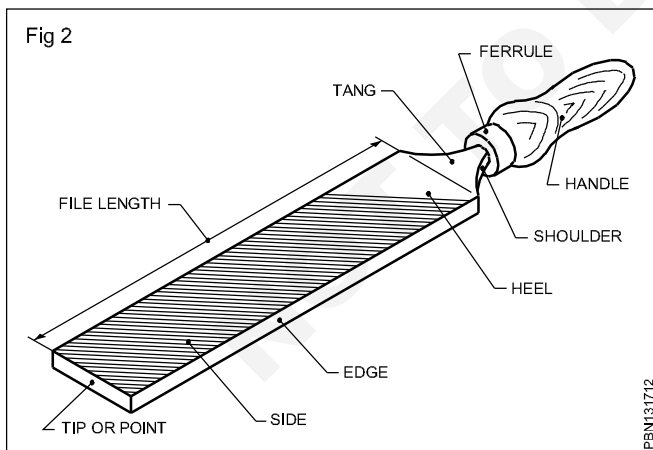
Filing is a method of removing excess material from a workpiece by using a file. (Fig 1)

Files are available in many shapes and sizes. They are made of high carbon or high grade cast steel. The teeth portion of the file (body) alone is hardened and tempered.



Parts of a file (Fig 2): The illustration above will help you in learning the parts of a file.

Files are specified according to their (1) length (2) grade (3) cut and (4) shape.



The length of a file is the distance from the tip to the heel.

File grades are determined by the spacing of the teeth.

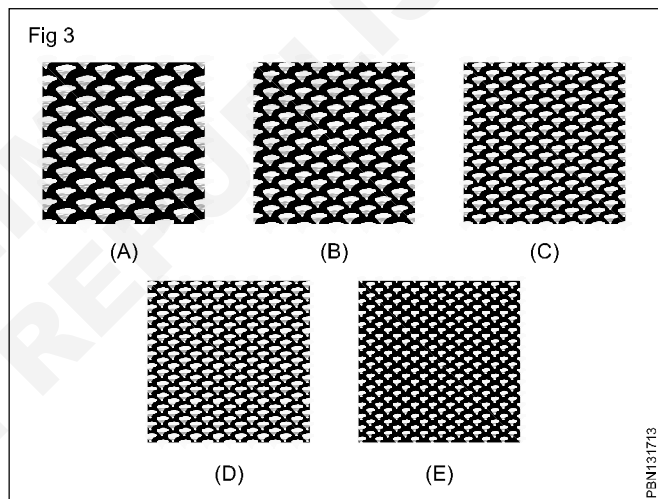
A rough file is used for removing rapidly a larger quantity of metal. It is mostly used for trimming the rough edges of soft metal castings. (Fig 3a)

A bastard file is used in cases where a heavy reduction of material is required. (Fig 3b)

A second cut file is used to give a good finish on metals. It is excellent to file hard metals. It is useful for bringing the jobs close to the finishing size. (Fig 3c)

A smooth file is used to remove small quantities of material and to give a good finish. (Fig 3d)

A dead smooth file is used to bring the material to accurate size with a high degree of finish. (Fig 3e)



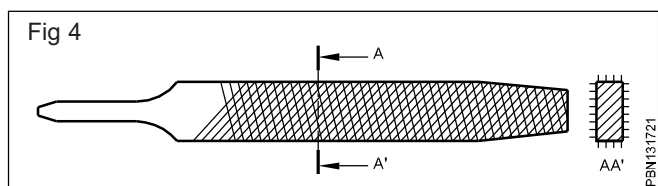
File shapes

Files are made in different shapes so as to be able to file and finish components to different shapes.

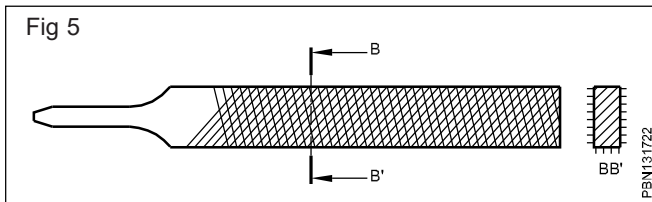
The shape of files is usually specified by their cross-section.

The files useful for this exercise are flat files and hand files.

Flat files (Fig 4): These files are of a rectangular cross-section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut and the edges single cut. These files are used for general purpose work. They are useful for filing and finishing external and internal surfaces.



Hand files (Fig 5): These files are similar to the flat files in their cross-section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is a single cut whereas the other is a safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces already finished.

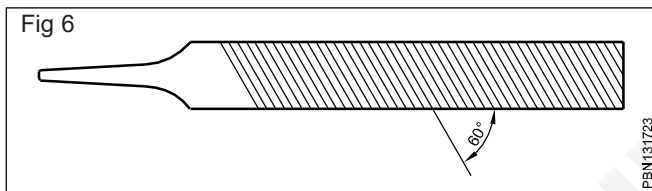


The most used grades of files are bastard, second cut, smooth and dead smooth. These are the grades recommended by the Bureau of Indian Standards. (BIS)

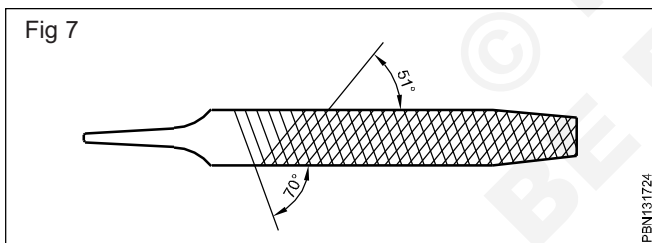
Different sizes of files with the same grade will have varying sizes of teeth. In longer files, the teeth will be coarser.

The uses of the different cuts of files are as follows.

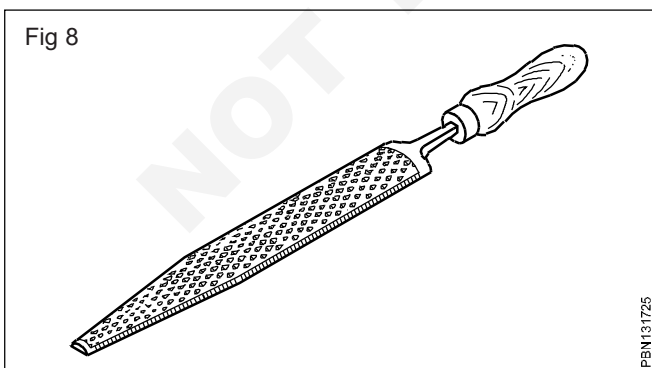
Single cut files are useful for filing soft metals like brass, aluminium, bronze and copper. (Fig 6)



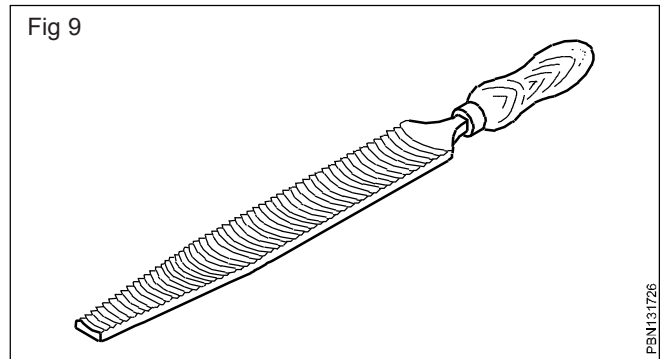
Double cut files remove material faster than the single cut files. (Fig 7)



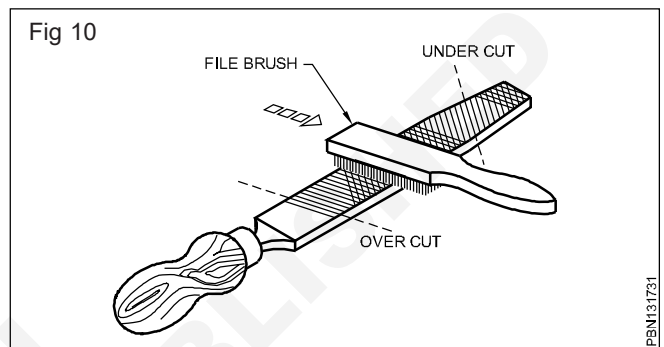
Rasp cut files are useful for filing wood, leather and other soft materials and are available only in half round shape. (Fig 8)



Curved cut files have deeper cutting action and are useful for filing soft materials like aluminium, tin, copper and plastic. (Fig 9)



Pinning of files: During filing, sometimes the metal chips (filings) will clog between the teeth of files. This is known as 'pinning' of files. (Fig 10).



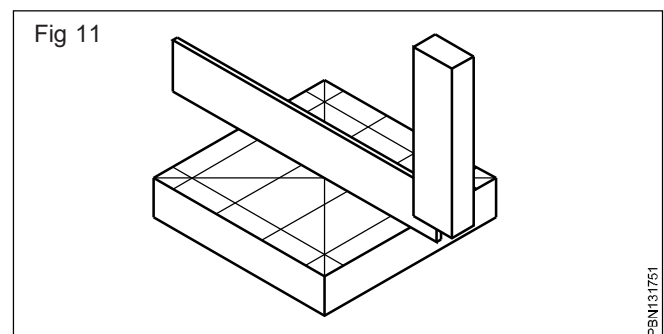
Precautions

- Clamp the work as low as possible on the vice.**
- Do not give extra leverage while tightening the work.**
- Lubricate the spindle and the box-nut periodically.**
- Do not tighten the jaws of the vices without any work in between.**
- Do not hammer on the vices for levelling metal.**

Checking flatness: During the initial stages of filing, the evenness of the surface can be visually observed to a reasonable degree of perfection from the surface texture of diagonal filing.

To ensure perfection, the surface should be checked with a straight edge. To do this the blade of a try square can serve as a straight edge.

Flatness should be checked in all directions so as to cover the entire surface. Light gap will indicate high and low spots. (Fig 11)

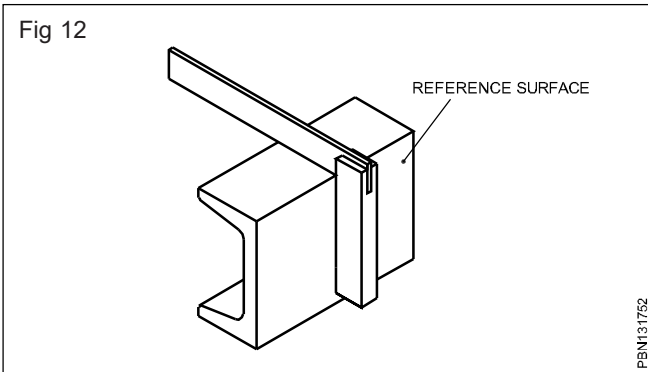


Checking Squareness

While checking for squareness, the large finished surface is taken as a reference surface. (Fig 12)

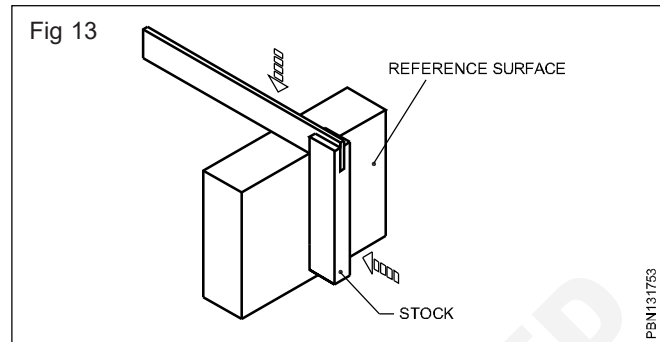
Ensure that the reference surface is finished perfectly before filing other surfaces.

Burrs, if any, should be removed before checking with a try square.



While checking with a try square, press the stock against the reference face and then slowly bring down the blade. (Fig 13)

Pressure is always applied to the stock against the reference surface.



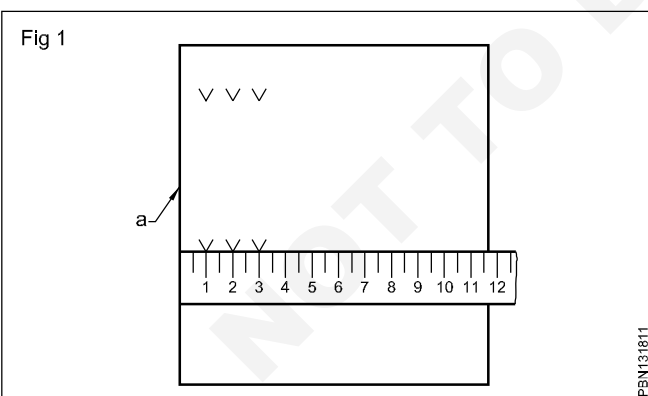
Marking instruments and their use simple drilling machine

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

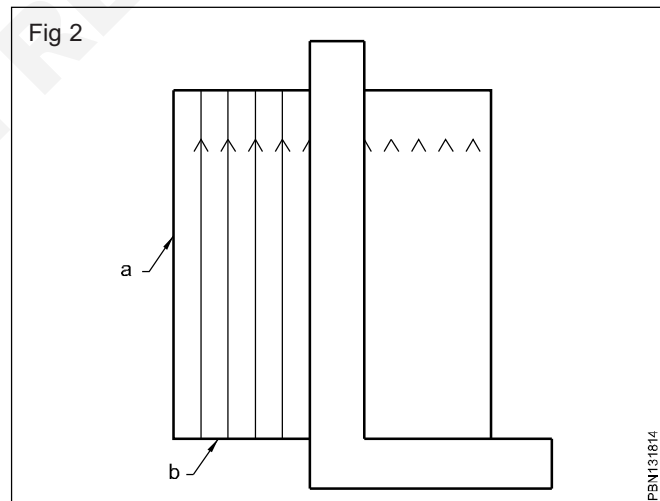
- state the purpose of marking media
- state the common types
- state the correct marking medium for different application
- state the different marking instruments for marking
- state the uses of caliper and dividers
- state the uses of punch
- state the types of punches.

Marking with steel rule and scribe and punching

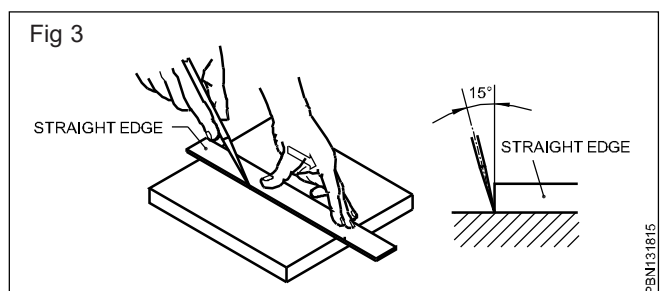
- 1 Apply prussian blue evenly over the surface.
- 2 Using a steel rule from the reference plane 'a' mark the measurements twice at two points as far away from one another as possible. (Fig 1)



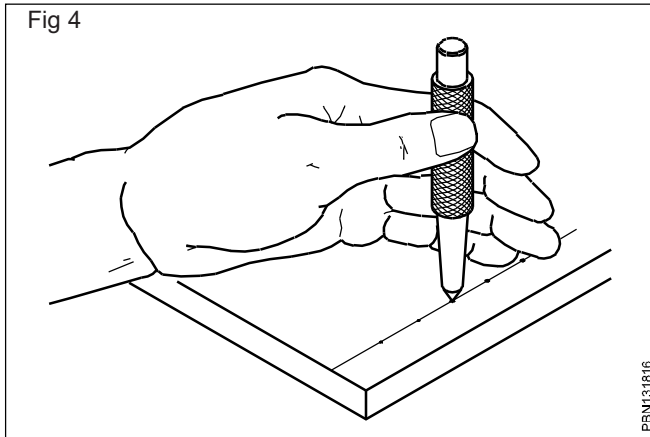
- 3 Place the try-square with its stock on reference plane 'b'.
- 4 Push the blade of the try-square right up to the markings. (Fig 2)
- 5 Draw the marking lines with the scribe.
- 6 For scribing lines place the point of the scribe on the workpiece against the straight edge.



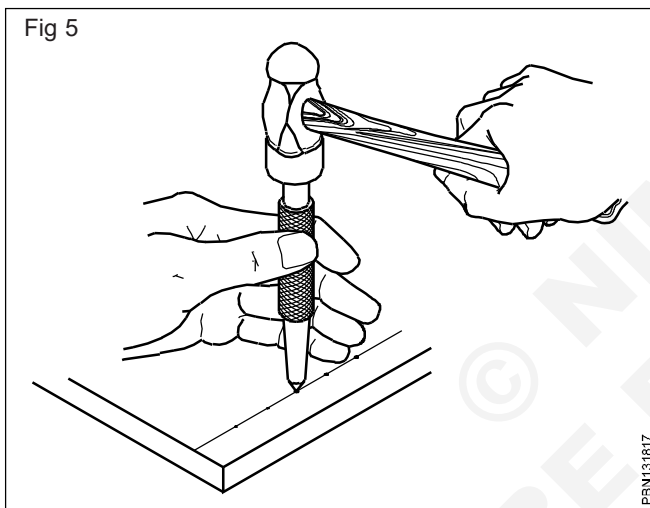
- 7 Hold the scribe inclined away from the straight edge and in the direction in which it is to be drawn. (Fig 3)



- 8 Place the dot-punch in position; while doing so rest your hand on the workpiece. (Fig 4)



- 9 Set the dot-punch upright.
- 10 The dot-punch is struck with the hammer; the blow must be delivered in the direction of the dot-punch axis. (Fig 5)



Marking media

Purpose of marking media

In marking off/Layout, the surface of the job/workpiece is coated with a medium to show the marked lines clear and visible. To get clear and thin lines, the best layout medium is to be selected.

Different marking media

The different marking media are Whitewash, Marking blue, Prussian Blue, Copper Sulphate and Cellulose Lacquer.

Whitewash

Whitewash is prepared in many ways.

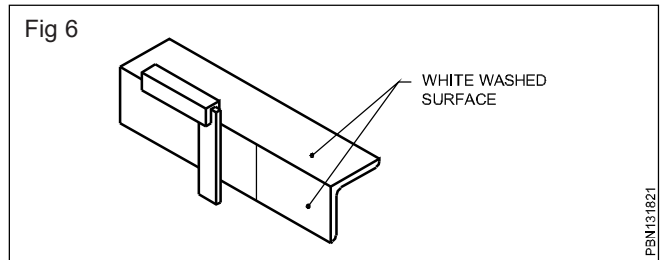
Chalk powder mixed with water

Chalk mixed with methylated spirit

White lead powder mixed with turpentine

Whitewash is applied to rough forgings and castings with oxidised surface. (Fig 6)

Whitewash is not recommended for workpieces of high accuracy.

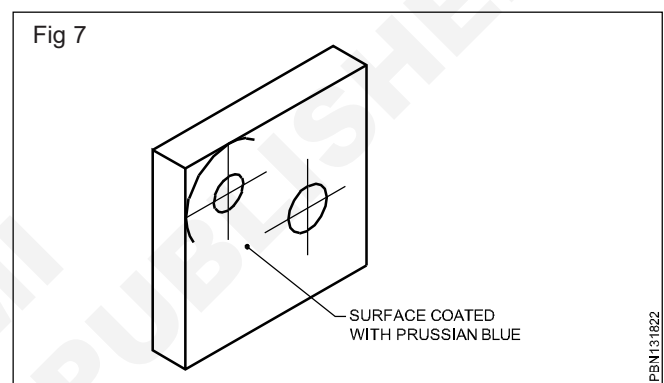


Marking blue

A Chemical dye, blue based colour mixed with methylated spirit used for marking on workpieces which are reasonably machined surface.

Prussian blue

This is used on filed or machine-finished surfaces. This will give very clear lines but takes more time for drying than the other marking media. (Fig 7)



Copper sulphated

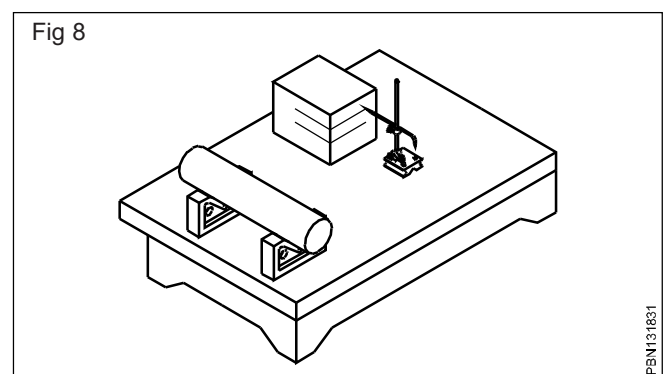
The solution is prepared by mixing copper sulphate water and a few drops of nitric acid. The copper sulphate is used on filed or machine-finished surfaces. Copper sulphate sticks to the finished surfaces well.

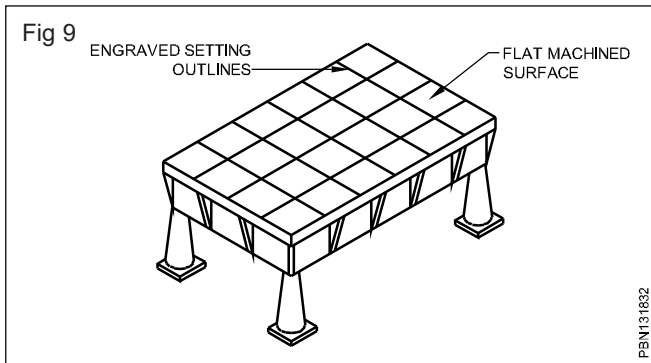
Cellulose lacquer: This is a commercially available marking medium. It is made in different colours and dries very quickly.

Marking off table (Fig 8 & 9)

A marking table (marking-off table) is used as a reference surface for marking on workpieces.

Marking tables are of rigid construction with accurately finished top surfaces. The edges are also finished at right angles to the top surface.





Marking tables are made of cast iron or granite, and are available in various sizes. These tables are also used for setting measuring instruments, and for checking sizes, parallelism and angles.

Care and maintenance

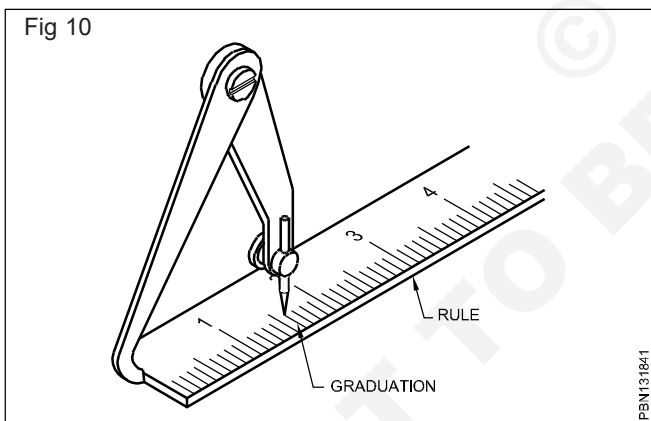
A marking table is very precise equipment, and should be protected from damage and rust.

After use, the marking table should be cleaned with a soft cloth.

The Surface of the marking table, made of cast iron, should be protected by applying a thin layer of oil.

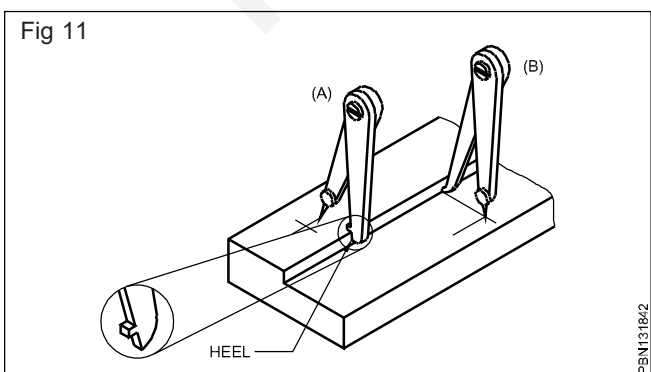
Jenny calipers

Jenny calipers have one leg with an adjustable divider point, while the other is a bent leg. (Fig 10) These are available in sizes of 150 mm, 200 mm, 250 mm and 300 mm.



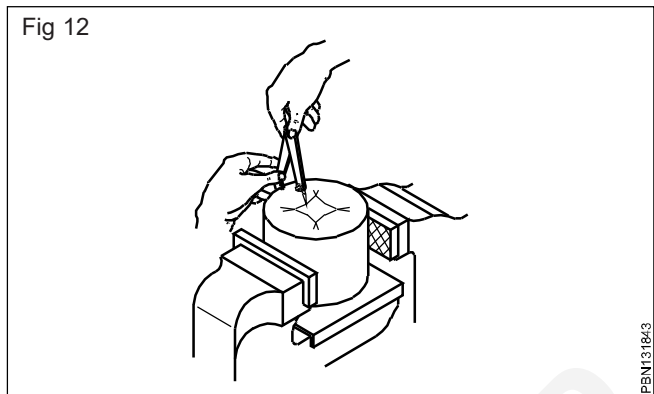
Jenny calipers are used

- for marking lines parallel to the inside and outside edges (Fig 11)



- for finding the centre of round bars. (Fig 12)

These calipers are available with the usual bent leg or with heel.



Calipers with bent leg (Fig 11B) are used for drawing lines parallel along an inside edge, and the heel type (Fig 11A) is used for drawing parallel lines along the outer edges.

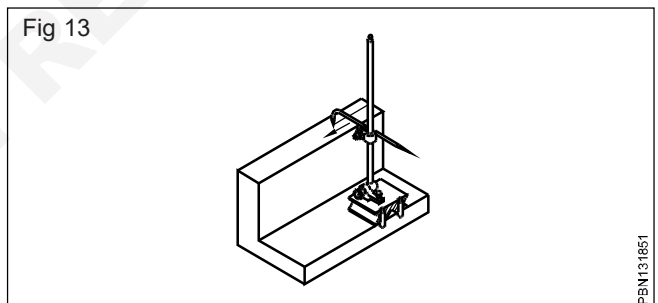
The other names for this caliper are:

- hermaphrodite calipers
- leg and point calipers
- odd leg caliper

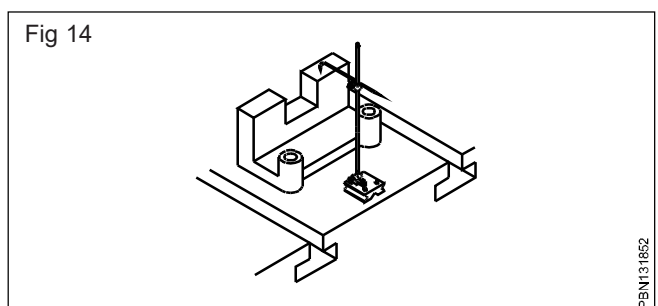
Surface gauges

The surface gauge is one of the most common marking tools used for:

scribing lines parallel to a datum surface. (Fig 13)



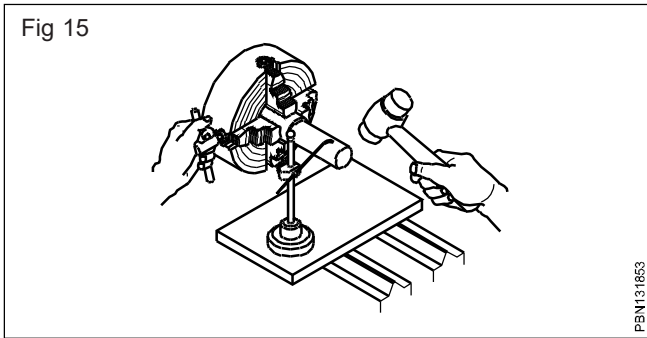
Setting jobs on machines parallel to a datum surface. (Fig 14)



Checking the height and parallelism of jobs, setting jobs concentric to the machine spindle. (Fig 15)

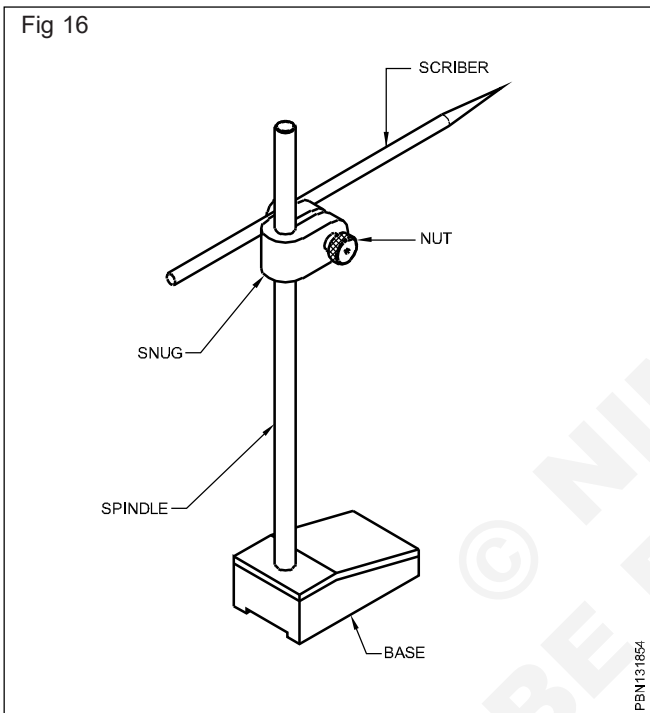
Types of surface gauges

Surface gauges/scribing blocks are of two types, fixed and universal.

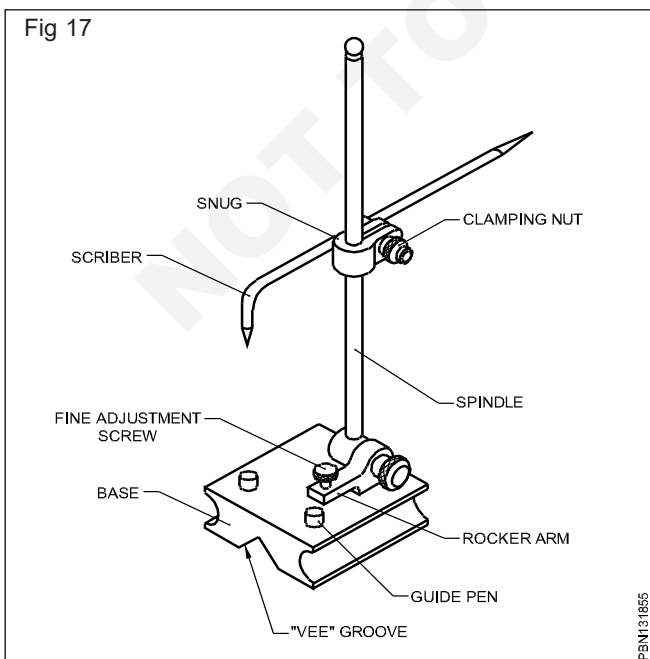


Surface gauge - fixed type (Fig 16)

The fixed Type of surface gauge consists of a heavy flat base and a spindle, fixed upright, to which a scriber is attached with a snug and a clamp nut.

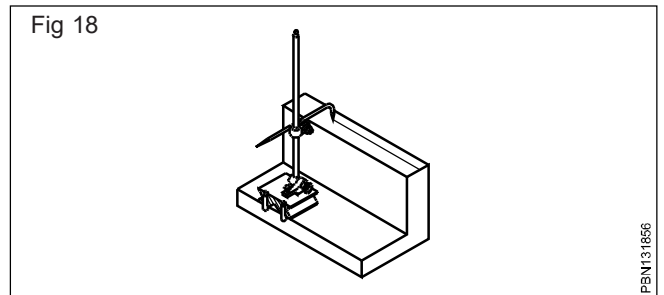


Universal surface gauge (Fig 17)



This has the following additional features: The spindle can be set to any position. Fine adjustment can be made quickly. Can also be used on cylindrical surfaces.

Parallel lines can be scribed from any datum edge with the help of guide pins. (Fig 18)



Parts and functions of a Universal Surface Gauge Base

The base is made of steel or cast iron with a 'V' groove at the bottom. The 'V' groove helps to seat on circular work. The guide-pins, fitted in the base, are helpful for scribing lines from any datum edge.

Rocker arm

The rocker arm is attached to the base along with a spring and a fine adjustments screw. This is used for fine adjustments.

Spindle

The spindle is attached to the rocker arm.

Scriber

The scriber can be clamped in any position on the spindle with the help of a snug and a clamping nut.

Care and maintenance

- Clean before and after the use
- Apply thin layer of oil to the bottom of the surface base before using for marking.
- Sharpen the Scriber if necessary.
- Do not exert more pressure while marking

Marking punches

Refer to Exercise: 1.2.11 - 1.3.13

Description of simple bench drilling machine method of using drills

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

- state the various types of drilling machines
- state the parts of the bench and pillar type drilling machines
- state the features of the bench and pillar type drilling machines
- state the types of drill holding devices
- state the features of drill chucks
- state the function of drift
- state the function of drills and parts of a drill.

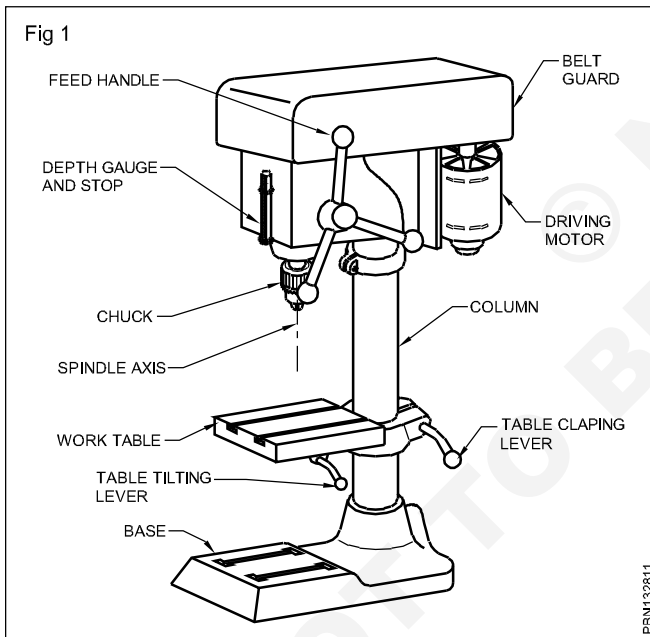
The principle types of drilling machines are:

- the sensitive bench drilling machine
- the pillar drilling machine
- the column drilling machine
- the radial arm drilling machine (radial drilling machine).

(You are not likely to use the column and radial type of drilling machines now. Therefore, only the sensitive and pillar type machines are explained here)

The sensitive bench drilling machine (Fig 1)

The simplest type of the sensitive drilling machine is shown in the figure with its various parts marked. This is used for light duty work.

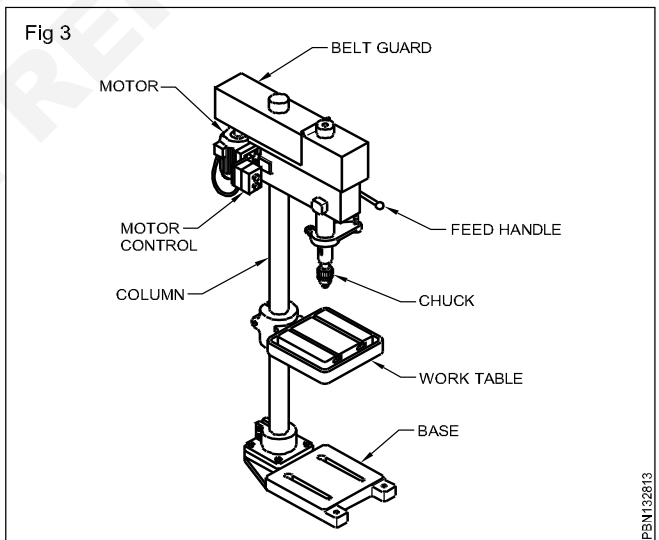
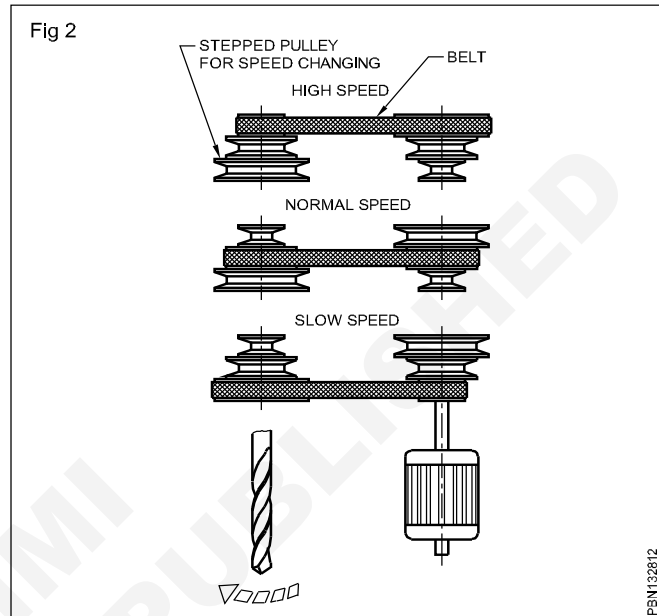


This machine is capable of drilling holes up to 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

For normal drilling, the work-surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted. (Tilting arrangement is shown in Fig 1).

Different spindle speeds are achieved by changing the belt position in the stepped pulleys. (Fig 2)

The pillar drilling machine (Fig 3): This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and driven by more powerful electric motors.



They are also used for light duty work. Pillar drilling machines are available in different sizes. The larger machines are provided with a rack and pinion mechanism to raise the table for setting the work.

Drill - Holding devices

For drilling holes on materials, the drills are to be held accurately and rigidly on the machines.

The common drill-holding devices are drill chucks and sleeves and sockets.

Drill Chuck

Straight shank drills are held in drill chucks. For fixing and removing drills, the chucks are provided either with a pinion and key or a knurled ring.

The drill chucks are held on the machine spindle by means of an arbor fitted on the drill chuck. (Fig 4)

Taper Sleeves and Sockets (Fig 4)

Taper shank drills have a mores taper.

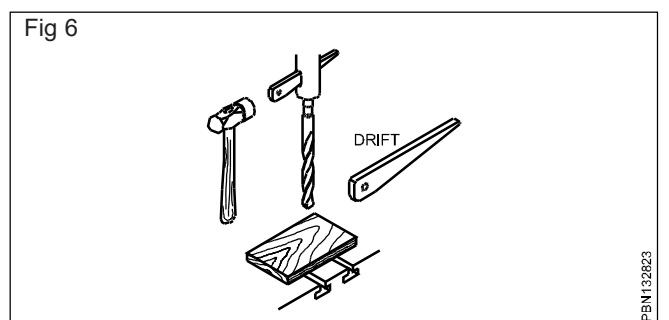
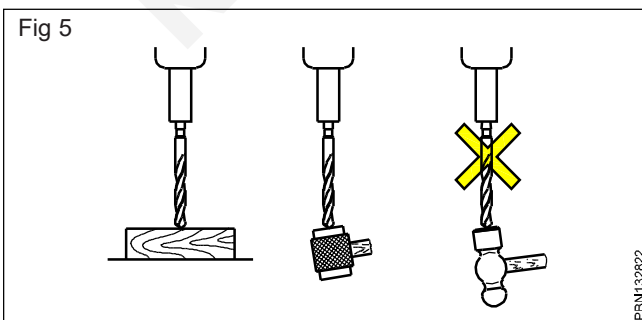
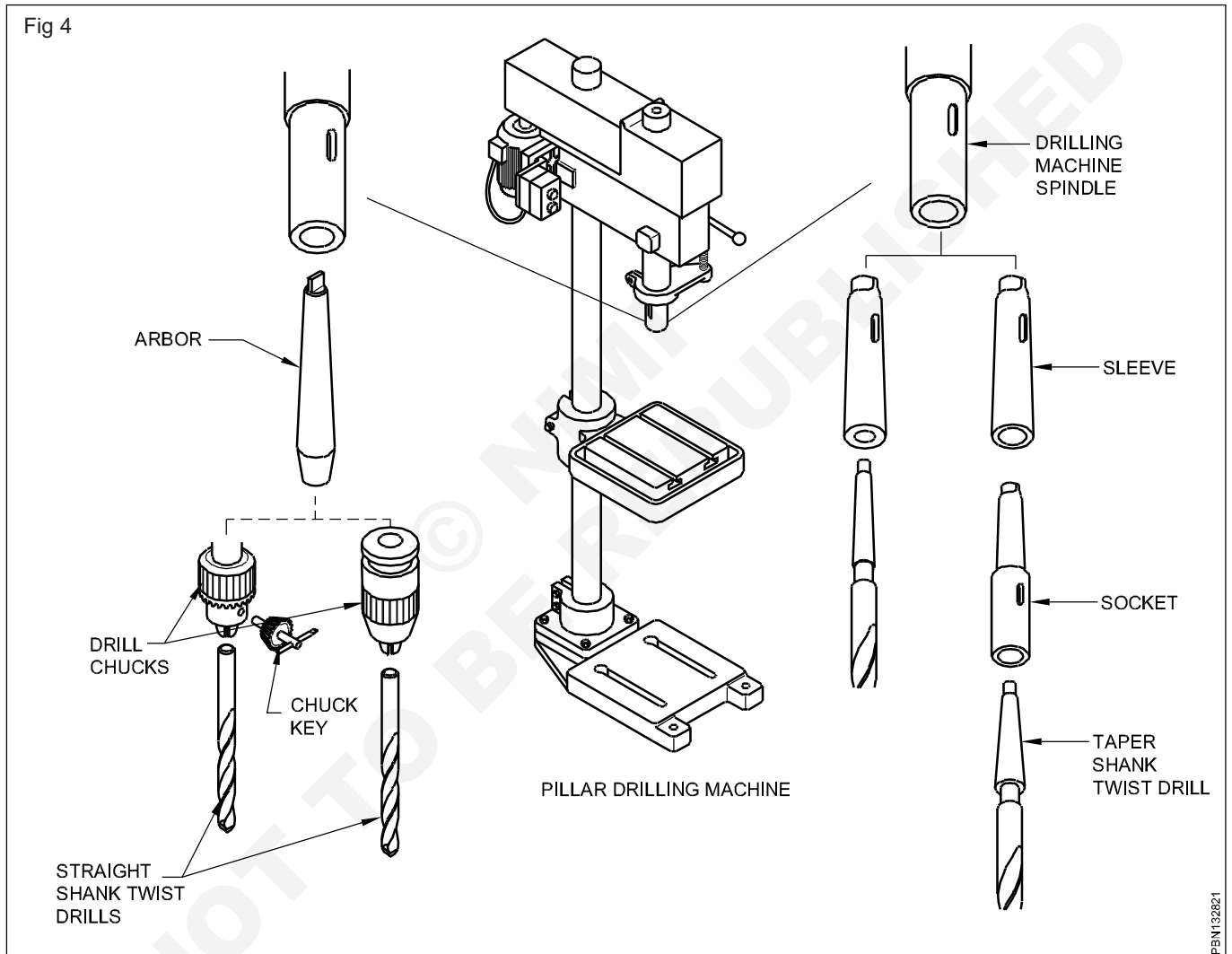
Sleeves and sockets are made with the same taper so that the taper shank of the drill, when engaged, will give a good wedding action. Due to this reason mores tapers are called self-holding tapers.

Drills are provided with five different sizes of morse tapers, and are numbered from MT1 to MT5.

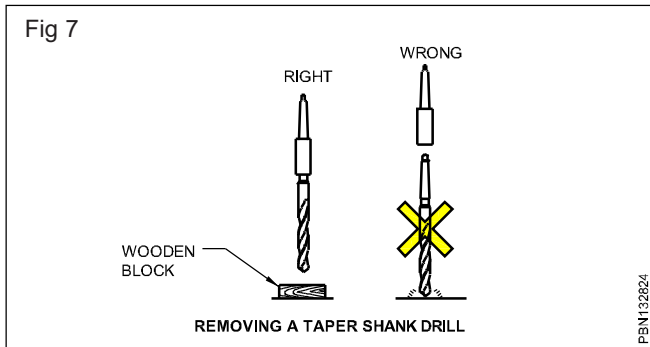
In order to make up the difference in sizes between the shanks of the drills and the type of machine spindles, sleeves of different sizes are used. When the drill taper shank is bigger than machine spindle, taper sockets are used. (Fig 4)

While fixing the drill in a socket or sleeve, the tang portion should align in the slot. (Fig 5) This will facilitate the removal of drill or sleeve from the machine spindle.

Use a drift to remove drills and sockets from the machine spindle. (Fig 6)



While removing the drill from the sockets/sleeves, don't allow it to fall on the table or jobs. (Fig 7)

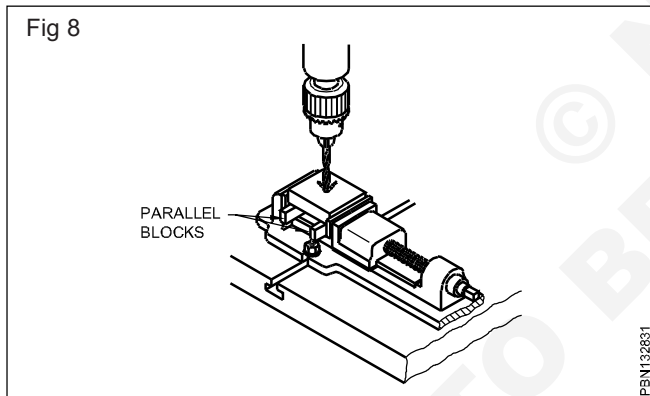


Work-holding devices

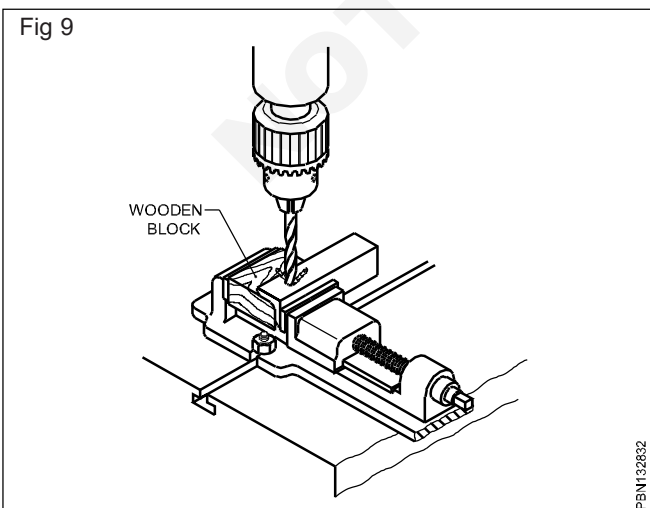
Workpieces to be drilled should be properly held or clamped to prevent from routing along with the drill. Improperly secured work is not only a danger to the operator but can also cause inaccurate work, and breakage to the drill. Various are used to ensure proper holding.

The machine vice

Most of the drilling work can be held in a machine vice. Ensure that the drill does not drill through the vice after it has passed through the work. For this purpose, the work can be lifted up and secured on parallel blocks providing a gap between the work and the bottom of the vice. (Fig 8)

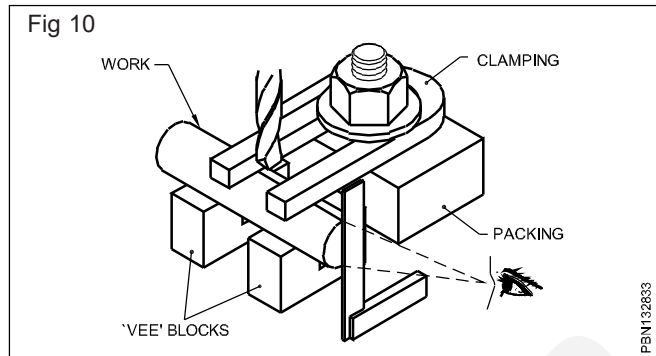


Workpieces which are not accurate may be supported by wooden pieces. (Fig 9)



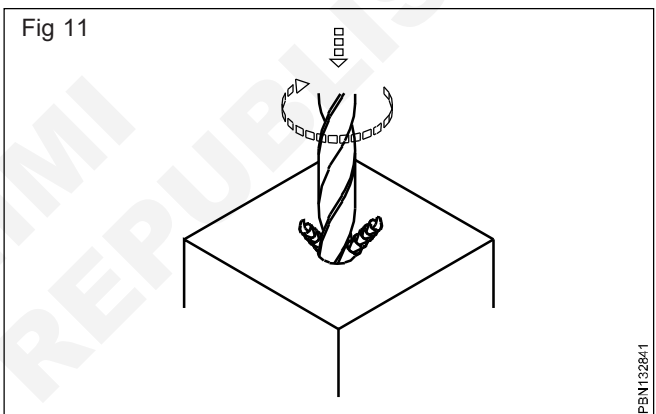
Clamps and bolts

Drilling machine tables are provided with T-slots for fitting bolt heads. Using clamps and bolts, the workpieces can be held very rigidly. (Fig 10) While using this method, the



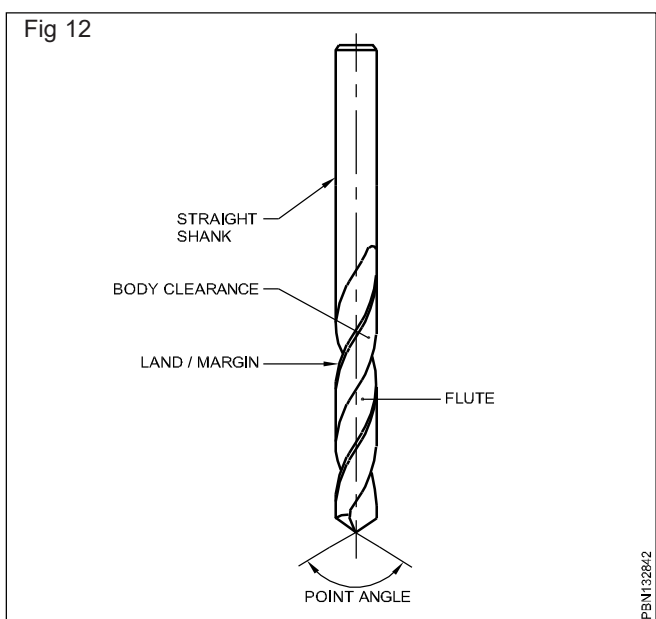
Drill (Parts and function)

Drilling is a process of making holes on workpieces. The tool used is drill. For drilling, the drill is rotated in clockwise direction with a downward pressure causing the tool to penetrate into the material. (Fig 11)



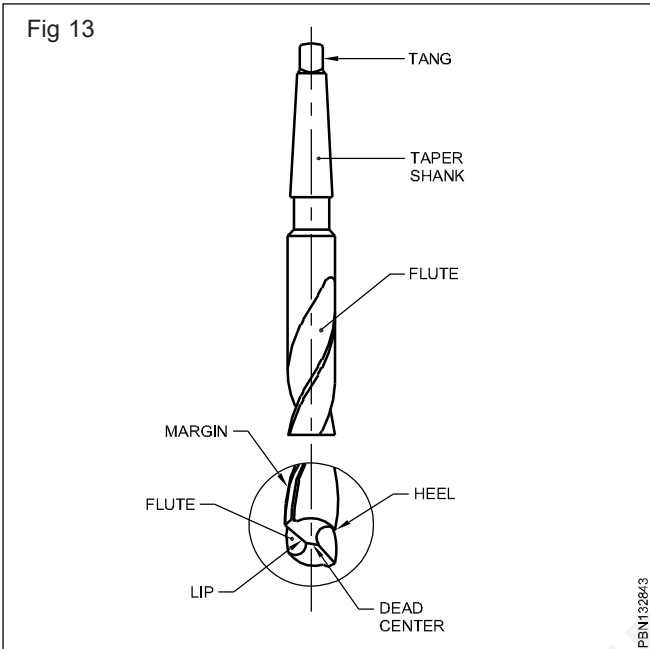
Parts of a drill

The various parts of a drill can be identified from the figure. (Fig 12)



Point: The cone shaped end which does the cutting is called the point. It consists of a dead centre, lips or cutting edges and a heel.

Shank: This is the driving end of the drill which is fitted on the machine. (Fig 13) Shanks are of two types. Taper shank is used for larger diameter drills, and straight shank is used for smaller diameter drills.



LIP: LIP is the cutting edge which penetrates into metal while drilling.

Tang: This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

Body: The portion between the point and the shank is the body of the drill. The parts of the body are flute, land/margin, body clearance and web.

Flutes: Flutes are the spiral grooves which run to the length of the drill. The flutes help

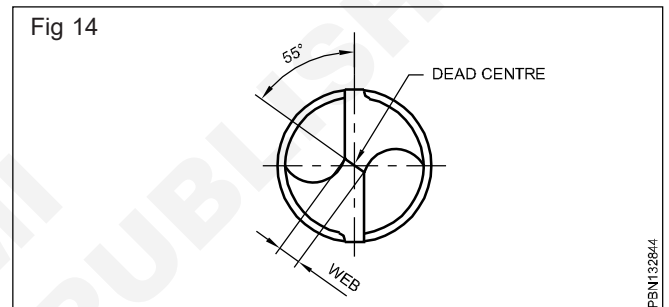
- to form the cutting edges
- to cut the chips and
- allow them to come out
- the coolant to flow to the cutting edge.

Land/margin: The land/margin is the narrow strip which extends to the entire length of the flutes.

The diameter of the drill is measured across the land/margin.

Body clearance: Body clearance is the part of the body which is reduced in diameter to cut down the friction between the drill and the hole being drilled.

Web: Web is the metal column which separates the flutes. It gradually increases in thickness towards the shank. (Fig 14)



Description of grinding and chisel

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

- state the purposes of off - hand grinding
- state the parts of grinding machines
- state the grinding procedures of chisel sharpening
- state the safety while grinding.

Grinding with bench and pedestal Grinders

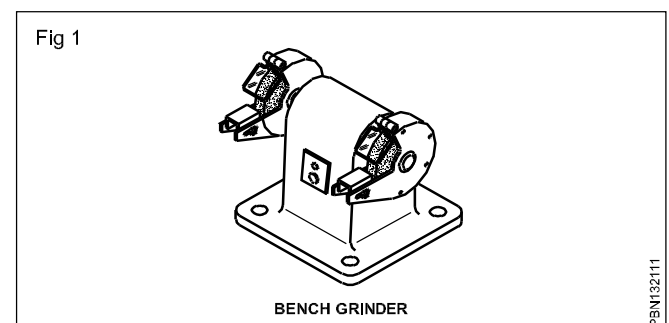
Off-hand grinding is the operation of removing material which does not require great accuracy in size or shape. This is carried out by pressing the workpiece by hand against a grinding wheel.

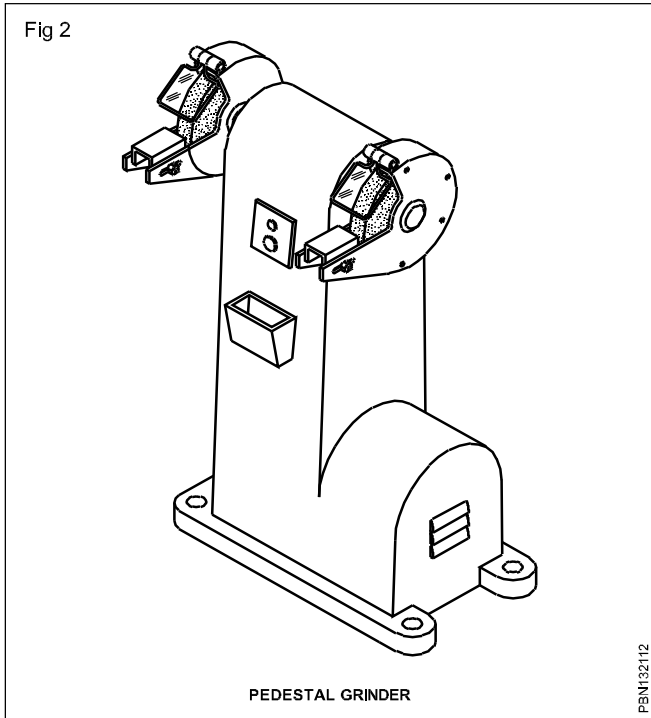
Off-hand grinding is performed for rough grinding of jobs and resharping of

- Scribers
- punches
- chisels
- twist drills

single point cutting tools etc.

off-hand grinding is performed with a bench or pedestal grinder. (Figs 1&2)





Bench grinders

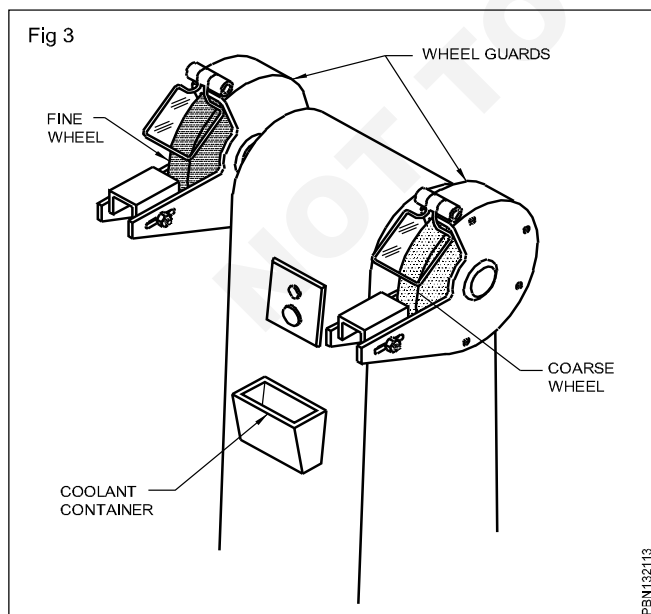
Bench grinders are fitted to a bench or table, and are useful for light duty work.

Pedestal grinders

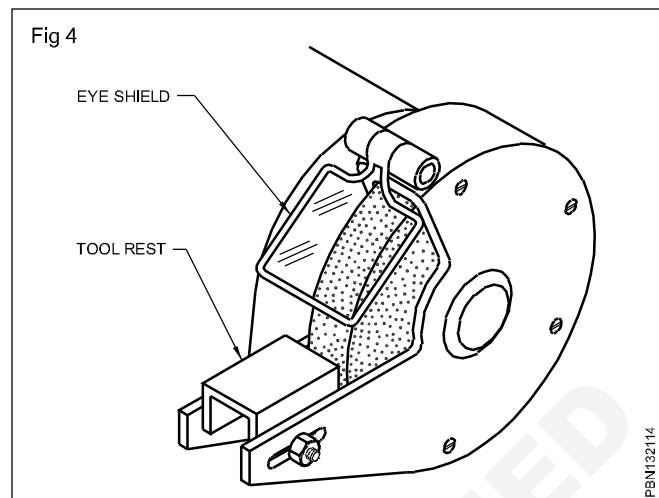
Pedestal grinders are mounted on a base (pedestal), which is fastened to the floor. They are used for heavy duty work.

These grinders consist of an electric motor and two spindles for mounting grinding wheels. On one spindle a coarse-grained wheel is fitted, and on the other, a fine grained wheel. For safety, while working, wheel guards are provided. (Fig 3)

A coolant container is provided for frequent cooling of the work. (Fig 3)



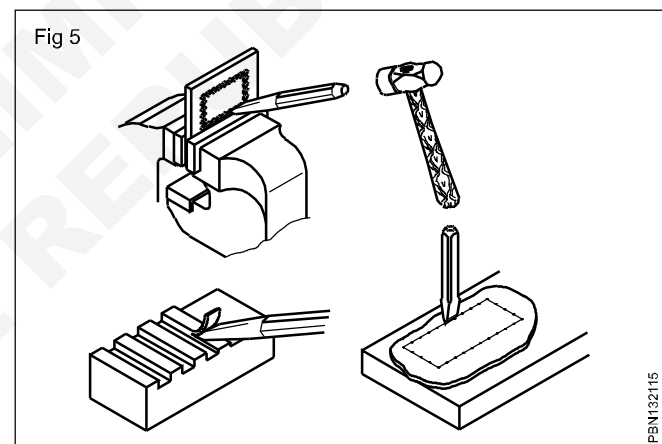
Adjustable work-rests are provided for both wheels to support the work while grinding. These work-rests must be set very close to the wheels. (Fig 4)



Extra eye-shields are also provided for the protection of the eyes. (Fig 4)

Chipping flat surfaces along a marked line with hammer.

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig 5)



Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

Flat chisels (Fig 6)

They are used to remove metal from large flat surfaces and chip-off excess metal of welded joints and castings.

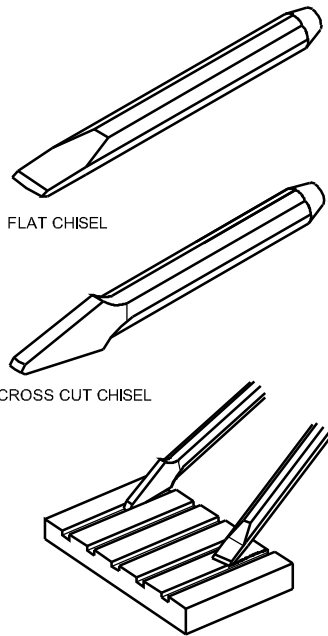
Sharpening of chisels

Chisels will become blunt due to use. For efficiency in chipping, the chisels are to be re-sharpened regularly.

Chisels are sharpened on grinding machines. (Fig 7)

After re-grinding many times, the cutting edges become too thick. Such chisels are unsuitable for resharping. They should be forged and brought to shape before grinding. (Fig 8)

Fig 6



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Ensure the wheel guards are in place, and are securely fastened.

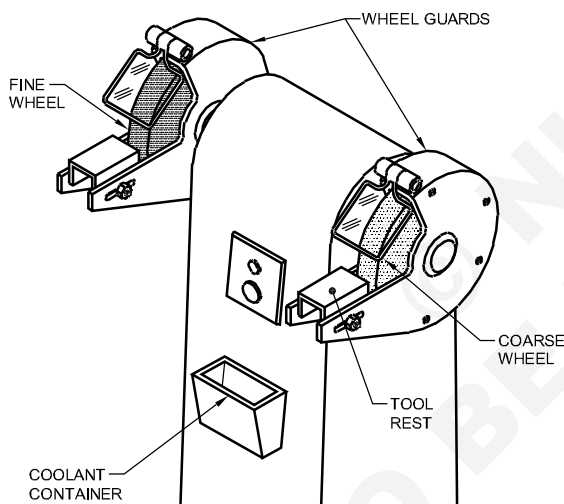
Inspect the condition of the grinding wheel for breakage and cracks.

Wear safety goggles.

When switching on the grinding machine, stand aside until the wheel reaches the operating speed.

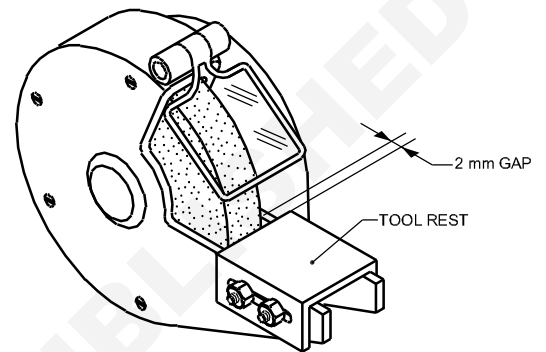
Inspect the tool-rest. If there is too much of a gap between the tool-rest and the wheel, adjust it, and position it as close to the wheel as possible. (Fig 9)

Fig 7



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Fig 9



PBN132123

Ensure that there is sufficient coolant in the container. While grinding, rest the body of the chisel on the tool-rest(A), and allow the point to touch the wheel. (Fig 10)

Rock the point slightly on both sides in an arc (B) to provide a slight convexity at the cutting edge. This will help to avoid digging in of the sides while chipping. (Fig 10)

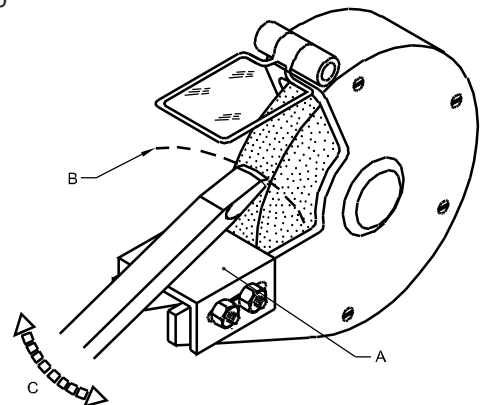
Keep moving the chisel across the face (C) to prevent formation of curves and grooves at the cutting edge. (Fig 10)

Fig 8



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Fig 10

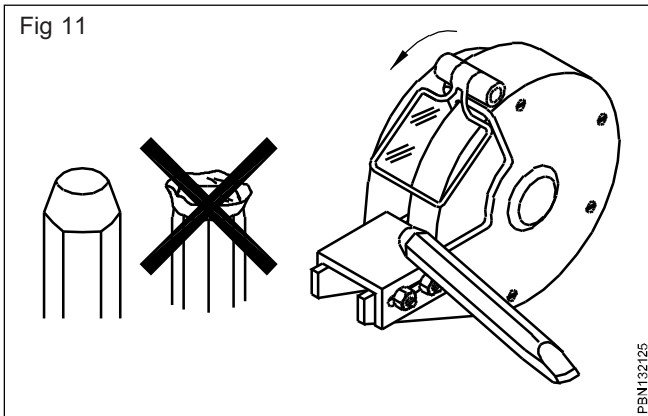


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Before commencing grinding, the following procedure should be observed.

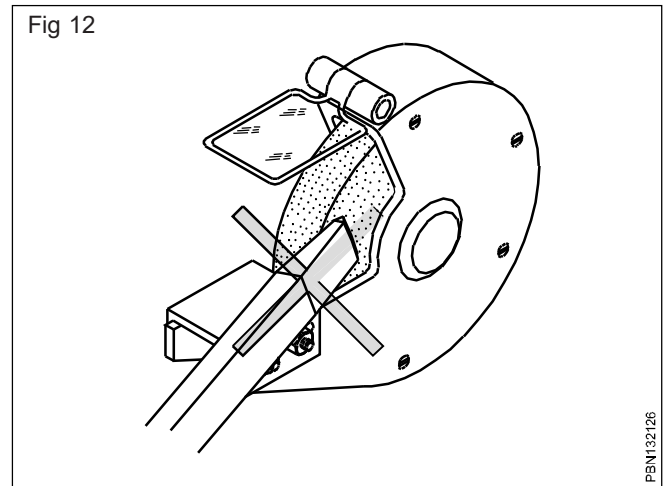
Dip the chisel frequently in the coolant to avoid overheating. Overheating will draw the temper of the chisel.

If the chisel-head is mushrooms head, it should be cleaned by grinding. (Fig 11)



Use only the front of the grinding wheel. (Fig 9) Do not grind on the sides. (Fig 12)

Use goggles while using a grinder
Any damage to the grinding wheel, if noticed, should be reported to the instructor.
Do not use cotton waste or other material for holding the chisel while grinding.



About different types of inner thread cutting

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

- state the uses of internal thread
- state the types of taps and wrench
- state the uses of taps in forming internal thread in pipes and flat.

Hand taps and wrenches

Use of hand taps: Hand taps are used for internal threading of components.

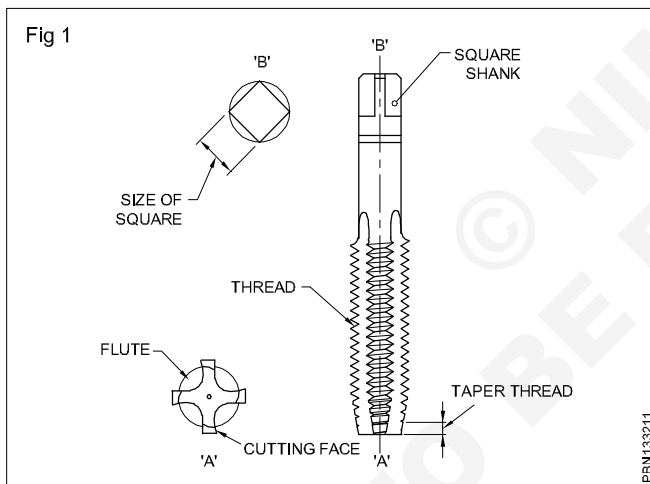
Features (Fig 1): They are made from high carbon steel or high speed steel, hardened and ground.

The threads are cut on the surface, and are accurately finished.

To form the cutting edges, flutes are cut across the thread.

The end of the shank of the tap is made of square shape for the purpose of holding and turning the taps.

The ends of the taps are chamfered (taper lead) for assisting, aligning and starting of the thread.



The size of the taps, the thread standard, the pitch of the thread, the dia. of the tapping hole are usually marked on the shank.

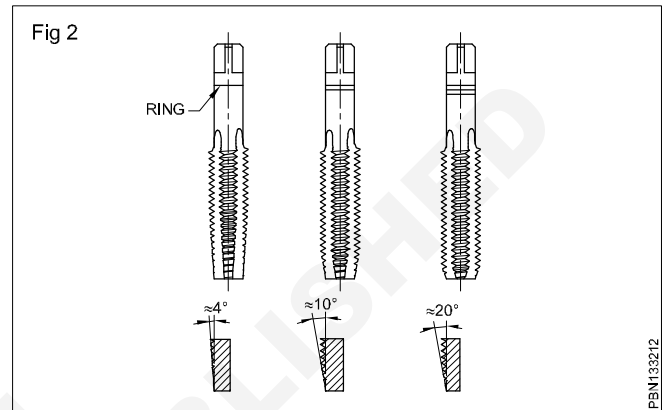
Markings are also made to indicate the type of tap i.e. first, second or plug.

Types of taps in a set: Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

These are:

- first tap or taper tap
- second tap or intermediate tap

- plug or bottoming tap.



These taps are identical in all features except in the taper lead.

The taper tap is used to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

For identifying the type of taps quickly - the taps are either numbered 1,2 and 3 or rings are marked on the shank.

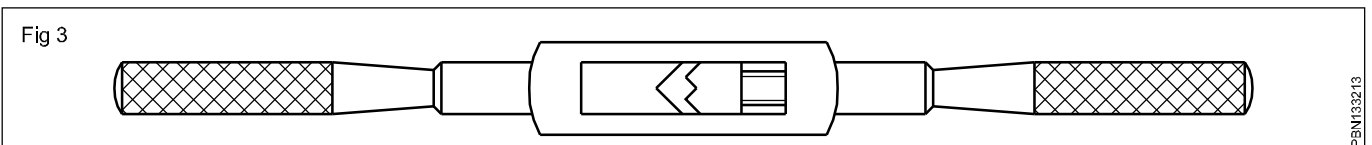
The taper tap has one ring, the intermediate tap has two and the bottoming tap has three rings. (Fig 2)

Tap wrenches: Tap wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

Tap wrenches are of different types, such as double-ended adjustable wrench, T-handle tap wrench, solid type tap wrench etc.

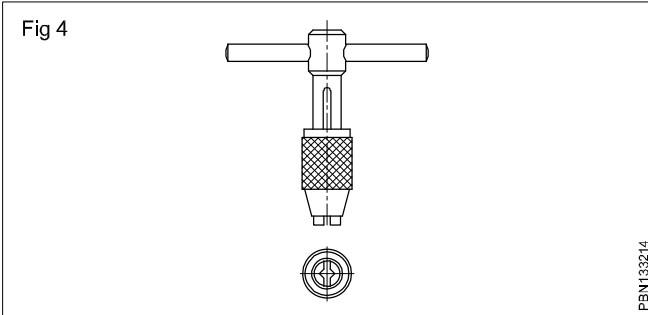
Double-ended adjustable tap wrench or bar type tap wrench (Fig 3): This is the most commonly used type of tap wrench. It is available in various sizes - 175, 250, 350 mm long. These tap wrenches are more suitable for large diameter taps, and can be used in open places where there is no obstruction to turn the tap.

It is important to select the correct size of wrench.



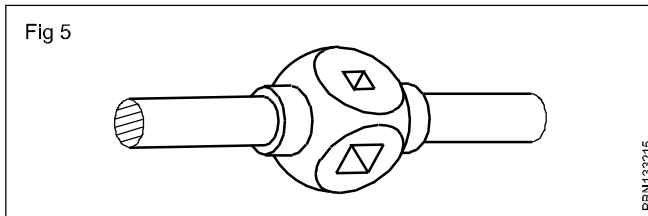
T-handle tap wrench (Fig 4): These are small, adjustable chucks with two jaws and a handle to turn the wrench.

This tap wrench is useful to work in restricted places, and is turned with one hand only. Most suitable for smaller sizes of taps.



Solid type tap wrench (Fig 5): These wrenches are not adjustable.

They can take only certain sizes of taps. This eliminates the use of wrong length of the tap wrenches, and thus prevents damage to the taps.



Tap drill size

What is tap drill size? Before a tap is used for cutting internal threads, a hole is to be drilled. The diameter of the hole should be such that it should have sufficient material in the hole for the tap to cut the thread.

Tap drill sizes for different threads

ISO metric thread

Tap drill size for M10 x 1.5 thread

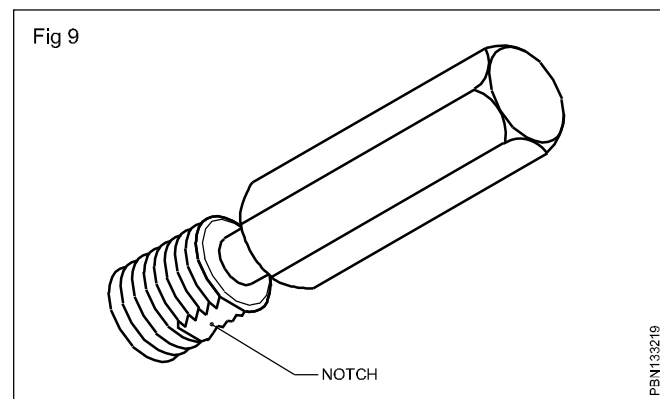
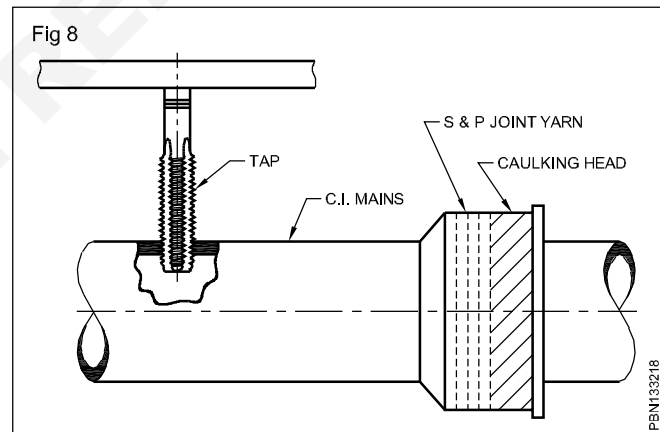
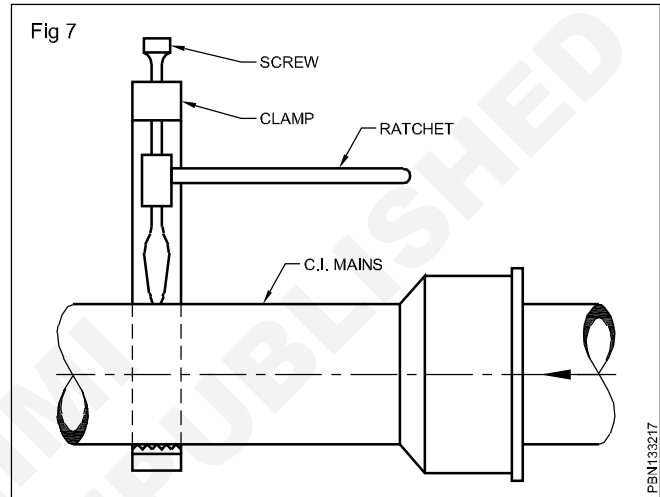
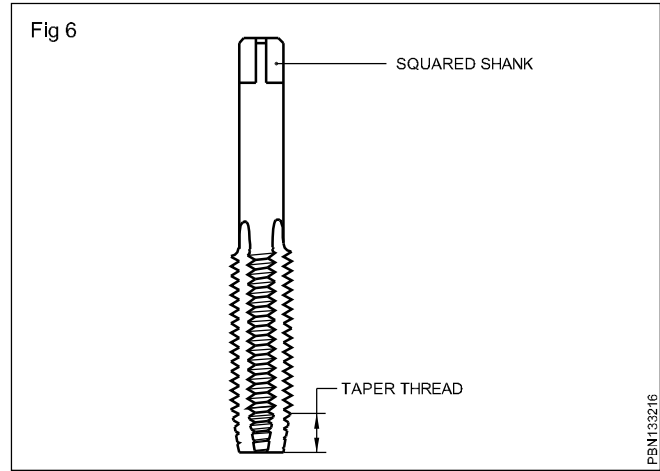
- Minor diameter = Major diameter - (2 x depth)
- Depth of thread = $0.6134 \times \text{pitch of a screw}$
- 2 depth of thread = $0.6134 \times 2 \times \text{pitch}$
- = $1.226 \times 1.5 \text{ mm}$
- = 1.839 mm
- Minor dia. = $10 \text{ mm} - 1.839 \text{ mm}$
- = 8.161 mm or 8.2 mm .

Pipe taps: Internal pipe threads are usually cut with standard taper pipe taps. (Fig 6)

To make the drill hole using ratchet brace. (Fig 7)

Make the internal thread using taps and wrench. (Fig 8)

In gauging internal pipe threads, the pipe plug thread gauge should be screwed tight by hand into the pipe until the notch on the gauge is flush with the face. When the thread is chamfered the notch should be flushed with the bottom of the chamfer. (Fig 9)



Description of different types of locking and fastening devices

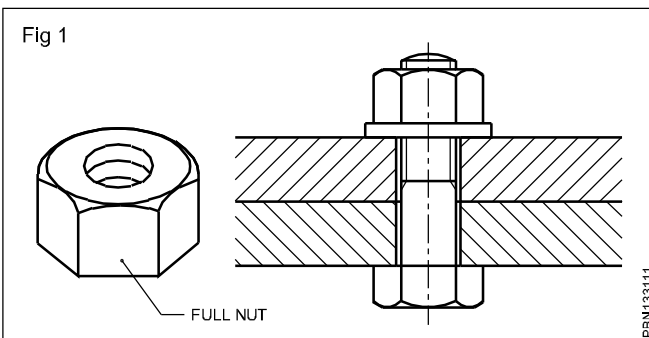
Objectives: At the end of this lesson you shall be able to

- state the uses of nuts
- state the uses of rivets
- state the difference between permanent and temporary fasteners
- state the name of the materials from which they are made
- state the types and specific uses.

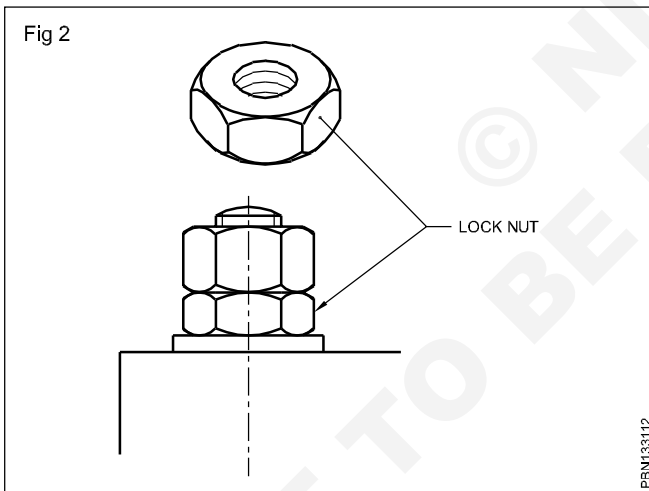
Types of nuts

Nuts of different types are used depending on the requirement of the assembly.

Hexagonal nuts: This is the most commonly used type of nut in structural and machine tool building. (Fig 1)



Hexagonal nuts are available in different thicknesses. Thin nuts are used as lock-nuts. (Fig 2)



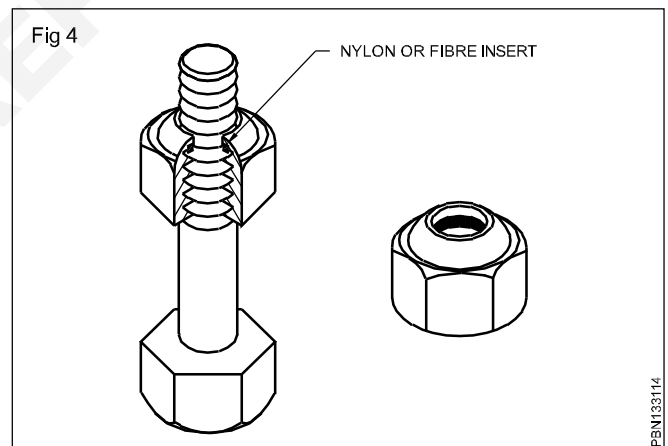
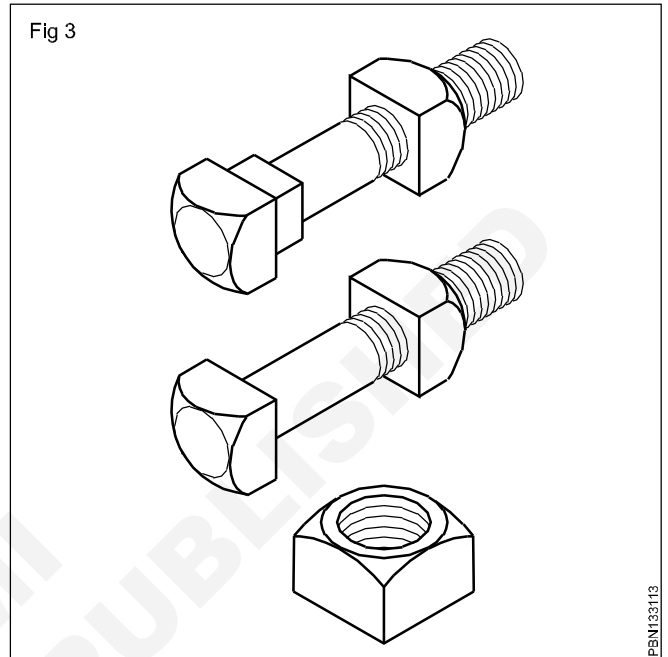
Square nut: Square bolts are provided with square nuts. In coac building mostly square nuts (Fig 3) are used.

Self-locking nut (Simmonds lock-nut) (Fig 4): This nut has an internal groove cut in which a fiber or nylon ring is inserted. This ring holds the nut tightly on the bolt and serves as a locking device.

Self-locking nuts are not used with studs.

Slotted and castle nuts: These nuts have special provision in the form of slots for fixing split pins for locking the nuts.

Slotted nuts are hexagonal shaped throughout. (Fig 5) In the case of castle nuts, the top part of the nut is cylindrical in shape.

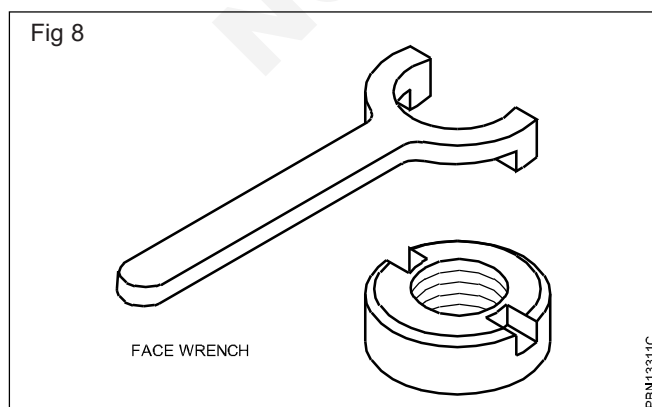
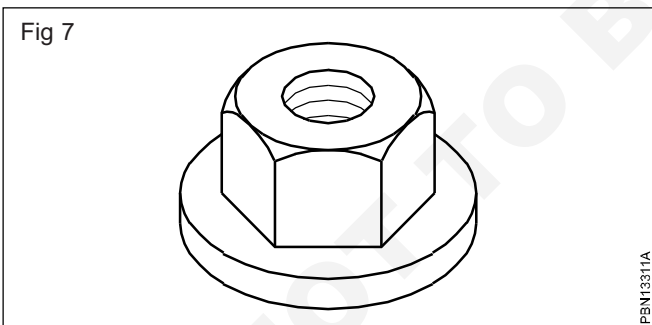
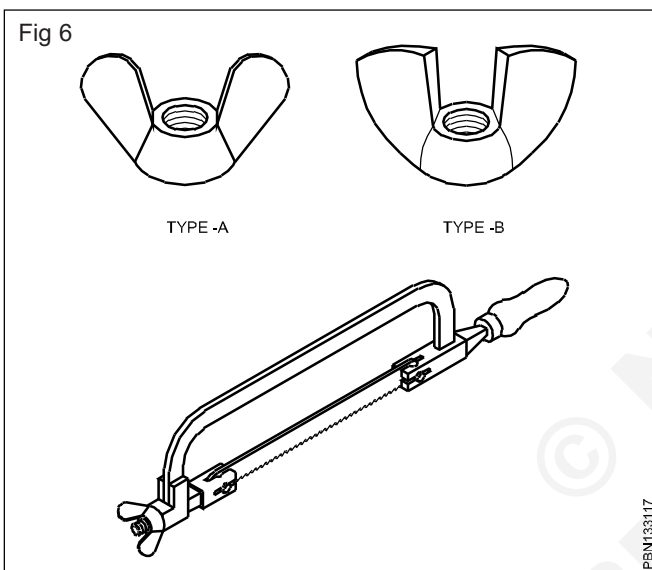
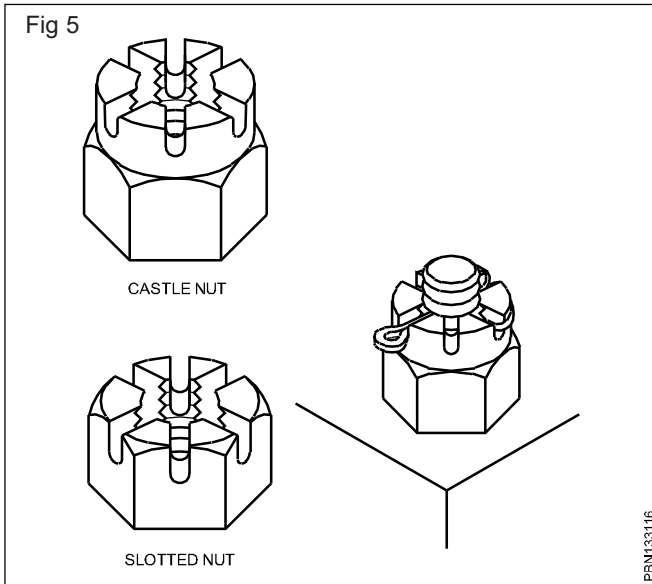


Wing-nuts (Fig 6): Wing-nuts are used in light duty assembly which require frequent removal and fixing. These are available as hot forged/cast (Type A) and cold forged (Type B)

Hexagonal nuts with collar (Fig 7) : These nuts have a machined collar on one end. This provides additional bearing surface in assembly. The collar acts like a washer and is useful where frequent tightening and loosening is necessary.

Round nuts

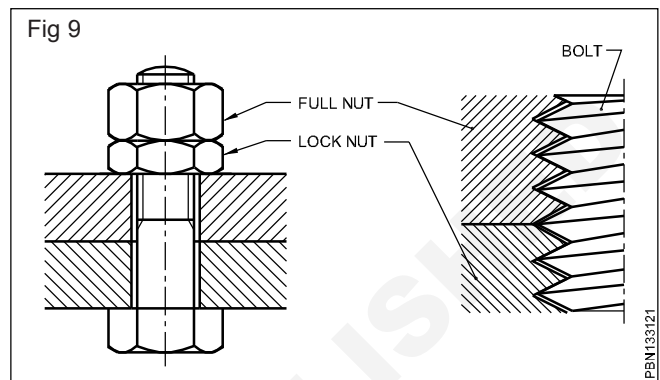
Round nuts of different types are available for special applications. Slotted round nut (Fig 8)



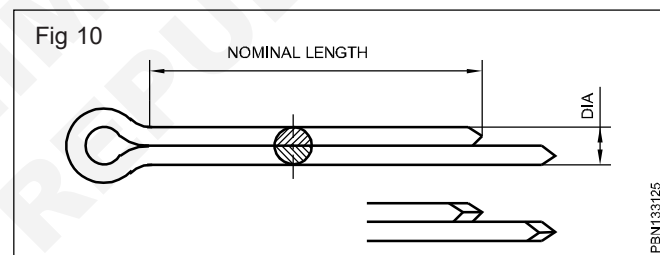
Locking devices for nuts

Nuts used along with bolts in assembly may loosen due to vibration. Different types of nut-locking devices are used depending on the severity of the condition in which the fastener is used. The following are the most commonly used types.

Lock-nut: A thin nut with both faces machined is placed below a nut in the assembly. (Fig 9) Both nuts are tightened over the bolt one after the other. Then using two spanners pressure is exerted on both nuts by turning in opposite directions. Both nuts are held together by friction.



Slotted and castle nut with split pin: The position of the nut can be locked using a split pin. (Fig 10)



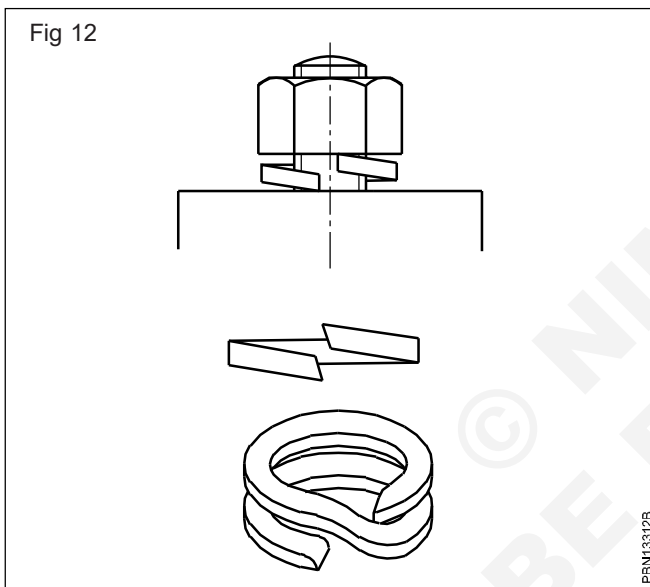
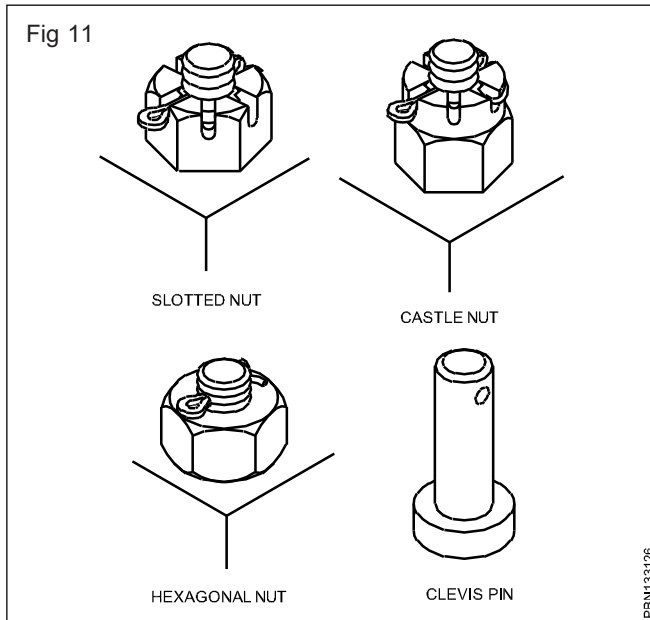
Split pins are designated by the nominal size, nominal length, the number of the Indian Standard and the materials (for materials other than steel only).

The nominal size is the diameter of the hole for receiving the split pins.

The nominal length is the distance from the underside of the eye to the end of the short leg.

Split pins are used for locking slotted nuts, castle nuts, hexagonal nuts, clevis pins etc. and are used in different ways. (Fig 11)

Spring washers (Fig 12): Spring washers are available with a single or a double coil. These are placed under a nut in the assembly as washers. The stiff resistance offered by the washer against the surface of the nuts serves to prevent loosening.



Rivets - Types and uses

Riveting

Riveting is a method of making permanent joints. For riveting the plates to be joined are drilled or punched.

Different types of outer thread cutting

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

- state the types of 'V' threads
- state the terminology of screw threads
- state the method of B.S.P threads
- state the uses of different die- stock
- state the uses of stud.

Screw threads - types of V threads and their uses

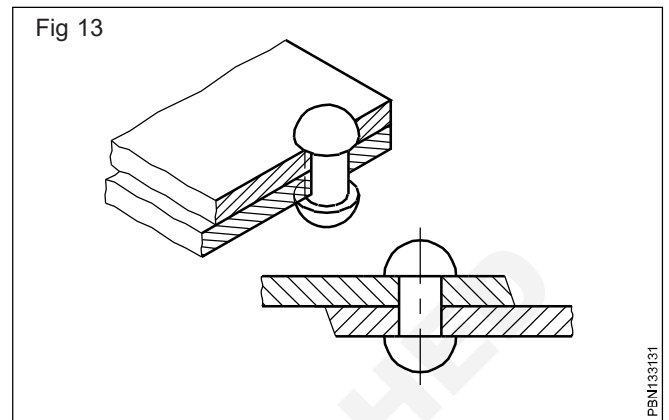
The different standards of V threads are:

- BSW thread: British Standard Whitworth thread
- BSF thread: British Standard fine thread
- BSP thread: British Standard pipe thread

Rivets

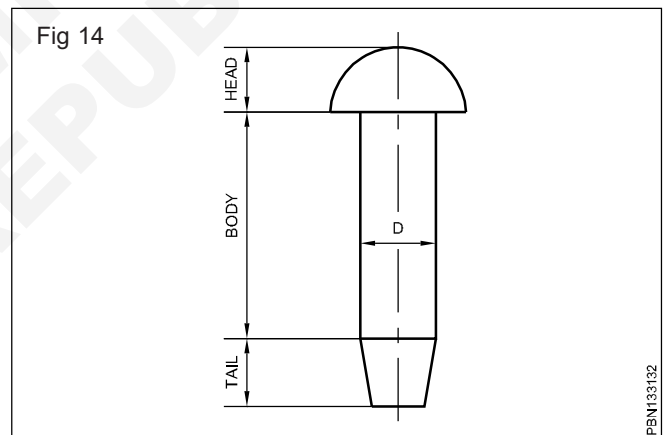
Rivets are fasteners used for joining metal sheets and plates in fabrication work such as bridges, ships, cranes, structural steel work, boilers, aircraft etc.

The rivet is then inserted and closed by force so that it completely fills the hole and forms a rigid joint. (Fig 13)



Parts (Fig 14)

- Head
- Body
- Tail

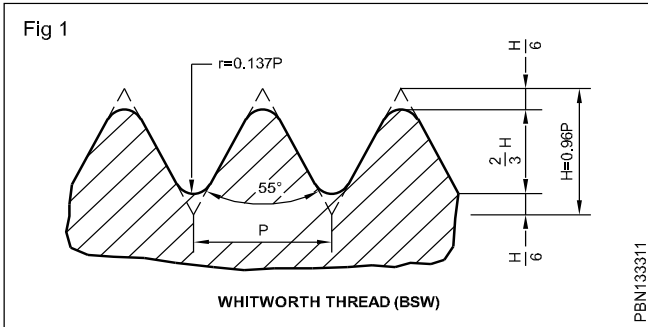


- B.A thread: British Association thread
- I.S.O Metric thread: International Standard Organisation metric thread
- ANS: American National or sellers' thread
- BIS Metric thread: Bureau of Indian Standard metric thread.

BSW thread (Fig 1)

It has an included angle of 55° and the depth of the thread is $0.6403 \times P$. The crest and root are rounded off to a definite radius. The (Fig 1) shows the relationship between the pitch and the other elements of the thread.

BSW thread is represented in a drawing by giving the major diameter. For example : $1/2"$ BSW, $1/4"$ BSW. The table indicates the standard number of TPI for different diameters. BSW thread is used for general purpose fastening threads.

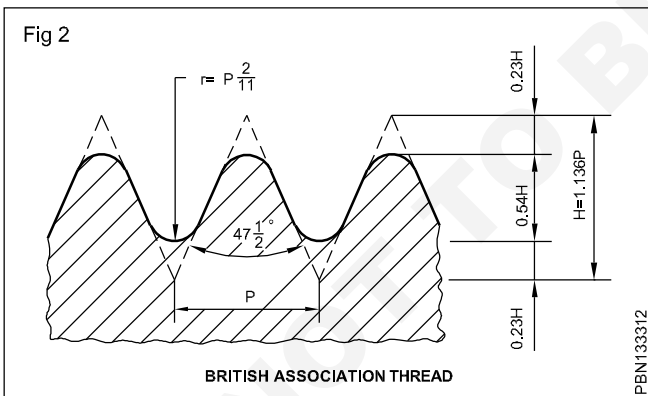


BSF thread

This thread is similar to BSW thread except the number of TPI for a particular diameter. The number of threads per inch is more than that for the BSW thread for a particular diameter. For Example, $1"$ BSW has 8 TPI and $1"$ BSF has 10 TPI. The table indicates the standard number of TPI for different dia. of BSF threads. It is used in automobile industries.

BA thread (Fig 2)

This thread has an included angle of $47 \frac{1}{2}^\circ$. Depth and other elements are as shown in the figure. It is used in small screws of electrical appliances, watch screws, screws of scientific apparatus.



Screw thread and elements

Parts of screw thread (Fig 3)

Crest

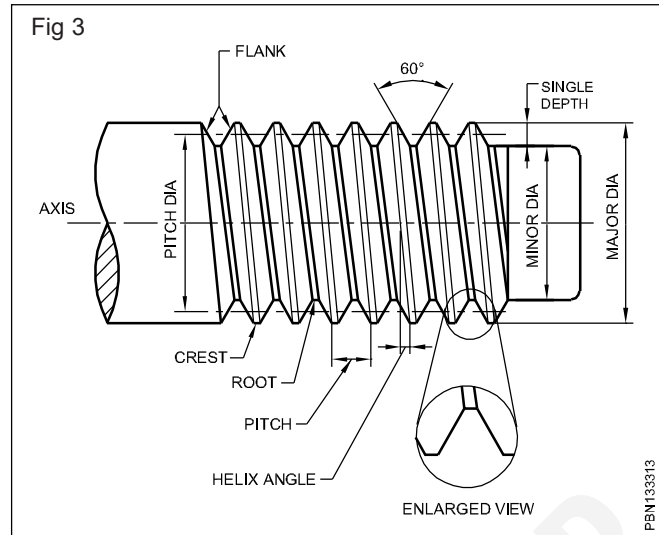
The top surface joining the two sides of a thread.

Root

The bottom surface joining the two sides of adjacent threads.

Flank

The surface joining the crest and the root.



Thread angle

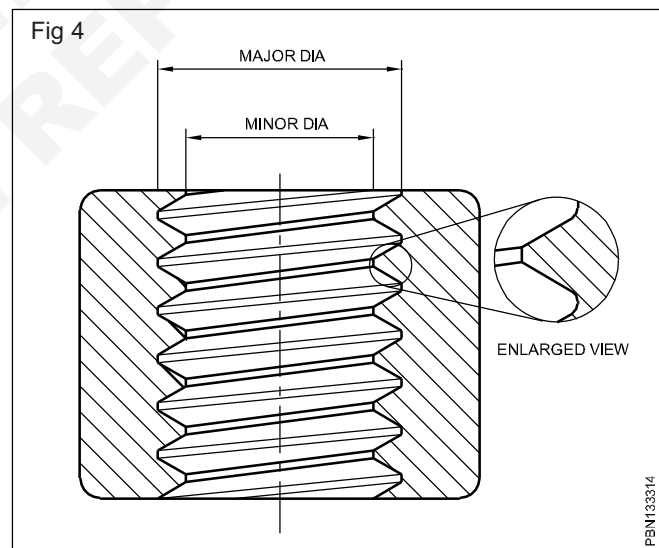
The included angle between the flanks of adjacent threads.

Depth

The perpendicular distance between the roots and crest of the thread.

Major Diameter

In the case of external threads it is the diameter of the blank on which the threads are cut and in the case of internal threads it is the largest diameter after the threads are cut that are known as the major diameter. (Fig 4)



This is the diameter by which the sizes of screws are stated.

Minor Diameter

For external threads, the minor diameter is the smallest diameter after cutting the full thread. In the case of internal threads, it is the diameter of the hole drilled for forming the thread which is the minor diameter.

Pitch Diameter (effective diameter)

The diameter of the thread at which the thread thickness is equal to one half of the pitch.

Pitch

It is the distance from a point on one thread to a corresponding point on the adjacent thread measured parallel to the axis.

Lead

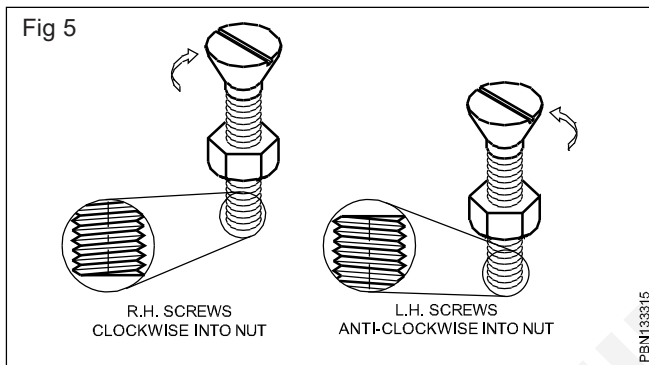
Lead is the distance of a threaded component moves along the matching component during one complete revolution. For a single start thread the lead is equal to the pitch.

Helix Angle

The angle of inclination of the thread to the imaginary perpendicular line.

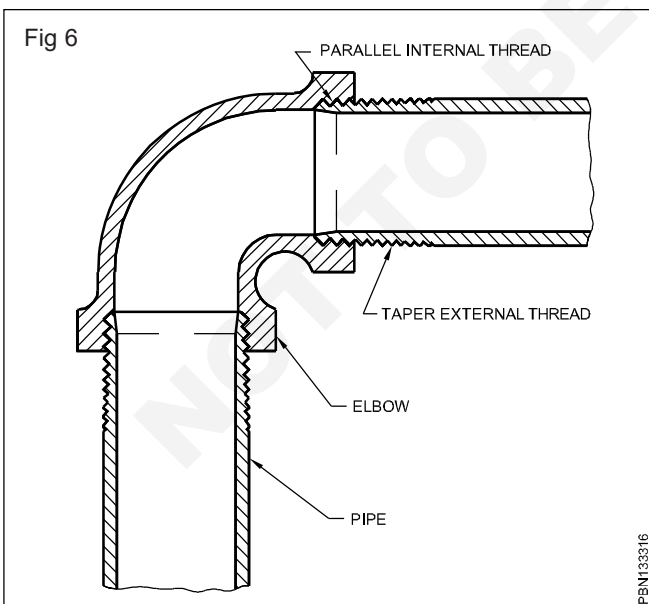
Hand

The direction in which the thread is turned to advance. A right hand thread is turned clockwise to advance, while a left hand thread is turned anticlockwise. (Fig 5)



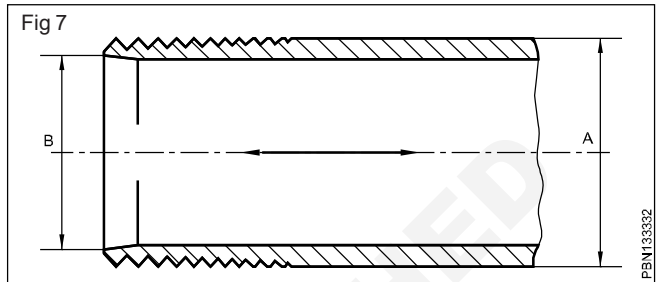
Pipe Threads and Pipe Taps

Pipe threads: The standard pipe fittings are threaded to British Standard pipe (BSP). The internal pipe threads have parallel threads whereas the external pipes have tapered threads as shown in (Fig 6).



B.S.P. threads

BSP thread: This thread is recommended for pipe and pipe fittings. The table shows the pitch for different diameters. It is also similar to BSW thread. The thread is cut externally with a small taper for the threaded length. This avoids the leakage in the assembly and provides for further adjustment when slackness is felt. Galvanized iron pipes are available in sizes ranging from 1/2" to 6" in several different wall thickness. The table 1 shows outside diameters and threads per inch from 1/2" to 4". (Fig 7)

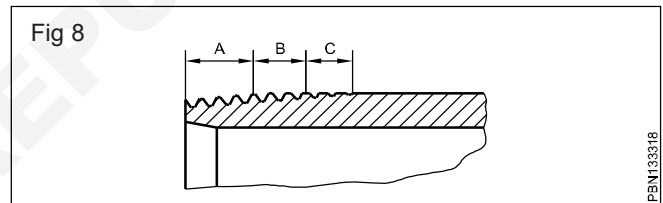


The next two threads have fully formed bottoms but flat tops. (B)

The last four threads have flat tops and bottoms. (C)

Sealing pipe joint

(Fig 8) shows that the pipe has several fully formed threads at the end. (A)



The pipe joint shown in (Fig 9) consists of the following:

- 1 Parallel female thread
- 2 Tapered male thread
- 3 Hemp packing

The hemp packing is used to ensure that any small space between two metal threads (male and female threads) is sealed to prevent any leakage. (Fig 9)

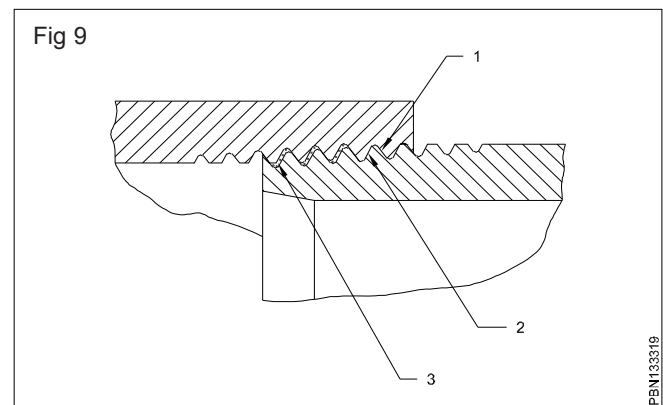
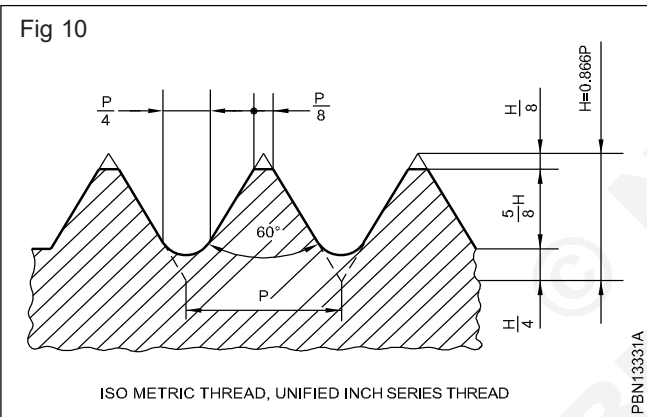


Table 1

BSP - Pipe sizes or DIN 2999 (inside) (B)	Threads inch	Outside diameter/ mm of the pipe (A)
1/2"	14	20.955 mm
3/4"	14	26.441
1"	11	33.249
1 1/4"	11	41.910
1 1/2"	11	47.803
2"	11	59.614
2 1/2"	8	75.184
3"	8	87.884
4"	8	113.030

Unified thread (Fig 10)

For both the metric and inch series, ISO has developed this thread. Its angle is 60°. The crest and root are flat and the other dimensions are as shown in the (Fig 10). This thread is used for general fastening purposes.



This thread of metric standard is represented in a drawing by the letter 'M' followed by the major diameter for the coarse series.

Ex : M14, M12 etc.

For the fine series, the letter 'M' is followed by the major diameter and pitch.

Ex : M14 x 1.5
M24 x 2

American National Thread (Fig 11)

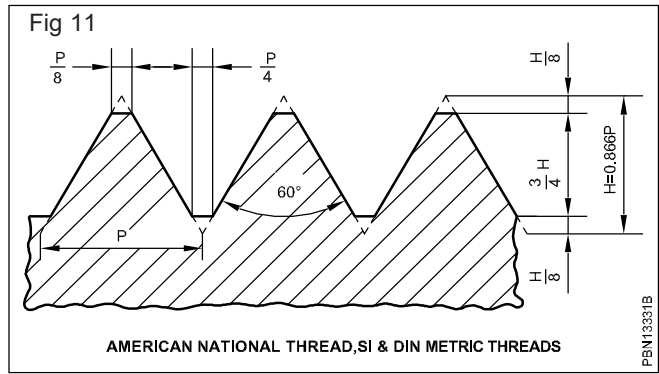
These threads are also called as seller's threads. It was more commonly used prior to the introduction of the ISO unified thread.

Screw pitch gauge

Purpose

A screw pitch gauge is used to determine the pitch of a thread.

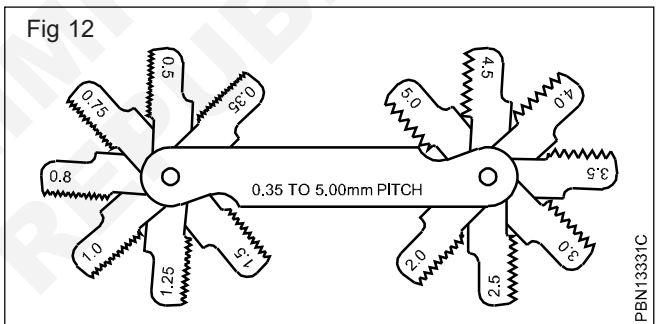
It is also used to compare the profile of threads.



Constructional features: Pitch gauges are available with a number of blades assembled as a set. Each blade is meant for checking a particular standard thread pitch. The blades are made of thin spring steel sheets, and are hardened.

Some screw pitch gauge sets will have blades provided for checking British Standard threads (BSW, BSF etc.) at one end and the metric standard at the other end.

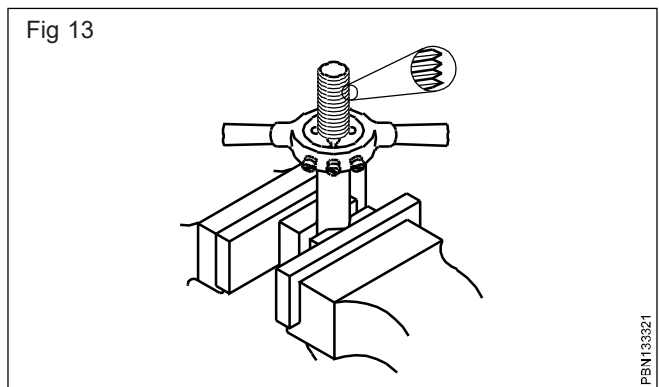
The thread profile on each blade is cut for about 25 mm to 30 mm. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 12)



Dies and die stock

Uses of dies

Threading dies are used to cut external threads on cylindrical workpieces. (Fig 13)



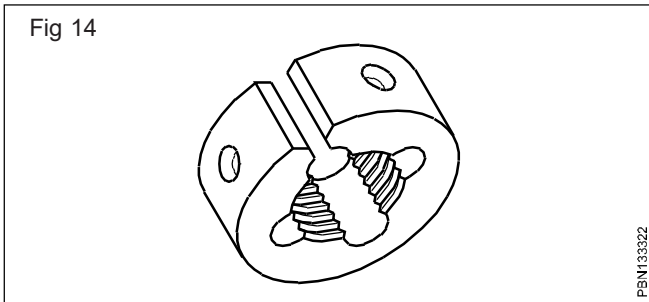
Types of dies

The following are the different types of dies.

- Circular split die (Button die)
- Half die

- Adjustable screw plate die

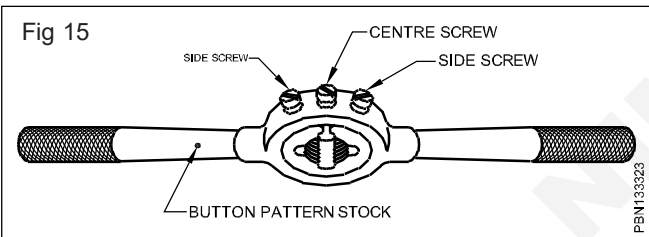
Circular split die/button die (Fig 14)



This has a slot cut to permit slight variation in size.

Dies are made of high speed steel.

When held in the diestock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly. (Fig 15) For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

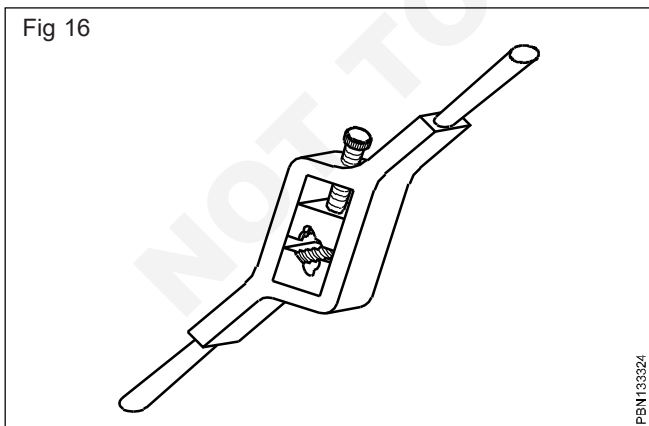


Half die (Fig 16)

Half dies are stronger in construction.

Adjustments can be made easily to increase or decrease the depth of cut.

These dies are available in matching pairs and should be used together.



By adjusting the screw of the diestock, the die pieces can be brought closer together or can be moved apart.

They need a special die holder.

Check blank size.

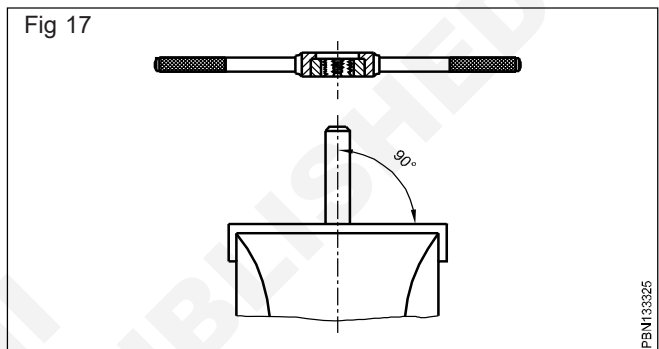
Blank size = Threads size - 0.1 × pitch of thread

Procedure

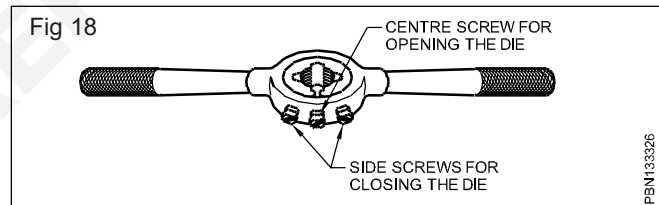
Fix the die in the diestock and place the leading side of the die opposite to the step of the diestock. (Fig 19)

Use false jaws for ensuring a good grip in the vice.
Project the blank above the vice - just the required thread length only.

Place the leading side of the die on the chamfer of the work (Fig 17).



Make sure that the die is fully open by tightening the centre screw of the diestock. (Fig 18)



Start the die, square to the bolt centre line. (Fig 19)

Apply pressure on the diestock evenly and turn clockwise direction to advance the die on the bolt blank. (Fig 20)

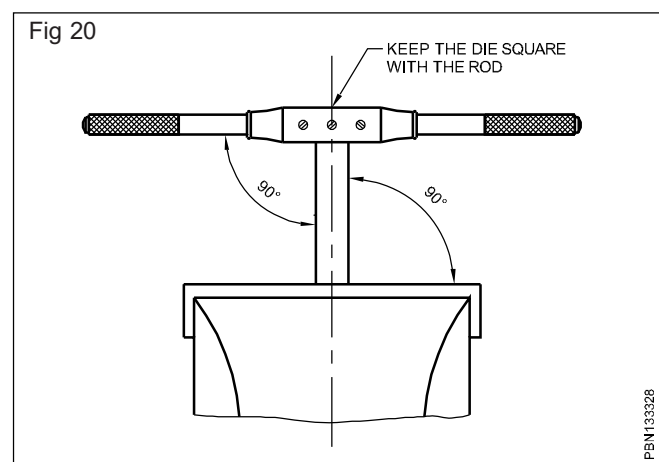
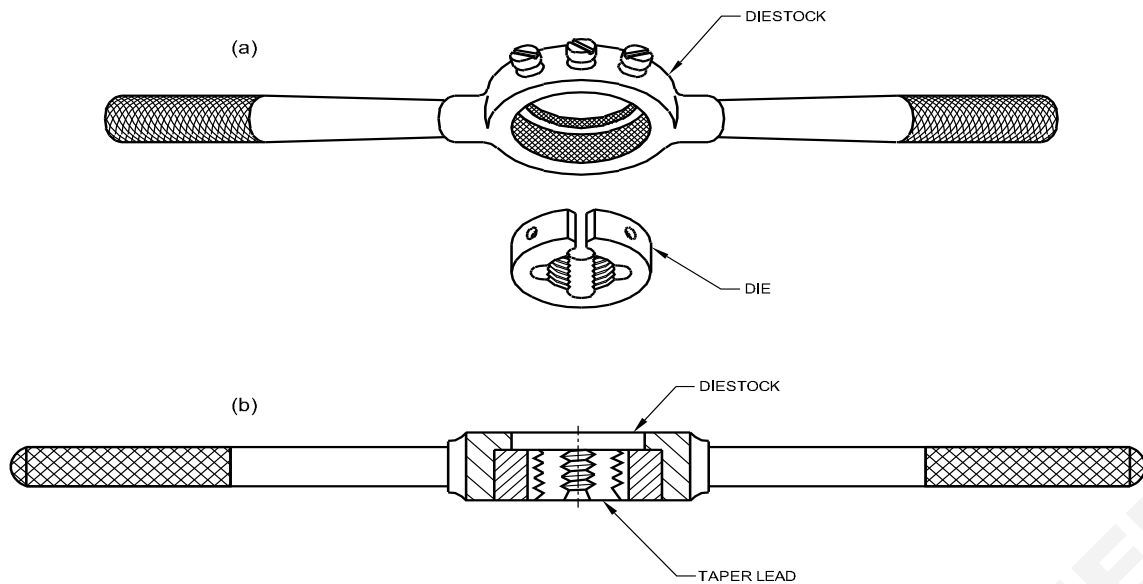


Fig 19

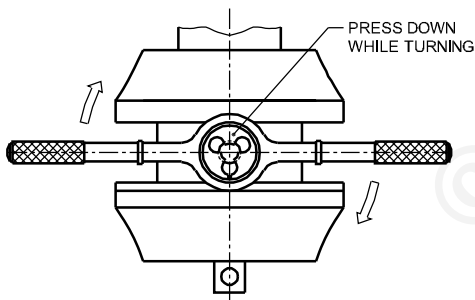


PBM133327

Cut slowly and reverse the die for a short distance in order to break the chips. (Fig 21)

Use a cutting lubricant.

Fig 21



PBM133329

Increase the depth of the cut gradually by adjusting the outer screws.

Check the thread with a matching nut.

Repeat the cutting until the nut matches.

Too much depth of cut at one time will spoil the threads. It can also spoil the die.

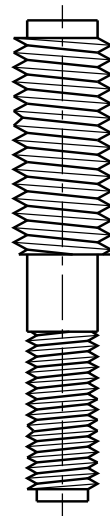
Clean the die frequently to prevent the chips from clogging and spoiling the thread.

Uses of studs (Fig 22)

Studs are mainly used in assembling flange to the pump sets big size is inserted into the pump casting. Smaller size is used to connect flanges of suction pipe with washers and nut.

It is also used for gland packing rope to tighten the gland cup.

Fig 22



OVERSIZE SPECIAL STUD TO SUIT THE TAPPED HOLE

PBM13332A

About different types of pipe G.I, C.I, D.I, PVC, CPVC, PPR, AC and HDPE etc.,

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

- state various types of pipes used for various purposes
- state the advantages and disadvantages of A C pipe
- state the various uses of cast iron pipe
- state the uses of P.V.C C.P.V.C and P.P.R
- state the uses of HDPE pipes.

Pipes and pipe fittings

Various types of pipes and tubes are used for the following purposes.

- Domestic hot and cold water supplies.
- Waste water outlets.
- High pressure steam supplies.
- Hydraulic oil supplies.
- Lubricating oil supplies.
- Special fluid and gases for industrial processes.
- Pneumatic systems.
- Refrigeration systems.
- Fuel oil supplies.

The common types of pipes classified according to material are:

- galvanized iron pipes
- mild steel pipes
- cast iron pipes
- C.I. soil pipes
- copper pipes
- aluminium pipes
- brass pipes
- lead pipes
- P.V.C. pipes
- rubber pipes
- plastic pipes
- stoneware pipes

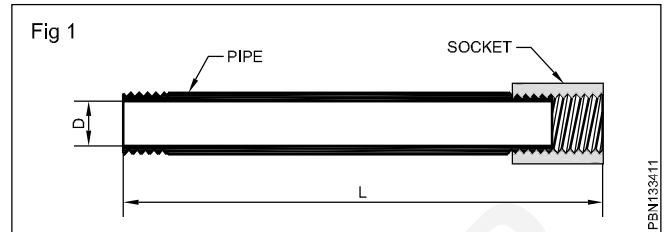
Standard pipe fitting: 'Pipe fittings' are those fittings that may be attached to pipes in order to:

- change the direction of the pipe
- connect a branch with a main water supply pipe
- connect two or more pipes of different sizes

close the pipe ends.

G.I. pipe

The hollow long open ended object of circular cross section is a pipe. (Fig 1)



Mild steel pipe after galvanisation are called galvanised iron pipes. It may be of hot finished seam less, electric resistance welded, high frequency induction welded, hot finished welded or cold finished seam less.

All screwed pipes and sockets shall have threads as per I.S.554. Dimensions and nominal mass of G.I. medium pipes are as per Table 2/I.S.1239.

Tolerance on thickness and mass of G.I. pipes shall be as per P2/I.S.1239.

G.I. pipes available in market are of 6m lengths. Measurements are taken including one socket. It will have threads on both ends. One end will have socket and another end has PVC bush to protect thread. Pipes used for water distribution are of 50 to 150mm ϕ . Pipes used in house connection are of 15 to 32mm ϕ .

Advantages of G.I. pipes

- It can withstand high pressure.
- It can be used for hot water supply.
- It will not get rusted easily because of galvanisation.
- It can be easily jointed after threading.
- Cutting and making holes are easy.
- Standard fittings like bend, elbow, union are available.
- It is easy to detach joints.

Disadvantage

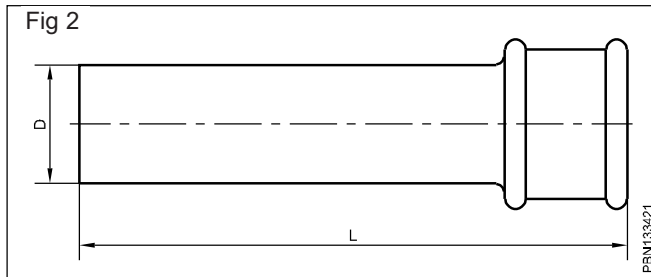
- These pipes are liable to corrosion in hazardous environments.
- This pipe can easily affected by acidic or alkaline water.
- It is costlier compared to PVC pipe.

Grades: There are 3 grades of G.I. pipe i.e. high, medium and low. They are marked with paint band of red, blue and yellow respectively. Medium grade pipes are used for water supply.

The diameter of pipe is specified by its nominal bore. The socket are designated by the respective nominal bore of pipe for which they are intended.

AC pipes

General: AC pipes are manufactured from pure asbestos fiber, portland cement and silica under high pressure in machines and are available from 5cm to 100cm in diameter and 2m to 3m in length. The pipes have socket at one end of the pipe for joining. AC pipes are used for carrying waste water or rain water. (Fig 2)



Advantages

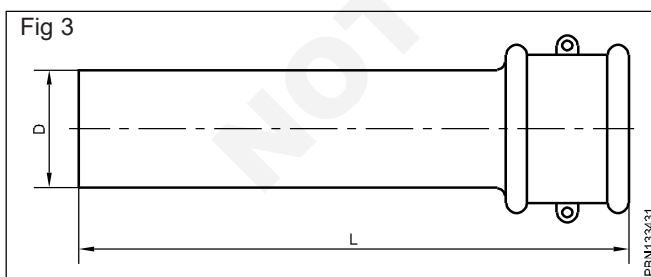
- It does not corrode.
- Transportation is easy because of its light weight.
- Cost is less compared to GI, CI pipes.
- It is easy to join.
- Cutting and drilling is easy.
- Inside of the pipe is smooth; therefore, has good carrying capacity.

Disadvantages

- AC pipes are brittle in nature therefore chances of breaking during handling and transportation is high.
- Damaged pipes cannot be repaired and used.
- Shock resistance is less therefore it should be laid with precautions.
- Use of asbestos cement is banned in many countries on health grounds.

C.I.pipe

C.I.pipes are manufactured using good quality grey cast iron. These pipes are manufactured in two different methods. i.e. sand casting or centrifugal casting. (Fig 3).



Sand cast pipes are manufactured by pouring molten pig iron in the sand moulds. The centrifugal cast pipes (spun pipes) are manufactured by using metal moulds and rotating mould by means of machine. Due to the centrifugal force the molten metal spreads uniformly. These pipes are generally free from Blister, sand holes, or air blocks.

Inside and outside are coated with Bituminous solution.

- Cast iron pipes shall have the following qualities.
- It should be able to cut, drill, chipping and fitting.
- There should not be any crack.
- There should be no visible blister, air block, sand holes.
- There should be bell sound on hammering with a small hammer.

C.I.pipes are classified into 5 types based on its use and physical properties.

- C.I water supply pipes
- C.I drain and sewer pipes
- C.I soil pipes
- C.I waste pipes
- C.I rain water pipes

Spun iron pipes used in water supply shall conform to IS1536. These are available from 80mm to 750mm. There are three class of pipes like Class LA, Class A and Class B. The specials used in these pipe shall conform to IS 1538- specials used in these pipe shall conform to IS 1538- specials like bends, collar, offset, reducer, tee, Y junction etc. are available. These pipes are joined with use of pig lead or lead wool.

Sand cast CI pipes used for soil pipes shall conform to IS. 1729. Spun iron CI pipes used for soil pipes shall conform to IS. 3989

Types of PVC pipes

Polyvinyl Chloride (PVC)

- Polyvinyl chloride (PVC) is manufacture from ethylene or acetylene.
- It is essentially consisting of polymerisation of vinyl chloride.
- PVC has to be mixed besides plasticizers, with release agents, stabilizers etc. to make it easily processable.

Uses

- Non plasticized grades are widely used for the manufacture of pipes and conduits.
- It is used as cable coating because of its high Electrical Resistance.
- Blow molded components are used for replacement of glass for its high transparency.
- Non-toxic products are used for packing foods.
- Manufacture of Toys, dolls, paper coating, lampshade, etc.
- PVC is used for temperature below about 140°F.

Poly propylene Random Co-polymer (PPR)

- Latest and advanced Technology using raw material PP co-polymer.

- It is used for cold and hot water system, water purifying, chemical flow, etc.
- Three key parameters for polyfusion welding are
 - i Temperature
 - ii Pressure
 - iii Time
- i Temperature
 - Temperature around $260^{\circ} \pm 5^{\circ}\text{C}$ to ensure proper classification of the joint.
- ii Pressure
 - Weld components need to be inserted into the weld at even pressure and length.
- iii Time
 - Warming up time

- Adoption time
- Connection time

i Warming up time

Warming up time starts when both components are simultaneously pressed.

ii Adoption time

Adoption time starts when components are removed from welder.

iii Connection time

Connection time is the components being pushed with each other with lateral pressure.

iv Weld hardening time

Hardening time is the joint to get cooled and free from physical stresses.

Table for PPR Welding

Diameter mm	Melting length mm				
		T1	T2	T3	T4(Seconds)
20	12	5	3	5	2
40	16	12	6	12	4
75	26	30	8	30	6
125	41	60	10	60	8

Co-polymer vinyl chloride (CPVC)

- CPC and CPVC are made of the same basic elements.
- CPVC is altered by a free radical chlorination reaction that effectively increases the chlorine content of the material
- CPVC to be used temperatures upto 190°F .
- CPVC pipe is an off-white or yellowish colour.
- CPVC pipe is more suitable for hot water and potable water system

surface of plastic pipes does not give the teeth of rodents sufficient hold to cause damage.

No damage to PE pipe lines by termites has ever been occurred PE and PP are not a nutrient medium for bacteria fungi and spores. Resistant to all forms of microbial attack as well as to both sulphurous acid and sulphates. The standard lengths of 6m reduced the amount of joints branches can be manufactured and delivered in every type and form triangle can be adapted individually from 30° to 90° .

HDPE pipe (Fig 4)

HDPE pipes and fittings

HDPE pipe was established in 2002. HDPE pipes and fittings ranges from 300 to 400 mm so far tests have shown that the pressure pipes made of HDPE have a life time of over 100 years.

Ensures a trouble free service of the pipe and of course the complete piping system. Pipes made of polyethylene (PE) and polypropylene (PP) are thermoplastics with excellent properties for the application of water and sewer These are resistant to many chemicals and very suitable for conveying and storing various liquids.

It can be welded, can be reused continuously. The whole pipe line is a homogenous systems and absolutely safe. This has good chemical resistance The smooth round

Fig 4



Different types of pipe fittings socket, elbows, tee, union, bend, cap, plug, cross, ferrule. etc.,

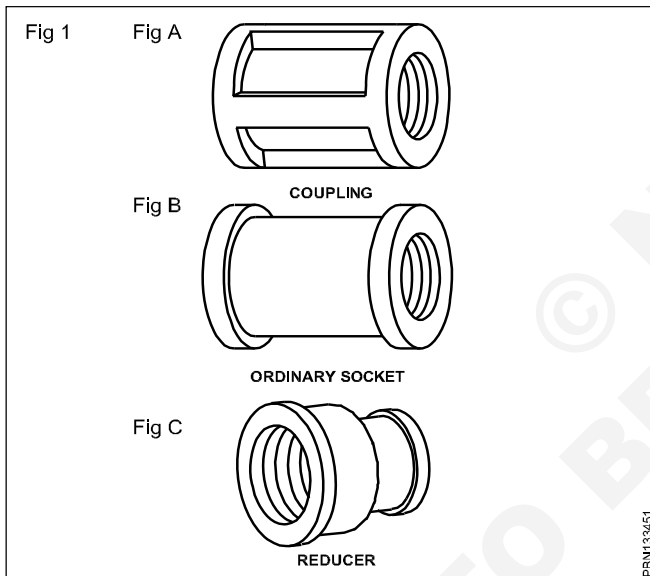
Objectives: At the end of this lesson you shall be able to

- state the standard pipe fittings of various types and sizes
- state the types of elbows, unions, plugs and special fittings
- state the materials from which they are made
- state the symbols used for the pipe.

Standard pipe fittings

Coupling: An ordinary coupling shown in (Fig 1), usually comes with the pipe, one coupling to each length. The couplings are made of wrought iron or cast iron metal or of brass. They are regularly threaded with right hand thread R and L coupling have projecting bars or rings to distinguish them from standard coupling. Another form of coupling called an extension piece is shown in (Fig 1). It differs from the standard coupling in that it has a male thread at one end there are numerous other type some known as reducers.

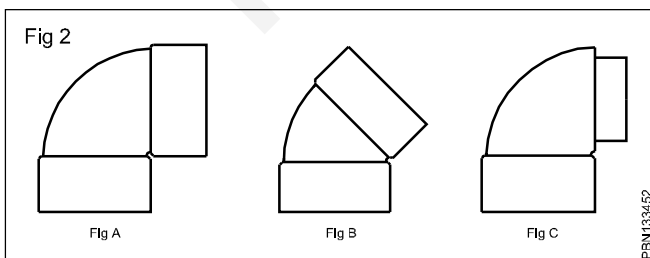
Reducer (Fig 1 b): A reducer coupling is used to connect two pipes with different diameters.



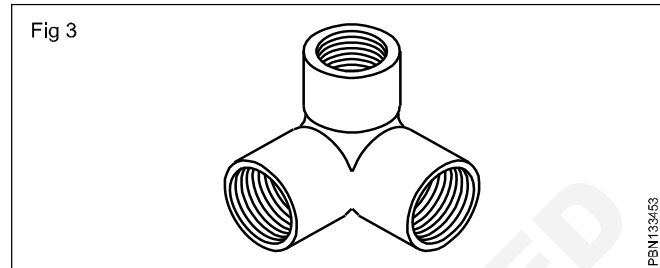
Elbows (Fig 2): Elbows and bends provide deviations of 90° and 45° in pipe work systems.

The 45° elbows allow pipe deviation of 450 (Fig 2b).

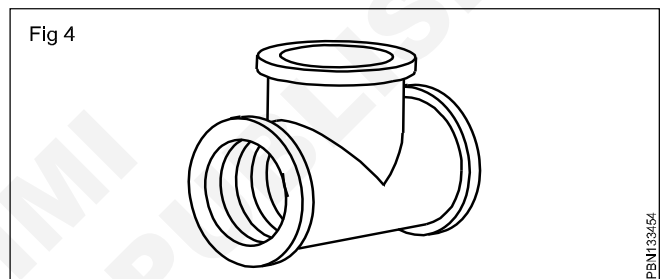
Reducer elbow (Fig 2 C): A reducer elbow is used to connect two different dia pipes in deviation of 90° in pipe line work systems.



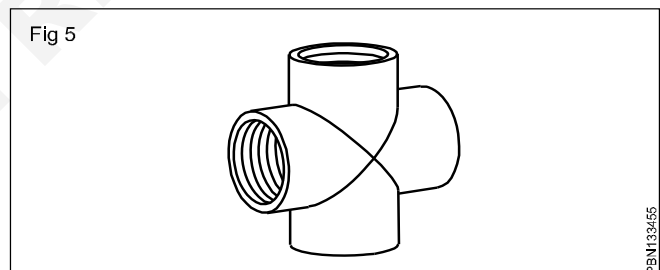
Three way elbow: A times way elbow is used to connect three pipes at deviations of 90°. (Fig 3)



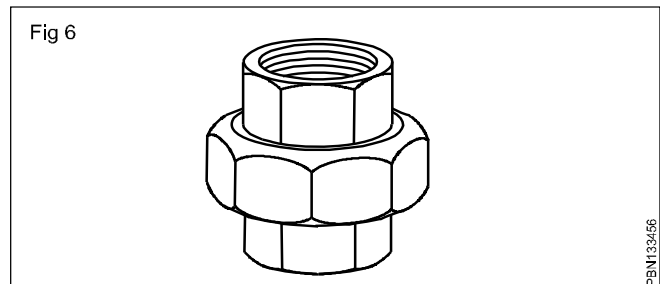
Tee (or) Three way: A tee is used to take a branch line at deviation of 90°. (Fig 4)



Four way: A fourway is used to connect four bits from straight line two opposite 90° are joined. (Fig 5)

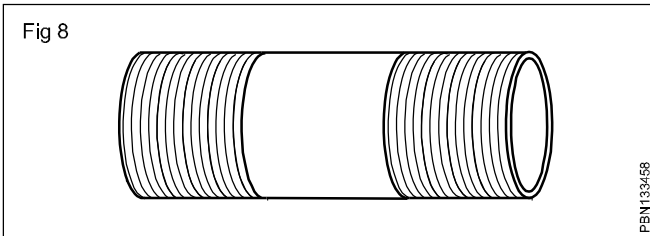
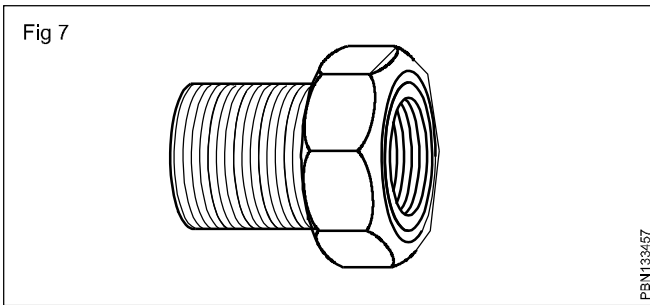


Union: A device used to connect pipes when unions are used in pipe lines it is easy to dismantle and repair. (Fig6)

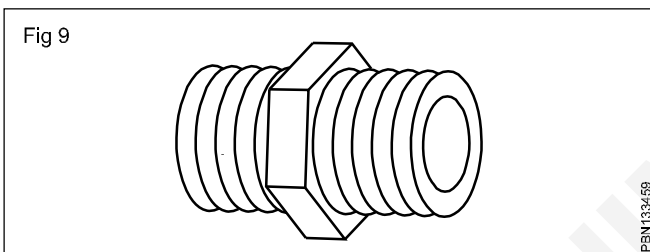


(Fig 7) This is special fittings used to connect two different diameter pipes one side is internal threaded used for joining small diameter pipe other type is external threaded used for joining bigger diameter pipe.

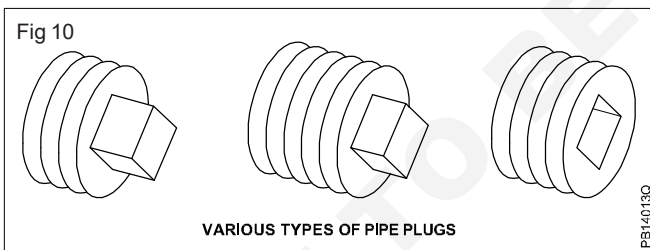
Pipe nipples (Fig 8): A nipple is a piece of pipe less than 30 CM length thread on both end.



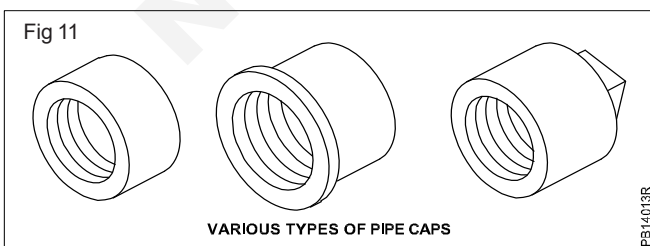
Hexagonal nipple (Fig 9): This nipple is used where fittings or valve are to be very close to each other. Both sides are external threaded and a hexagonal step at the middle for gripping. (Fig 9)



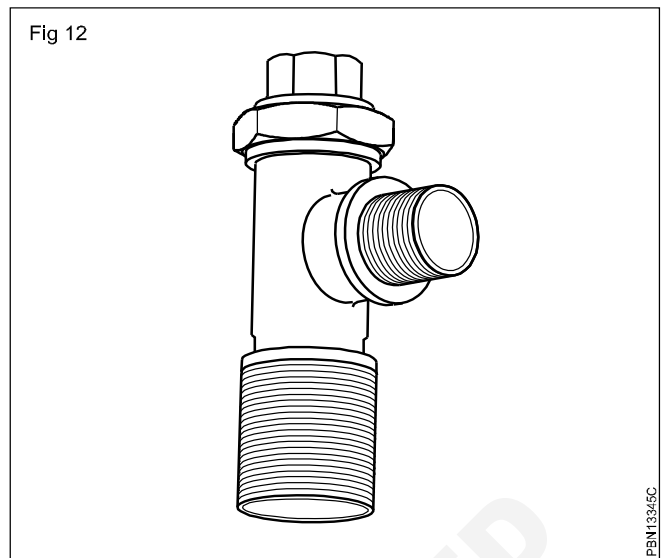
Plug (Fig 10): A plug is used for closing the end of a pipe or a fitting having a female thread square head is provided at the top to grip. Plugs are made on sizes ranging from 6 mm to 300 mm. It is made of castiron, malleable iron and brass.



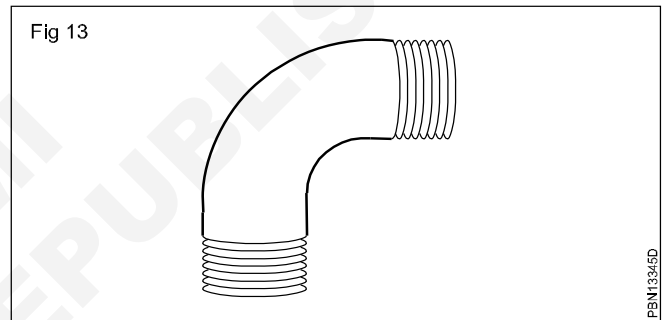
CAP (Fig 11): A cap is female threaded and is used for closing the end of a pipe or fitting having a male thread cap are made of castiron malleable iron and brass They are regularly made in sizes from 6mm to 150mm.



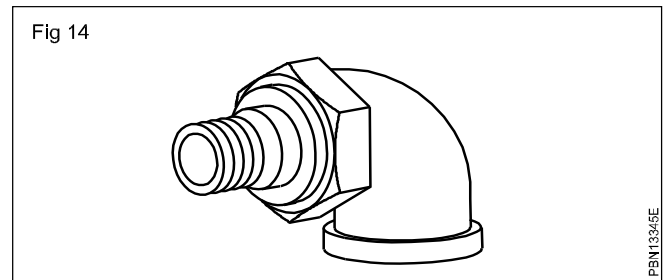
Ferrule (Fig 12): This ferrule is made of gun metal and is used to take service connection from water supply main line. It is fitted in the C.I pipes and P.V.C supply main line. It is fitted in the C.I pipes and P.V.C saddle.



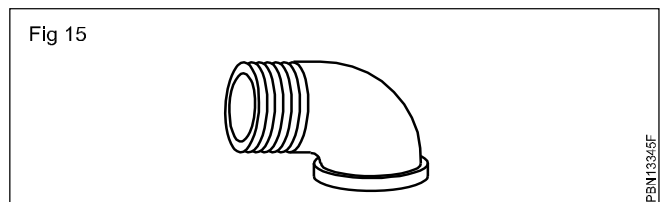
BEND (Fig 13): This bend is made of G.I pipe having external thread on both end It is used to join with the male threaded pipes using couplings or flanges join directly to the female threaded fittings.



Union elbow (Fig 14): A pipe fitting with a male union at one end.



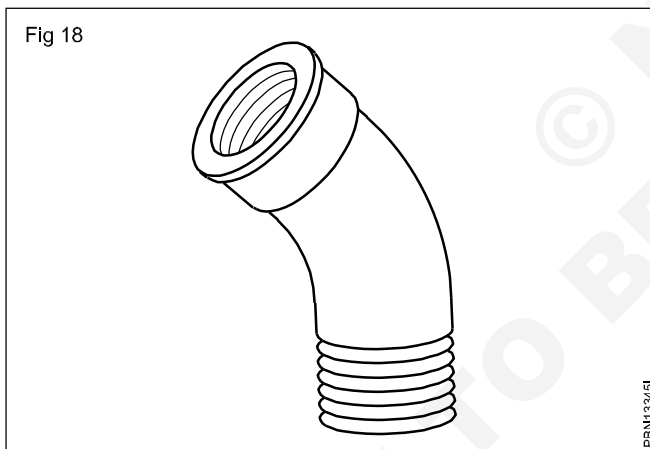
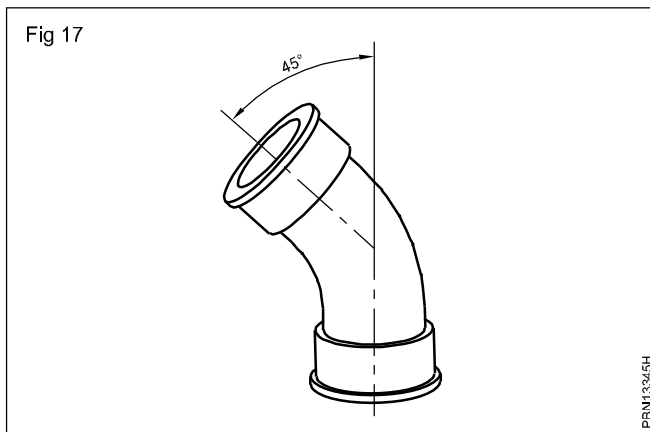
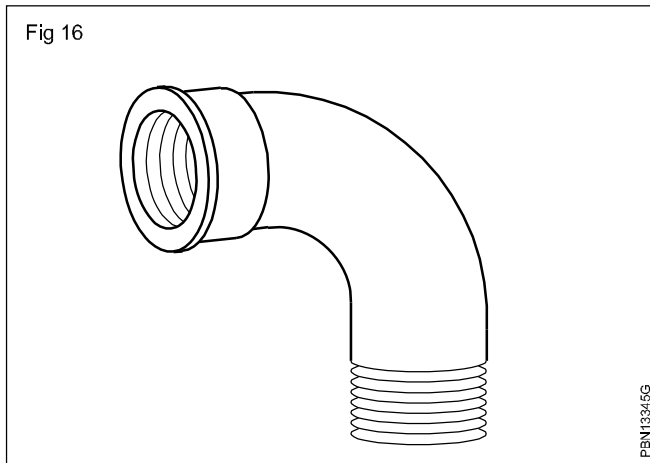
Elbow M+F: A pipe fitting as above only one internal threads and other one external thread. (Fig 15)



Bend 45° (F+F): A fitting as before. Both ends have internal threads. (Fig 17)

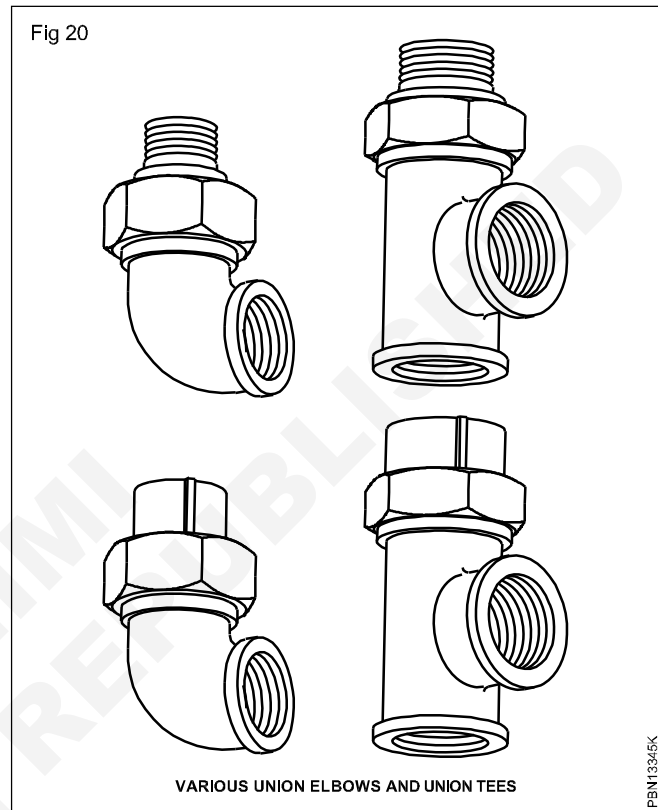
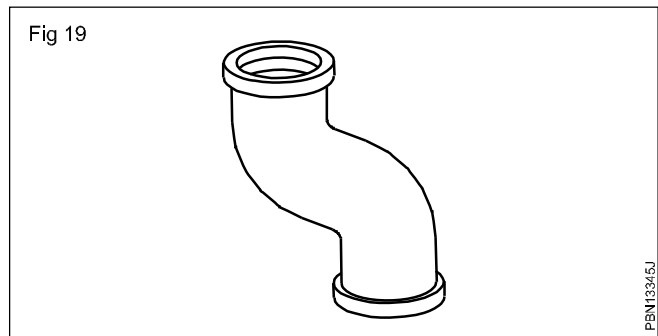
Bend (M+F): A fitting as before but with an external thread and internal thread. (Fig 16)

Bend 45° (M+F): A pipe fitting as before only one end has an external (Male) thread and the other end has internal (female) thread. (Fig 18).

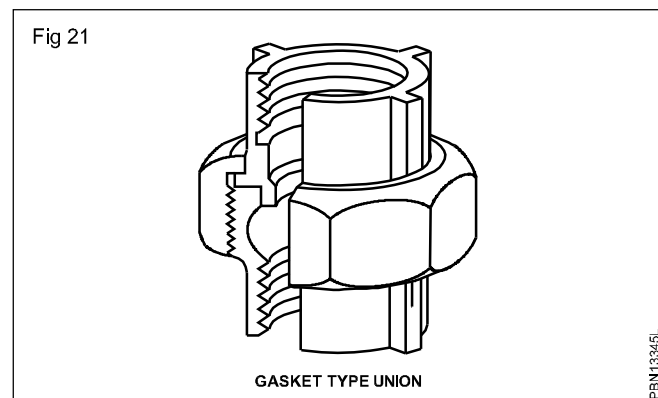


Offsets: In piping, part of the pipe line must sometimes be in a position, parallel to but not in alignment with the balance of the pipe. An experienced pipe fitter can offset the line by bending the pipe, but ordinarily when the offset or distance between the axes of the two pipes is of standard dimension, a fitting called an offset, can be used more conveniently. (Fig 19)

Special union elbow and tee: The frequent use of union in pipe lines is desirable for convenience in case of repair. When the union is combined with a fitting, the advantage of a union is obtained with only one threaded joint instead of two as in the case of a separate union. A disadvantage of union fittings is that they are not usually as easily obtainable as ordinary fitting as shown in (Fig 20). Various union elbows and union tees of the female and of the male and female types.



Unions: There are various kinds of unions available in the market. The two pipes are to be joined by the union must be in approximate alignment to secure a tight joint. (Fig 21)



On working drawings or sketches plumbing pipe fittings are shown by symbols.

Piping symbols are used by architects and plumbing engineers on blueprints or working drawings. They represent the various plumbing fixtures and piping systems as well as the pipe fittings and valves used to construct these systems.

Plumbers must recognize these symbols in order to locate water supply systems on drawings or sketches (Fig 22).

Fig 22

STANDARD SYMBOLS FOR PLUMBING, PIPING, AND VALVES							
Plumbing		Plumbing (continued)		Pipe Fittings (continued)			
Corner Bathtub.....		Drinking Fountain (Projecting-Type).....		Fitting			
Recessed Bathtub.....		Hot Water Tank.....		Elbow-Long Radius.....		Screwed	
Sitz Bath.....		Water Heater.....		Side Outlet Elbow-Outlet Down.....		Soldered	
Bidet.....		Meter.....		Side Outlet Elbow-Outlet Up.....			
Shower Stall.....		Hose Rack.....		Base Elbow.....			
Shower Head.....		Hose Bibb.....		Double Branch Elbow.....			
Overhead Gang Shower.....		Gas Outlet.....		Single Sweep Tee.....			
Pedestal Lavatory.....		Vacuum Outlet.....		Double Sweep Tee.....			
Wall Lavatory.....		Drain.....		Reducing Elbow.....			
Corner Lavatory.....		Grease Separator.....		Tee.....			
Handicapped Lavatory.....		Oil Separator.....		Tee-Outlet Up.....			
Dental Lavatory.....		Cleanout.....		Tee-Outlet Down.....			
Standard Kitchen Sink.....		Garage Drain.....		Side Outlet Tee-Outlet Up.....			
Kitchen Sink, R & L Drain Board.....		Floor Drain with Backwater Valve.....		Side Outlet Tee-Outlet Down.....			
Kitchen Sink, L H Drain Board.....		Roof Sump.....		Cross.....			
Combination Sink & Dishwasher.....		Piping		Concentric Reducer.....			
Combination Sink & Laundry Tray.....		Soil and Waste, Above Grade.....		Eccentric Reducer.....			
Service Sink.....		Soil and Waste, Below Grade.....		Lateral.....			
Wash Sink (Wall-Type).....		Vent.....		Expansion Joint.....			
Wash Sink.....		Cold Water.....		Valves			
Laundry Tray (Single).....		Hot Water.....		Valve			
Laundry Tray (Double).....		Hot Water Return.....		Gate Valve.....		Screwed	
Water Closet (Tank-Type).....		Fire Line.....		Globe Valve.....		Soldered	
Water Closet (Integral Tank).....		Gas Line.....		Angle Globe Valve.....			
Water Closet (Flush Valve, Floor Outlet).....		Acid Waste.....		Angle Gate Valve.....			
Water Closet (Flush Valve, Wall-Hung).....		Drinking Water Supply.....		Check Valve.....			
Urinal (Wall-Hung).....		Drinking Water Return.....		Angle Check Valve.....			
Urinal (Stall).....		Vacuum Cleaning.....		Stop Cock.....			
Urinal (Trough-Type).....		Compressed Air.....		Safety Valve.....			
Drinking Fountain (Recessed).....		Pipe Fittings			Quick-Opening Valve.....		
Drinking Fountain (Semi-Recessed).....		Fitting			Float Valve.....		
		Joint.....		Motor-Operated Gate Valve.....			
		Elbow-90°.....					
		Elbow-45°.....					
		Elbow-Turned Up.....					
		Elbow-Turned Down.....					

Purpose of gas welding method of gas welding, safety precautions to be observed

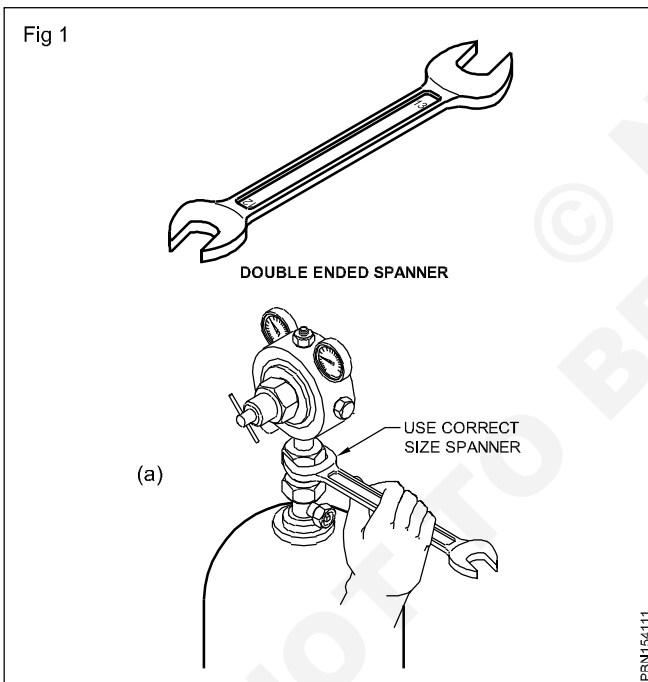
Objectives: At the end of this lesson you shall be able to

- state the uses of gas welding in pipes
- state the method of gas welding and their techniques
- state the filler rod uses for gas welding
- state the safety while doing the gas welding work.

Gas welding hand tools

The following are the details of different hand tools used by a welder.

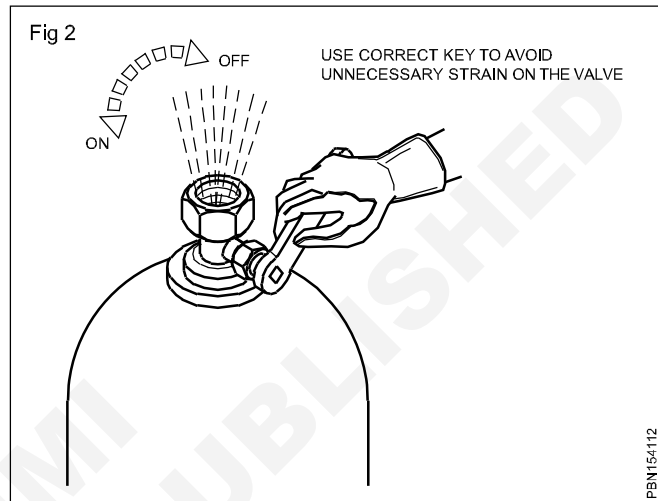
Double ended spanner: A double ended spanner is shown in (Fig 1&1a). It is made of forged chrome vanadium steel. It is used to loosen or tighten nuts, bolts with hexagonal or square heads. The size of the spanner is marked on it as shown in (Fig 1). In welding practice the spanners are used to fix the regulator onto the gas cylinder valves, hose connector and protector to the regulator and blow pipe, fix the cable lugs to the arc welding machine output terminals, etc.



Do not use the spanner as a hammer; use the correct size spanner to avoid damage to the nut/bolt head.

Cylinder key: A cylinder key is shown in (Fig 2). It is used to open or close the gas cylinder valve socket to permit or stop the gas flow from the cylinder to the gas regulator.

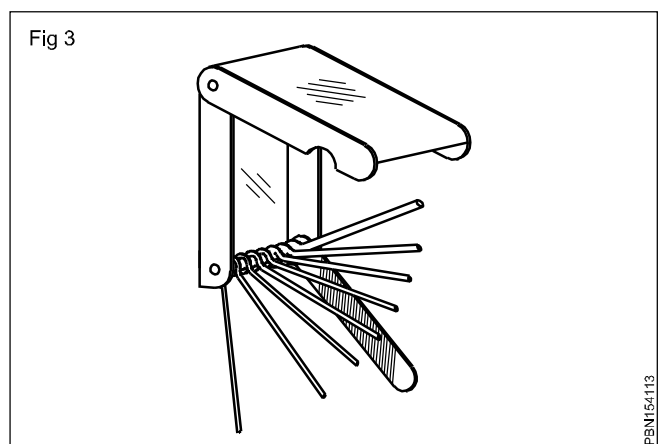
Always use correct size key to avoid damage to the square rod used to operate the valve. The key must always be left on the valve socket itself so that the gas flow can be stopped immediately in case of flash back/back fire.



Nozzle or tip cleaner

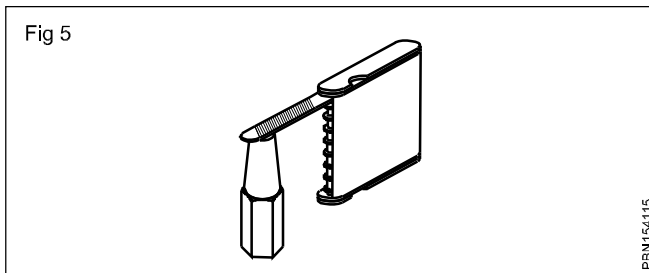
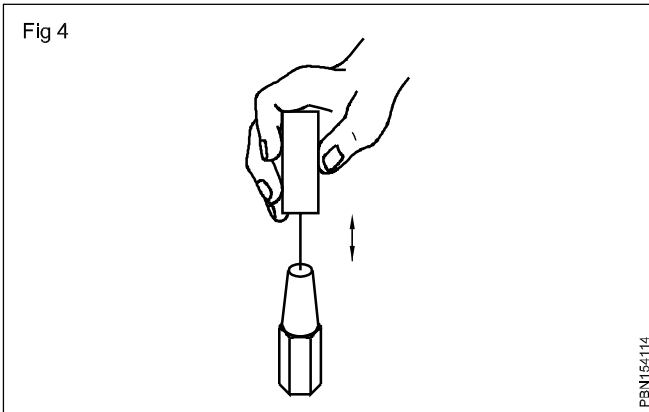
Cleaning the tip: All welding torch tips are made of copper. They can be damaged by the slightest rough handling-dropping, tapping or chopping with the tip on the work may damage the tip beyond repair.

Tip cleaner: A special tip cleaner is supplied with the torch container. For each tip there is a kind of drill and a smooth file. (Fig 3)

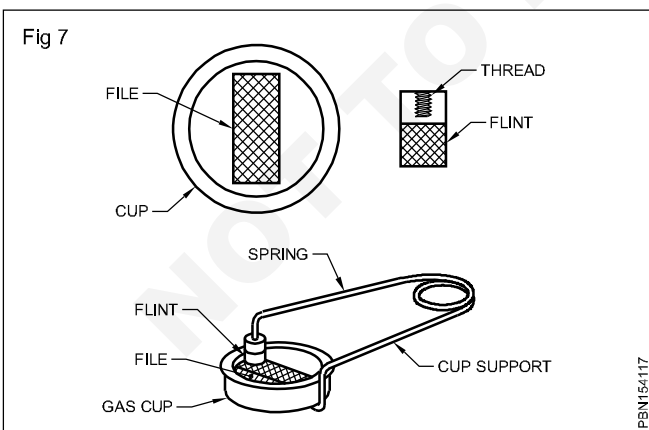
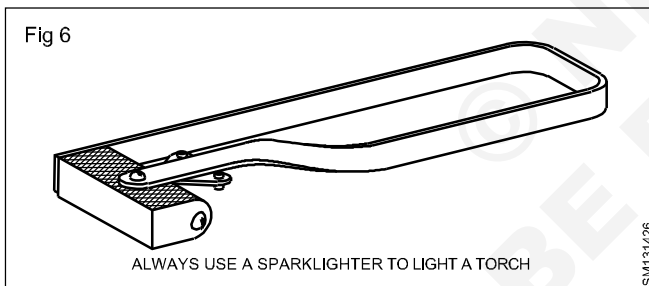


Before cleaning the tip, select the correct drill and move it, without turning, up and down through the hole in the tip. (Fig 4).

The smooth file is then used to clean the surface of the tip (Fig 5). While cleaning, leave the oxygen valve partly open to blow out the dust.

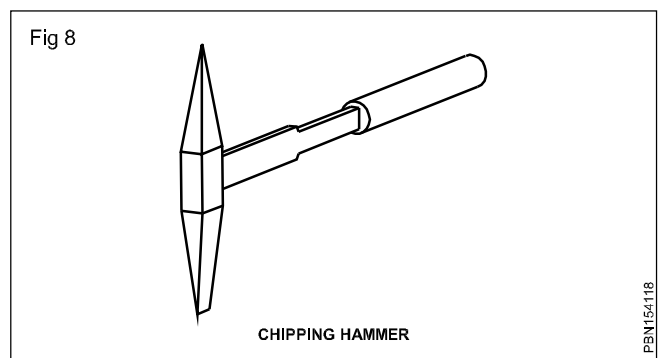


Spark lighter: The spark lighter, as illustrated in (Figs 6&7) is used for igniting the torch. While welding, form the habit of always employing a spark lighter to light a torch. Never use matches. The use of matches for this purpose is very dangerous because the puff of the flame produced by the ignition of the acetylene flowing from the tip is likely to burn your hand.



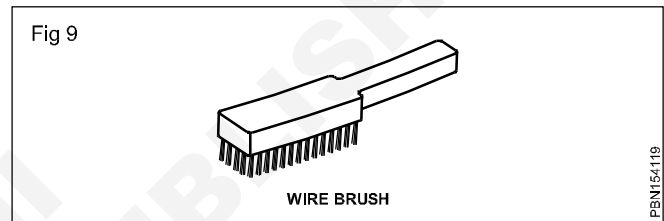
Chipping hammer: The chipping hammer (Fig 8) is used to remove the slag which covers the deposited weld bead. It is made of medium carbon steel with a mild steel handle. It is provided with a chisel edge on one end and a point on the other end for chipping off slag in any position.

Care should be taken to maintain the sharp chisel edge and the point for effective chipping of slag.



Carbon steel wire brush: A carbon steel wire brush is shown in (Fig 9). It is used for

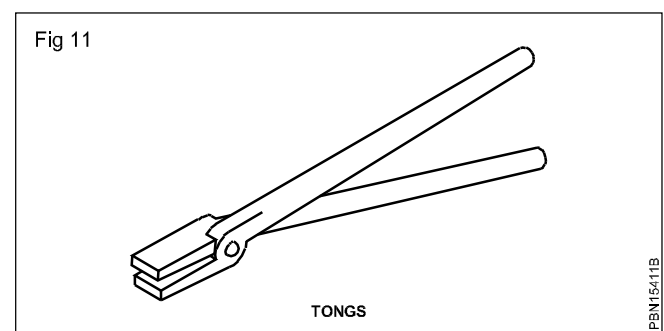
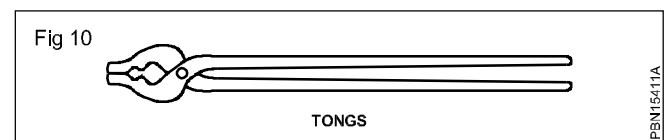
- Cleaning the work surface from rust, oxide and other dirt etc. prior to welding.
- Cleaning the interbead weld deposits after chipping off the slag.
- General cleaning of the weldment.



A stainless steel wire brush is used for cleaning a nonferrous and stainless steel welded joint.

It is made of bunch of steel wires fitted in three to five rows on a wooden piece with handle. The wires are hardened and tempered for long life and to ensure good cleaning action.

Tongs: (Figs 10&11) shows a pair of tongs used to hold hot work pieces and to hold the job in position.



Welding blowpipe

Types

There are two types of blowpipes.

- High pressure blowpipe or non-injector type blowpipe.
- Low pressure blowpipe or injector type blowpipe.

Uses of blow pipes

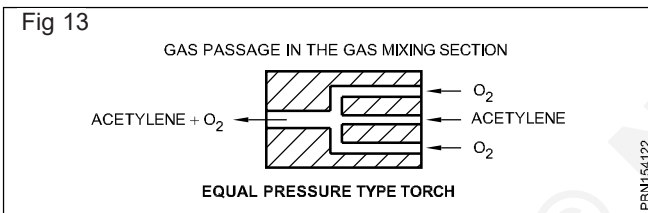
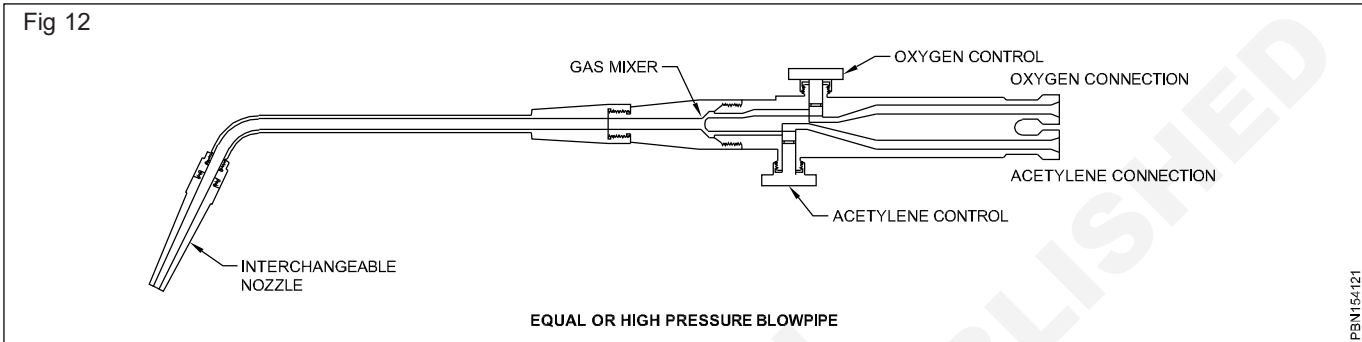
Each type consists of a variety of designs depending on the work for which the blowpipe is required. i.e., gas welding, brazing, very thin sheet welding, heating before and after welding, gas cutting.

Equal or High pressure blowpipe (Fig 12)

The H.P. blowpipe is simply a mixing device to supply approximately equal volume of oxygen and acetylene to the tip, and is fitted with valves to control the flow of the gases as required. i.e. the blow pipes/gas welding torches are used for welding of ferrous and non-ferrous metals, joining thin sheets by fusing the edges, preheating and post heating of jobs, brazing, for removing the dents formed

by distortion and for gas cutting using a cutting blow pipe.

The equal pressure blow pipe (Fig 12) consists of two inlet connections for acetylene and oxygen gases kept in high pressure cylinders. Two control valves to control the quantity of flow of the gases and a body inside which the gases are mixed in the mixing chamber (Fig 13). The mixed gases flow through a neck pipe to the nozzle and then get ignited at the tip of the nozzle. Since the pressure of the oxygen and acetylene gases are set at the same pressure of 0.15 kg/cm^2 they mix together at the mixing chamber and flows through the blow pipe to the nozzle tip on its own. This equal pressure blow pipe/torch is also called as high pressure blow pipe/torch because this is used in the high pressure system of gas welding.

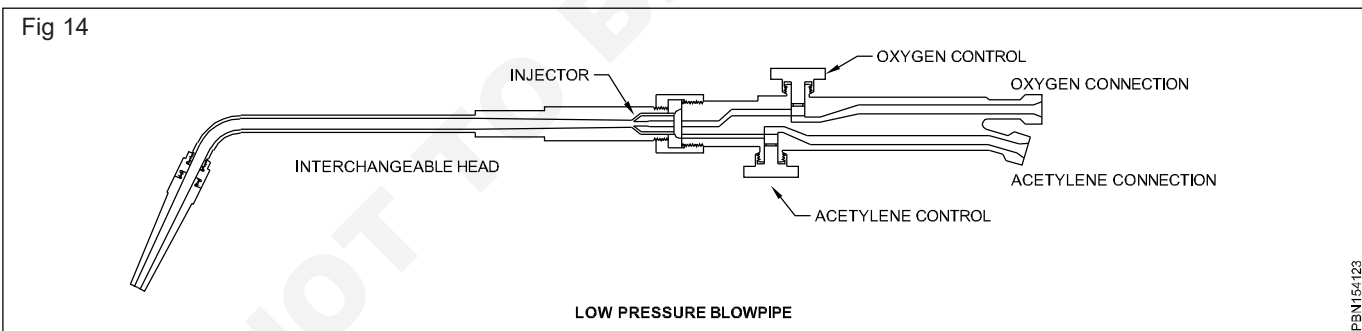


Important caution: A high pressure blowpipe should not be used on a low pressure system.

Low pressure blowpipe (Fig 14)

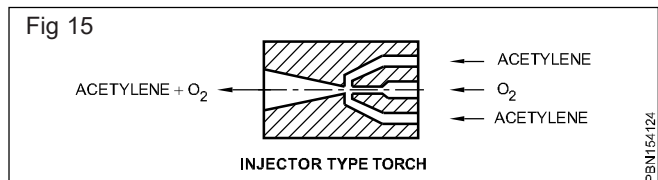
This blowpipe has an injector (Fig 14) inside its body through which the high pressure oxygen passes. This oxygen draws the low pressure acetylene from an acetylene generator into a mixing chamber and gives it the necessary velocity to get a steady flame and the injector also helps to prevent backfiring.

A set of nozzles is supplied with each blowpipe, the nozzles having holes varying in diameters, and thus giving various sized flames. The nozzles are numbered with their consumption of gas in liters per hour.



The low pressure blow pipe is similar to the equal pressure blow pipe except that inside its body an injector with a very small (narrow) hole in its centre through which high pressure oxygen is passed. This high pressure oxygen while coming out of the injector creates a vacuum in the mixing chamber and sucks the low pressure acetylene from the gas generator. (Fig 15)

It is usual for the whole head to be interchangeable in this type, the head containing both the nozzle and injector. This is necessary, since there is a corresponding injector size for each nozzle.



The L.P. blowpipe is more expensive than the H.P. blowpipe but it can be used on a high pressure system, if required.

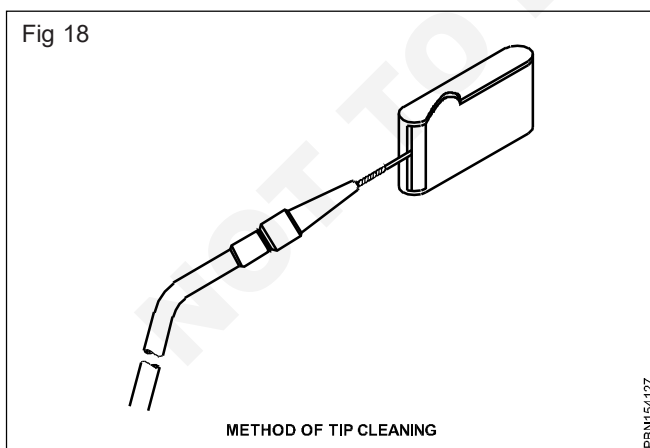
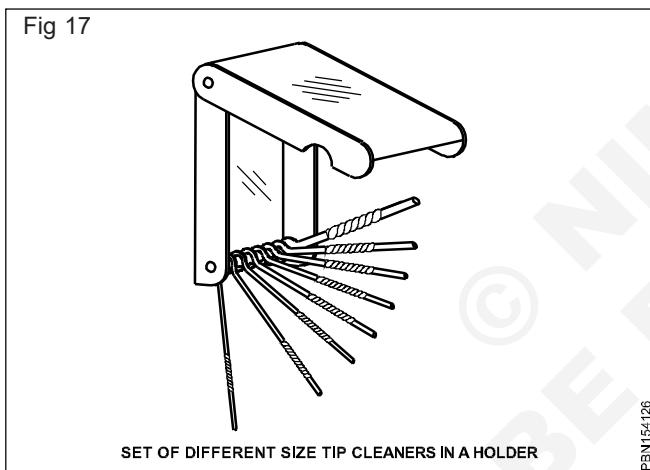
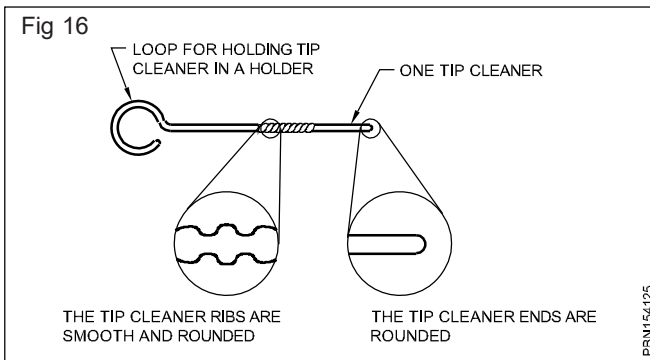
Care and maintenance

Welding tips made of copper may be damaged by careless handling.

Nozzles should never be dropped or used for moving or holding the work.

The nozzle seat and threads should be absolutely free from foreign matter in order to prevent any scoring/scratch on the fitting surfaces when tightening on assembly.

The nozzle orifice should only be cleaned with a tip cleaner specially designed for this purpose. (Fig 16, 17 & 18)



At frequent intervals the nozzle tip should be filed to remove any damage to the tip due to the excessive heat of the flame and the molten metal.

The inlet for acetylene has left hand thread and that for oxygen has right hand thread. Take care to fit the correct hose pipe with the blow pipe inlet. At frequent intervals, put off the flame and dip the blow pipe in cold water.

Types of oxy-acetylene flames

The oxy-acetylene gas flame is used for gas welding because;

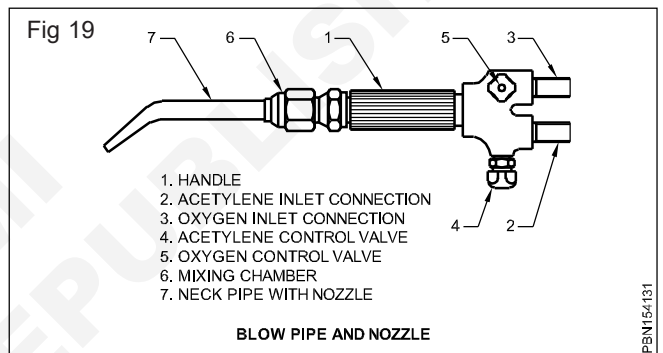
- It has a well controlled flame with high temperature.
- The flame can be easily manipulated for proper melting of the base metal.
- It does not change the chemical composition of the base metal/weld.

Three different types of oxy-acetylene flames as given below can be set.

- Neutral flame
- Oxidising flame
- Carburising flame.

Characteristics and uses

Neutral flame (Fig 19): Oxygen and acetylene are mixed in equal proportion in the blowpipe.

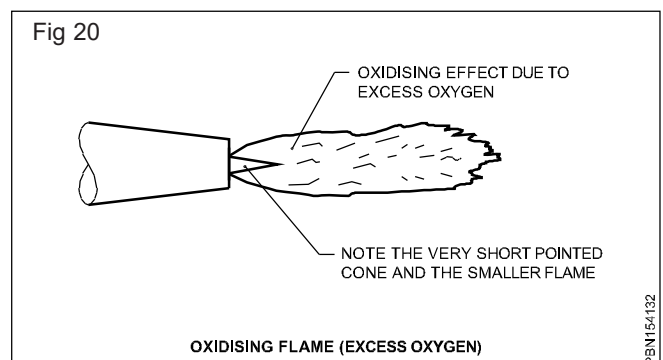


Complete combustion takes place in this flame.

This flame does not have a bad effect on the base metal/weld i.e. the metal is not oxidised and no carbon is available for reacting with the metal.

Uses: It is used to weld most of the common metals, i.e. mild steel, cast iron, stainless steel, copper and aluminium.

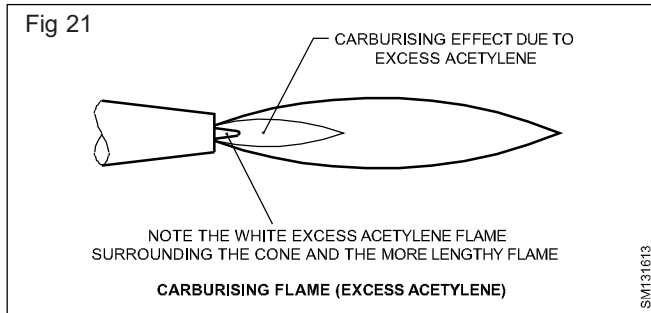
Oxidising flame (Fig 20): It contains an excess of oxygen over acetylene as the gases come out of the nozzle.



The flame has an oxidising effect on metals which prevents evaporation of zinc/tin in brass welding/brazing.

Uses: Useful for welding of brass and for brazing of ferrous metals.

Carburising flame (Fig 21): It receives an excess of acetylene over oxygen from the blowpipe.



The flame has a carburing effect on steel, causing hard, brittle and weak weld.

Uses: Useful for stelliteing (hard facing), 'Linde' welding of steel pipes, and flame cleaning.

The selection of the flame is based on the metal to be welded

The neutral flame is the most commonly used flame. (See the Table 1 given below.)

Table 1

SI No.	Metal	Flame
1	Mild steel	Neutral
2	Copper (de-oxidised)	Neutral
3	Brass	Oxidising
4	Cast iron	Neutral
5	Stainless steel	Neutral
6	Aluminium (pure)	Neutral
7	Stellite	Carburing

Gases used in welding and gas flame combinations

In the gas welding process, the welding heat is obtained from the combustion of fuel gases in the presence of a supporter of combustion (oxygen).

Tubes and pipes

Introduction

Metal tubes are used in different types of machines and installations. Tubes in hydraulic system rarely runs in a straight line. Tubes are curved, twisted for making structural frames and are bent by computerised numerical control (CNC) pipe bending machines.

Conduit pipes ranging from 16 mm to 65 mm diameter are used for electrical installations.

Pipes and tubes are made of metals and plastics and are used for transport, water, oil, gas and for domestic and industrial purposes. G.I.Pipe (galvanised iron) is commonly used for many purposes.

British standard pipe threads BSP, ISO, DIN. Standard threads are cut on pipes for joining purposes. Pipes are first cut to length with a hacksaw or pipe cutter and then a pipe reamer is used to remove the burr on the inside diameter of the pipe.

Generally the tube size is specified by the outer diameter, whereas the pipe size is specified by the internal diameter.

Pipe and Tubing: The sheet metal worker uses both black pipe and galvanized pipe as legs and stiffeners. In general the pipe work is done by plumber or pipe fitter.

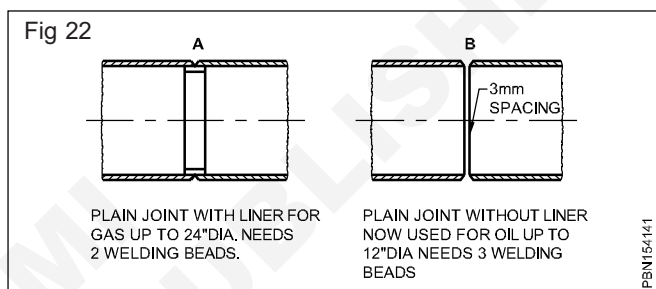
Sheet metal worker may sometimes have to connect few small fittings to connect the equipment to the installed pipe.

Pipes can be obtained in various sizes. The pipes commonly used in the sheet metal trade are from 3/8 inch to 1 1/4 inch in diameter.

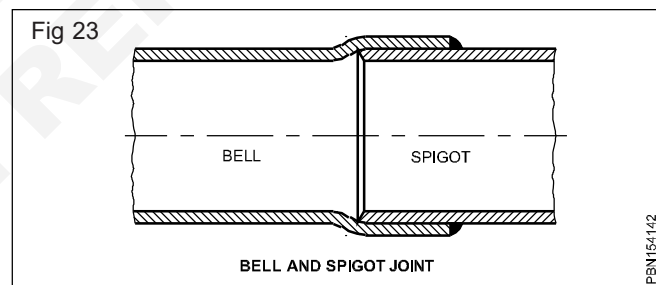
Split pipe: For a smooth, very stiff edge, the sheet metal worker uses split pipe. Split pipes are available in galvanized black and stainless steel pipes.

Various types of Pipe joints

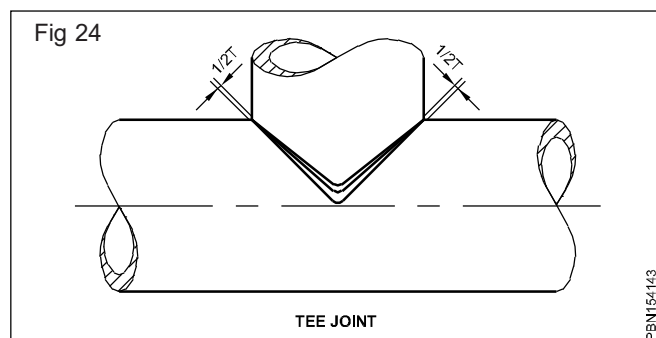
Square butt joint with liner and without liner (Fig 22).



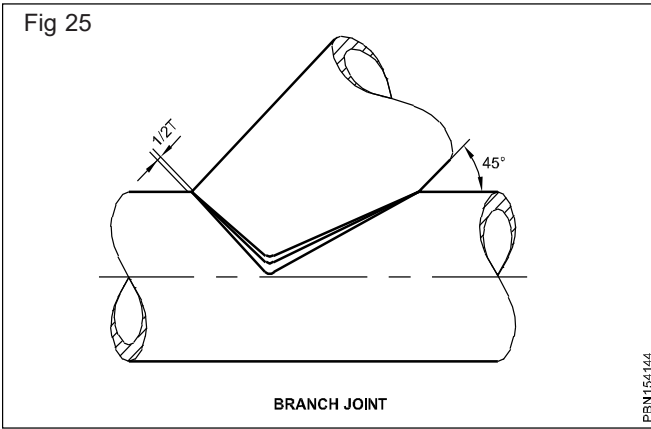
Bell and spigot joint. (Fig 23).



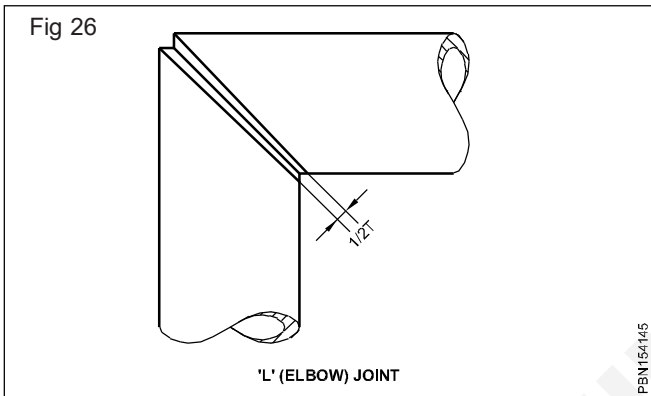
'Tee' joint. (Fig 24).



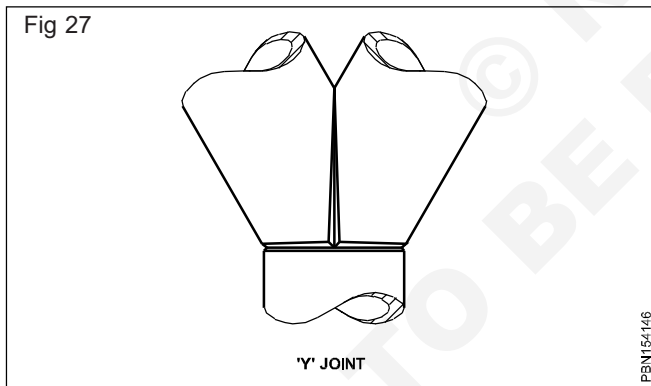
Branch joints. 45°. (Fig 25)



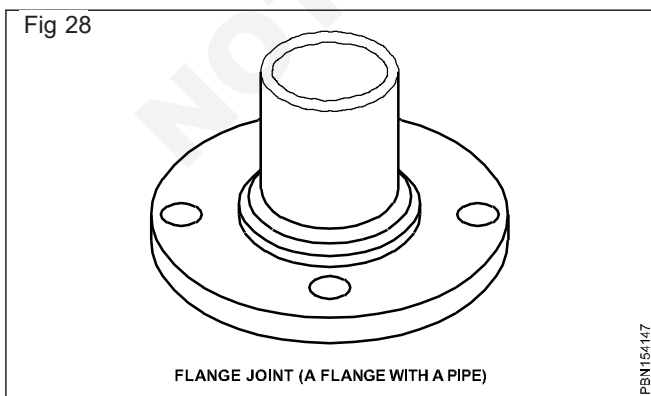
'L' elbow joint. (Fig 26)



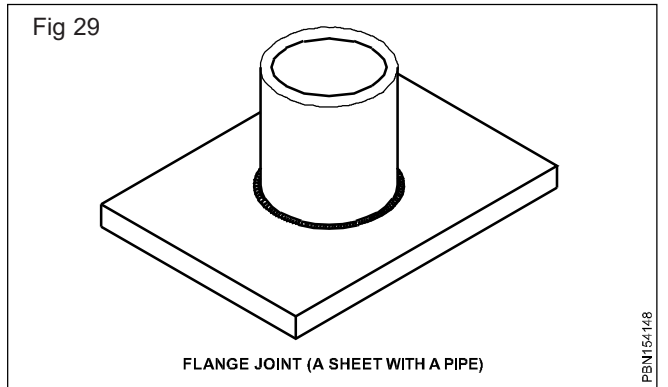
'Y' joint. (Fig 27)



Flange joint (A flange with a pipe). (Fig 28)

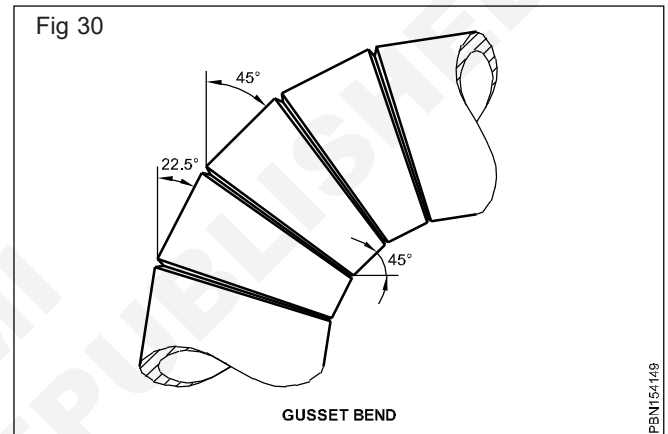


Flange joint (A sheet with a pipe). (Fig 29)



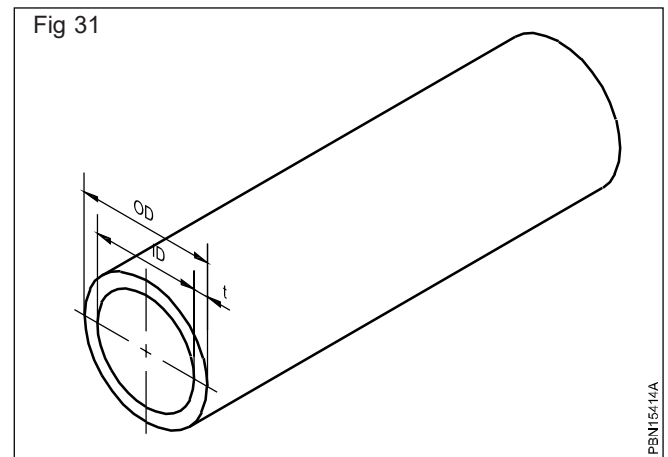
Gusset bend. (Fig 30)

The factors to be considered for a pipe joint



Check the pipes for:

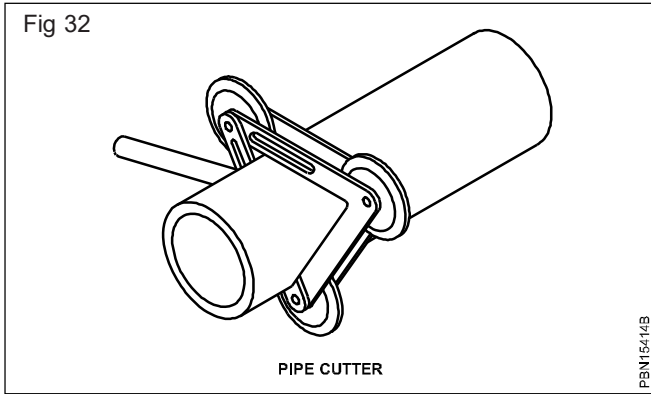
- Specification of material and diameter (O.D/I.D). (Fig 31)



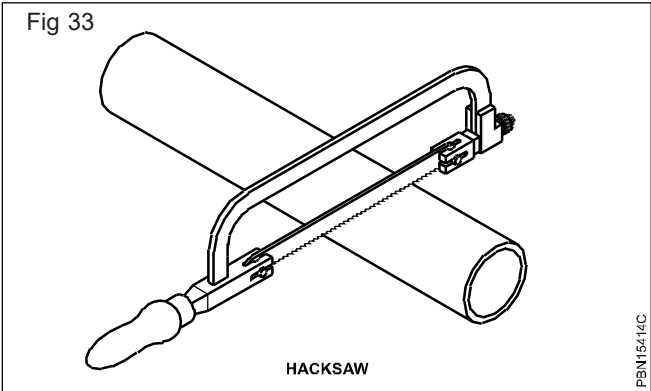
- Wall thickness
- End preparation required

Method of edge preparation: For small diameter pipe end cutting may be done by a;

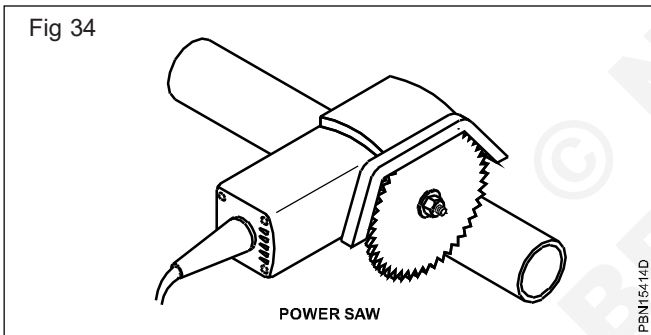
- Pipe cutter. (Fig 32)



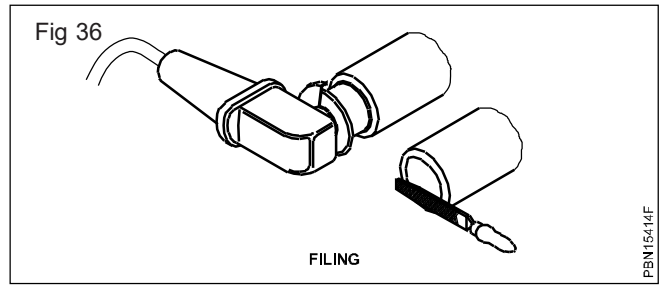
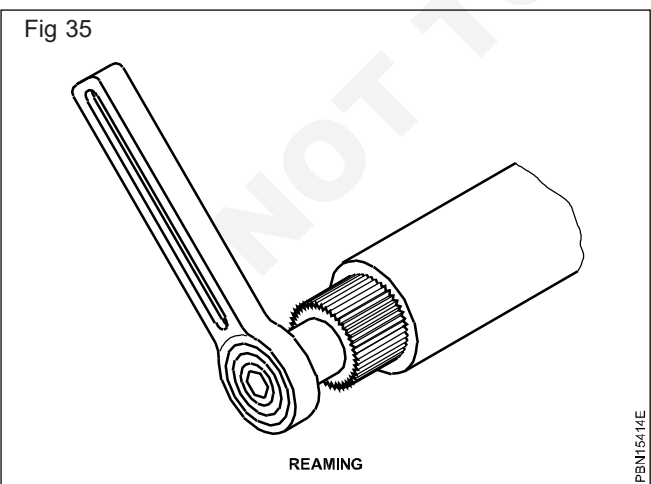
- Hacksaw. (Fig 33)



- Power saw (Fig 34)



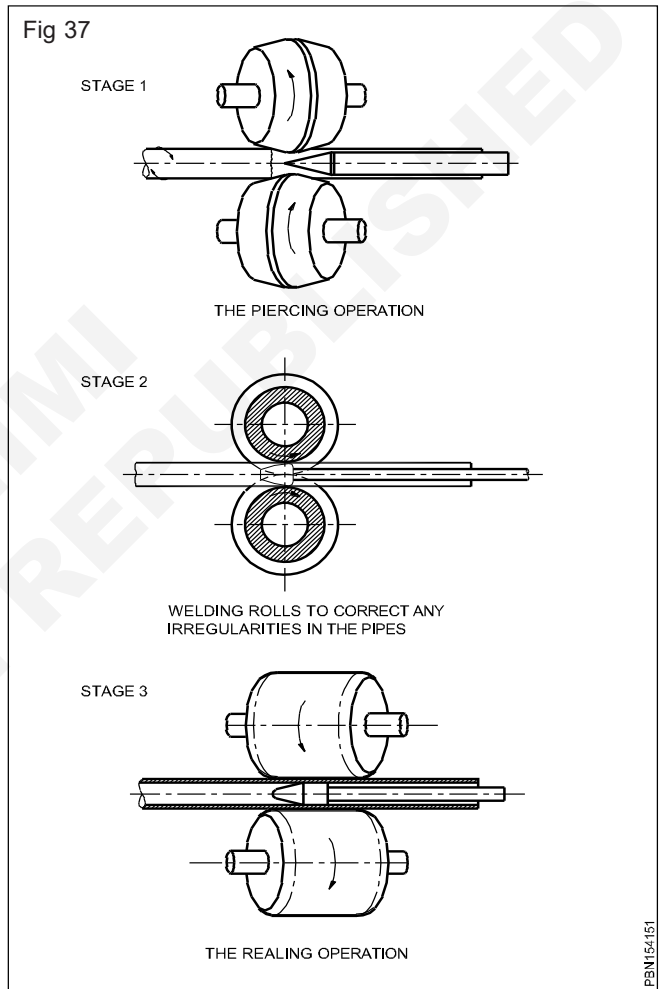
After cutting to length, remove any burrs on the inside of the pipe by reaming or filing. (Figs 35 & 36)



Welding of M.S pipe

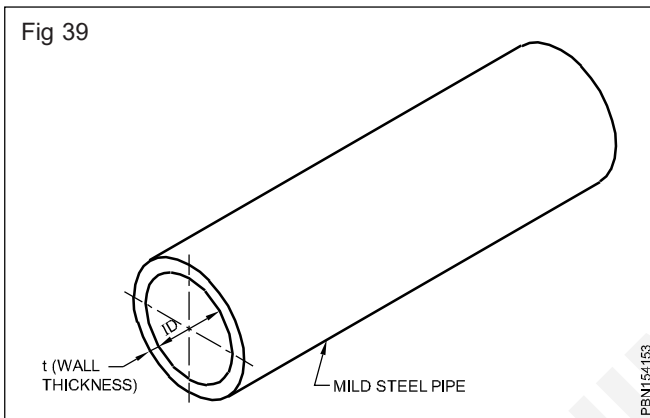
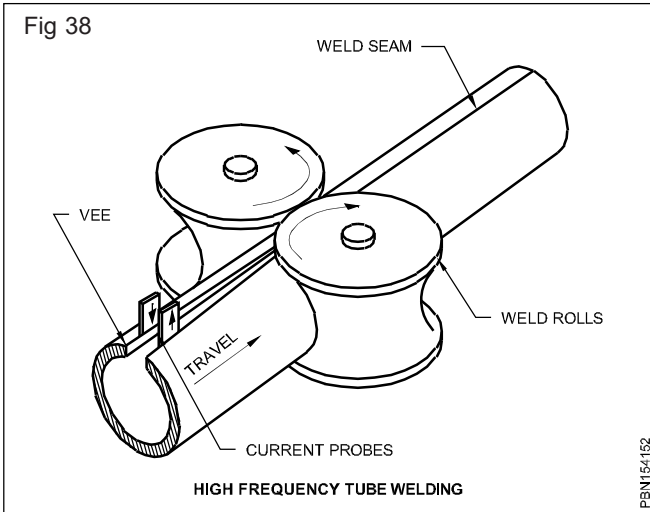
Welding of M.S pipe: Mild steel pipes are classified into two groups.

- 1 Seamless pipes manufactured by piercing a hot solid round billets/rods. (Fig 37)



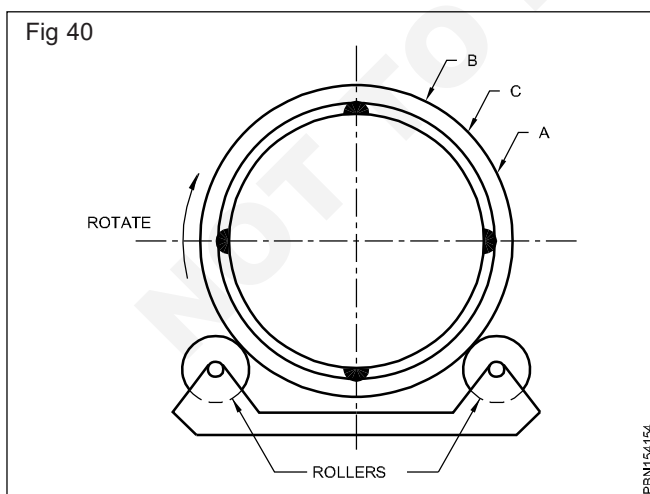
- 2 Resistance welded pipes manufactured by continuously feeding a strip of metal through a machine which rolls the strip into cylindrical shape and the seam is electrically resistance welded. (Fig 38)

Based on the wall thickness, these pipes are further categorised as "Standard pipes", "Extra strong pipes" and "Double extra strong pipes". Also the pipes are specified by first the material then by the diameter followed by the wall thickness. (Fig 39) For example an M.S pipe 100mm long with 50mm inside diameter and 3mm wall thickness is specified as M.Sf50 WT3 x 100mm.

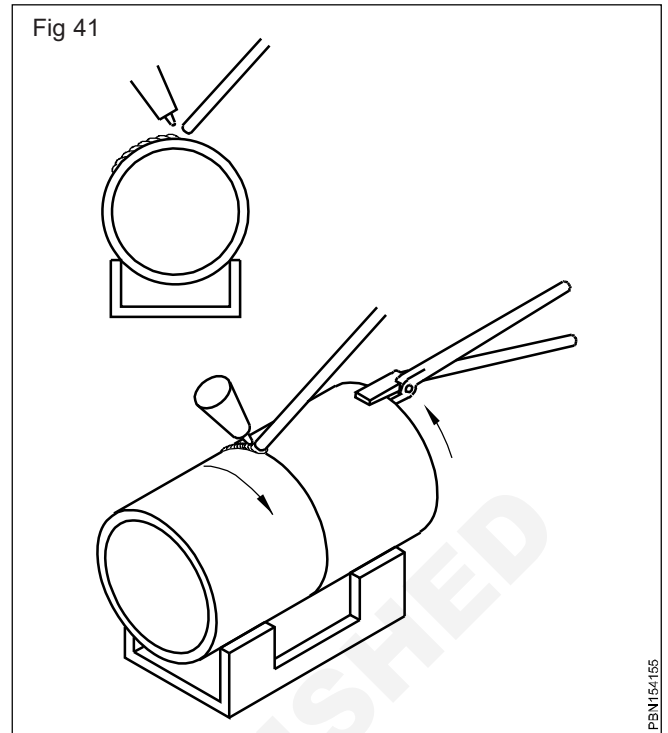


In the actual usage of pipes in various applications like transmitting water, oil, chemicals, air, gases etc, it is necessary to weld them as a butt, elbow and Tee joints as well as branch pipe joints at various angles.

The welding of smaller diameter pipes and bigger diameter pipes inside a welding shop can be done by rotating the pipes on rollers or manually by a helper using an angle iron and tongs. (Fig 40 and Fig 41)



If the pipes are larger and are to be welded in the field/work site or if the pipes cannot be rotated, then in such cases, the pipes are welded in fixed position i.e. the pipe will not be rotated, but the welder has to move the blow pipe and filler rod along the curved line of the joint around the pipe to complete the weld.



The edges of the pipe joints are prepared depending on the type of joint and the wall thickness of the pipe. For a pipe flange joint and for pipe butt joint with 1.5 to 3mm wall thickness, the pipe edges are filed or ground square (Fig 42) For pipe butt joints above 3mm wall thickness, the pipe edges are beveled as shown in (Fig 43) with 1.5mm root face.

Weld defects like incomplete or lack of root penetration cannot be rectified from inside small diameter pipes. Hence slightly larger root gaps are given while welding pipe butt joints to ensure proper root penetration. (Table 1) (Fig 42 & 43) gives the details of edge preparation.

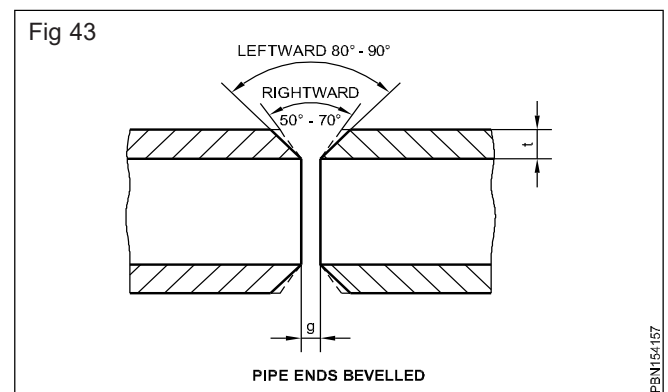
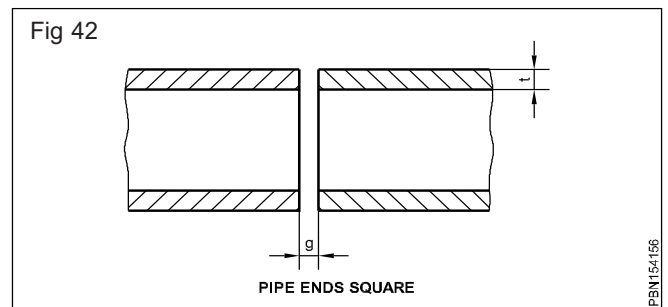
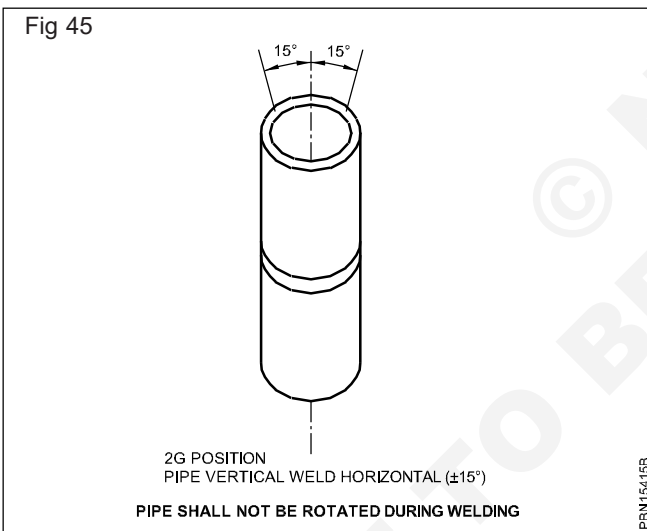
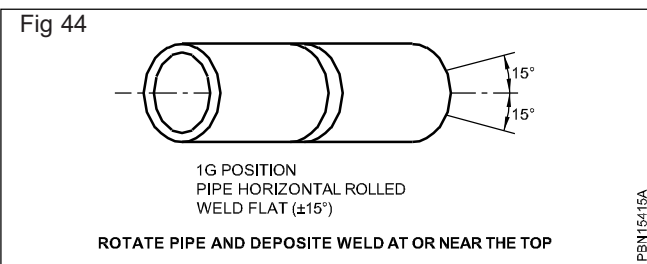


TABLE 1

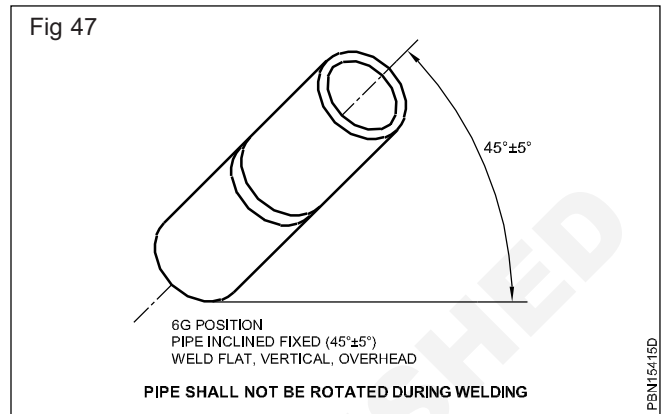
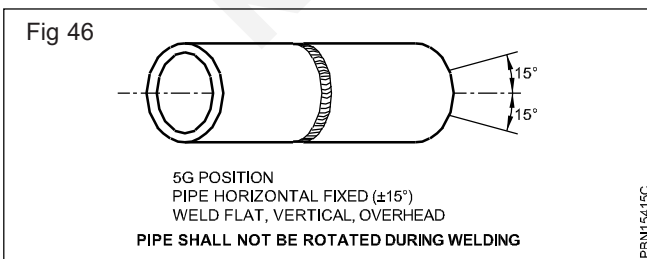
Wall thickness (t)	Pipe and preparation	Welding technique	Root gap (g)
3mm or less	Square	Leftward	2.5 - 3mm
5mm or less	Square	Rightward or all-positional rightward	2.5 - 3mm
3 - 5mm	Bevelled	Leftward	1.5 - 2.5 mm
5 - 7mm	Bevelled	Rightward or all-positional rightward	3 - 4mm

As welding of pipes is done either by rotating the pipe or by the fixed method, the pipe welding procedure also differs accordingly.

The different positions used to weld pipe butt joints are named as 1G, 2G, 5G and 6G as shown in (Figs 44, 45, 46, 47). These positions are decided based on the position of the pipe axis and whether the welding is done by rotating the pipe or by keeping the pipe fixed.



But in gas welding only 1G, 2G and 5G positions are used. The 6G position welding is done by arc welding and it is usually used to test the skill/ability of a welder in pipe welding.



Welding technique of oxy-acetylene welding

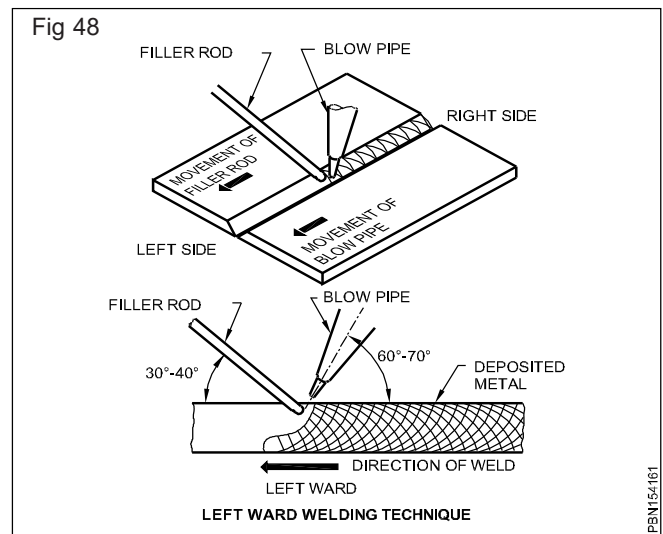
There are two welding techniques used in oxy-acetylene welding process. They are

- 1 Leftward welding technique (Forehand technique)
- 2 Rightward welding technique (Backhand technique)

The leftward technique is explained below. For details of rightward technique refer Related Theory for exercise 2.06.

Leftward welding technique

It is the most widely used oxy-acetylene gas welding technique in which the welding commences at the right hand edge of the welding job and proceeds towards the left. It is also called forward or forehand technique. (Fig 48)



In this case welding is started at the right hand edge of the job and proceeds towards the left. The blowpipe is held at an angle of 60° - 70° with the welding line. The filler rod is held at an angle of 30° - 40° with the welding line. The welding blowpipe follows the welding rod. The welding flame is directed away from the deposited weld metal.

The blowpipe is given a circular or side-to-side motion to obtain even fusion on each side of the joint.

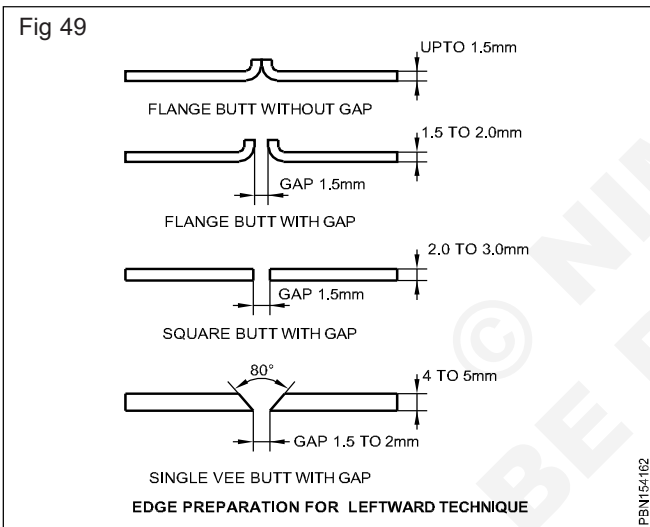
The filler rod is added in the (weld) molten pool by a piston like motion and not melted off by the flame itself.

If the flame is used to melt the welding rod itself into the pool, the temperature of the molten pool will be reduced and consequently good fusion cannot be obtained.

Edge preparation for leftward technique

For fillet joints square edge preparation is done.

For butt joints the edges are prepared as shown in (Fig 49). The table given below gives the details for welding mild steel by leftward technique for butt joints.



For fillet joints one size larger nozzle is to be used.

Above 5.0 mm thickness, the rightward technique should be used.

Application

This technique is used for the welding of:

- mild steel up to 5mm thick.
- all metals both ferrous and non-ferrous.

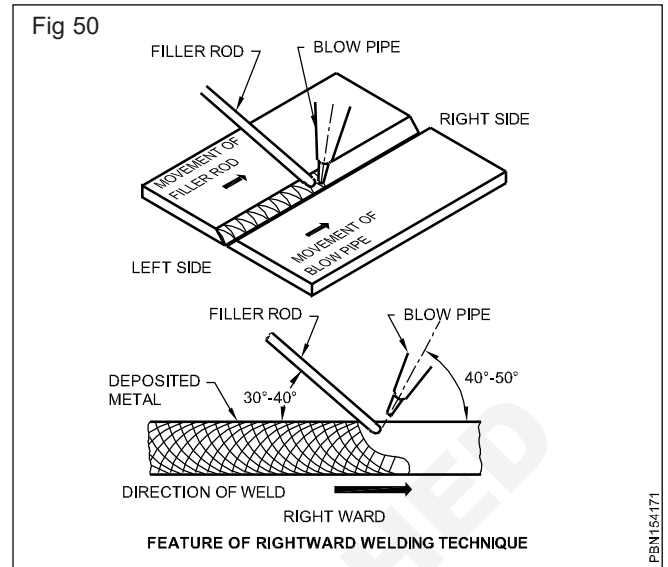
Rightward technique of oxy-acetylene gas welding

Rightward welding technique: It is an oxy-acetylene gas welding technique, in which the welding is begun at the left hand edge of the welding job and it proceeds towards the right.

This technique was developed to assist the production work on thick steel plates (above 5mm) so as to produce economic welds of good quality.

It is also called backward or backhand technique.

The following are its features. (Fig 50)



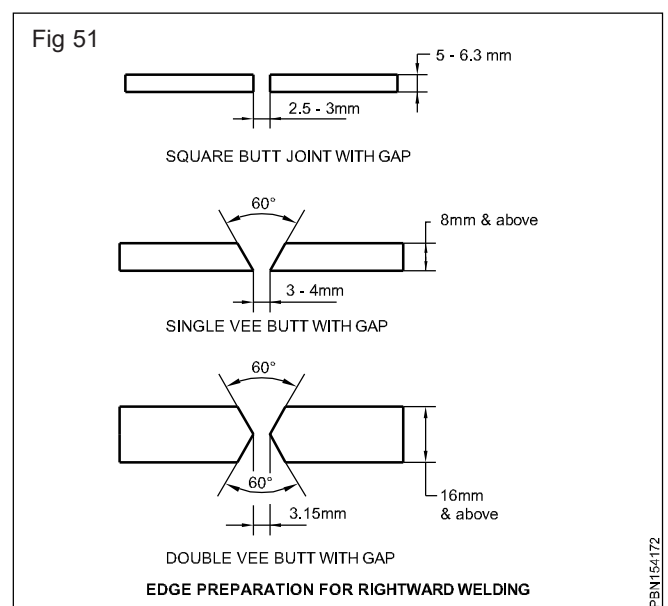
Welding is commenced at the left hand edge of the job and it proceeds to the right. The blowpipe is held at an angle of 40° - 50° with the welding line. The filler rod is held at an angle of 30° - 40° with the welding line. The filler rod follows the welding blowpipe. The welding flame is directed towards the deposited weld metal.

The filler rod is given a rotational or circular loop motion in the forward direction. The blowpipe moves back in a straight line steadily towards the right. This technique generates more heat for fusion, which makes it economical for thick steel plate welding.

Edge preparation for rightward technique (Fig 51)

For butt joints the edges are prepared as shown in (Fig 51).

The table given below gives the details for welding mild steel by rightward welding technique for Butt joints.



Application: This technique is used for the welding of steel above 5 mm thickness and 'LINDE' WELDING PROCESS of steel pipes.

Advantages: Less cost per length run of the weld due to less bevel angle, less filler rod being used, and increased speed. Welds are made much faster.

It is easy to control the distortion due to less expansion and contraction of a smaller volume of molten metal. The flame being directed towards the deposited metal, it is allowed to cool slowly and uniformly. Greater annealing action of the flame on the weld metal as it is always directed towards the deposited metal during welding.

We can have a better view of the molten pool giving a better control of the weld which results in more penetration. The oxidation effect on the molten metal is minimized as the reducing zone of the flame provides continuous coverage.

Filler rods used in gas welding

Definition of filler rod

A filler rod is a metallic wire made out of ferrous or non-ferrous metal to deposit the required metal in a joint or on the base metal.

Types of filler rods

The following types of filler rods are classified in gas welding.

- Ferrous filler rod
- Non-ferrous filler rod
- Alloy type filler rod for ferrous metals
- Alloy type filler rod for non-ferrous metals

A ferrous type filler rod has a major % of iron.

The ferrous type filler rod contains iron, carbon, silicon, sulphur and phosphorous.

The alloy type filler rod contains iron, carbon, silicon and any one or many of the following elements such as manganese, nickel, chromium, molybdenum, etc.

The non-ferrous filler rod is a filler rod which contains elements of non-ferrous metals. The composition of non-ferrous type filler rods is similar to any non-ferrous metal such as copper, aluminium. A non-ferrous alloy type filler rod contains metals like copper, aluminium, tin, etc. along with zinc, lead, nickel, manganese, silicon, etc.

Selection of the correct filler rod for a particular job is a very important step for successful welding.

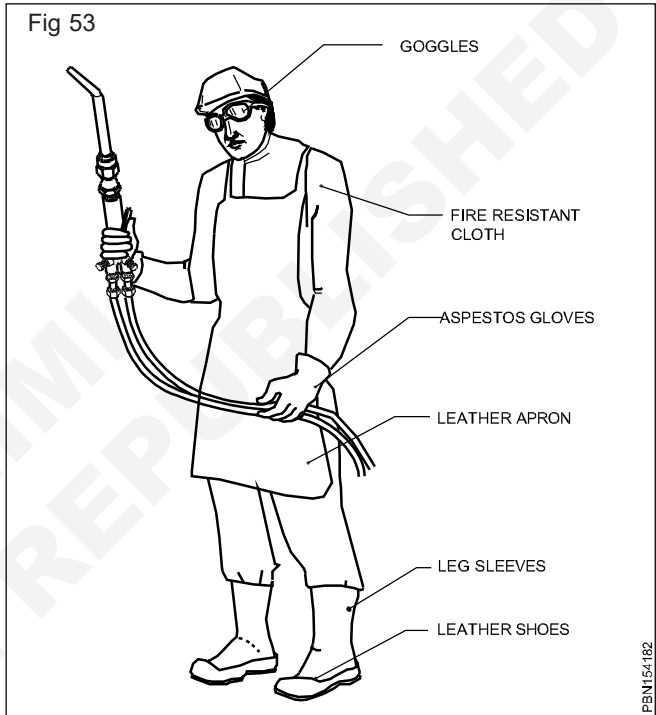
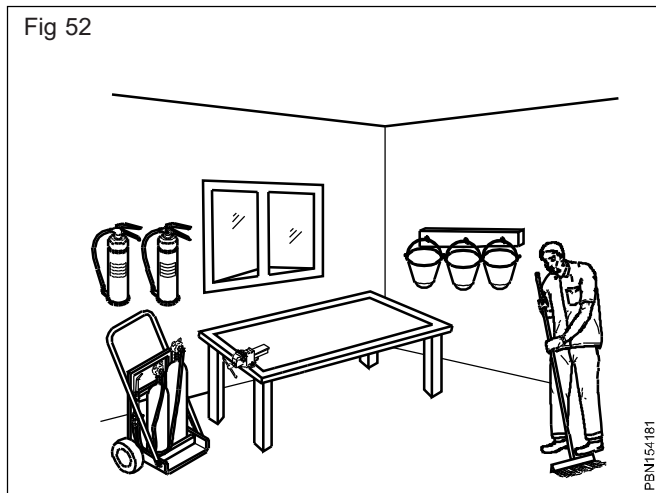
General Safety precaution

All inflammable materials should be kept away from the welding area. (Fig 52)

Always wear goggles with filter glasses during welding.

Wear fire-resistant clothes, asbestos gloves and an apron while welding. (Fig 53)

Never wear nylon or greasy clothes while welding.



Rectify the gas leakages noticed immediately as even a small leakage can lead to serious accidents.

Always keep fire extinguishing devices handy and in working order. (Fig 51)

While leaving the work area, make sure the place is free from any form of fire.

Safety concerning gas cylinders: Do not roll gas cylinders for shifting; always use a trolley to carry cylinders.

Do not drop the gas cylinders.

Close the cylinder valves when not in use or empty.

Keep the empty cylinders and full cylinders separately.

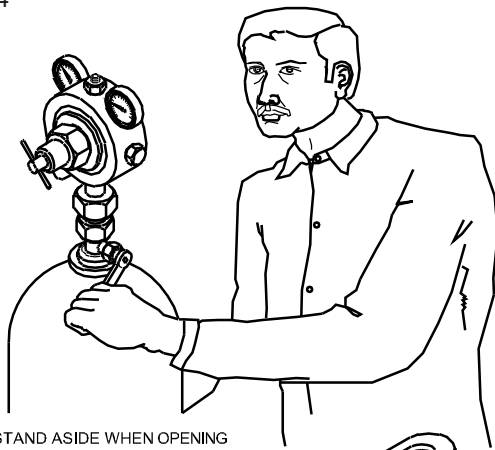
Always open the cylinder valves slowly and not more than one and a half turns.

Use always the correct size cylinder keys. (Fig 54)

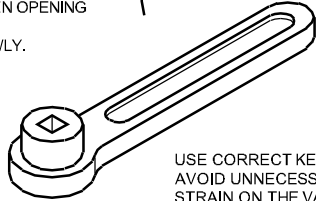
Stand aside when opening the cylinders. (Fig 55)

Do not remove the cylinder keys from the cylinders during welding. It will help to close the cylinders quickly in case of an emergency.

Fig 54



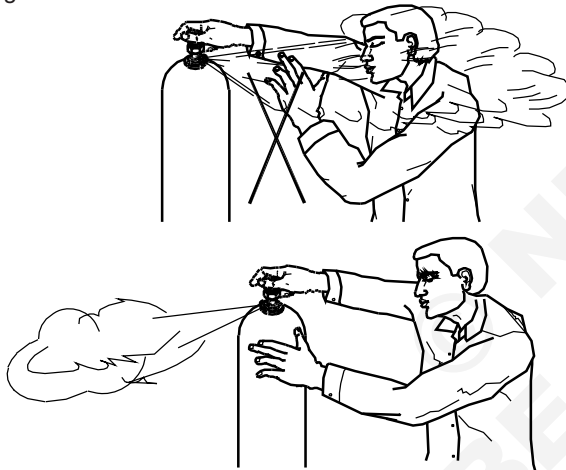
STAND ASIDE WHEN OPENING CYLINDER VALVE. OPEN VALVE SLOWLY. 1½ TURN ONLY



USE CORRECT KEY TO AVOID UNNECESSARY STRAIN ON THE VALVE

PBN154183

Fig 55

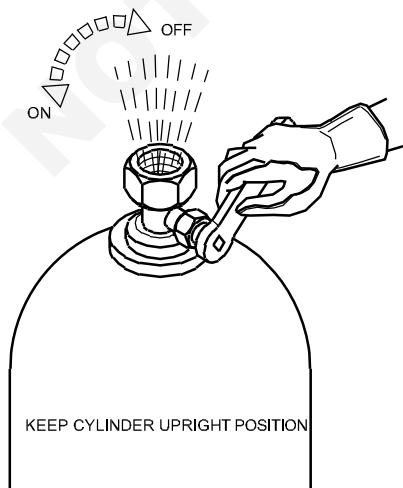


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Always keep the cylinders in an upright position keeping in view safety and ease in handling. (Fig 55)

Fig 56

BLOW OUT THE CYLINDER VALVE SOCKET BEFORE CONNECTING THE REGULATOR CRACKING OPEN THE CYLINDER VALVE MOMENTARILY



KEEP CYLINDER UPRIGHT POSITION

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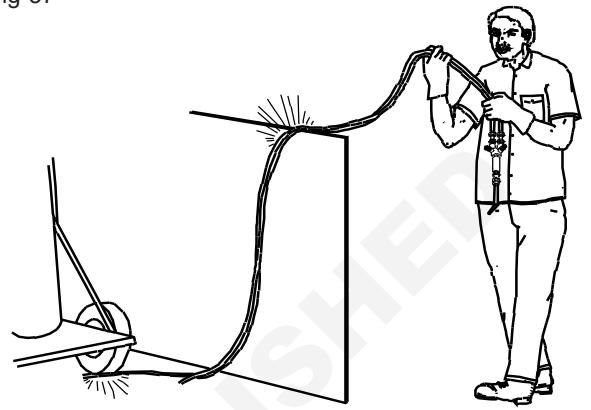
Always crack the cylinder valves to clean the valve socket before attaching the regulators.

Safety of rubber hose-pipes: Use only the type of hose recommended for use in gas welding.

Use only black coloured hoses for oxygen and maroon coloured ones for acetylene gas.

Avoid damage to the hose-pipes caused by rubbing against hard or sharp edges. (Fig 57)

Fig 57



PBN154186

Ensure that the hoses do not cross the gangways.

Do not add bits of hose together to make up the length.

Blow out the hose-pipes before connecting to the blowpipe to remove dirt or dust. Protect the regulators from water, dust, oil etc.

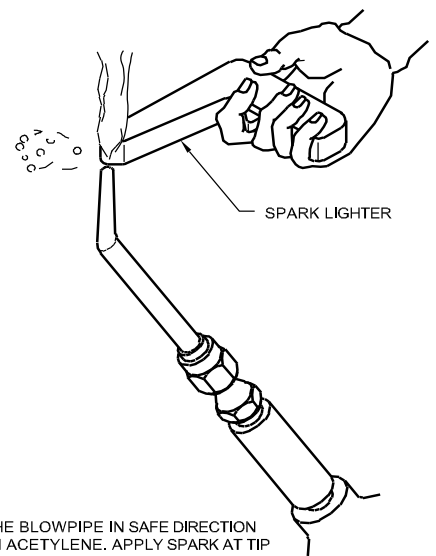
Never attempt to interchange oxygen and acetylene regulators while fitting as it can damage the threads.

Always remember the oxygen connection is right-hand threaded and the acetylene connections have left hand threads.

In the event of backfire shut both the blowpipe valves (oxygen first) quickly and dip the blowpipe in water.

While igniting the flame, point the blowpipe nozzle in a safe direction. (Fig 58)

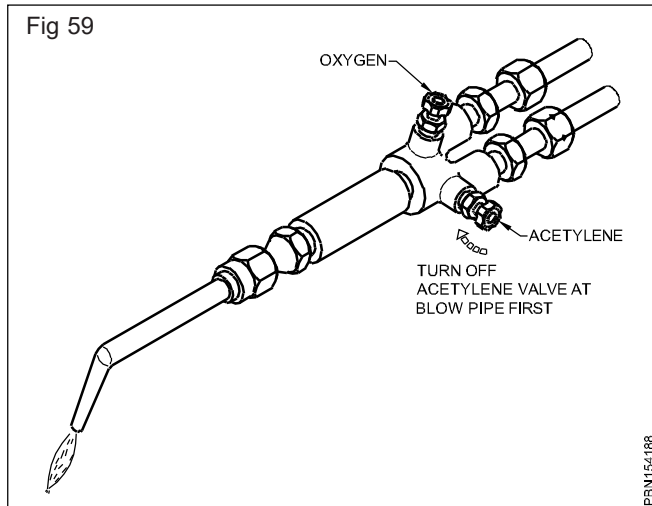
Fig 58



POINT THE BLOWPIPE IN SAFE DIRECTION TURN ON ACETYLENE. APPLY SPARK AT TIP

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While extinguishing the flame, shut off the acetylene valve first and then the oxygen to avoid backfire. (Fig 59)



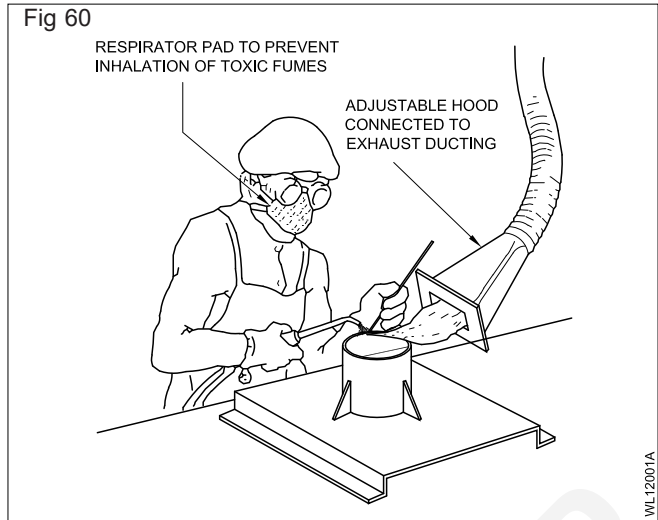
Toxic and poisonous fumes given out during welding of some materials should be collected and cleared so as to be prevented from inhaling. For this an exhaust ducting and a respirator are used. (Fig 60)

Flashback and backfire

Backfire

At certain times during flame ignition in gas welding, a small explosion of the flame occurs at the torch tip.

The flame may or may not go off. This is backfire.



Causes

A backfire is caused when;

- the gas pressure setting is low.
- the nozzle is overheated.
- the nozzle orifice is blocked by carbon or spark deposits.
- the nozzle touches the molten pool.
- there is leakage near the nozzle.

Eliminate the causes before proceeding further to avoid backfire.

Flashback: Sometimes during backfire, the flame goes off and the burning acetylene gas travels backward in the blowpipe, towards the regulator or cylinders. This is known as 'flashback'.

Method of soldering and brazing fluxes used and types fluxes precautions to be observed hard and soft solders their properties, composition and uses

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

- state the uses of soft and hard solders
- state the uses of flux and their types
- state the method of soldering and brazing
- safety precautions to be observed while soldering and brazing
- state the uses of brazing dissimilar metals.

Soldering

Soldering method

There are different methods of joining metallic sheets. Soldering is one of them.

Soldering is the process by which metals are joined with the help of another alloy called solder without heating the base metal to be joined. The melting point of the solder is lower than that of the materials being joined.

The molten solder wets the base material which helps in binding the base metal to form a joint.

Soldering should not be done on joints subjected to heat and vibrations and where more strength is required.

Soldering can be classified as soft soldering and hard soldering. Hard soldering is further divided as (a) brazing (b) silver brazing.

The process of joining metals using tin and lead as a soldering alloy which melts below 420°C is known as soft soldering.

The process of joining metals using copper, zinc and tin alloy as filler material in which the base metal is heated above 420°C but below 850°C is called brazing.

Silver brazing is similar to brazing except that the filler material used is a silver-copper alloy and the flux used is also different.

Soldering iron

Soldering iron

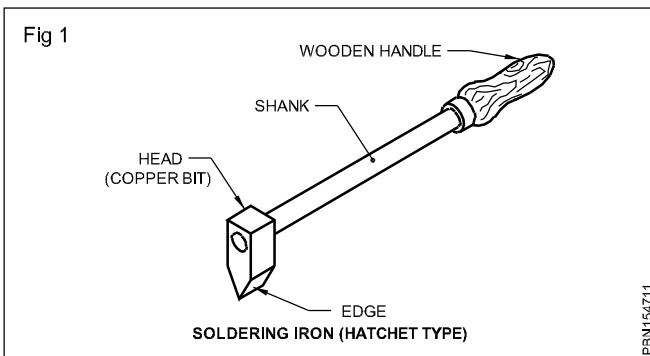
The soldering iron is used to melt the solder.

Soldering irons are normally made of copper or copper alloys. So they are also called as copper bits.

Copper is the preferred material for soldering bit because

- it is a very good conductor of heat.
- molten tin lead alloy easily adheres to it.
- it is easy to maintain in serviceable condition.
- it can be easily forged to the required shape.

A soldering iron has the following parts. (Fig 1)



- Head (copper bit)
- Shank
- Wooden handle
- Edge

In the above soldering iron copper tip is heated by a forge. Electric soldering iron which are heated by electrical heating elements are also very frequently used for soldering operation.

Soldering Flux

All metals get oxidised when exposed to the atmosphere. This oxide layer must be removed before soldering because it affects proper formation of the joint. For this, a chemical compound called flux is applied to the joint.

Function of the fluxes

- 1 Fluxes remove oxides from the soldering surface. It prevents corrosion.
- 2 It forms a liquid cover over the workpiece and prevents further oxidation.
- 3 It helps molten solder to flow easily in the required place by lowering the surface tension of the molten solder.

Sl.No.	Types of solder	Tin	Lead	Application
1	Common solder	50	50	General sheet metal applications
2	Fine solder	60	40	Because of quick setting properties and higher strength
3	Fine solder	70	30	They are used for copper water tanks, heaters and general electrical work.
4	Coarse solder	40	60	Used on galvanised iron sheets
5	Extra fine solder	66	34	Soldering brass, copper and jewellery
6	Eutectic alloy	63	37	Similar to fine solder

Selection of flux

The following criteria are important for selecting a flux.

- Working temperature of the solder
- Soldering process
- Material to be joined

Safety Precautions in Soldering

Safety precautions followed while soldering

- 1 Wear safety glasses to protect your eyes from solder splattering and flux.
- 2 Be careful while storing hot soldering irons after use to avoid burns.
- 3 Wash your hands thoroughly after using soft solder because it is poisonous.
- 4 Tin the soldering iron in a well ventilated area to exhaust fumes coming out while soldering.

- 5 Wear safety goggles when using acids for cleaning.
- 6 When making acid solution, always pour acid into water slowly.
- 7 Never pour water into the acid.
- 8 All inorganic fluxes are poisonous.
- 9 Wear goggles and gloves while handling corrosive flux.

Brazing

Brazing is a process of jointing two similar or dissimilar metals with the help of some fusible alloy.

Brazing is essentially similar to soldering but it gives a much stronger joint than soldering. The principal differences is the use of a harder filler material, commercially known as spelter which fuses at some temperature above red heat, but below the melting temperature of the parts to be joined. Filler materials used in this process may be divided into two classes. Copper base alloys and silver base alloys. There are a number of different alloys in each class, but

brass (Copper and zinc) sometimes with upto 20% tin are mostly used mainly for brazing the ferrous metals. Silver alloys (silver and copper or Silver and copper and Zinc) having a melting point range of 600 to 850° C are suitable for brazing any metals capable of being brazed. They are giving a clean finish and a strong ductile joint. Shelters are commonly made according to the thickness of sheets.

After brazing, the joint must be hammered to check the leakages and to remove flux. Mostly and commonly used flux is "Borax" for ferrous and non - ferrous metals. It removes rust and prevents atmospheric effect, when brazing operation is going on.

Different kinds of brazing joints

- **DIP brazing:** In this method assembled parts are dipped in a flux kept at a temperature required to melt the filler metal.
- **Furnaces brazing:** In this method the parts are kept in a furnaces maintained at a temperature that will melt the filler metal.
- **Torch brazing:** In this method the heat is applied by oxy - acetylene flame and the brazing rod is melted with addition of flux.
- **Electric brazing:** In this method the heat to melt the filler metal is applied by arc, resistance or induction heating technique.

Forging

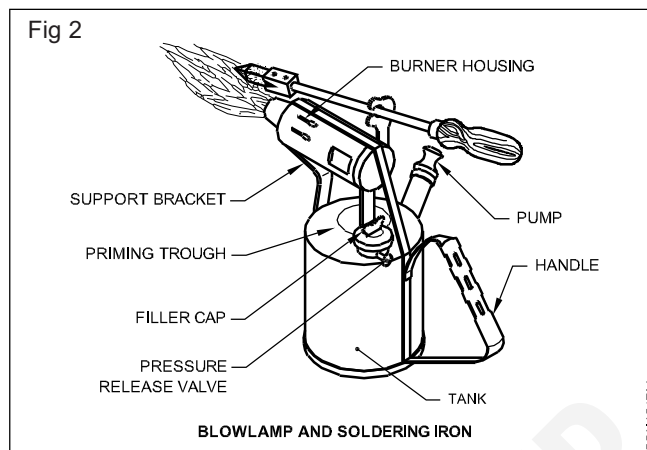
Blow lamp

The parts of blow lamp are detailed below. (Fig 2)

- 1 Fuel tank
- 2 Handle
- 3 Pump
- 4 Pressure release valve
- 5 Filer cap
- 6 Priming trough

7 Support bracket

8 Burner housing



Safety precautions to be followed

If the liquid kerosene is emitted from the jet during pumping to pressure tank, the pressure valve should be operated quickly.

If the lamp is blown at the wind or extinguished, the pressure valve should be opened to prevent kerosin vapour from tank in the air.

The flame should not be directed at flammable material.

After the work is over, the flame should be extinguished by pressure relief valve.

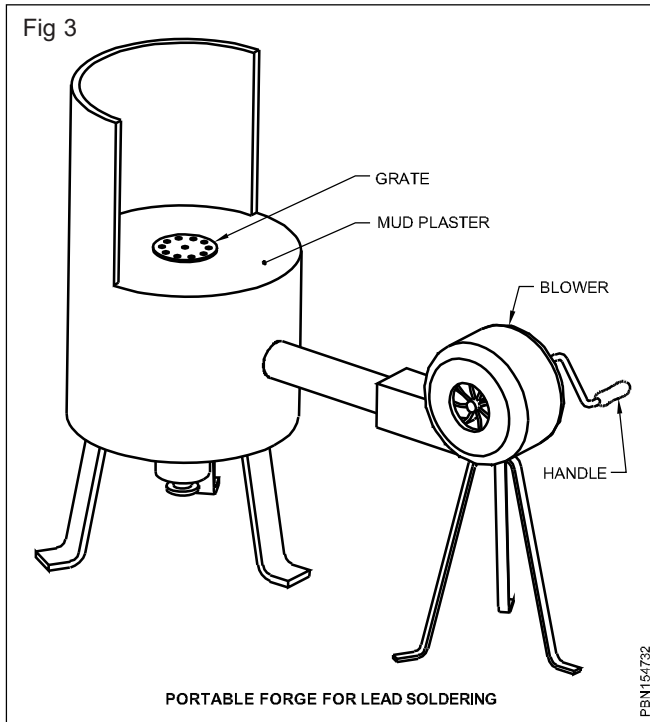
Hand forge (Portable)

Hand forge is commonly used for heating purpose where pipe brazing pig lead melting, plumbers solder heating are done. (Fig 3)

It is a portable one.

Composition of spelter and melting points

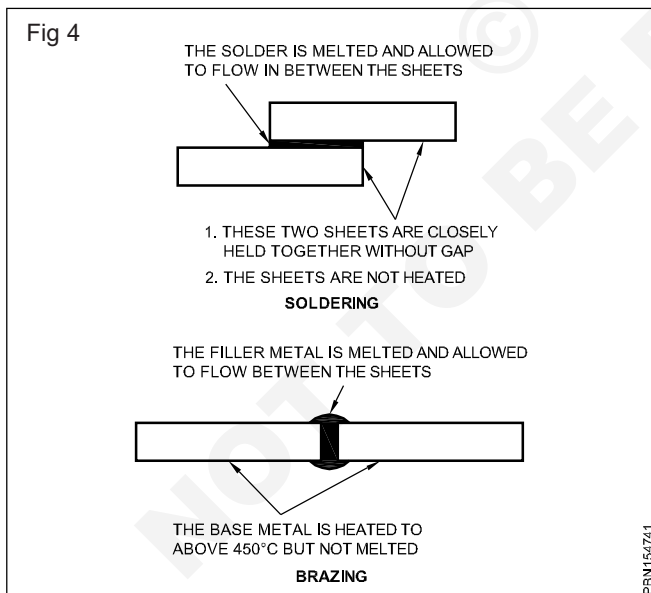
SI No	Types of spelters	common metals	copper %	Zinc %	Silver %	Melting temperatures	Uses
1	Copper + Zinc base spelter	Common	60	40	NIL	850°C	Hard brazing on copper and non - ferrous\
2	- do -	Ferrous metals	80	20	NIL	600°C	Brass sheet thick
3	- do -	Brass	30	70	NIL	400°C	Brass sheet thin
4	Silver solder	Gold	10	10	80%	350°C	It is used for gold or naments brazing.



Soft soldering, brazing and silver brazing

Soldering and brazing

The soldering and brazing processes differ from welding in the sense that there is no direct melting of the base metal(s) being welded. In brazing or soldering, the filler alloy flows between two closely adjacent surfaces by capillary action. (Fig 4)



Soft soldering

The filler metals used in soldering have a melting point below 427°C.

The alloys used for soft soldering are:

- tin-lead (for general purpose soldering)
- tin-lead-antimony
- tin-lead-cadmium.

The process is referred to as 'soft soldering'. The heat required for 'soft soldering' is supplied by a soldering iron, whose copper tip is heated either by a forge or electrically.

Composition of soft solder

Usually soft solder is an alloy of lead and Tin in different ratios depending on the base metals soldered and the purpose of soldering.

Soft solders are available in different shapes and forms such as stick, bar, paste, tape or wire etc.

Types of fluxes

Corrosive

In this type the solution contains inorganic substances like zinc chloride, ammonium chloride, hydrochloric acid. This type of flux leaves a corrosive deposit on the base metal surface which must be thoroughly washed off after soldering. This type of flux is not used on electrical works or where the joint cannot be effectively washed.

Non-corrosive

These are fluxes based on resin. These leave a non-corrosive residue. They are used on electrical works, instruments like pressure gauges, and parts where washing is difficult.

Suitable fluxes for various materials

Steel - zinc chloride

Zinc and galvanized iron - hydrochloric acid

Tin - zinc chloride

Lead - tallow resin

Brass, copper, bronze - zinc chloride, resin.

Brazing: Brazing is a metal joining process which is done at a temperature of above 450°C as compared to soldering which is done at below 450°C.

So brazing is a process in which the following steps are used.

- Clean the area of the joint thoroughly by wire brushing, emerying and by chemical solutions for removing oil, grease, paints etc.
- Fit the joints tightly using proper clamping. (Maximum gap permitted between the two joining surfaces is only 0.08mm)
- Apply the flux in paste form (for brazing iron and steel a mixture of 75% borax powder with 25% boric acid (liquid form) to form a paste is used). Usually the brazing flux contains chlorides, fluorides, borax, borates, fluoroborates, boric acid, wetting agents and water. So suitable flux combination is selected based on metal being used.

Brazing is employed where a ductile joint is required.

Brazing filler rods/metals melt at temperature from 860°C to 950°C and are used to braze iron and its alloys.

Brazing fluxes

Fused borax is the general purpose flux for most metals.

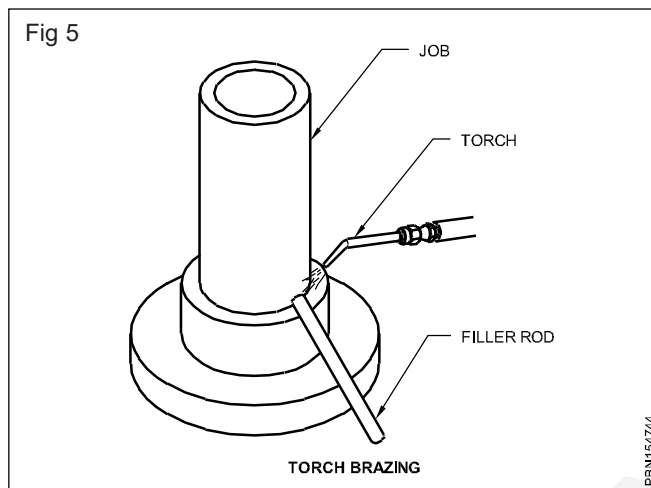
It is applied on the joint in the form of a paste made by mixing up with water.

If brazing is to be done at a lower temperature, fluorides of alkali materials are commonly used. These fluxes will remove refractory oxides of aluminium, chromium, silicon and beryllium.

Various methods of brazing

Torch brazing

The base metal is heated to the required temperature by the application of the oxy-acetylene flame. (Fig 5)



Advantages of brazing

The completed joint requires little or no finishing.

The relatively low temperature at which the joint is made minimizes distortion.

There is no flash or weld spatter.

The brazing technique does not require as much skill as the technique for fusion welding.

The process can be easily mechanised.

The process is economical owing to the above advantages.

Disadvantages of brazing

If the joint is exposed to corrosive media, the filler metal used may not have the required corrosive resistance.

All the brazing alloys lose strength at an elevated temperature.

The colour of the brazing alloy which ranges from silver white to copper red may not match the base metal very closely.

Name and description of mason's hand tools, types and their uses

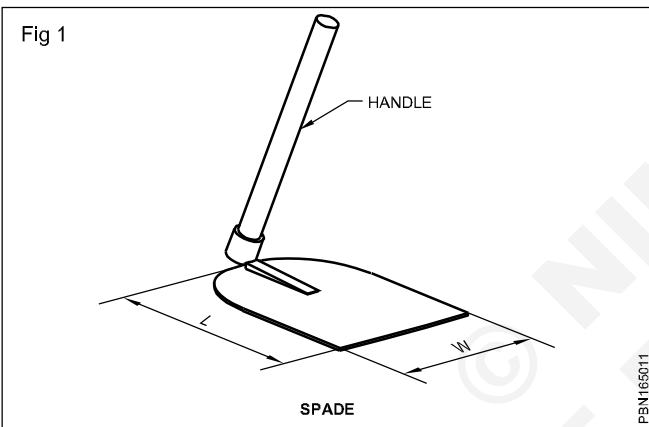
Objectives: At the end of this lesson you shall be able to

- state the uses of masons hand tools
- state the types of tools for various processes
- state the levelling tools uses
- state the setting out process with line and pin
- state the cutting of bricks with brief cutting tools.

Masons' tools

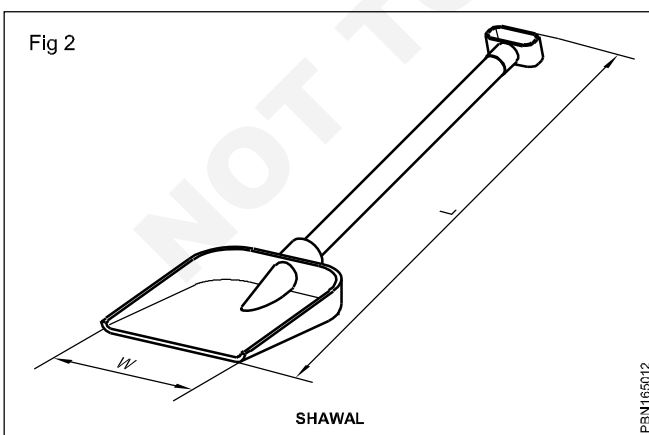
Spade

Spade is used for earth work excavation, mixing mortar and mixing concrete. It is manufactured out from tool steel. It consists of plate form with eye hole to hold handle. Wooden handle is fixed with help of a wedge at an inclination in the eye hole. Size is designated by it's width and length. (Fig 1).



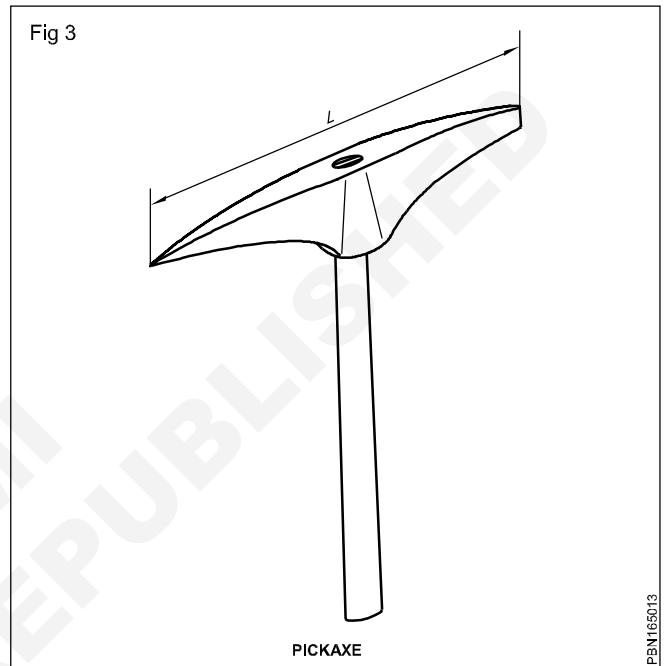
Shawl

Shawl is used for mixing concrete and also for carrying concrete to mortar pans. Shawals are made of tool steel sheets. The size is designating by its lengths and widths. (Fig 2).



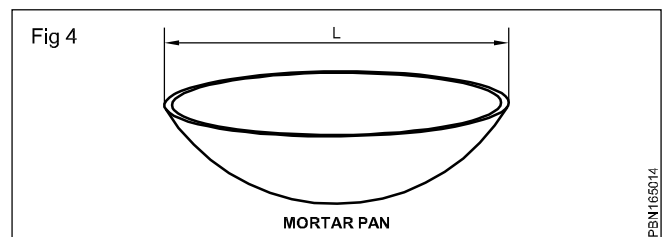
Pickaxe (Fig 3)

Pickaxe is used to excavate hard soils. It is manufactured from tool steel. One end of the pickax is flat while the other end is sharp. It helps for two different operations. The size is denoted by its lengths.



Mortar pan

Motar pan is used to carry the excavated material, cement mortar, concrete etc. It should never be used as a measure for mixing cement mortar etc. It is manufactured out from mild steel sheet. The size is designated by its radius at top. (Fig 4).



Masonry tools

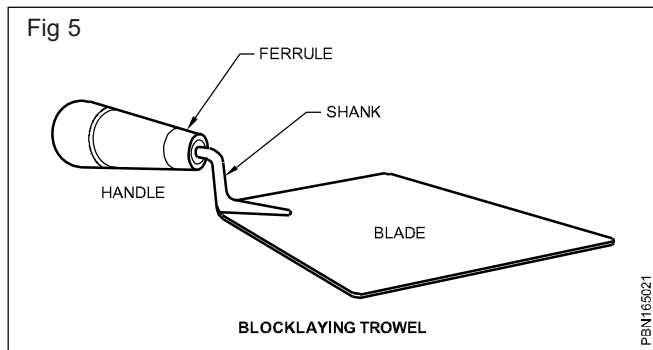
- 1 Laying tools
- 2 Wall straightening tools
- 3 Cutting and Trimming tools
- 4 Finishing tools.

1 Laying tools

Block Trowel (Fig 5)

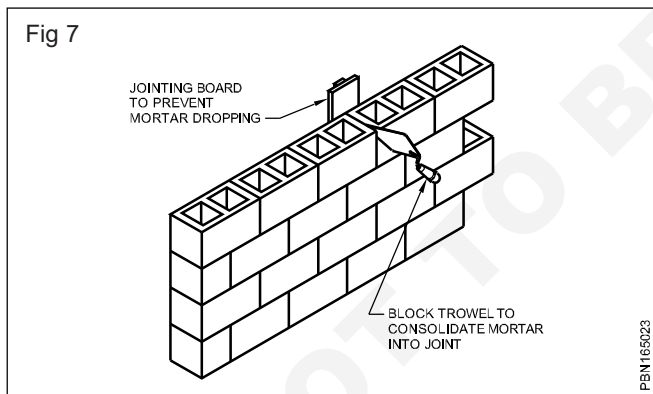
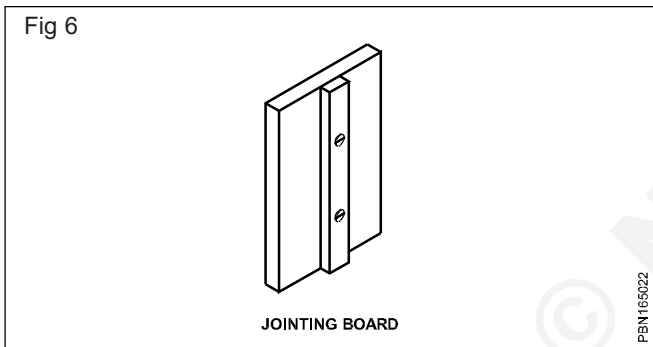
This is a tool which every block layer and concreter must possess used for picking up mortar from the mortar board,

spreading it on the wall for bed joints, forming cross joints on blocks, cutting of excess mortar and consolidating cross joints. It is also used for tapping down laid blocks and for rough cutting of blocks.



Jointing Board (Fig 6)

The jointing board can be made quite easily from either a 25mm thick piece of wood or a 19mm thick piece of plywood. It measures 300mm long by 75mm wide, with a 25mm gripping piece screwed to the back. Its use as a tool is to facilitate the filling of cross joints to prevent mortar dropping (Fig 7)



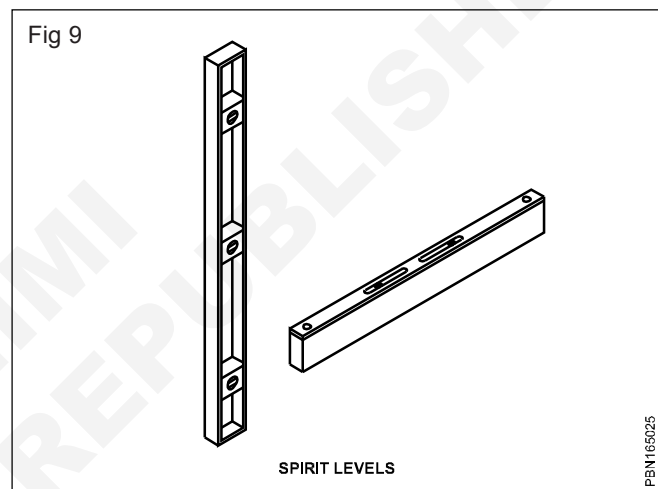
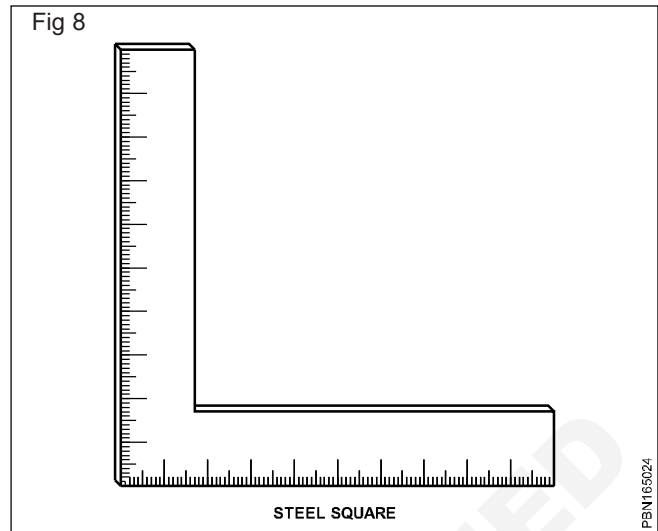
Steel square (Fig 8): This tool is used in checking whether or not the angle formed by two walls meeting one another is 90°. It is marked in millimeters and measures 600mm by 450mm.

2 Wall Straightening Tools

Spirit level (Fig 9)

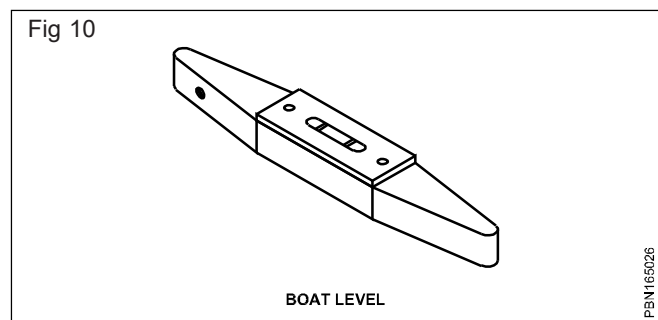
The spirit level or plumb level as it is sometimes called is a very useful tool in the Brick layer or Block layer's toolkit. It may be made of wood or metal with straight edges. It is fitted with 3 spirit tubes for levelling and plumbing. These spirit tubes are fitted one at each end with single tubes used for checking the plumb of the wall, and other two

tubes fitted at the centre for checking levels. The most common type is 1 metre long.



Boat level (Spirit level) (Fig 10)

This level performs the same functions as the spirit level or plumb level. But is used mainly at small openings. Boat levels measure from 225 mm to 300mm

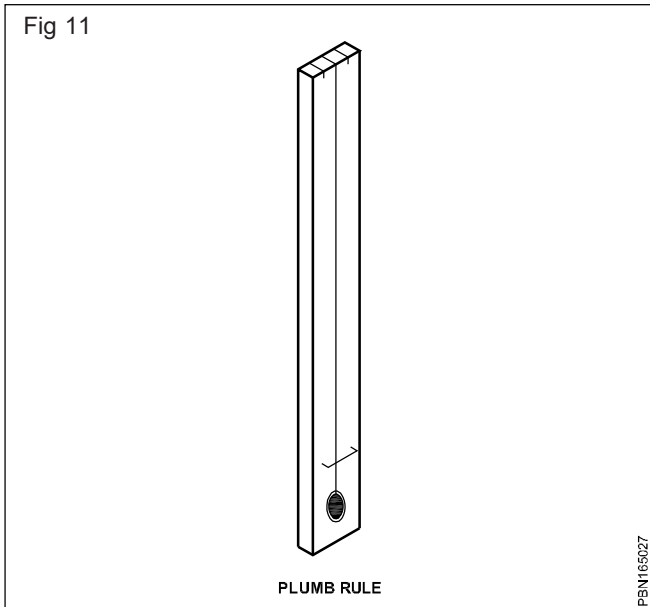


Plumb rule

This is a straight edge with a cut line running down the centre from the top from the bottom edge where a hole is made slightly larger than the plumb bob.

The plumb bob is an egg shaped angle piece of steel or lead held in position by a plumb line.

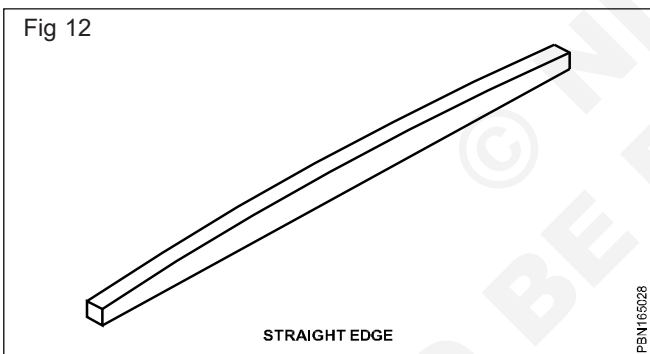
This tool ensures a very accurate vertical check as shown in (Fig 11).



Straight edge (Fig 12)

This is a piece of timber or Aluminium hollow piece of a length to suit its purpose, a convenient length for the brick layer or Block layer being 2 meters. It is beveled at both ends to reduce the overall weight in the case timber.

The straight edge is used to check the flatness of a newly laid piece of wall and ensure that all blocks or bricks are laid to the same level in each course.



Gauge Rod or Rule (Fig 13)

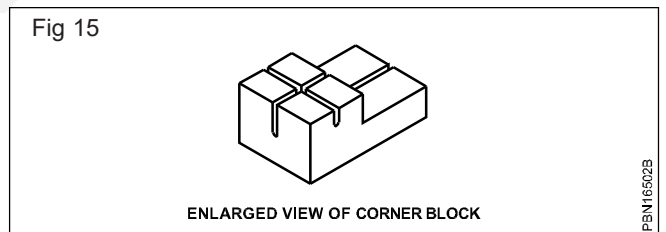
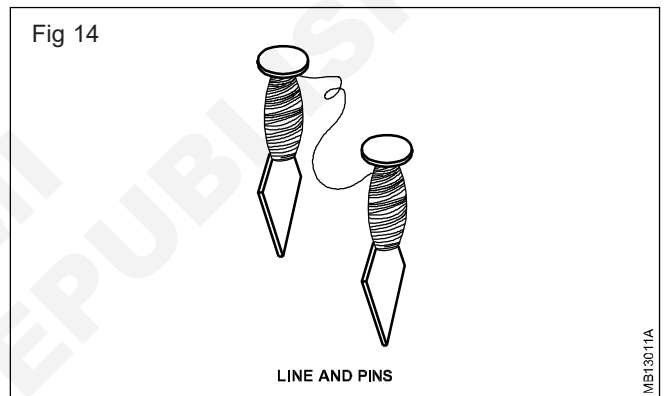
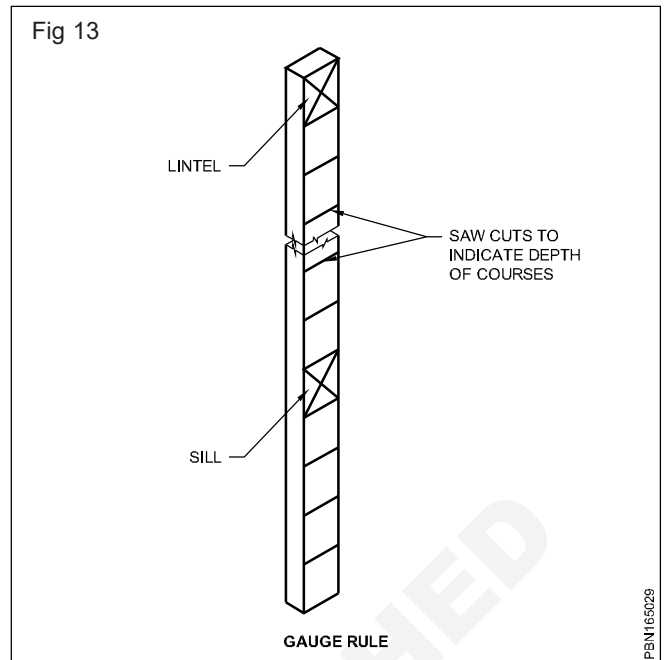
The Gauge rule should be sufficiently long. It has the depth of Block courses or Brick courses including mortar joints thickness marked on it. In addition to the courses of Bricks or Blocks, various important levels such as sill level, springing level are marked on it.

Line and Pins (Fig 14)

The line is usually made of hemp or nylon. It is wound round the spear like steel pins. To use this tool, the pins are each pushed into a joint at each end or Quoin of the wall to hold the line tant. Each course is then laid using the line as a guide. The blocks or bricks being laid to leave just a strip of daylight between their edges and the lines so that they do not actually touch it.

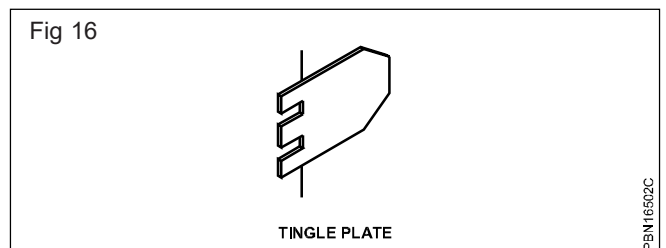
Corner Blocks

Where glazed work is involved and the joints are so tight that pins cannot be inserted into them, corner blocks are used instead of pins to hold the line tant. as shown in (Fig 15)



Tingle plate

This is a small metal plate with three fingers at one end used to take up the sag of the line. A common size is 100mm long as shown in (Fig 16)

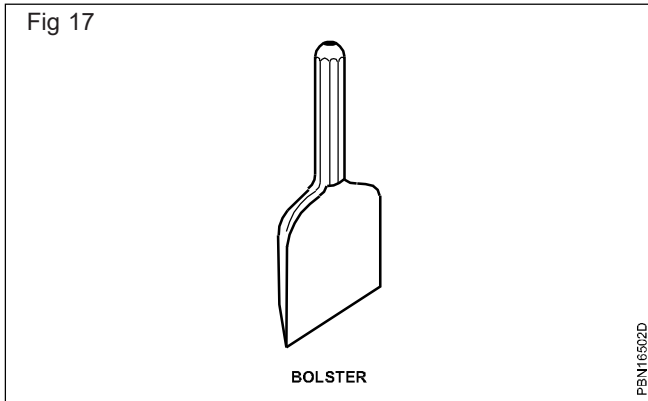


3 Cutting and Trimming Tools

Bolster (Fig 17)

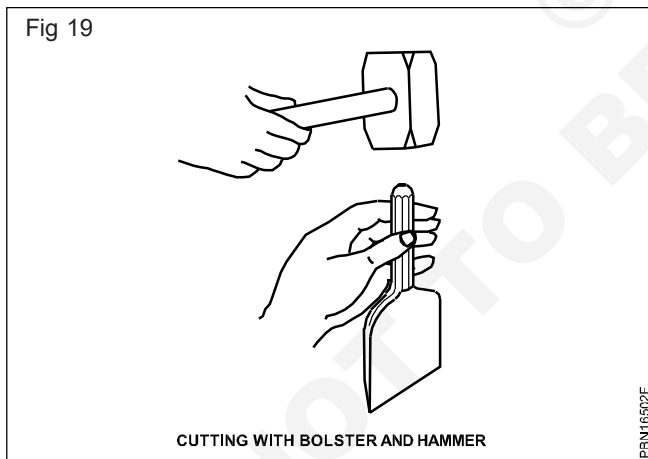
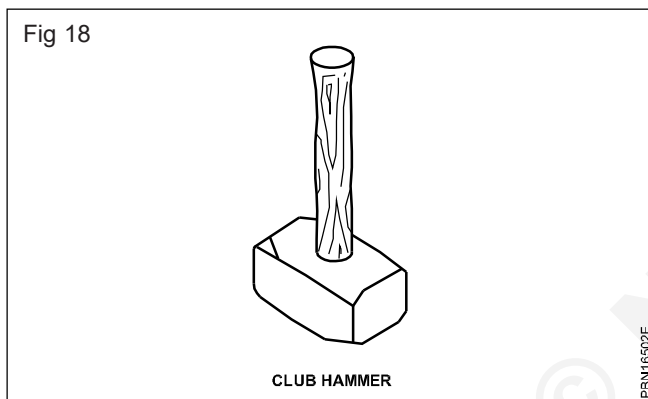
The bolster is used for the clean cutting of Blocks and concrete components. It has a blade whose cutting edges ranges from 75mm to 125mm wide with a slight convex curve. It is hardened for cutting. The stock or striking end

is left unhardened to prevent pieces of metal braking and flying off when struck with hammer.



Club Hammer (Figs 18&19)

The club Hammer is made in two ranges those with the steel head weighing 1.135Kg and those with 1.81kg head. It is fixed to a handle about 225mm long. This tool is used together with the bolster for cutting purposes.



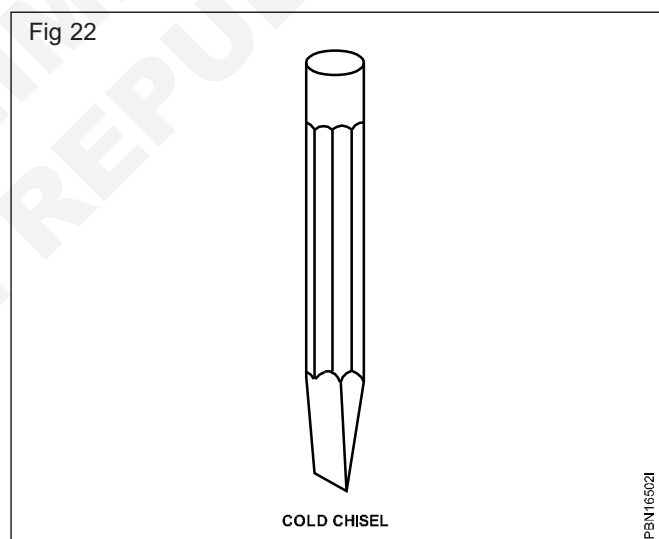
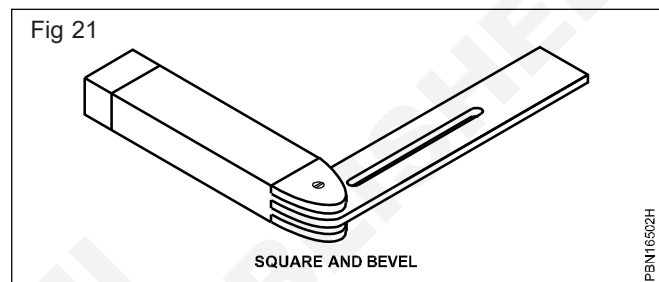
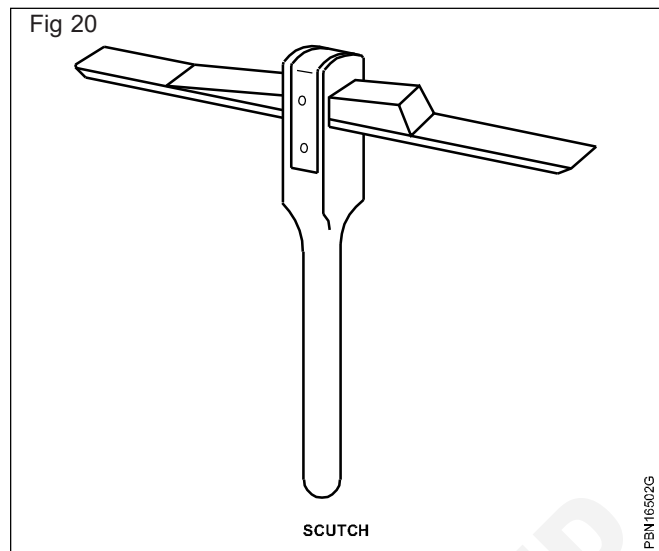
Scutch: The scutch consists of a stock wedge and reversible blade. It is used for trimming a block when cut. as shown in the (Fig 20)

Square and bevel (Fig 21)

The square and bevel are used for marking splayed cuttings.

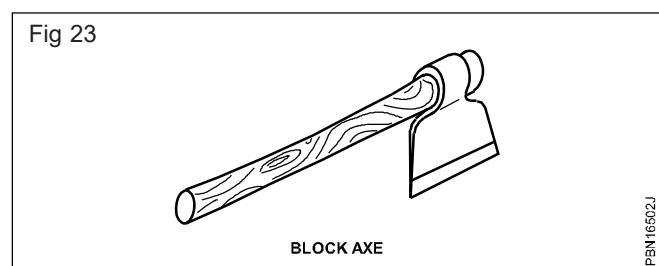
Cold chisel (Fig 22)

The cold chisel is made in varying lengths and thickness from 6.25mm x 400mm to 25mm x 450mm They are made of steel with the cutting edge and the stock treated in a similar manner to those of a bolster.



Block Axe (Fig 23)

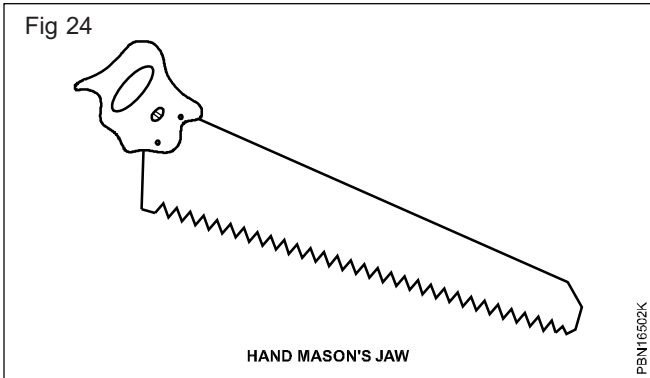
The block axe is very popular among block layers. It is used for cutting blocks into required dimensions and for cleaning the cut edges in much same way as a scutch is used.



Hollow blocks are difficult to cut with the success using a bolster and Hammer, because of the thickness of the ribs bounding the holes.

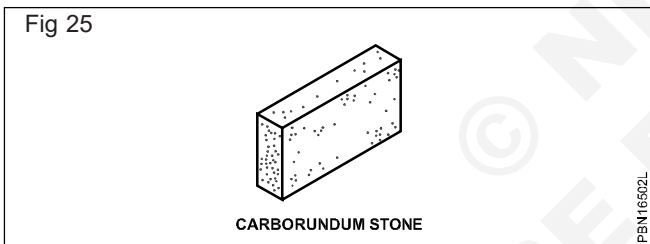
Mason's hand saw (Fig 24)

The hand saw with 12mm teeth is used for cutting soft stones and sand crete blocks. The saw is similar in all respects to the carpenter's hand saw except that the mason's hand saw is set with chisel shaped teeth of the necessary clearance for the saw cut. When cutting a block with saw, the block is first soaked with water and kept wet throughout cutting operation. The water acts as a lubricant to minimise friction between the saw and the block.



Carborundum stone (Fig 25)

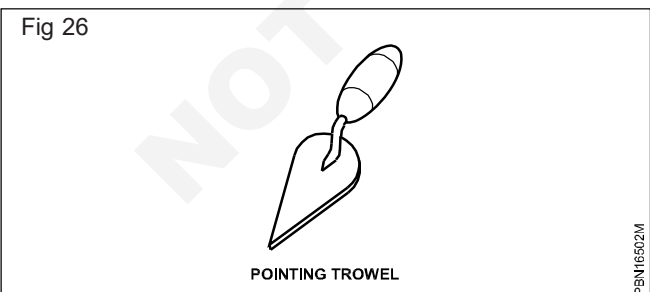
A carborundum stone is used for rubbing down the cut edges of blocks.



4 Finishing Tools

Pointing Trowel (Fig 26)

This is smaller in shape and lighter than the laying Trowel. It is used for filling in the joints of a Brick or Block wall during the pointing operation.



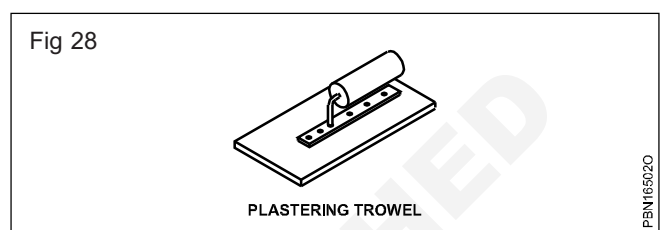
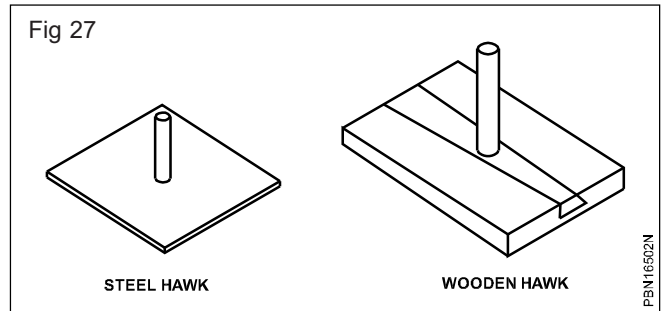
Hawk (Fig 27)

The Hawk is a hand board made from wood, steel or aluminium and is used to carry mortar while pointing or plastering.

Plastering Trowel (Fig 28)

Made of steel with a rectangular face of about 275mm by

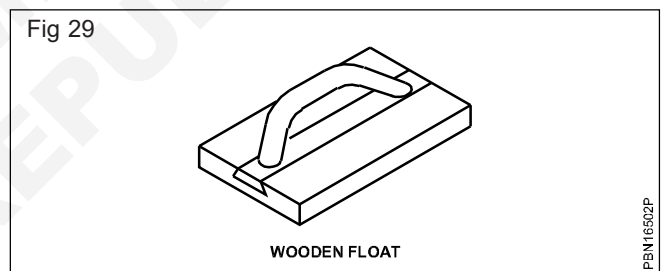
125mm The plastering Trowel is used for laying mortar on the wall surface and when final coat is applied it is used as finishing tool to give a very smooth surface to the walls.



Wooden float (Fig 29)

The cross grained wooden float, as the name implies, has grains running across the sole.

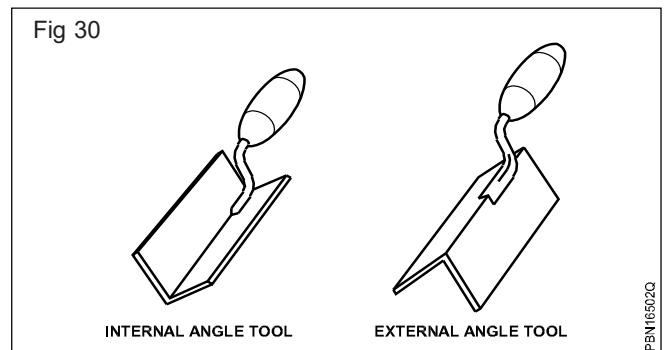
It is used for scouring of excess mortar on the surface of the wall finishing coats and making angles square and clean.



Angle tool (Fig 30)

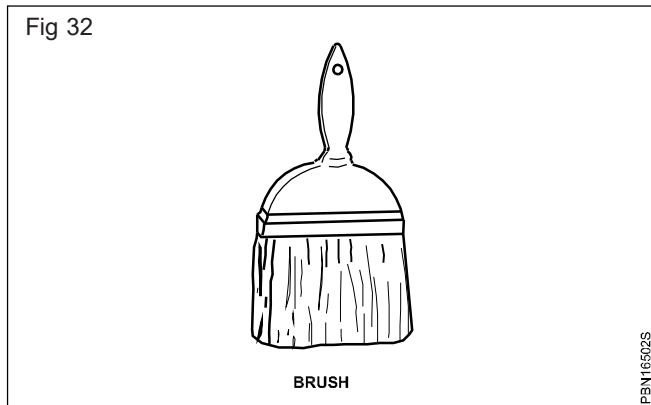
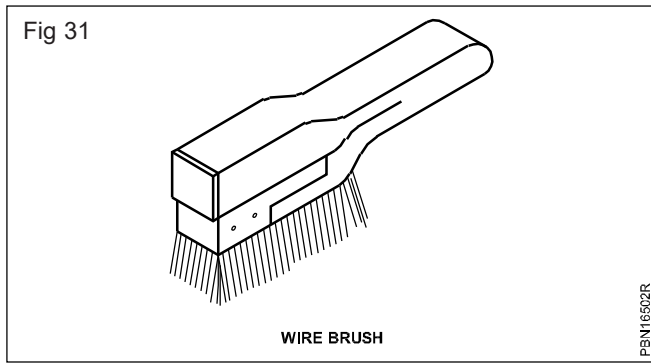
These are made with either wooden or steel plate bent into angle of 90°. It is used for finishing angles in neat and square form.

- A Internal angle Tool
- B External angle Tool



Wire brush (Fig 31)

Used for multi purposes such as cleaning the joints of Brick work or block work, before pointing operations removing dirt from plastered surfaces before a painting operation and cleaning tiled work etc. (Fig 32)



Joint cluster

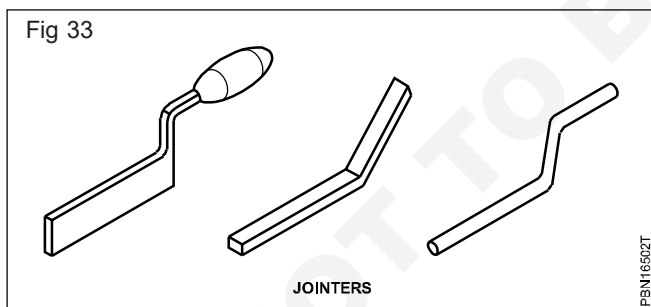
The job of pointing in brick work and jointing block wall is much improved by finally using a joint cluster.

It is used to remove the excess mortar pieces from the finished work.

It is a convenient tool to use in wetting the joints before and as the work proceeds.

Jointing tools

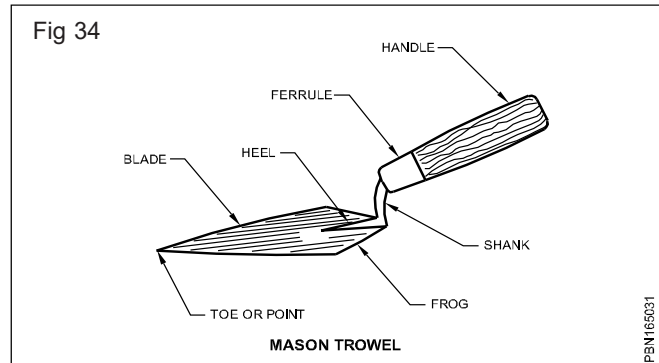
These are popularly called jointers. They are of three main shapes as shown in the (Fig 33)



Different types of tools and equipment used in masonry

All trowels consists of six main parts (Fig 34)

- 1 The Handle
- 2 The Blade
- 3 The Steel Tang
- 4 The Ferrule
- 5 The Toe
- 6 The Heel

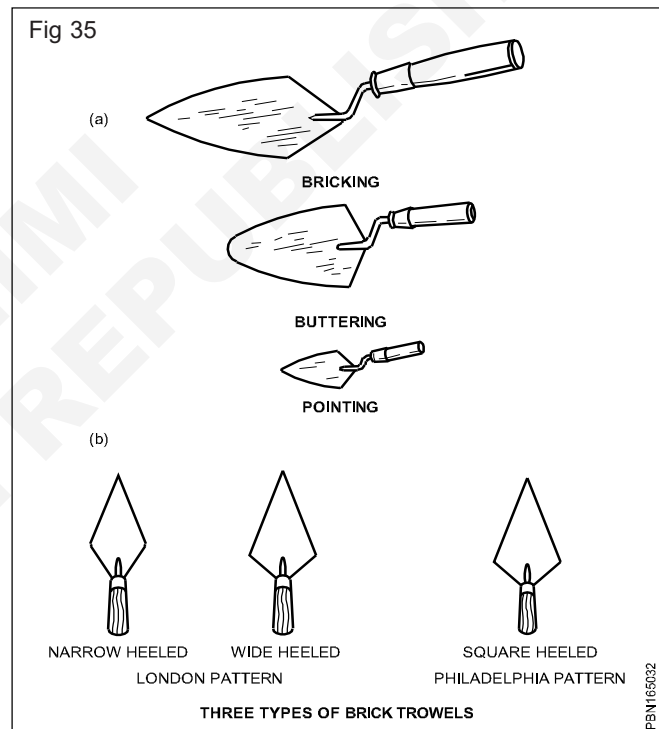


The Blade of the Trowel is made from Highly tempered select steel.

Types of Trowel

Mason's Trowel

The Mason's trowel is a flat piece of steel ground to the proper balance, Taper and Shape as shown in the (Fig 34) and (Fig 35), (Fig 35 (A) & (B))

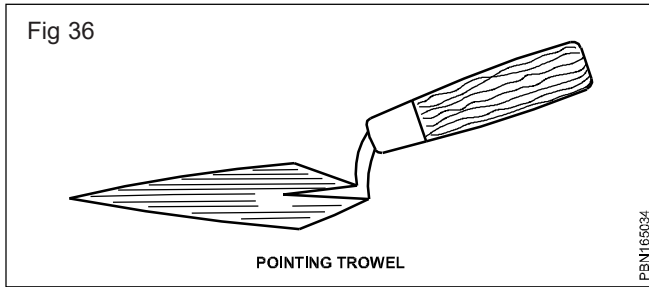


- The blade side or edge is also used for tapping brick into place or alignment.
- The blade side is used for cutting off excess Mortar, cutting soft bricks.
- The End of the handle is used for Tapping the masonry units to level or settle them to place.
- The Toe of the trowel is used for furrowing the mortar.

Pointing Trowel (Fig 36)

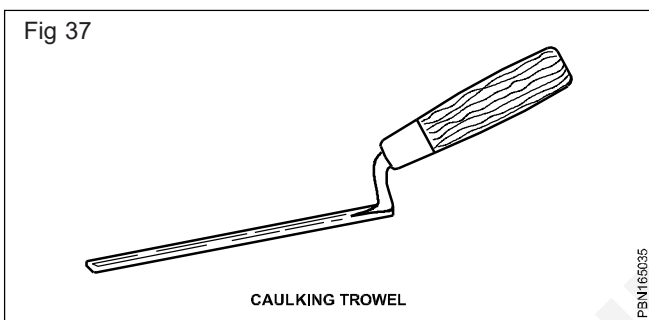
- Pointing Trowel blade is much narrow end than toe mason's Trowel.
- Used for 'Pointing'
- Used for making 'V' Joint.

- Used for applying mortar in small areas and small piece of work.



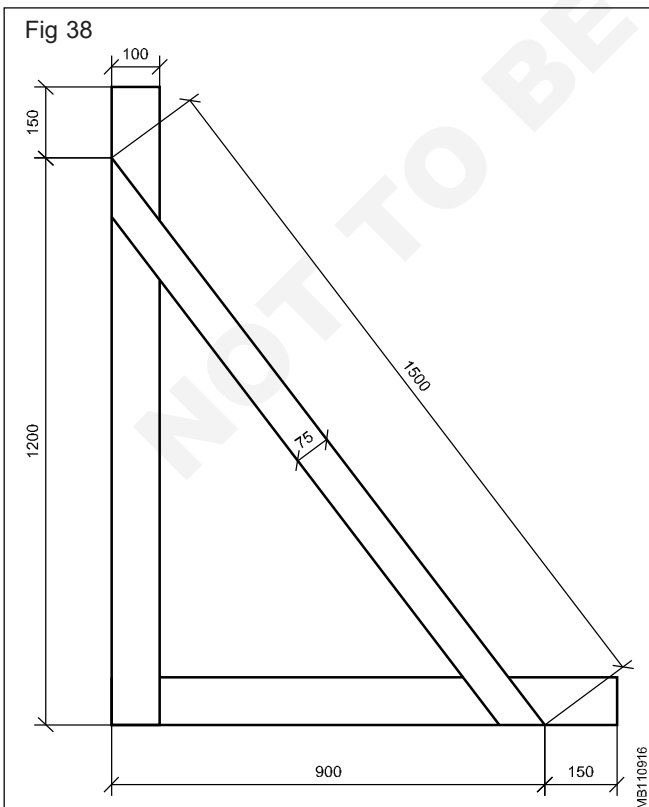
Caulking Trowel (Fig 37)

- Caulking Trowel (Fig 37)
- Caulking Trowel Blade is uniformly narrow
- Used for filling, finishing joints with mortar
- Used for filling special adhesive



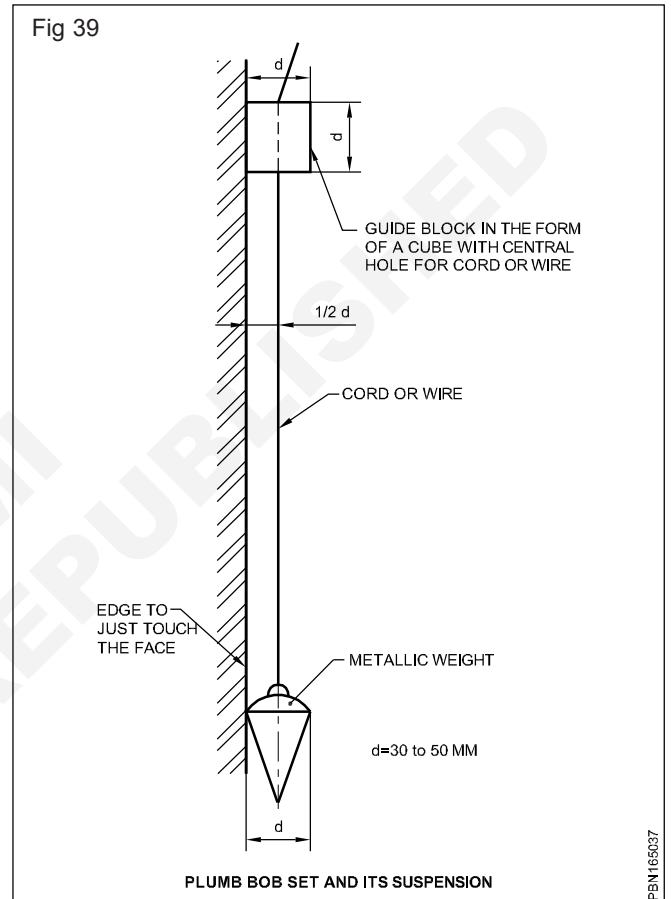
Builders square

- Builders square is a timber square as shown in (Fig 38)
- Used for setting out and checking for squareness with the aid of a straight edge or plumb rule.



Plumb bob

- Plumb bob set is a Brass or mild steel cone of 30 to 50mm overall diameter as shown in (Fig 39).
- A piece of cord (usually nylon) passes centrally to the conical weight.
- Suspended wood piece in the shape of cube, or a metal piece in the shape of a rod and of side dimension equal to the diameter of the plumb bob.
- The wood or metal piece will have a central hole through which the cord is threaded.



Mason's Square

- consists of two arms of rectangular Mild steel piece at right angles to each other as shown in (Fig 40).
- the external angle as well as the internal angle of the arms shall be 90°.
- one of the arm is graduated to measure or read lengths.
- used for laying right angles of the measurements.

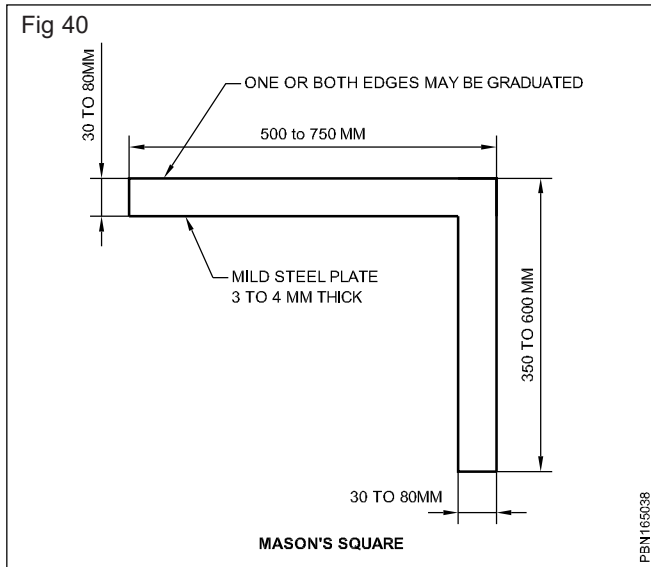
Basic layout tools

The following constitutes the types of basic layout tools

- 1 The wooden peg
- 2 The wooden profile
- 3 The line thread
- 4 The Nails
- 5 The Lime powder

6 The Hammer

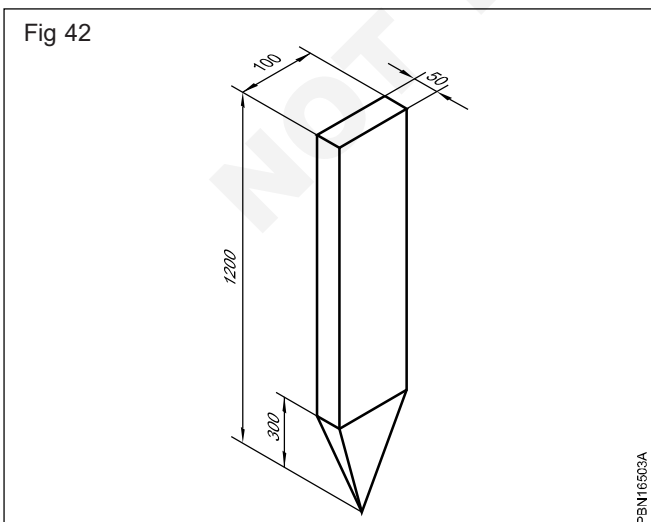
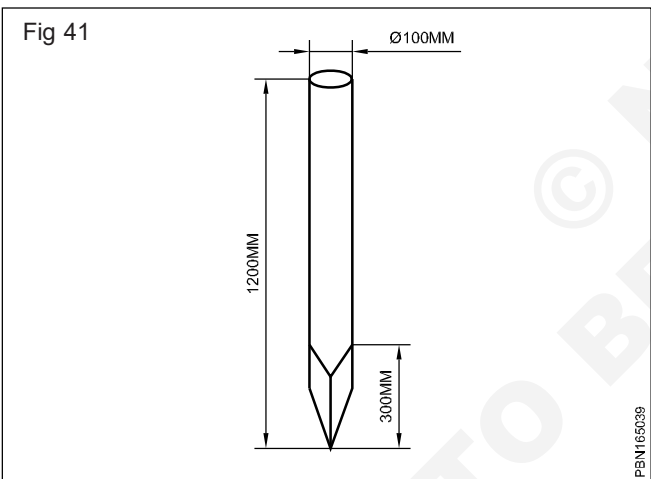
7 The Handsaw



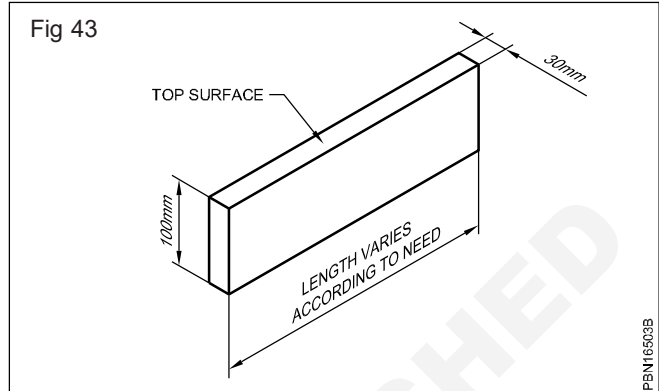
State the uses of various types of basic layout tools

1 The wooden peg

Usually a casuarina pole of about 100mm diameter with the top end neatly cut flat and the other end shaped pointed (see Figs 41 & 42)



- Pegs can also be made out of country wood Battens of about 100 x 50 mm size (see Fig 43)
- The length of pegs should be suitable to drive in the Ground to fix firmly and the projected length from Ground level to be about 90cm.
- Pegs are used to hold/support profile battens.
- Pegs are used for Initial markings.

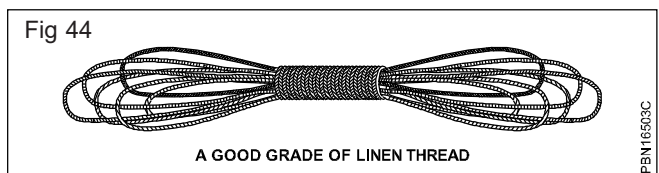


2 The wooden profile

- Usually made out good quality country wood battens of 100mm x 30mm straight in lengths and truly cut to square (see Fig 43).
- These battens when fixed to wood pegs form the Profiles the top surface of the profile are kept planed and truly horizontal level.
- Profiles are used for setting out markings.
- Profiles are used to hold line threads

3 Line thread

- Usually a bundle of nylon rope of say 3mm diameter and required length (Fig 44) enabling to be stretched between profile to profile without sagging.
- Used for producing marking lines
- Used for transferring points to ground
- Used for as a 'TAUT' line or guide line. It is fastened from corner to corner in a brick work or block work, to establish the height of the next course of brick or block.



4 The Nails

- Usually wire nails of sufficient length say 50mm to connect profile to pegs.

Method of making holes in walls and floors

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

- state the uses of portable hand drilling machines
- state the various methods of making holes in walls and floors
- state the uses of hand drill and rawl jumper.

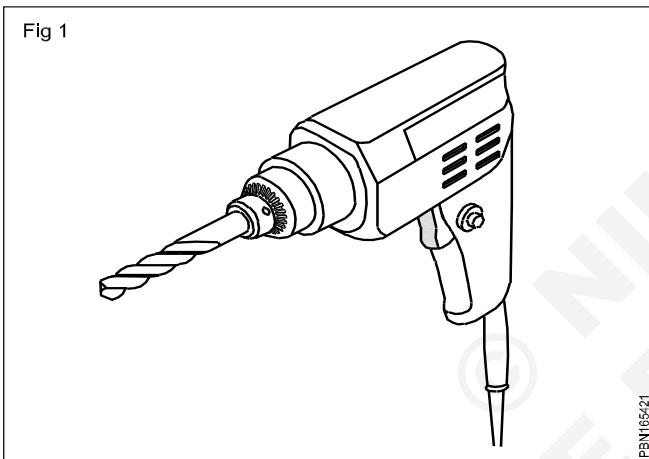
Drilling machines (Portable type)

Necessity portable hand drills of different types are used for certain jobs which cannot be handled on stationary drilling machines.

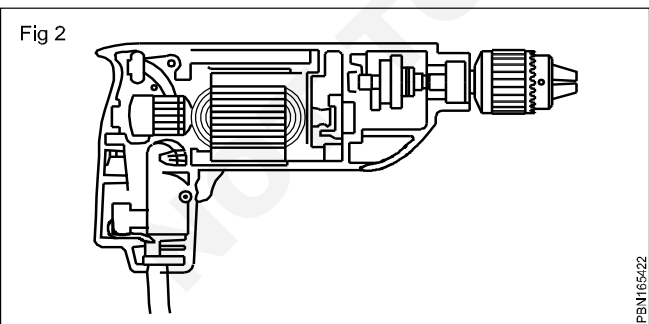
Types there are two types of portable drilling machines, power operated and hand operated.

Power operated drilling machines

Electric hand drill (light duty) (Fig 1): These are available in different forms. The electric hand drill has a small electrical motor for driving the drill. On the end of the spindle, a drill chuck is mounted. Electric hand drills used for light duty will have, usually, a single speed.

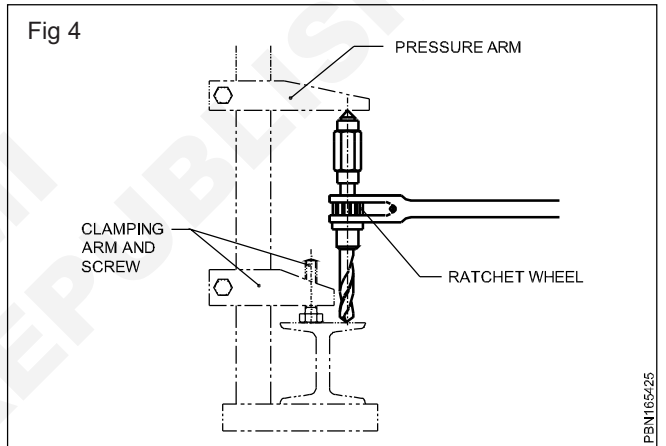
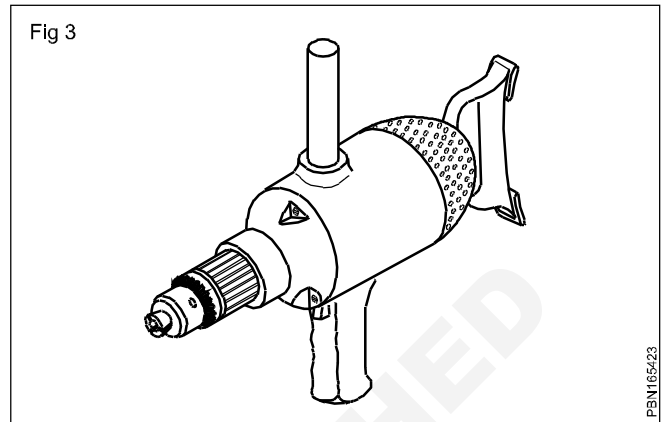


Electric hand drill (heavy duty) (Figs 2&3): This drill has an additional feature by which the drill speed can be varied through a system of gears. This is particularly useful for drilling larger diameter holes.

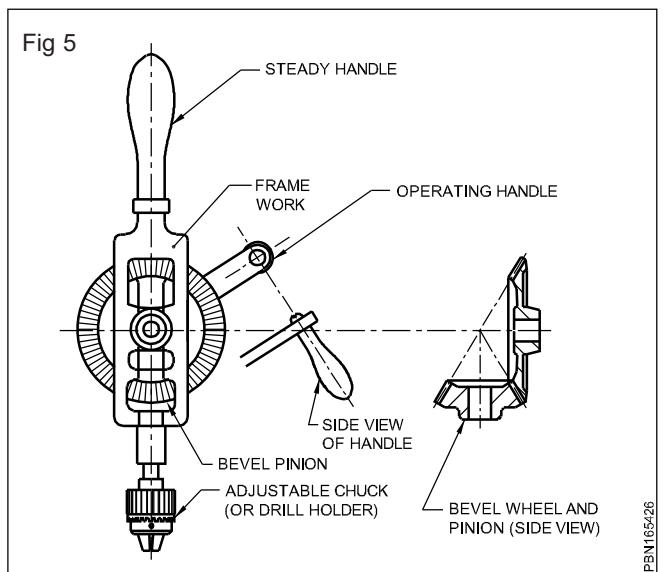


Hand operated drilling machines: Different types of hand operated drilling machines are shown below. They are used in structural fabrication, sheet metal and carpentry, particularly where electricity or pneumatic supply is not available.

The ratchet drilling machine (Fig 4) is commonly used in structural fabrication. Square head, taper shank drills are used on these machines.



The bevel gear type drilling machine (Fig 5) is used for drilling small diameter holes up to 6mm.

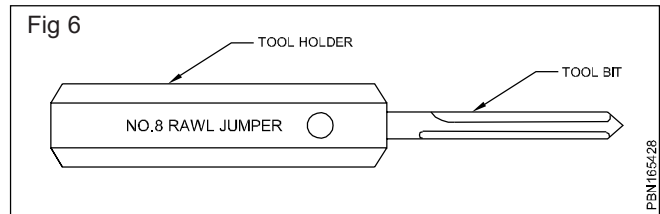


Rawl jumper

The purpose of the rawl jumper is to make holes in the brick and concrete walls or ceiling for fixing plug wood. It consists of two parts. Tool bit and tool holder as shown in (Fig 6) the tool bit is made of carbon steel whereas the holder is made of mild steel.

The tool bit is fluted to allow maximum debris clearance and ensure fast penetration. The shank of the tool bit is tapered to fit into the tool holder.

There are different sizes available. Numbers 8, 10, 12, 14 and 18 are used in plumbing work. As the number increases the size of the bit as well as the size of the holder increases.



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Concept of bricks, lime and cement

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

- state the types of bricks and uses
- state the types of lime and their uses
- state selection of cement in field
- state the reason for rejection of cement
- state the loss of strength of cement.

Bricks

Bricks are used for construction works as load bearing structure walls.

There are three types of bricks.

1 First class bricks

First class bricks are such as table moulded, wire cut and fire bricks.

Characteristics of first class bricks

- All bricks should be uniform in shape and size and compact structure.
- Bricks should be well burnt.
- First class bricks should be in reddish colour.
- The edges of first class bricks should be sharp and right angle.
- The brick should give ringing metallic sound when struck with each other.
- The first class brick should not absorb water not more than 20% of its own weight.
- The first class brick should not break into pieces when dropped on the ground.
- When bricks are scratched with finger nail, no impression should be marked on the brick.
- Compressive strength of first class brick not less than 105 kg/cm².

Sizes of modular bricks

190mm x 90mm x 90mm

190mm x 90mm x 40mm

Note

With mortar joint the size of bricks

190mm x 90mm x 90mm

190mm x 90mm x 40mm

2 Second class bricks

- Second class bricks shall have uniform colour.
- Second class bricks may be slightly over brunt.
- Second class bricks may be slightly distorted and round edges.
- Second class bricks have compact and uniform structure.

- Second class bricks emit a clear ringing sound when struck.
- Compressive strength of Second class brick not less than 70kg/cm².
- The second class brick should not absorb water more than 22% of its own height.

3 Third class brick

- Third class bricks may be slightly under-burnt or over burnt.
- Third class brick may be distorted and have round edges.
- Third class bricks should not absorb water more than 25% of its own weight.
- The compressive strength of bricks less than 35 kg/cm².

Heavy duty bricks

- Heavy duty bricks are made by pressing process.
- Heavy duty bricks are used in heavy constructions such as bridges, industrial foundation, machine foundations multi-storeyed buildings etc.

Hollow bricks, cellular bricks, cavity bricks

- These bricks are light in weight with cavities.
- The thickness of bricks about 20 to 25mm.
- The bricks are used as partition wall.
- The bricks provide good insulation against heat, sound and dampness.

Perforated bricks

- Perforated bricks are light in weight.
- Perforation may be circular, square, elliptical, rectangular or any other shape, throughout the thickness.
- The bricks are used panels for light weight structure and decoration purpose.

Fire bricks (or) refractory bricks.

- Fire bricks can resist high temperature.
- Fire bricks are yellowish in colour.
- Fire bricks are used for lining of furnaces construction of boiler, chambers, chimneys etc.

Sand lime bricks

- The bricks are prepared by mixing sand, lime, water and pigments.
- Sand lime bricks are used for ornamental work.

Mortar mill mixing

- The bullock - drawn mortar mill is popularly turned the lime chakki or ghanni.
- In this mill slaked lime which is generally in the form putty and aggregate are added in the requisite proportions along with water and grinding is done till a mortar of uniform consistency is obtained.
- Grinding is done generally for 80 to 180 revolutions of the stone roller depending upon the nature of lime.

Good qualities of Lime

The lime possess the following unique properties which results in better quality construction.

- Better Workability and plasticity.
- Early stiffening
- Low shrinking on drying which makes for durability.
- Good strength
- Resistance to moisture
- Freedom from major cracking
- Excellent adherence to masonry units.
- Adjustments to stresses in the masonry in course of time due to slow setting.
- Improvement in strength continuously with time.

Recommended specifications

- It has been found that mixtures such as 1 cement, 1 lime, 6 sand or (1:1:6).
- 1 cement, 2 lime, 9 sand are satisfactory for general purpose mortars.

Cement

Identification of cement

- Color of cement

Half brick wall	11 cm	1:1:6
One brick wall	23 cm	
	One part cement One part lime Six parts sand	
Cavity wall		
External wall plaster	1:1:6	
Internal plaster on all walls	1:2 1:1:1	

- The colour of cement should be uniform
- Grey colour with light greenish.

Physical properties of cement

- Feel when touch the cement of rubbed in between fingers.
- If cement is felt rough, it indicates adulteration with sand.
- If hand is inserted in a bag of cement, it should feel cool and not warm.
- Put small quantity of cement in a bucket of water, it would sink and should not float on the surface.
- Cement should be free from any lumps,
- Such lumps are formed by absorption of moisture from atmosphere.
- Reject such bag of cement.

Selection of cement in field

- When hand is inserted into the bag of cement, it should feel cool and not warm.
- Thick paste of cement, if keep in water for 24 hours should not crack but set.
- When cement is thrown into the bowl of water, cement should sink and not float.

Way the cement should be rejected

- The following causes are to reject the cement.
- Lumps of cement which cannot be pulverised by hand should not be used.
- Cement losses its strength by continued storage.
- The following shows the percentage of compressive strength of a mixture of 1:5 cement mortar for normal storage contains as compared with the mixture of cement before storage.
- Cement as received from factory 100% strength.
- After 3 months storage of cement 85% strength.
- After 6 months storage of cement 75% strength.
- After 1 year storage of cement 60% strength.
- After two year storage of cement 48% strength.

Precaution

- If the cement has been storage for more than 6 months. It is necessary to test the strength and soundness.
- Cement stored for a period of two years. This cement is rejected.

Classification of cement according to grade

- 53 grade ordinary Portland cement conforming (IS 12269).
- 53 grade cement is faster hydration process, the concrete releases heat at initially and also release the heat is highest.
- 53 grade cement should be used for making higher strength concrete.
- Due to heat of hydration being higher, the changes of micro-cracking of concrete is greater.

- During initial setting period of concrete, the higher heat of hydration can lead to damaging micro cracking with in concrete.
- The micro cracking may not be visible at surface.
- The 53 grade cement is being used even for low strength concrete as mortar or plastering. This can be lead to unnecessary cracking of concrete surface.
- 33 grade of ordinary Portland cement conforming (IS8112)
- Grade 33 or 43 are enough produce the concrete of desired strength.
- Cement bags marked as grade 33 or 43 may really be containing cement of much higher grade.
- 33 grade cement gain in strength will continue beyond 29th day.
- Other cement are early gain, the gain of strength do not increase much beyond 28th days.

Preparation of mortars with various materials of varying composition

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

- **state the use of water**
- **state the effects of impurities in water**
- **state the properties of good mortars mix**
- **state the types of mortar and its uses**
- **state the proportion of mortar according to the work.**

Use of water

- Water is used for mixing and curing of cement.
- Portable water is considered for mixing.
- The ph value of water shall not be less than 6.
- Water shall be free from injurious qualities of alkalies, acids, oils, salts, organic matter, vegetable growth etc.

Limits of acidity

- To neutralise 100ml sample of water using phenolphthalein as an indicator, it should not require more than 5ml. of 0.02 normal NaOH.

Limits of alkalinity

- To neutralise 100ml. sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H_2SO_4 .

Percentage of solids

- Maximum permissible limits of solids when tested in accordance IS: 3025 shall be under;

Organic = 200 mg/litre

Inorganic = 3000mg/litre

Sulphate = 400 mg/litre

Chlorides = 500 mg/litre for concrete not containing embedded steel.

Suspended matter = 2000 mg/litre

Sea water

- Mixing or curing of concrete with sea water is not recommended because of presence of harmful acids in sea water.

Effects of impurities presents in water

- Sodium carbonate may cause very rapid setting.
- Bicarbonate may accelerate or retard setting and also reduce the strength of concrete.

- Bicarbonate content is water concreting shall not exceed 400 ppm.
- Calcium chloride used for concrete upto 2% by weight of cement. This will be effect on setting as well as hardening. This salt may not be allowed in prestressed concrete.
- When the iron salt are present upto 40,000 ppm motrat strength are unaffected.
- The strength of concrete is reduced due to presence of salts of manganese, zinc, copper and lead.
- Sodium iodate, sodium phosphates are bring down the initial strength of concrete.
- Sodium sulphate which is most harmful concrete, if exceed of even 100 ppm.

Building materials mortar

The term mortar is used to indicate a paste prepared by adding required quantity of water to a mixture of binding materials like cement or lime and fine aggregate like sand.

The above two components of mortar, namely the binding materials and fine aggregate sometimes refered to as the matrix and adulterant respectively.

The properties of good mortar mix and mortar

The important properties of a good mortar mix are mobility, placeability, and water retention.

Mobility

The tem mobility is used to indicate the consistency of mortar mix depends on the composition of mortar and the mortar mixed to be used for masonry work, finishing work etc.

Place ability

The placeability of mortar mix should be such that a strong bond is developed with the surface of the bed.

Water retention

A good mortar mix should possess the ability of retaining adequate humidity during the transportation and laying over the porous bed.

If water retention power of mortar mix is low, it breaks into pieces.

Properties of good mortar

- It should be cheap.
- It should be durable.
- It should be easily workable.
- It should be capable of developing good adhesion with the building units such as brick, stones etc.
- It should be capable of developing the designed stresses.
- It should be capable of resisting penetration of rain water.
- It should set quickly.
- It should not affect the durability of materials.
- The joints formed by mortar should not develop cracks.

Preparation of mortar

For preparing mortar, the water is added to an intimate mixture of binding material and sand. The water which is good and fit for drinking should only be used for preparing mortar.

Mortar is usually of the following types

- Mud mortar
- Lime mortar
- Cement mortar
- Cement lime mortar

Mud mortar

This type of mortar commonly used for small works in villages.

- Clay and potable water mixed together to get a paste and stiffness.

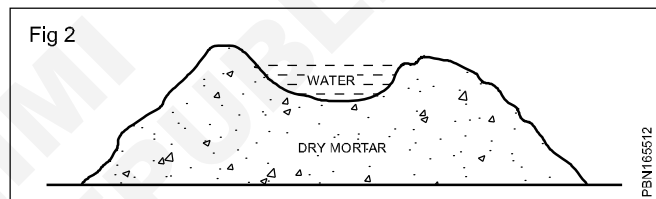
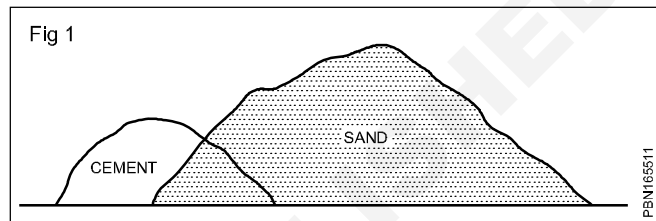
Lime mortar

- The lime mortar is prepared by pounding or grinding.
- The pounding is adopted for preparing small quantities.
- The grinding is adopted for preparing large of mortar.
- The lime mortar is used in brick works and also for plastering the surface of wall both external and internal walls.

Cement mortar

The cement and sand are mixed in required proportions in dry state on a water light platform or steel trough.

The mixing indri state is done twice or thrice up and down.



The potable water is then added and the binding materials and sand are again thoroughly mixed until good plasticity workability. (Fig 1&2)

Uses of mortar

- To bind the building units such as bricks, blocks, stones, etc into a solid mass
- To carry out pointing and plastering work on exposed surfaces of masonry

Selection of mortar

In civil Engineering works, suitable type of mortar shall be selected or recommended as follows.

Sl.No.	Type of mortar	Nature of work
1	Cement or lime mortar 1:3 lime being eminently hydraulic lime.	Construction work in water logged areas and exposed positions.
2	Cement mortar 1:2	Damp - proof courses and cement concrete roads
3	General R.C.C works such as lintels, pillars slabs, stains etc	Cement mortar 1:3 the concrete mixing 1:2:4
4	Partition walls and parapet walls.	Cement mortar 1:3 or lime mortar 1:1
5	Plaster work	Cement mortar 1:3 or 1:4 or lime mortar 1:2
6	Pointing work	Cement mortar 1:1 or 1:2
7	Brickwork, foundations stone masonry, block masonry work etc	Lime mortar 1:2 cement mortar 1:6
8	Thin joints in brick work	Lime mortar 1:3 Cement mortar 1:2

- To form an even and soft bedding layer for building units.
- To prepare moulds for coping, carbels cornice etc
- To improve the general appearance of structure.
- To form joints of pipes
- To distribute uniformly the super imposed loads from upper layer to lower layer of bricks or stones.
- To hide and close the open joints of brickwork and stone work.

- To fillup the crakes detected in the structure.

Tests for mortar

The following are the usual tests for mortar

- Adhesiveness to building units
- Crushing strength
- Tensile strength

Common brick joints - Description of bonds

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

- state the necessity of bonding brick
- state the various types of brick joints
- state the various types of bonds.

Brick masonry technical terms used

Masonry is the art of construction in brick or stone

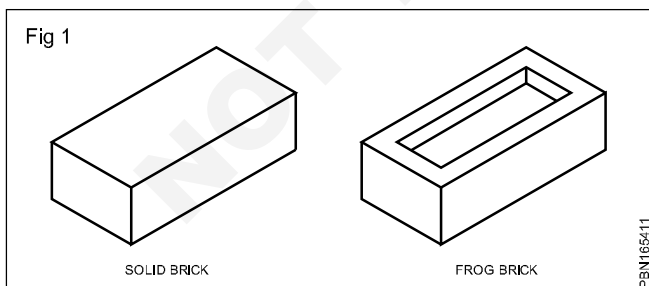
- From the very early ages of civilization new know the art of construction though the method were crude.
- But the advancement of age the technique of construction have appreciably developed.

Masonry broadly divided into two parts

- Stone masonry
- Brick masonry
- Stone masonry is that in which stone is used as a construction material.
- Brick masonry is that in which brick is used as a construction material.
- Technical terms used in brick masonry

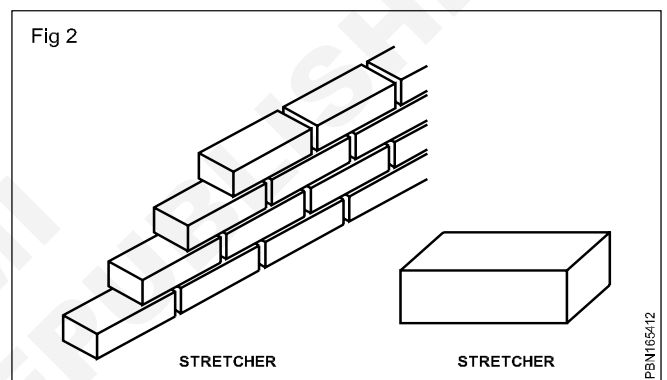
Brick

Brick is the artificially manufactured it is in rectangular shape and size is 230mm x 110mm x 70mm as shown in (Fig 1) (in ISI 200 x 100 x 100mm).



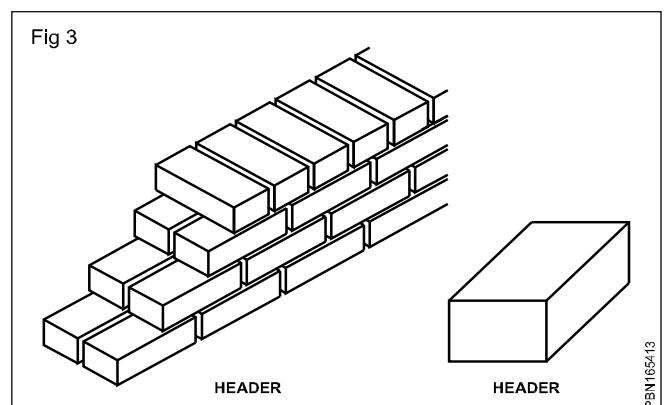
Stretcher

These are the bricks or stones laid long in a wall as shown in (Fig 2).



Header

These are bricks or stone blocks laid breadth wise or their headers length of the wall as shown in (Fig 3).

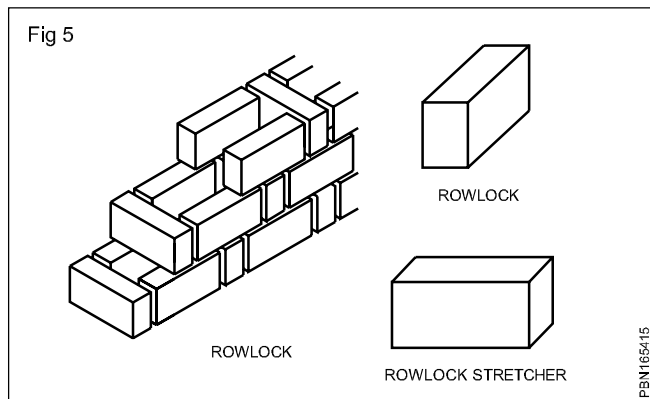
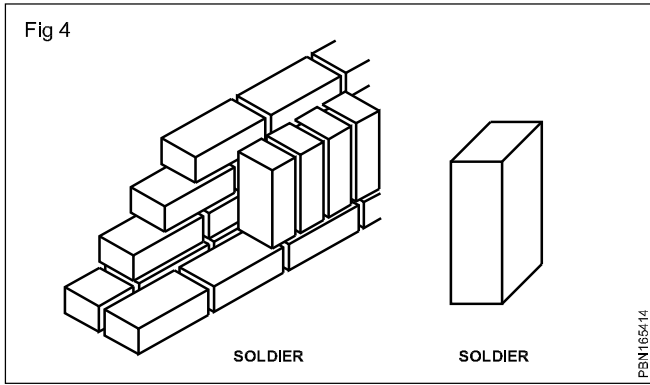


Soldier

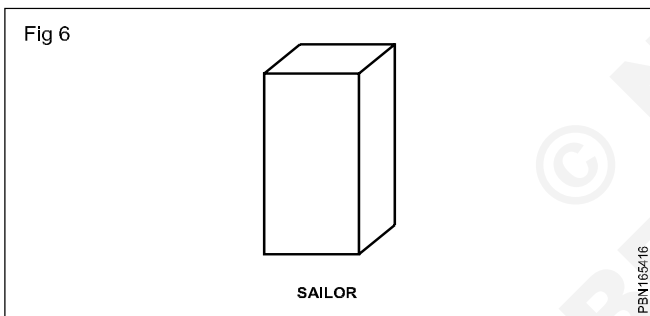
These are bricks, laid stretcher face in vertical position as shown in (Fig 4).

Row lock

These are bricks which are laid on its edge as shown in figure. This is also called brick - on edge as shown in (Fig 5).

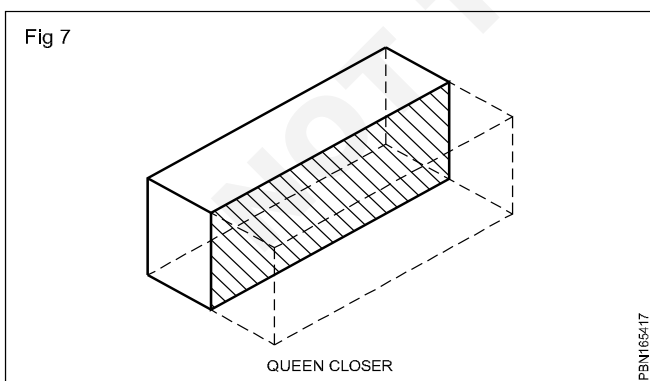


Safe are bricks which are laid vertical position with bed of the brick is placed in elevation shown in (Fig 6).



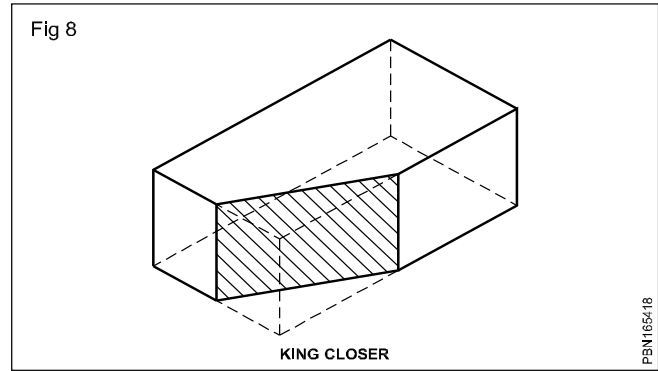
Queen closer

These are half bricks cut length wise. It is used along the length of a quoin for staggering joints of alternate course see (Fig 7).



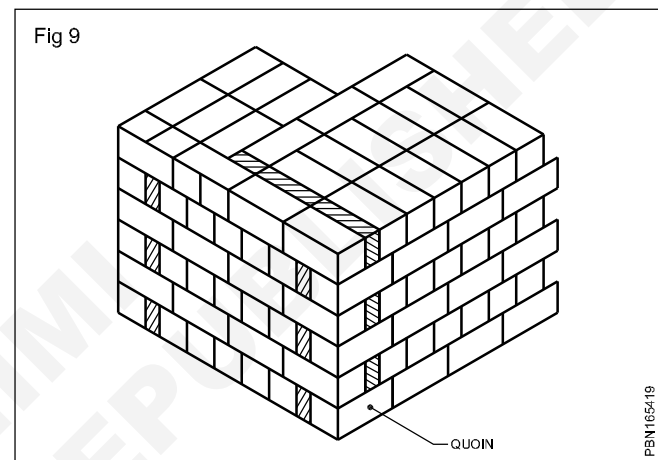
King closer

It is a brick which is cut in such a manner that the width of one of its ends is half a full brick. It is formed by cutting a triangular portion from one of the corners of a brick between the centre of one end of the centre of the other end as shown in (Fig 8).



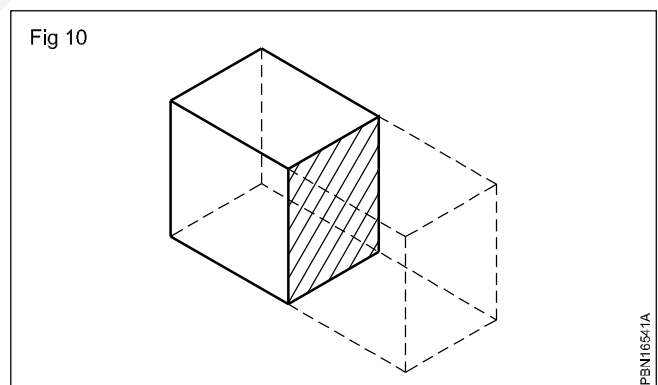
Quoin (or) Quoin header

It is the brick or block of stone used at the corner of two walls. This bricks or block of stone will look as header from one side and stretcher from the other side as shown in (Fig 9).



Bats

These are bricks which are cut length wise into two half bats, which are known as half brick as shown in (Fig 10).

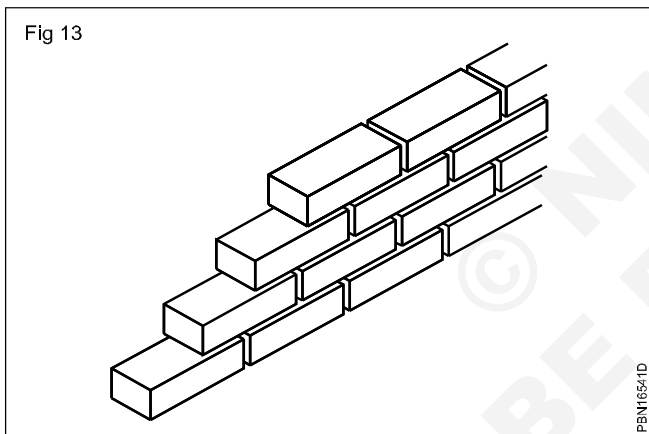
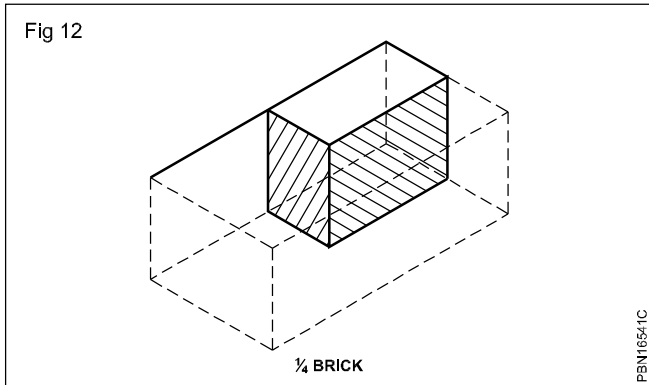
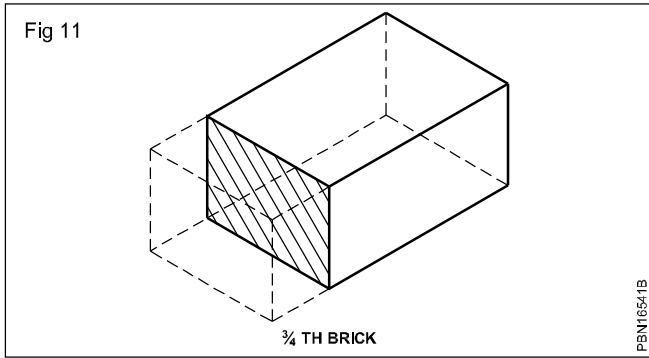


If the full brick is cut into 3/4 then it is called as 3/4 the bat as shown in (Fig 11).

If the full brick is cut length wise into two half portion is queen closer, and again cut into two half is known as 1/4 brick as shown in (Fig 12).

Course

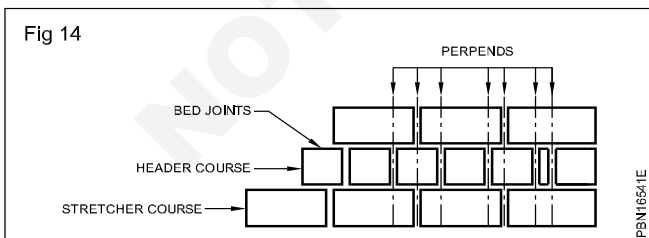
The contal layer of bricks or stones laid in mortar or without mortar in a systematic way is called as course see (Fig 13).



Bed joints

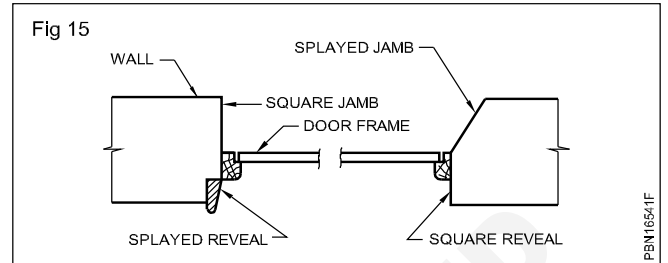
These are horizontal joints of a brick or stone masonry.

Perpends: These are imaginary vertical lines, containing the vertical joints of masonry. (Fig 14)



Jamb: These are vertical sides of a door or window openings on the backside these may be squared or splayed and are provided with recess to receive the door or window frame.

Reveal: These are exposed vertical surface of walls on the outside of an opening of a door or window. The function of a reveal is to protect the frame and to keep privacy of the room as shown in (Fig 15).



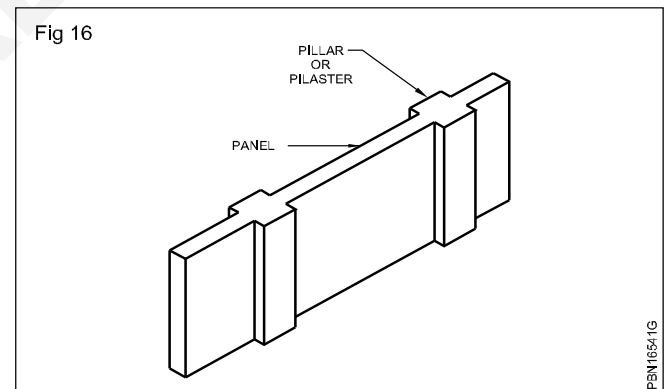
Panel and pilaster wall These are boundary walls consisting of pillars at regular intervals and thin partition walls. The function of a panel and pilaster wall is to increase the transverse strength of the long boundary wall. (Fig 16)

Necessity of bonding bricks

According to their uniform size and shape the bricks are arranged various pattern.

Bonding is essential to eliminate continuous vertical joints both in the body as well as in the face of the wall to give the strength to masonry.

A wall having continuous vertical joints does not act as a homogeneous mas to distribute the superimpose load.



Scaffolding and plastering, define plain cement concrete, R.C.C & it's proportion

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

- state the uses of scaffolding
- state various types of scaffolding
- state materials used for scaffolding
- state the materials used for plastering
- state the special types of plastering
- state the ratio for various plastering works.

Scaffolding

A scaffolding is a temporary platform erected to enable building operations to gain easy and safe access to their work above ground level.

Scaffolding can be classified in two ways;

- by the material used for the scaffold. (ie) wood or steel.
- by method of erection (ie) dependent or independent.

parts and terms used in scaffolding

Standard

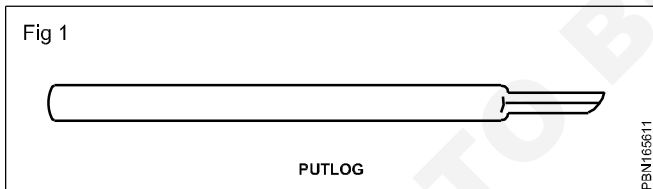
The upright members positional in alignment and parallel to wall face.

Ledgers

The horizontal members which connect the row of standard.

Putlog

shorter lengths with one end flattened to enter the wall joints as shown in (Fig 1).



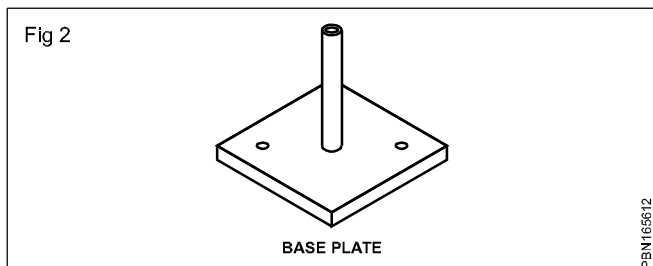
Brace

A ledger fixed diagonally across the standards for added rigidity.

Base plate

A base plate is used at the foot of the standard to provide the stable footings.

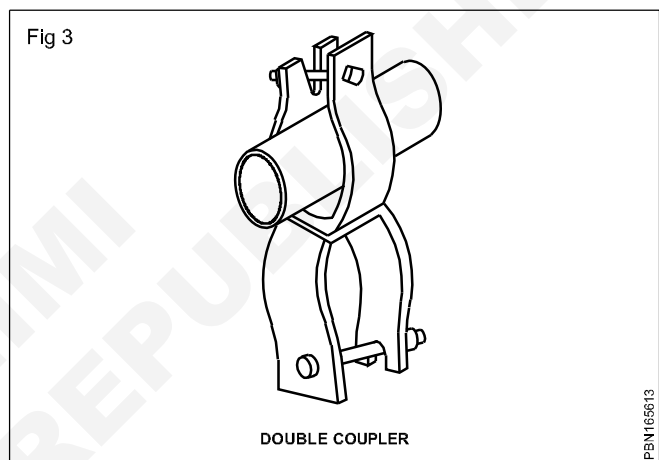
The base is nailed to a base board as shown in (Fig 2).



Double coupler

This is used to tie ledgers to standards at right angles.

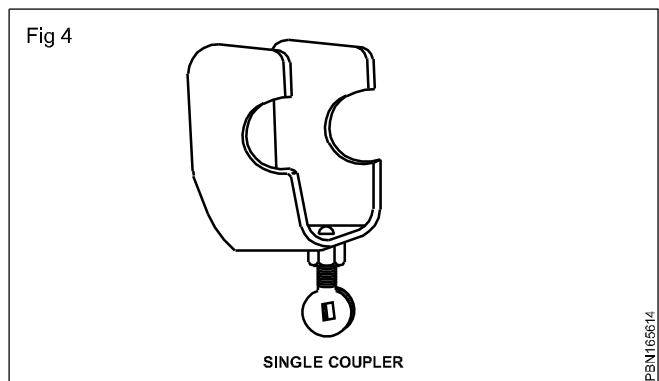
The double coupler is shown in (Fig 3).



Single coupler

Single coupler is used to tie a putlog to a ledger.

Single coupler is also called putlog clip as shown in (Fig 4).



Swivel coupler

A rotating fitting used to tie a brace to the standard as shown in (Fig 5).

Jointing pin

Used to join two lengths of tubing. The pin consists of split halves connected by a coach screw. as shown in (Figs 6 - 20).

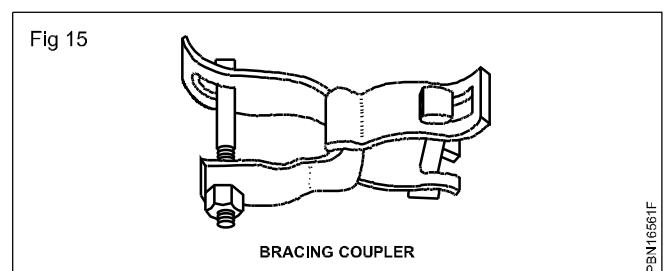
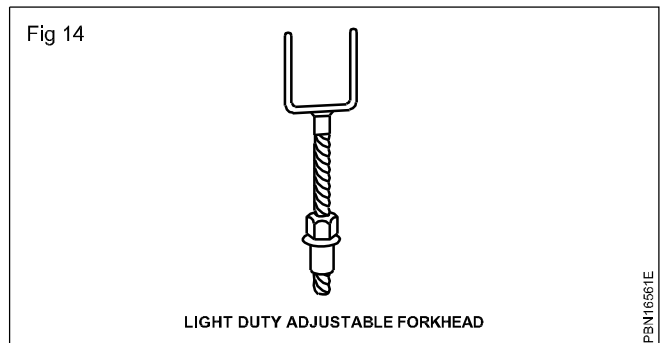
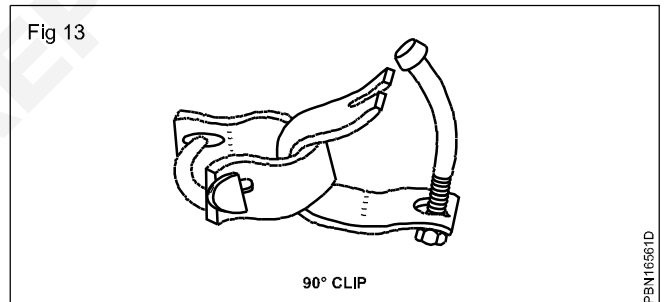
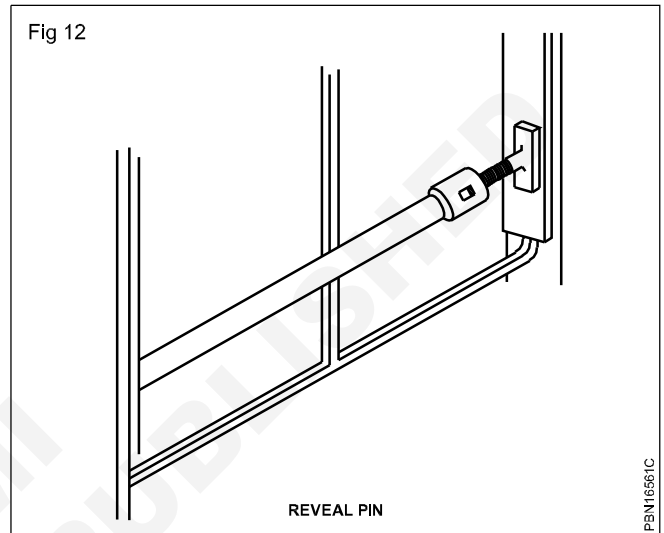
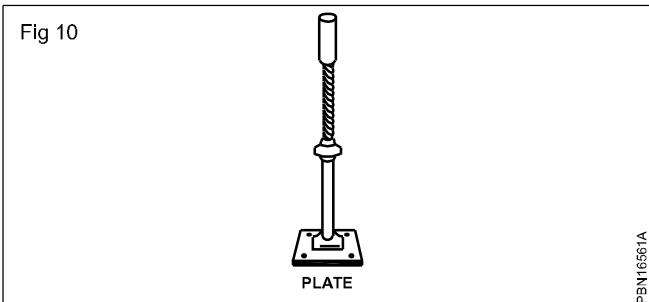
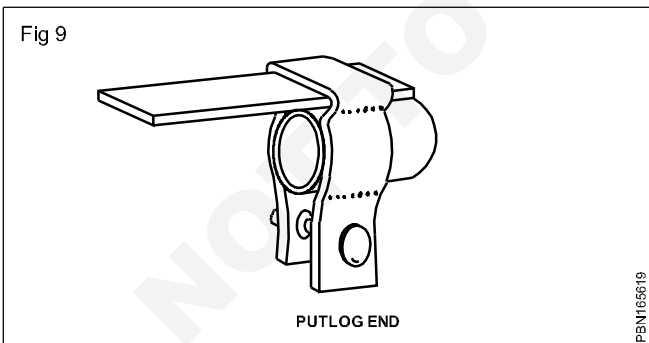
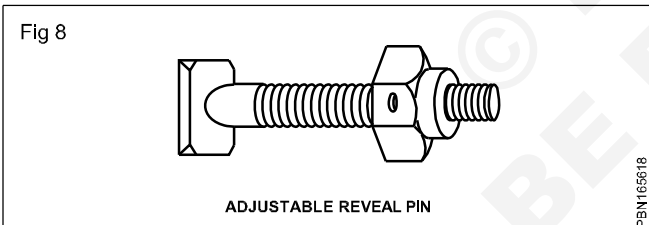
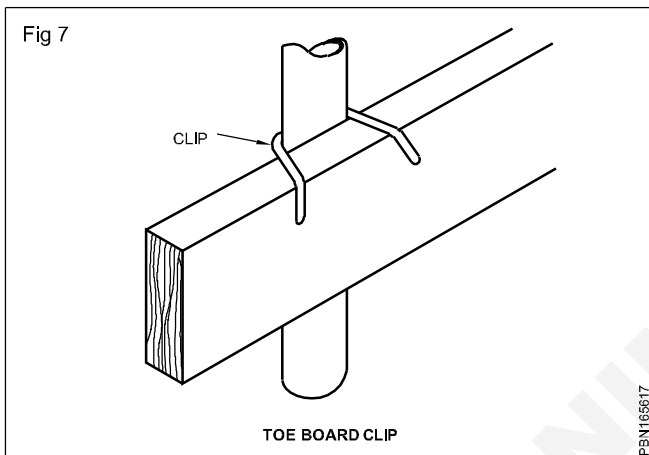
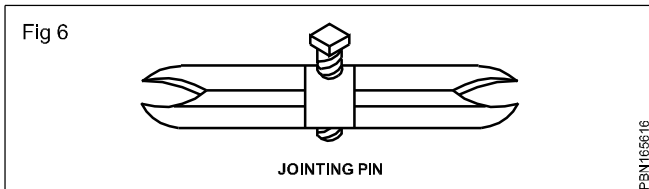
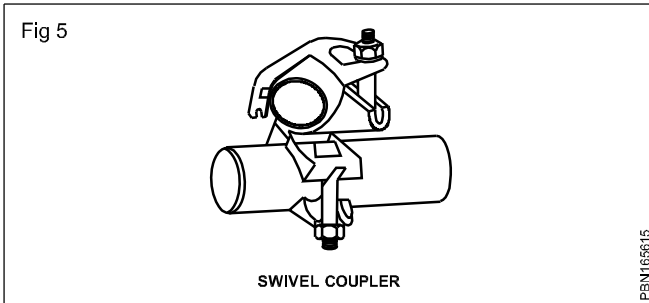
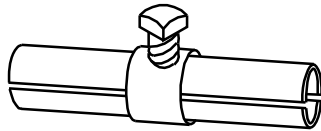


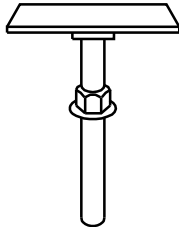
Fig 16



EXPANDING JOINT PIN

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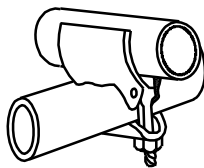
Fig 17



SHORING JACK

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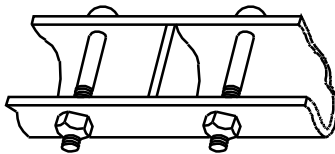
Fig 18



TRANSOM CLIP

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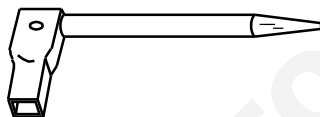
Fig 19



SLEEVE COUPLER

PBN16561J

Fig 20



SWING-OVER BOX SPANNER

PBN16561K

Classification by type of material

- Wood
- metal

Wooden scaffolding

- Wood is commonly for scaffolding.
- For single story building wooden scaffolds are used.

Advantages of wooden scaffolds

- In areas where wood is available plenty and cheap.
- No fittings used.
- No extra maintenance costs.
- Easily cut to size.

- Wastage and old logs can be sold as fine wood.
- Required length of log may cut accordingly.
- Large holes are left in the wall after use and these need to be patched.
- Regular replacement is essential old logs must be removed and new added to avoid failure.

Tubular scaffolding

- Steel and light alloy tubes are used commonly.
- This scaffolds needs a lot of fittings hence it cost and to maintain.

Advantages of tubular scaffolding

- Less deteriorate than wooden scaffolding.
- This can be erected rapidly and dismantled.
- More convenient for internal work.
- Takes up less space for storing the materials after use.
- Tubular scaffolding is mostly used for multi-story buildings.
- Quickly transported from one side to another side.
- These scaffoldings do not require holes in the walls as in the case of other types of wooden or timber scaffolding.

Method of Erection

- Dependent scaffolding (Figs 21,22 & 23).
- Independent Scaffolding.

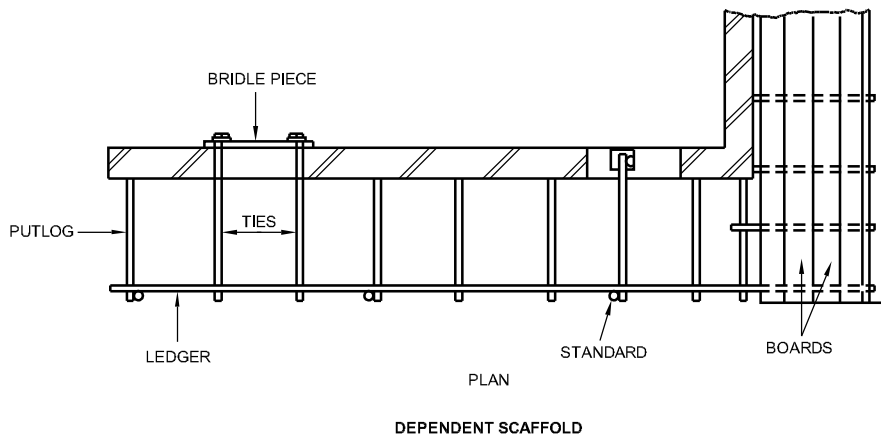
Dependent scaffolding

- This scaffolding commonly termed as bricklayer's scaffolding or putlog scaffolding.
- The vertical members called as standards are firmly embedded in ground as shown in (Fig 23).
- The diameter of this standards is about 10 to 15mm and placed in 1.5m away from the building in a row with 2m centre to centre spacing.
- These standards are connected with ledgers.
- Putlogs are then placed with their one end on the ledgers and the other end in the holes kept in the wall as shown in (Fig 23).
- Over the putlogs wooden planks are placed to keep materials and tools platform at different levels as shown in (Fig 22).
- In the case high buildings diagonal members known as braces are fixed, to the standards and ledgers for giving more strength.

Tubular scaffolding

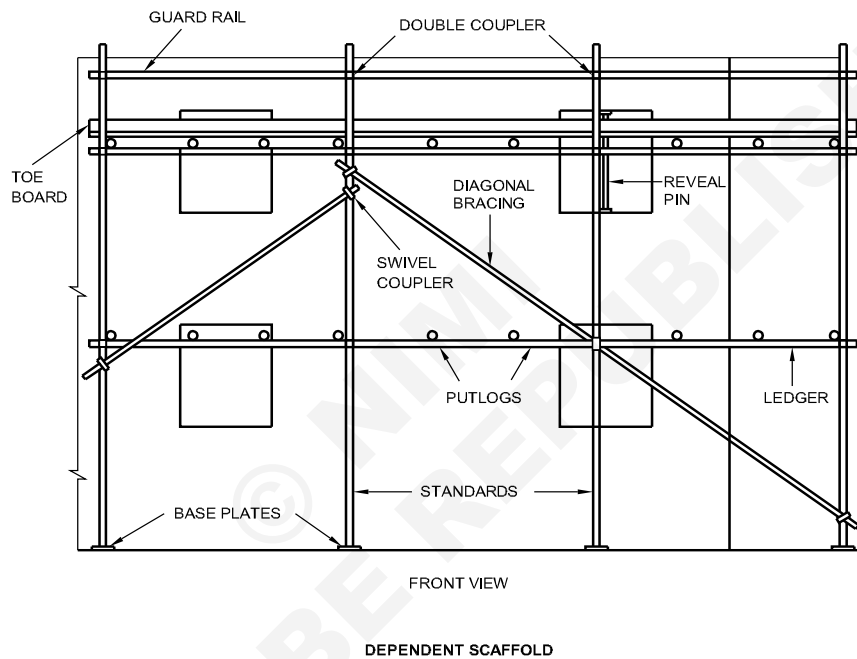
- Tubular or steel scaffoldings are being more popular over bamboos or timber scaffoldings.
- Tubular scaffolding consists of 40mm to 60mm diameter weld less tube pipes are used.

Fig 21



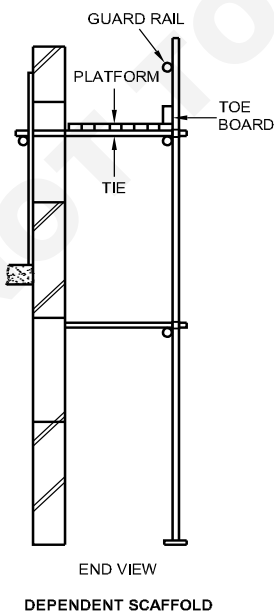
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Fig 22



PBN16561M

Fig 23



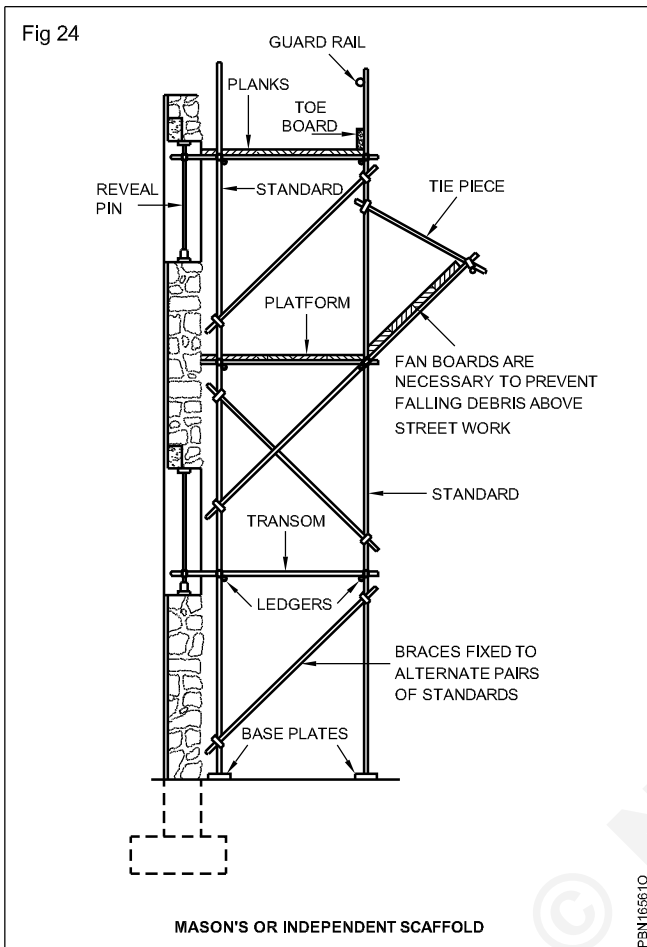
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- These are connected together by means of couplers.
- Tubular scaffolding can be easily erected in position and dismantled quickly and transported to one site to another.

Independent Scaffolding

- This type of scaffolding is called as mason's scaffolding.
- It has two rows of standards.
- One close to the building structure and another at a distance equal to the required platform width.
- Independent scaffolding is very stronger and is used for heavy operations such as masonry work as shown in (Fig 24).
- Procedure for erecting a tubular scaffolding.
- The scaffolding units have been brought to the site.
- Sort out their various lengths, fittings, oiled Place the base plates for standards.

- With the aid of an assistant stand the standards on the base plate.
- Connect the ledger using double coupler as shown in the (Fig 24).



- The ledger should be sighted for level.
- The bolts of the coupler should be placed uppermost.
- Put logs can be fixed by using single coupler or put log clips as shown in (Fig 24).
- After fixing standards in position connect ledgers by using jointing pin at the ends.
- Use the double couplers to fix put logs and standards after correct alignment.
- Use the standards for diagonal braces for firm rigidity.
- Repeat the procedure until the required length of scaffold is obtained.

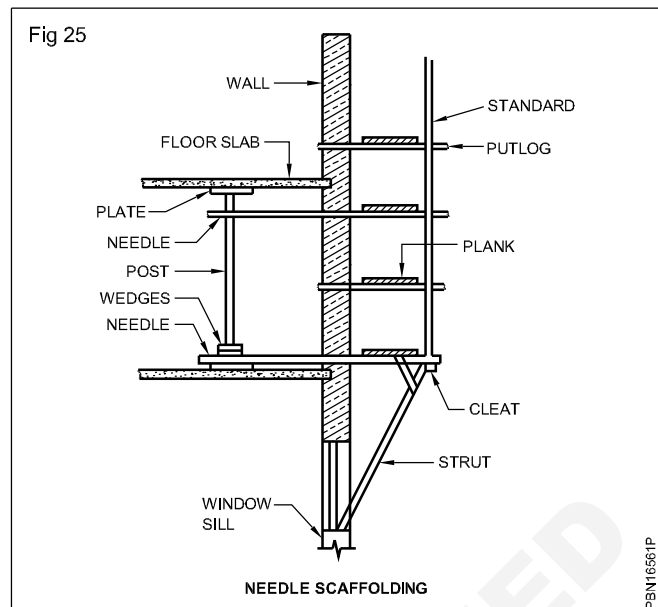
“Some other types of scaffoldings”.

Needle scaffolding

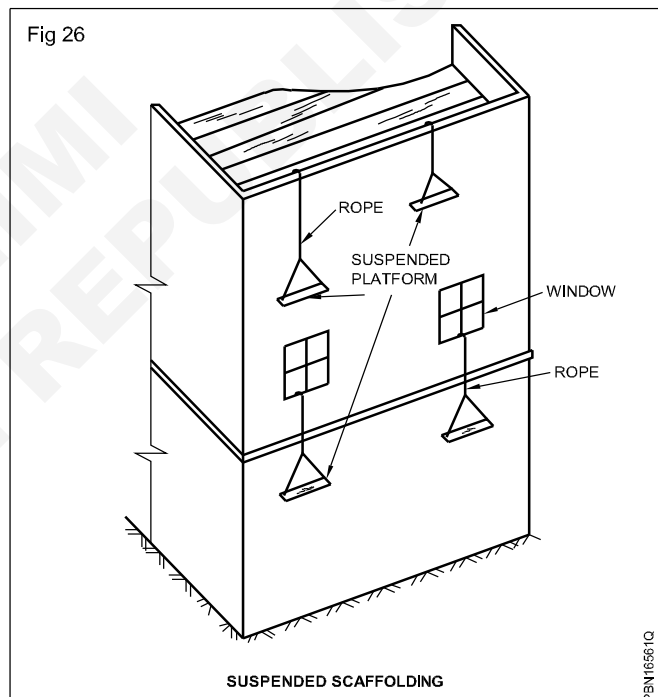
This is generally used for repairing purposes and for adding further stories in the existing building as shown in (Fig 25).

Suspended scaffolding

- For repair cleaning painting and erection of buildings various types of working platforms are required at various levels.

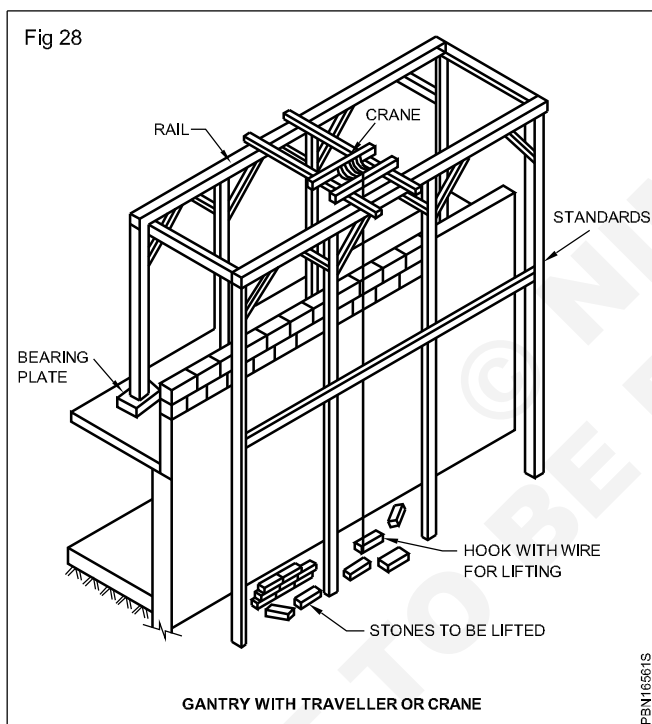
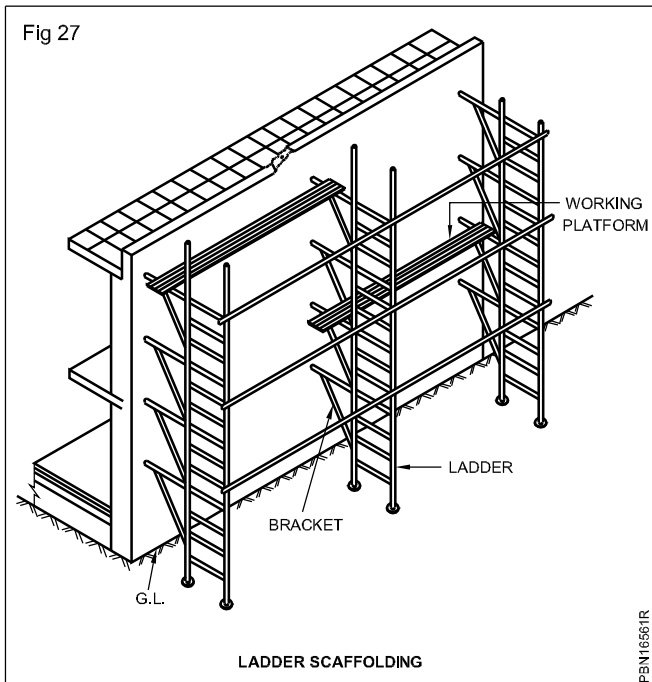


- It can be easily provided and removed from time to time such platform can be easily suspended as shown in (Fig 26).



Ladder scaffolding

- painting work of the multistory building ladders are not suitable due to their limited length.
- In such places ladder scaffoldings are provided as shown in (Fig 27).
- Gantry with traveler or crane.
- This type of Gantry consists of wooden standards generally square in section and erected vertically.
- Longitudinal member called runners are fixed at the top of standards on which rails are fixed. The lifting tackles move on the rails.
- The tackles can also move perpendicular to the wall as shown in (Fig 28).



- Plastering protects the structure from the atmospheric action such as sun, wind, rains, frost etc.
- Plastering helps in hiding the irregularities of workmanship.
- Plastering covers the unsound and porous material of the construction.
- Plastering provides a base for other finishing's such as white and colour washing, distempering, painting etc.
- Plaster material is a fine paste either made of cement and sand or lime and sand or surki, and sometimes cement, lime and sand.
- When cement forms the binding material the plaster is called cement plaster.

Water

- Water used for mixing and curing shall be clean, free from deleterious matter and sea water or blackish water shall not be used. Water fit for drinking is normally suitable.

Preparation of mortar and surface of walls

Preparation of cement mortar

- Mixing shall be done preferably in a mechanical mixer.
- If done by hand mixing operation shall be carried out on a clean water tight platform.
- cement and sand shall be mixed dry in the required proportion to obtain a uniform colour.
- The required quantity of water shall be added.
- In the case of mechanical mixing, the mortar shall be mixed for atleast 3 minutes after addition water.
- Cement mortar shall be freshly mixed for immediate use.

Preparation of Lime mortar

- Lime and sand in the specified proportion shall be mixed with or without the addition of water on a dry water proof platform or in mixer.
- The mix shall be fed into a mortar mill with required addition of water.
- The mortar shall be raked continuously during grinding. Particularly in the angular edges of the mortar mill.
- Water may be added during grinding as required to bring the mix to the working consistency.

Finish

- The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required.
- The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs.
- All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as work proceeds.

Materials for plastering / finishing

- Masonry structures after their construction require interior and exterior finishing's. This finishing is known as plastering.
- Plastering is the covering of walls so as to improve their (Walls) appearance and to hide their irregularities of construction and also to provide a base for white and colour washing, painting, distempering etc.
- The following are the generalised advantages of plastering.
- Plastering provides a true, smooth and finished surface which improve the appearance of the structure.

Thickness

- The thickness of plaster specified shall be measured exclusive of the thickness of key ie grooves or open joints in brick work.
- The average thickness of plaster shall not less than the specified thickness (12mm).

Curing

- Curing shall be started 24hours after finishing the plaster.
- The plaster shall be kept wet for a period of seven days.
- During this period, it shall be suitably protected from all damages.

Precautions

- Any cracks which appear in the surface and all portions which sound hollow when tapped or are found to be soft or defective shall be cutout in rectangular shape and remove the plastering.
- When ceiling plastering is done it shall be finished to chamfered edge, at an angle at its junction with a tool when plaster is being done.
- Similarly, when the wall plaster is being done it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm
- To prevent the surface cracks appearing between junctions of column/beam and walls 150mm wide chicken wire mesh should be fixed with 'U' nails 150mm centre to centre before plastering the junctions.

Measurements

- Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.
- The measurement of wall plaster shall be taken between the walls or partitions for the length and from the top of the floor, or skirting to the ceiling for the height.

Types of plastering

Plastering with lime mortar

- The mortar shall be of proportion as specified in the work and shall be prepared as per the specification on lime mortar.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with wooden float or wooden rule.

- The finished thickness shall be sufficient to cover by minimum 12mm the surface of wall in brick masonry and by 20mm all the projections in the case of Random rubble masonry.
- The plaster shall be well press into the joints and surface rubbed smooth with a wooden straight edge or plaster Trowel sprinkling as much water as is necessary.
- During the process of rubbing an addition of lime and water of the consistency of thick cream is to be applied to give a smooth and even surface.
- The completed plaster shall be allowed to rest for 24hours and then sprinkled with water at short intervals and kept damp for atleast seven days.

Plastering with cement mortar

- Mortar shall conform to specification on "Cement mortar".
- It must be freshly mixed for immediate use and in such quantities as to permit the whole batch being used in the work before the mortar has commenced to set.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with a wooden rule or straight edge.
- The finished thickness shall be sufficient to cover by 10mm the surface of the wall in brick masonry and by 6mm all the projections in the case of rubble stone masonry.
- The plaster shall be well pressed into the joints and surface rubbed smooth with a floating coat about 3mm of pure portland cement.
- The finishing coat must be applied while the base coat is still fresh.

Special type of plasters

- Apart from the plain plaster which is used on the walls in ordinary cases.
- There are certain other plasters which have got a specific use.
- Rough coat plaster
- Pebble dash plaster
- Stucco plaster

Grades of coarse aggregate and fine aggregate, knowledge of water proofing compound

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

- state the aggregates of various proportions
- state the uses of various proportions to various works
- state the uses of P.C.C and R.C.C in building construction
- state the water proofing compounds used in damp proofing
- state the methods of arresting cracks and leakage.

Fine aggregate (sand)

- The grading of fine aggregate is expressed in terms of IS test sleeves Nos. 480, 240,120,60,30 and 15.
- The grading of fine aggregate has a marked effect on the uniformity, workability and finishing qualities of concrete.

Grading limits for fine aggregate

IS Sieve	Percentage by weight passing through sieve	
	Natural or crushed gravel sand	Crushed stone sand
No. 480	95-100	90-100
No. 240	75-95	60-90
No. 120	45-85	40-80
No. 60	25-60	20-50
No. 30	5-30	5-30
No. 15	0-10	0-15

Characteristic of fine aggregate

- Fine aggregate are either rounded, sub-roundes, angular, sub-angular or flat fragments of more or less unaltered rocks or minerals consisting of 90% of the particles greater of size than 0.06mm and less than 2mm.
- These are coarse grained cohesion less particles of silica derived from the disintegration of rocks.
- Aggregate shall be high crushing strength, durability, sufficient handiness, high resistance to wear good fine resistance.
- Specific gravity more than 2.7.
- High impact value, low water absorption, weather resistance.

Function of sand

- During drying prevents cracks.
- Sand is used for making mortar.
- Sand increases density of mortar.
- Sand helps in early setting of mortar.
- Sand is added as binding materials.

Types of sand

Natural sand

- Natural sand may be of river sand, sea sand, nalla sand and pit sand.

Artificial sand

- Artificial sand is prepared by crushing stone and gravel to powder.
- Sand is sieved by sand screening machine or manual screening depends on required quantity.

Proportions mixing of P.C.C

Mixing

All concrete should be mixed thoroughly until it is uniform in appearance all ingredients are uniformly distributed.

- Mixing will done either
- Hand mixing
- Machine mixing.

Hand mixing

- Hand mixing of concrete is done on hard plat form.
- This method is mainly employed at such places where the quantities of concrete to be mixed in small.

- Cement and sand are first mixed together in dry condition.
- The coarse aggregate is spread on the plat form in uniform thickness varying from 20 to 30cm.
- The mixed cement and sand are spreader in a uniform thick layer over the stack of coarse aggregate.
- These are mixed together first in dry state.
- Then measured quantity of water is sprinkled over it and the mass is continuously mixed till uniform workable concrete is obtained.

Machine mixing

- Machine employed for mixing concrete are known as “Concrete mixers”
- These mixers may be of continuous mixing type or batch mixing type. For big projects where large quantity of concrete is required continuous mixing type mixers are used.

Placing of concrete:

Placing of concrete is most important, as the concrete must be placed in position, properly compacted within 30 minutes after adding water in as after this time the initial setting of cement will start.

While mixing concrete it is most important that only the required quantity of concrete which can be used within 30 minutes, after adding water in it should be used.

Compaction of concrete

- Immediately after placing concrete in position, it should be properly compacted to obtain uniform compact concrete.
- The main object of compaction is to remove all the air pockets and porousness of the concrete.
- The concrete will gain only strength if its is compact.
- Compaction of concrete may be done by “hand or machine”.
- While doing compaction by hand concrete, iron bars, hammers or rammers tampers are employed.
- Rodding is done in compacting concrete of beams, Lintels or thin structures.
- Tamping is done by bricks wooden tampers in compacting the floor slab concretes.
- For compacting heavy mass of plain concrete hammers are used.

- Machines are employed for compacting concrete are known as vibrators.
- Needle vibrators.
- Surface vibrators
- Shutter vibrators.
- Screening of concrete will takes place after compaction is completed either hand or machine compaction as shown in (Fig 1).

Curing of concrete

- The strength of the concrete depends on the chemical actions in the presence of water.
- For gaining ultimate strength of concrete it is most essential that concrete should be kept damp or wet for at least 7 to 28 days.
- This process of keeping the concrete damp or wet is known as “Curing”.

Joints in Concrete

- During the construction of R.C.C or P.C.C structures it is impossible to do-concreting work continual.
- When concrete work is stopped at one time and continue after same time concrete joint occur.
- For making the concrete at such joints strong enough certain care is taken while concreting at these joints are classified as,

Reinforcement:

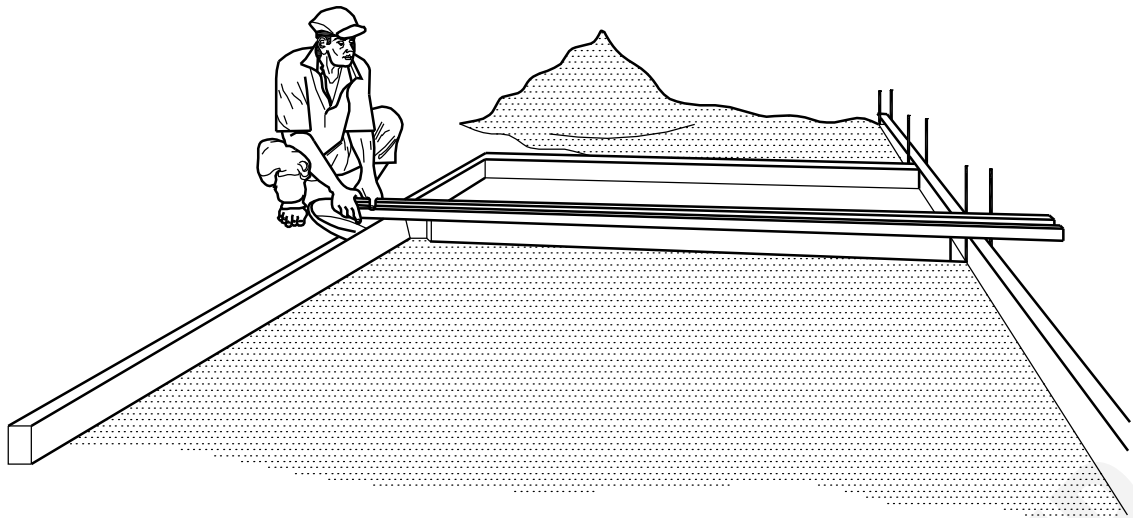
Any material embedded in concrete to increase its load taking capacity and taking all the tension is called reinforcement. The most common material used as reinforcement is steel throughout the world. The reinforcement of mild steel, high tensile steel and hard down steel bars is used depending on the load type of structure. Indian Standard 432-1960 gives te specification for mild steel, high tensile steel bars and hard drawn steel bars for concrete reinforcement. The most common steel reinforcement section is round bars.

The steel reinforcement to be used in R.C.C. work should be free from loose mill scale, loose rust, oils, grease and other harmful material to the concrete or steel.

Water proofing compound

Water proofing compound are used as damp-proof courses, depending upon the location, economy and degree of damp-proofing desired. The following materials are used as water proofing compound.

Fig 1



CEMENT CONCRETE IS USING A TEMPLATE TO CHECK THE SUBGRADE FOR SMOOTHNESS AND PROPER HEIGHT

PBN165811

1 Flexible materials

Hot Bitumen (Or) Hot Asphalt

- Hot Bitumen is a flexible material.
- Hot Bitumen is heated and then spread over is bedding or over walls.
- Hot Bitumen applied in thickness not less than 3mm.

Bituminous Felts

- Bituminous Felts is available in rolls of normal wall widths.
- A layer of cement mortar is laid on the brickwork and then Bituminous felts is bedded on it.
- An overlap of 10cm in case of joints.
- Bituminous fetts cannot with stand heavy loads.

Metal Sheet (Lead, Copper and aluminium)

Sheet of Lead

- The sheet of lead embedded in Lime mortar not in cement mortar.
- The surface of lead protected by a coating of bitumen against corrosion.

Sheet of copper

- The sheet of copper embedded in Lime mortar or in cement mortar.
- The sheet of copper has high durability and good resistance to aluminium.

Sheet of aluminium

- Sheet of aluminium is not as good as lead or copper sheet.
- Sheet of aluminium is protected with a layer of bituminous.

2 Semi-rigid Materials

Mastic Asphalt

- Mastic asphalt is obtained by heating the asphalt with Sand and mineral filters.
- Mastic asphalt has high durability, good water proofing quality, elasticity, etc.
- Mastic asphalt withstand slight distortion and is liable to lateral movements under heavy loads or hot climates.

3 Rigid Materials

Bricks

- Bricks are suitable where dampness is not excessive.

STONES

- The stones such as granite, trap and slate are laid in cement mortar.

Cement concrete layer

- The proportion of Cement concrete 1:2:4. (ie 1 cement, 2 sand, 4 stone aggregate) are laid at planter level.
- The thickness of cement concrete layer varying from 4 to 15cm.

Knowledge of mortar filling and raking joint, hacking concrete surface and cutting the bricks

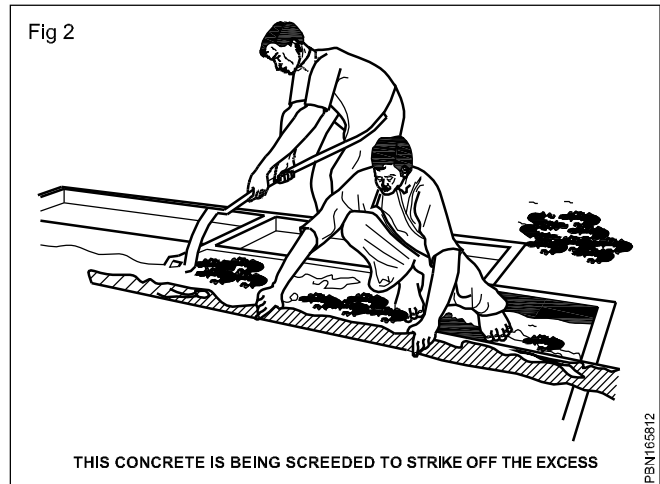
Mortar filling raking joints

- Check the masonry construction before raking.
- Mix the mortar as per specification.
- Add sufficient quantity of water and mix well until for workability.
- The joints are carefully filled with cement mortar with small pointing trowel.
- The mortar is well pressed into the joints with trowel.
- The joints are filled up with the face of the wall.

- All joints in the masonry work should be raked out to a depth of 20mm.
- Care should be taken without damaging of masonry work during raking of horizontal and vertical joints.
- The bend of small steel or iron tool called jointer is used as shown in (Fig 1).
- Use jointer frequently until the uniform semicircular notch is formed.
- The wooden straight edge is placed horizontal and level.
- Check the plumb for all vertical joints, they should be in one line as shown in (Fig 2).
- Excess mortar sticking to the sides of joints are carefully scraped away.

Hacking on concrete surface

- All concrete old plaster and stone surface if any projection or bulging or smooth should be cut off by using chisel and hammer.
- If any holes and joints in R-C-C beam should be filled with rich mortar.
- Sufficient hacking should be done at all R.C.C work.
- Vertically of door and window frames should be checked, by using plumb bob.



Cutting the bricks

- In order to cut the bricks accurately use steel bolster.
- Brick hammer is used for cutting bricks to different shape and sizes. One end of hammer is square and the other end sharp edged.
- Scutch is used for dressing to cut surfaces and for cutting soft bricks.
- The hammer is made of special steel.
- The striking face is tempered.
- The handle is made of hard wood.
- The hammer is used to cut the bricks.

Knowledge of building plan and cross section of wall. Identify plumbing services required for each type of building according to usage

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

- state the various sections of the wall
- state about the building plan
- state the plumbing services according to the plan
- state the services in plumbing shaft.

Introduction

A building consists of sub - structure and super structure. Foundation, plinth, walls, floors and roofs are the main structural components of the building. Each of these components is an essential part of a building and requires due consideration in design and construction for their functional performance.

Parts of a building

The sectional view of a building shows all constructional details from the foundation level to the top of roof such as total height and different levels i.e depth of foundation, plinth level ground floor level, thickness of wall, window sill level, floor to ceiling height, window/door height, chajja level, roof top level, parapet level and coping.

The sequence is listed form foundation

- 1 Foundation
- 2 Plinth
- 3 Plinth course
- 4 Sill
- 5 Door & window
- 6 Lintel
- 7 Floors
- 8 Roof
- 9 Parapet
- 10 Coping

1 Foundation

It is the lowest artificially prepared part, below the surface of the surrounding ground, which is in direct contact with sub - starter and transmits, all the loads to the sub - soil.

2 Plinth

It is the middle of the structure, above the surface of the surrounding ground up to the surface of the floor, immediately above the ground.

3 Plinth course

It is top most course at plinth level which is finished flush with the surface of ground floor.

4 Sill

It is the horizontal member comprising concrete, stone or wood to give support to the vertical members of wooden window. It helps in shedding rain water from face of wall.

5 Door & window

Door is a frame work of wood, steel, glass. The purpose of door to give access to the users of the structure and free movement into and outside the structure. The door provides a good ventilation. Windows are constructed for providing light and ventilation in the building.

6 Lintel

A horizontal member of stone, wood, brick, steel, reinforced brick, R.C.C etc above the opening to support the masonry or load above, it is called lintel.

7 Floors

Floors are horizontal elements of a building structure which divide the building into different levels for the purpose of creating more accommodation.

8 Roof

A roof is the upper most part of a building which is supported on structural members and covered with a roofing material. The main function of a roof is to enclose the building and to protect the same from the damaging effects of weather such as rains, wind, snow etc.

9 Parapet

It is the wall built around a flat roof which acts as a protective wall for the users of the terrace. In case of pitched roof, the parapet wall is used to conceal gutter at eaves level.

10 Coping

The coping is covering of bricks or stones which is placed on the exposed top of an external wall to prevent seepage of water through joints of top most course in a wall.

Parts of a building (Fig 1)

Buildings: Building is not only a "SHELTER" but:

- 1 Energy saving
- 2 Efficiency improving
- 3 Environment friendly
- 4 Users friendly

5 Building can be defined as the three dimensional shape or form in the space, resting on the earth, secured to the earth by foundation for stability.

Different stages in the life of building

Planning: Decides the initial form.

Designing: Decides the final form.

Drawing: Tool to convert requirements into reality.

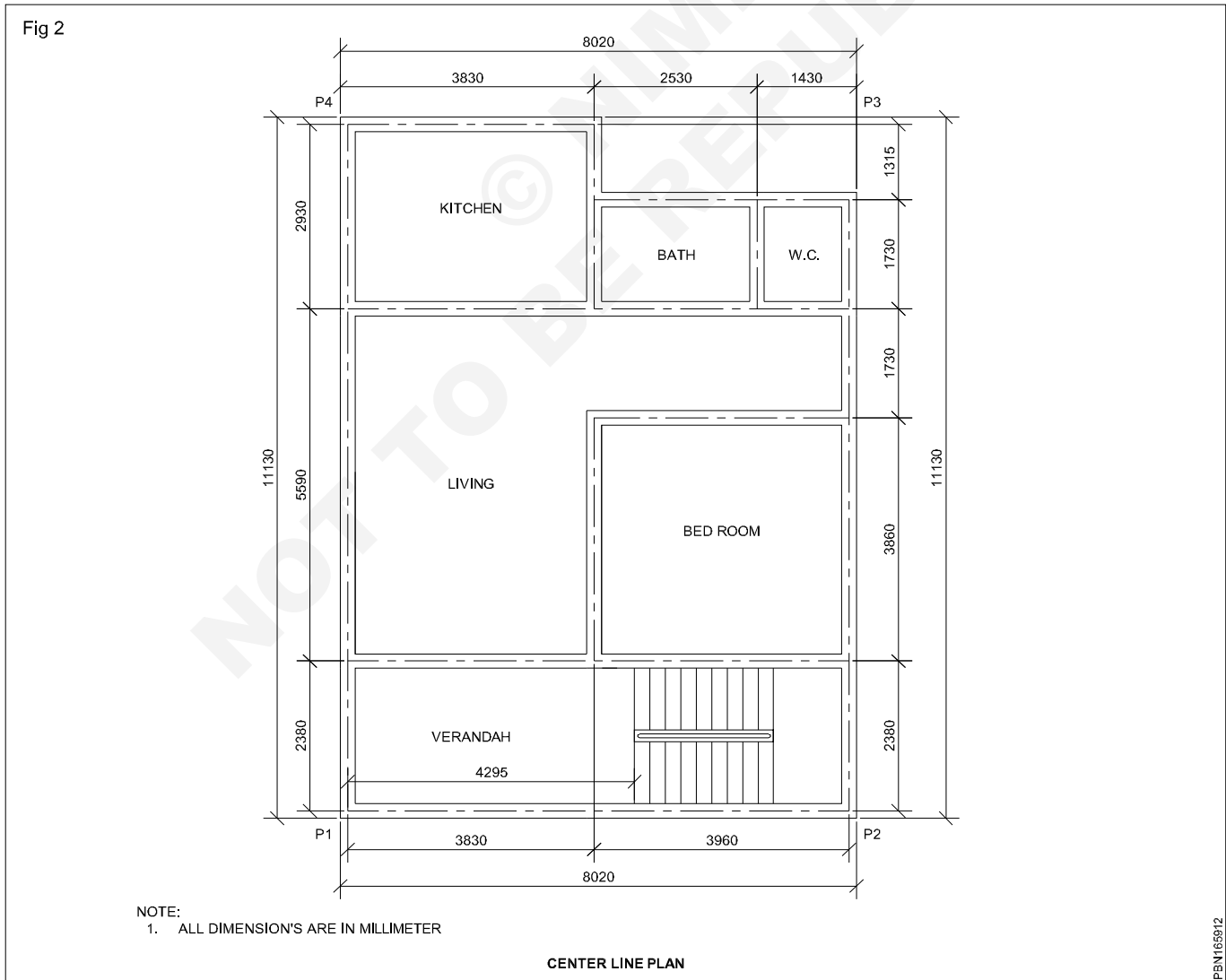
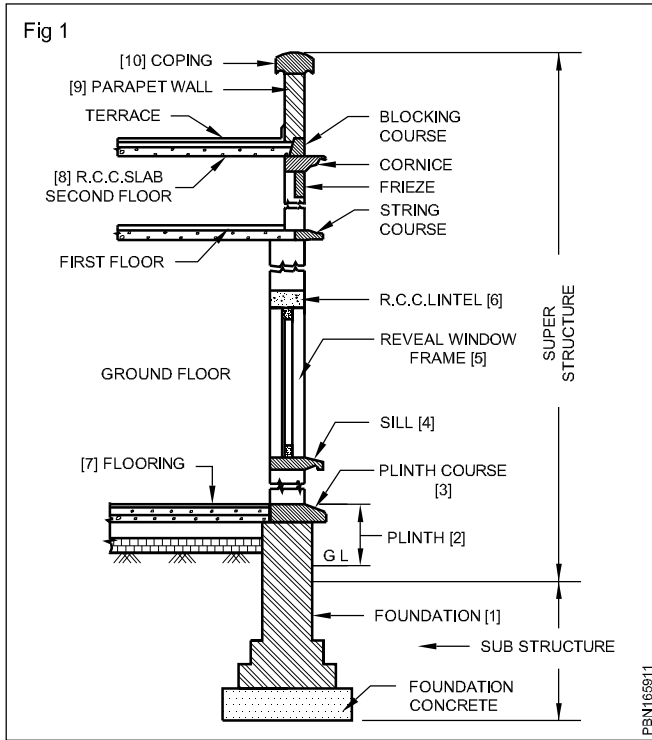
Construction: Conversion of two dimensional drawing into three dimensional structure. It is engineering in action, hence needs construction management.

Occupation: Environment design evaluation is essential after occupation to assess achievements in planning, Designing and construction by observing behavior of user and by obtaining user's views.

Maintenance and preservation: Preparation of maintenance programmer to maintain livability throughout the life of the building by observing effect of sun, rain, wind, and human behavior on building materials and construction.

A guide to good plumbing practices

Size of plumbing shaft should be decided based on the number of services to be installed within. Co - ordination with other services such as heating, ventilation and air - conditioning (HVAC) pipes and ducts should be done at the planning stage. Regulations do not usually permit installation of firefighting, cooking gas and electrical



services within plumbing shafts and therefore separate shafts must be provided for these. In high - rise structures (where access to shafts cannot be achieved through portable ladders) Provision shall be made in the form of cat ladders/rungs and platforms at floor levels within the plumbing shaft for the operatives to attend to repair and maintenance.

Table

Services in plumbing shaft (Fig 3,4&5)

Sl. No.	List of services in plumbing shaft
1	Cold water supply, Domestic
2	Cold water supply, flushing
3	Hot water supply
4	Hot water return
5	Isolation and regulating valves for above
6	Domestic water riser to OHT

7	Flushing water riser to OHT
8	Rain water leader (Down take)
9	Soil stack (one or more)
10	Waste stack (one or more)
11	Vent stack (One or more)
12	Shaft drain and drain stack
13	Access Door form toilet / passage
14	Toilet exhaust
15	Working platform

Additional services accommodated in plumbing shaft

16	Water heaters
17	Flush tanks or flush valves
18	HVAC pipes
19	Artificial ventilation
20	Artificial lighting

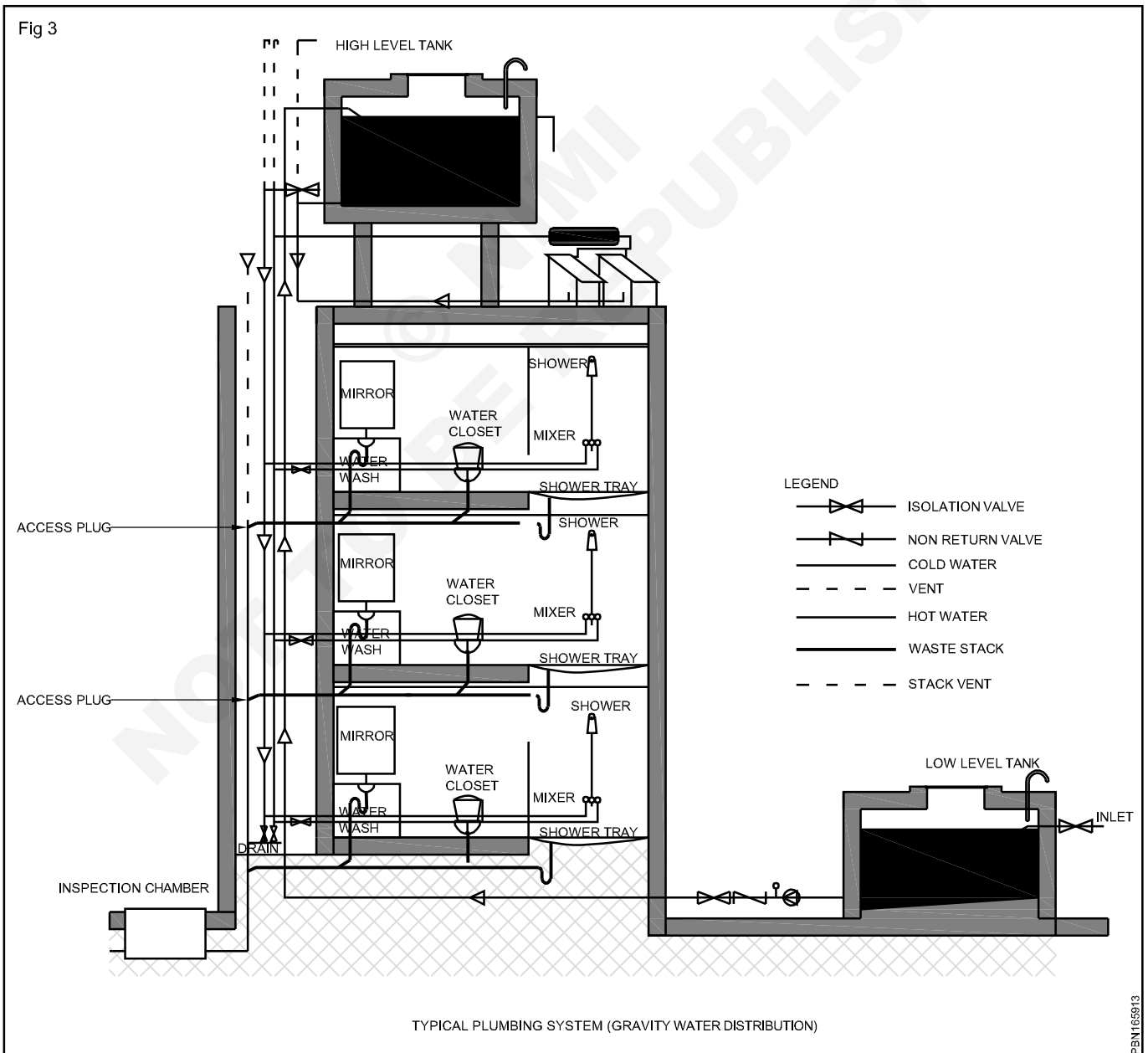
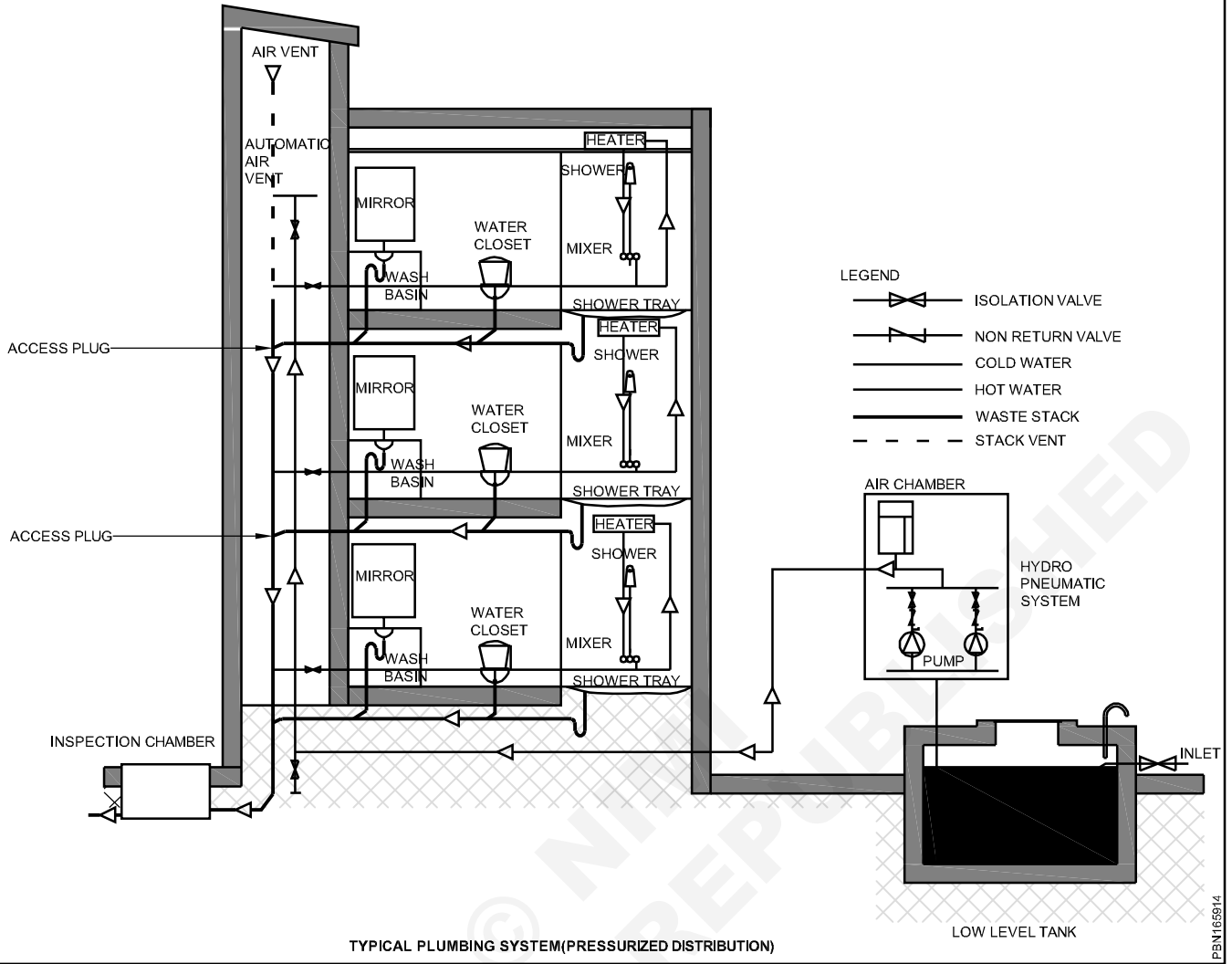


Fig 4



PBN165814

Fig 5



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Description of plumber tools and equipment care and use of tools

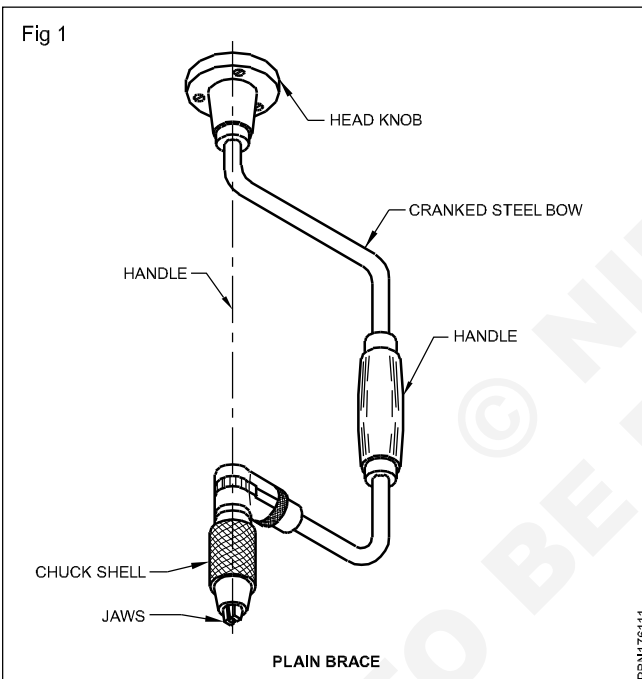
Objectives: At the end of this lesson you shall be able to

- state the uses of ratchet brace and threading die
- state the uses of pipe wrench, sliding wrench and chain wrench
- state the uses of spanner set
- state the care and maintenance.

The brace (plain & Ratchet)

Circular holes are drilled or bored in wood by means of drill. To penetrate into the wooden piece, it is necessary to use the drill to cut a hole.

The brace is a cranked tool for holding a bit while boring a hole. The brace is used to give a rotating movement. The head, knob and the handle can rotate freely. (Fig 1)



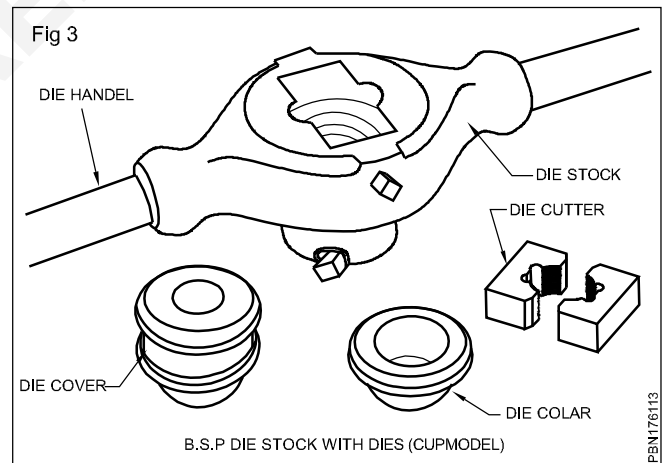
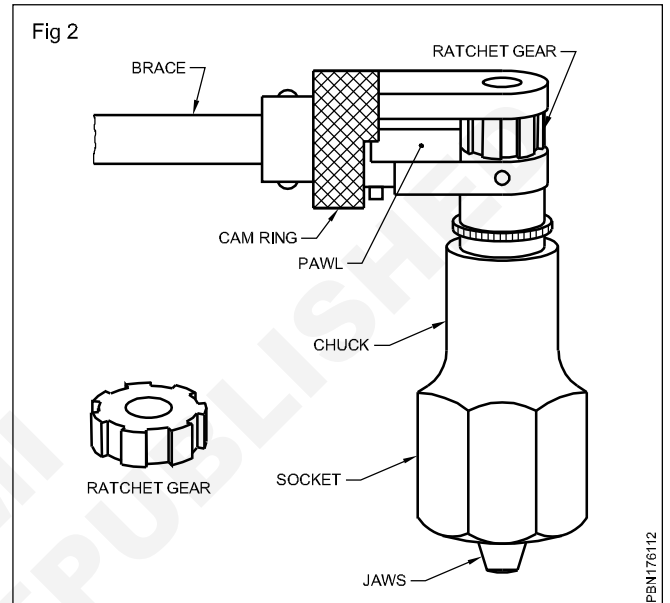
The chuck consists of a metal screwed chuck shell in which the jaws are enclosed. When the shell is loosened the jaws will be open to receive the bit.

The ratchet brace (Fig 2)

The ratchet brace is provided with a ratchet mechanism. The ratchet permits the brace to be rotated to and fro while the chuck rotates in only one direction. The cam ring can be set in positions for clock - wise and anti - clockwise rotation.

Die stock and dies (Fig 3)

This B.S.P die set is used for making external threads on pipes used for plumbing work 1/2" (15mm) 3/4" (20mm) 1" (25mm) cutters and collars are changed and can be used to cut the threads using same die - stock and die - cover cutter are split into two pieces. One end of the cutters are chamfered which makes easy to assemble before threading.

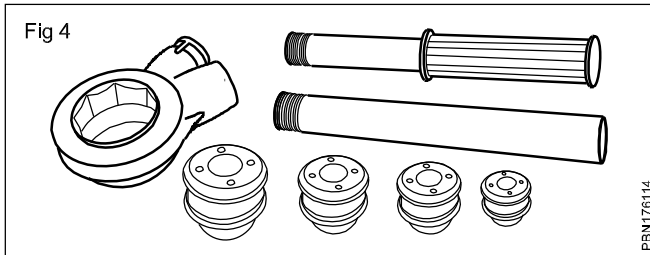


Parts

- Die - stock
- Die - Cover
- Die - Collar
- Die - Cutter
- Die - Handle
- Adjustable screw

Use lubrication oil frequently as this will make threading easy and prevent the damage of teeth in the die cutter.

Ratchet type die set (Fig 4)



This type die set are now a days used to cut threads up to 32 mm ϕ G.I pipes another type is from 1/2" (15mm) to 2" (50mm)

If the pipe is loose it must be hold securely in either a pipe stands or pipe vice or a bench mounted vice.

To fit the die head to the ratchet head select the size die according to the size of the pipe push it into the left side of the ratchet head.

Die stock with the die located over the pipe place a small quantity of cutting oil.

Avoid long cut as this will increase the heat and teeth is in the dies will be damaged.

Plumbing tools - Pipe wrench and chain pipe wrench

Pipe wrenches

These are adjustable pipe wrenches with different shapes. They are used for:

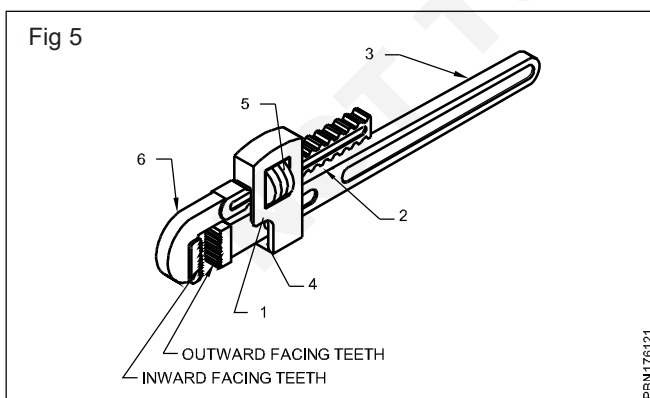
- holding and gripping pipes
- assembling and dismantling of pipes and fittings.

The Stilson pipe wrench (Fig 5) is designed as a heavy duty tool to withstand rough handling and heavy work. The jaws give an immediate and positive grip.

It may be used for all pipes with 15mm to 50mm diameters. Pipe wrenches are selected according to the pipe size.

Parts (Fig 5)

The Stilson pipe wrench consists of the following parts:



- 1 Pivot
- 2 Spring
- 3 Handle or lever
- 4 Spring

5 Adjusting nut

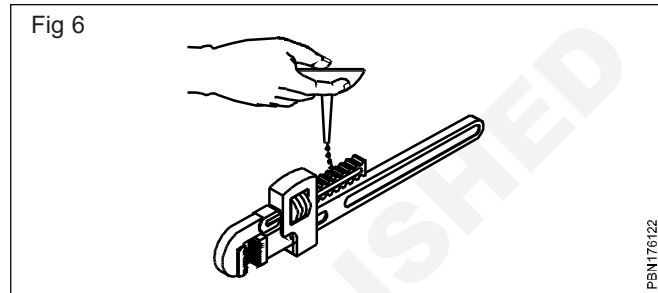
6 Moveable jaw.

While using this pipe wrench, the jaws must be placed over the workpiece to their full depth and tightened by means of the adjusting nut.

Care and maintenance: The ability of the pipe wrench to grip the pipe is directly related to the condition of the teeth.

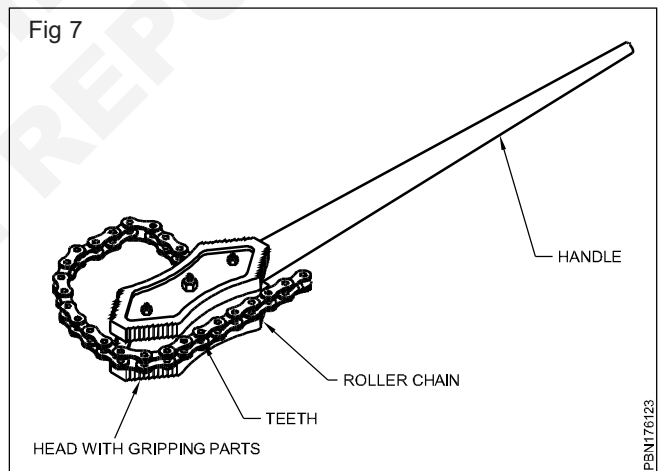
Cleaning the teeth and sharpening them with a triangular file can restore some wrenches to useful condition.

Oil should be applied to the adjustment nut periodically to prevent rusting. (Fig 6)



Chain pipe wrench (Fig 7)

Chain pipe wrenches are used for pipes with diameters of 50mm to 150mm. They may be used for gripping cylindrical or irregular objects.

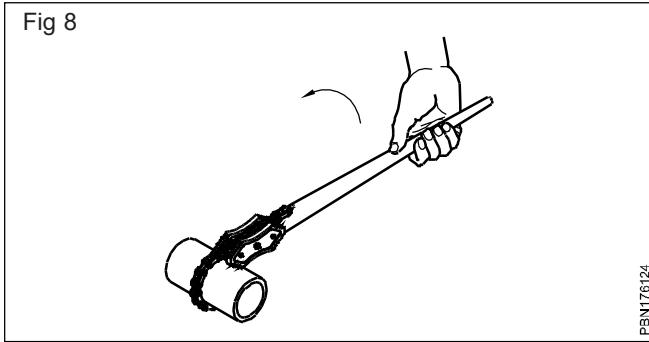


Application of chain pipe wrench

To use a chain pipe wrench, the head is placed on the pipe and the chain pulled round the circumference of the pipe. The chain is then engaged with the large teeth in the centre of the head.

The movement of the lever in the direction indicated by the arrow in the figure caused the serrated edges of the head to wedge firmly against the pipe giving a firm grip. (Fig 8)

The chain pipe wrench is a heavy gripping tool and should not be used for pipes with less than 50mm diameter.



Spanners

A spanner is a hand tool with jaws or opening or a ring at one end or at both ends of tightening or slackening nuts and bolts and screw heads. (Fig 9) it is made of drop forged, high utensil or alloy steel and head treated for strength.

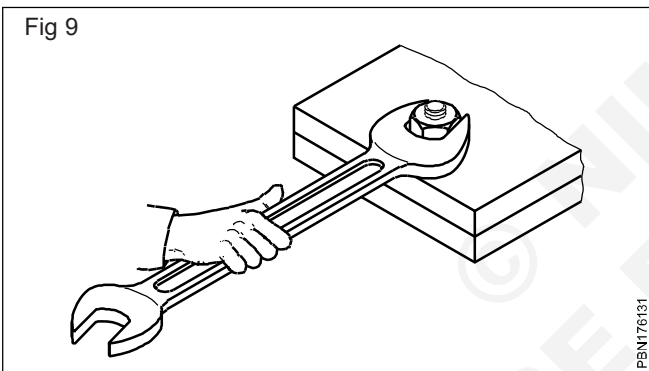
Types of spanners

Open end spanners

Ring spanners

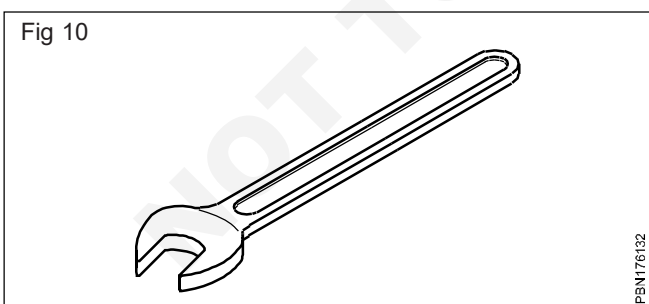
Open end spanner

They can be single ended or double ended.



Single ended spanners (Fig 10)

These are general purpose spanners. Single ended spanners are mostly supplied with machine tools for a specific purpose. (Fig 10)

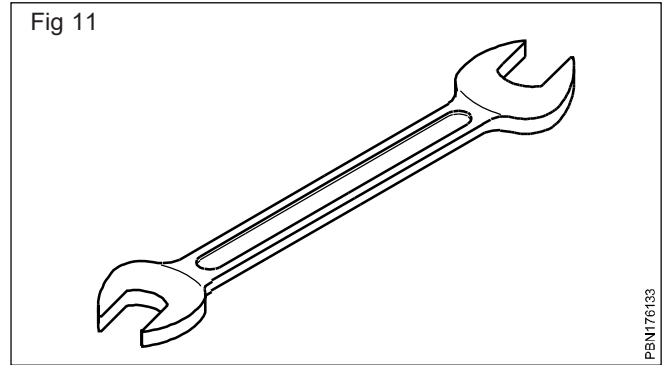


Double - ended spanners (Fig 11)

Double - ended spanners are standard spanners having two different size openings. Some spanners are made of chrome vanadium steel.

They are available in a set of 8, Nos 8 to 27 mm.

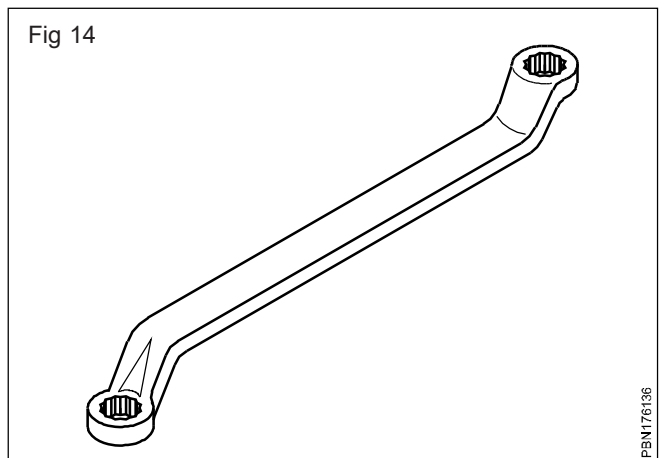
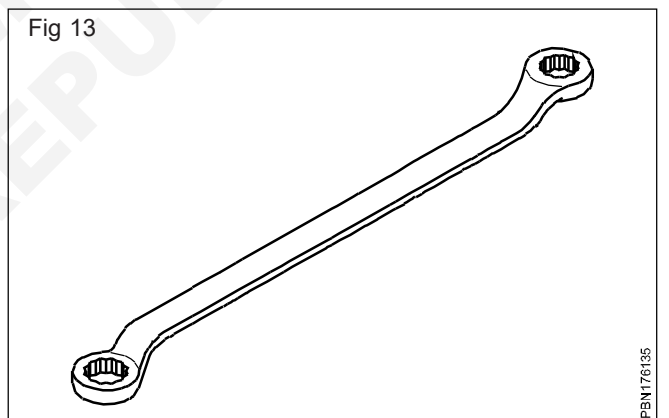
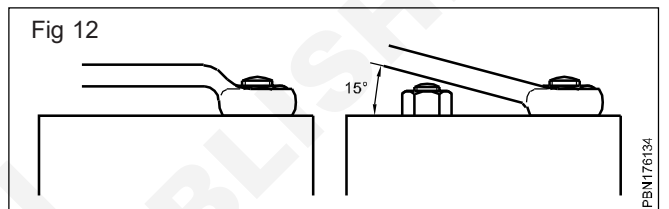
8 x 10, 9 x 11, 12 x 13, 14 x 15, 16 x 17, 18 x 19, 20 x 22 and 24 x 27 mm.



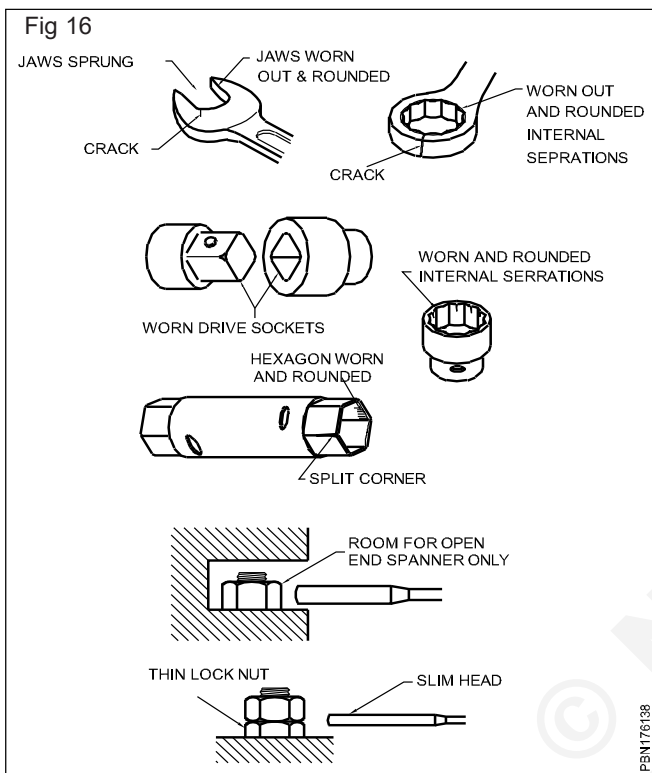
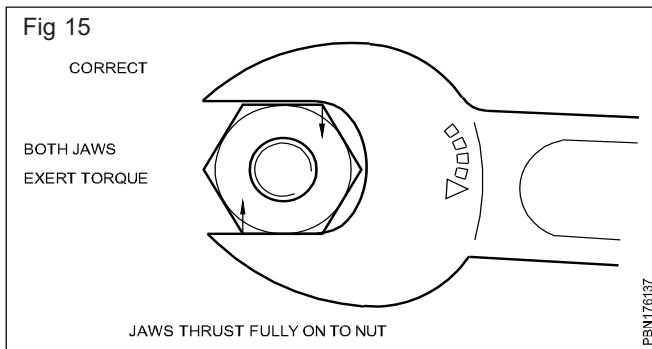
Ring spanners (Figs 12, 13 & 14)

These types of spanners are used where obstruction close to the side of a nut prevails (Fig 15) and application of open ended spanners is not possible.

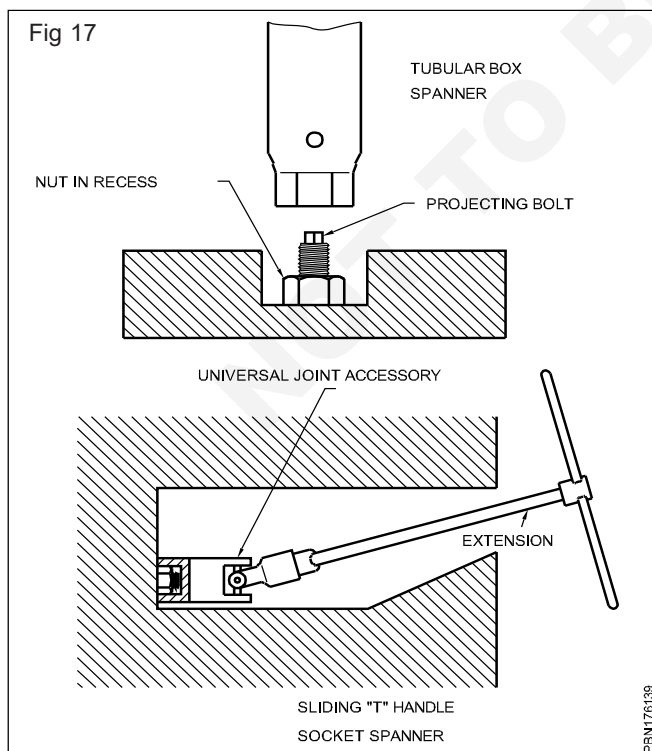
These are available in a set of 8 nos. (8 to 27 mm) 8 x 9, 1 x 11, 12 x 13, 14 x 15, 16 x 17, 18 x 19, 20 x 22 and 24 x 27 mm.



Nuts in inaccessible positions may be reached with socket spanners, with special drawing accessories. (Fig 16)



Length of spanners (Fig 17)



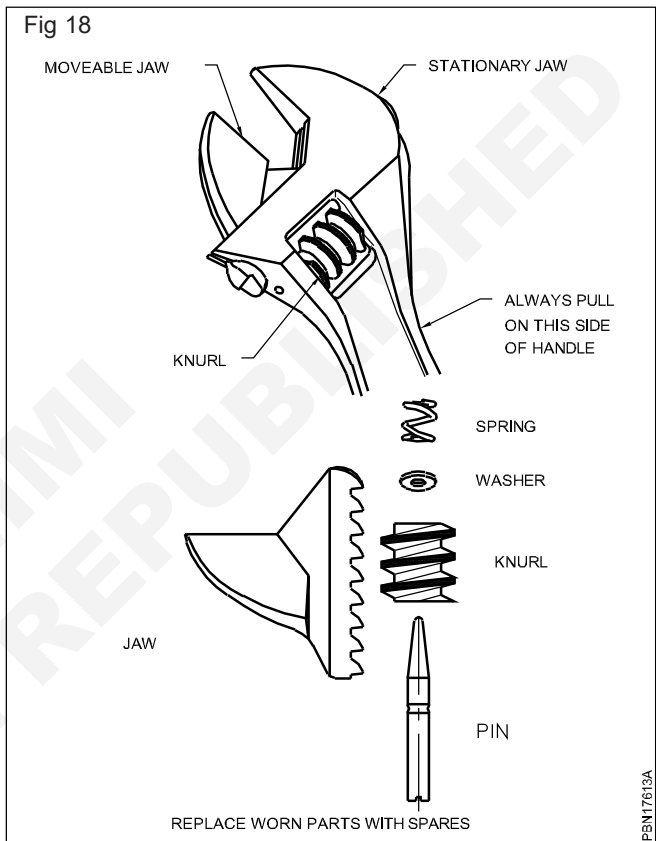
Normally spanners have a length that is about ten times the width of the jaw opening.

Never exert excessive pull on a spanner, particularly by using a pipe to extend the length of a spanner.

Excess turning effect of the spanner could result in:

- striping the thread
- shearing the bolt
- straining the jaws of the spanner
- making the spanner slip and cause an accident.

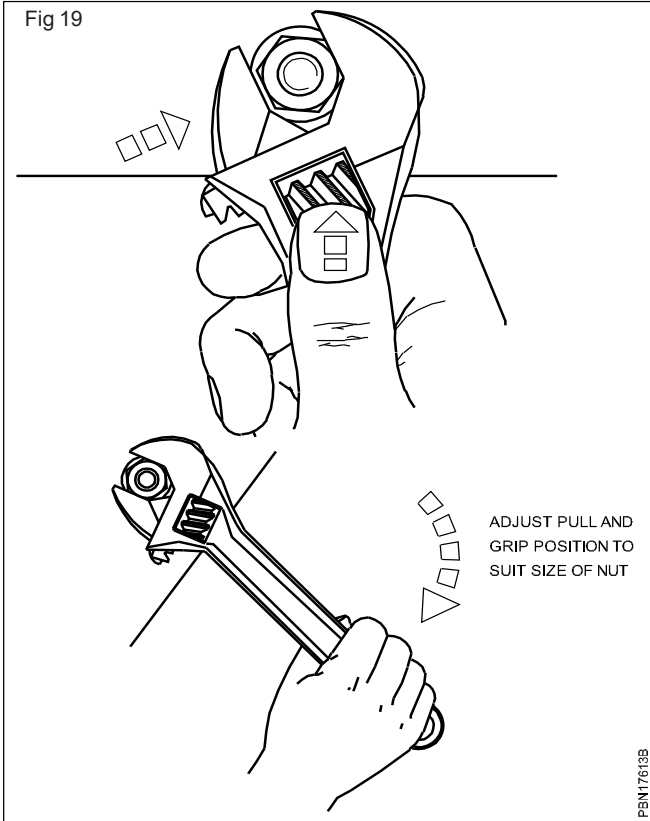
Adjustable spanners (Figs 18 & 19)



Most common types of adjustable spanners are similar to open and spanners, but they have one movable jaw. The opening between the jaws of a typical 250 mm spanner can be adjusted from zero to 28.5 mm. Adjustable spanners may range in length from 100 mm to 760 mm. the type illustrated has its jaws set an angle of 22 1/2° to the handle. Adjustable spanners are convenient for use where a full kit of spanners cannot be carried about. They are not intended to replace fixed spanners which are more suitable for heavy service. If the movable jaw or knurled screw is cracked or worn out, replace them with spare ones.

When using the adjustable spanner follow the steps given below.

Place it on the nut so that the jaw opening points in the same general direction the handle is to be pulled. In this position the spanners are less liable to slip and the required turning force can be exerted without damage to the moving jaw and knurl.



Push the jaws into full contact with the nut.

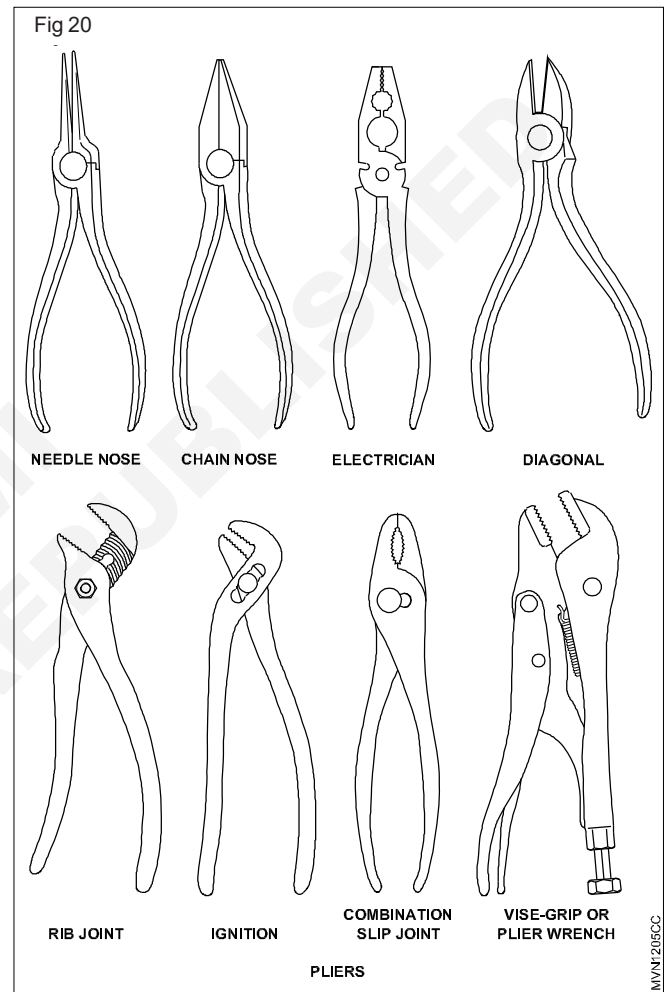
Use the thumb to tighten the adjusting knurl so that the jaws fit the nut strongly.

Pull continuously. The length of the handle is designed to suit the maximum opening of the jaws. With small nuts, a very small pull on the handle will produce the required torque.

Pliers: Pliers are commonly used for cutting wires, holding parts, crimping electrical connections and bending cotter pins. (Fig 20)

Safety:

- 1 Avoid cutting hardened objects.
- 2 Never use pliers for striking works.



Pipes different kinds

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

- state the uses of different pipes for different purpose
- state the cutting method of G.I.C.I., A.C and P.V.C pipes
- state the uses of cutting tools like hacksaw, pipe cutter and hand saw
- state the sizes and grades of each pipes.

Refer to R.T. for Exercise : 1.3.17

Method of pipe bending in different dia

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

- state the uses of pipe bending in plumbing works
- state the method of pipe bending in G.I pipe and steel pipe
- state the method of P.V.C bending by heat process
- state the precautions while bending.

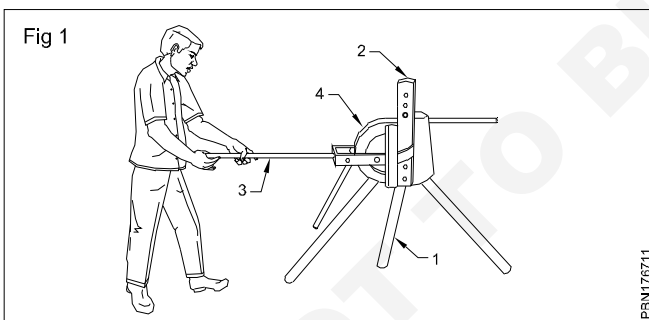
There are some situations in plumbing jobs, where it is preferable to bend a pipe rather than use a pipe fitting,

The most common pipe benders are listed here.

Portable hand operated pipe bender (Fig 1)

The portable hand-operated pipe bender consists of the following parts

- | | |
|-------------------|-------------------|
| 1 Tripod stand | 2 Pipe stop lever |
| 3 Handle or lever | 4 Inside former |



Bench type hand operated pipe bender (Fig 2)

This consists of the following parts. It is used for bending galvanized iron and steel pipes.

- | | |
|----------------------------------|-------------------|
| 1 Inner former, | 2 Lever or handle |
| 3 Adjusting screw with lock nut. | 4 Pipe guide |

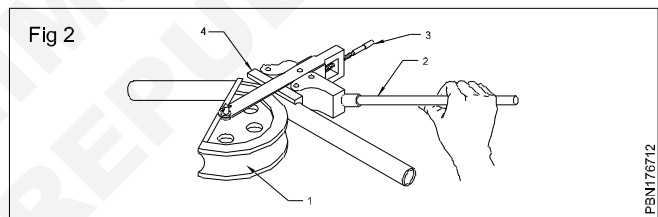
Hydraulic bending machine (Fig 3)

This machine can be used for bending G.I and M.S.pipes without sand filling to any direction.

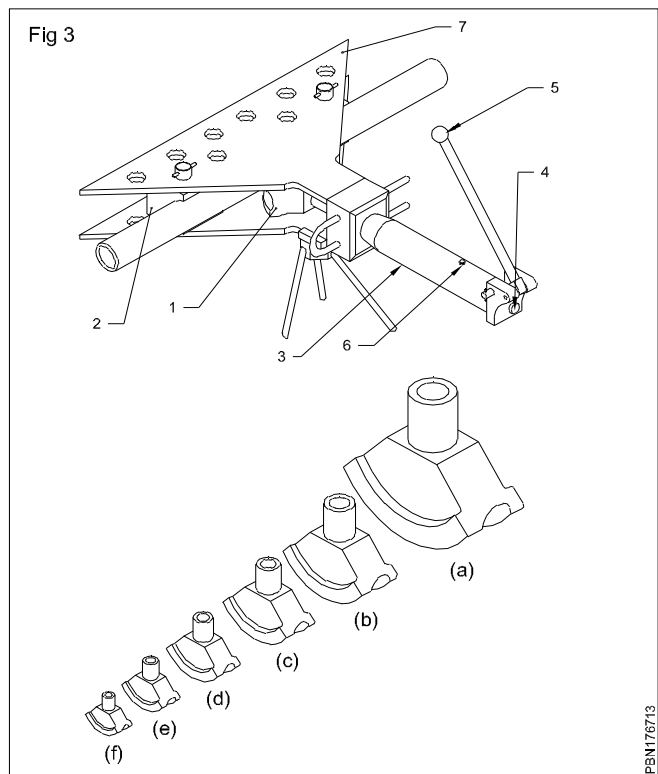
It consists of the following parts.

- | | |
|-------------------|--------------------------|
| 1 Inner former | 2 Back farmer |
| 3 Hydraulic ram | 4 Pressure release valve |
| 5 Operating lever | 6 Bleed screw |

7 Base plate



Inner formers are interchangeable and are able to bend pipes up to 75mm diameters. (Figs 3a, b, c, d, e & f)



Bending of pipes by hot and cold process

Objectives: At the end of the lesson you shall be able to

- state the bending of pipes by cold and hot process.

Tube or pipes are bent at different angles, in different planes and shapes. Bent tubing is widely used for fuel pipes, oil, air conduits, and plumbing works etc.

The bending of the tubes can be done by hand or mechanized methods, in cold and hot conditions, with or without fillers. The choice of bending method depends in the tube diameter material of tube and the angle of bend.

Cold bending: Simplest method for bending tubes of 1 to 15 mm in diameter is done by the simple device. This device comprises a plate with holes and radius pins, which are inserted into suitable holes.

Pipes upto 40 mm dia. in cold condition are bend to large radius by means of simple bender. The pipes after fixing in clamp at the end of the radius collar are bend around the groove of the collar.

Pipes upto 20 mm dia. bent by the radius-collar bending unit. This unit is fixed at the top of the work bench through its base plate by means of bolts. Radius collar and the clamp are mounted on the base. Movable roller is fixed in yoke with hand lever. Now the pipe is inserted in between the roller and the collar. So that its end is hold by the clamp. Now the hand lever is turned with yoke and roller around the radius collar, until the pipe is bend as per requirement.

Hot bending: Hot bending is used for pipes over 100 mm diameter. In hot bending with a filler, the tube is annealed, layed out and one end is closed with wooden or metal plug. For preventing the tube from crushing, bulging or cracking, it is filled with dry sand, shifted through a sieve with 2mm makes. Hammers or vibrators are used for proper filling and compacting the sand in the pipes. After filling sand the pipe is snugly fitted with plug.

Pipes are heated red-hot with blow lamps in furnaces or with gas burners, before bending. The pipes are bend in the required shape in hot condition in proper bending devices.

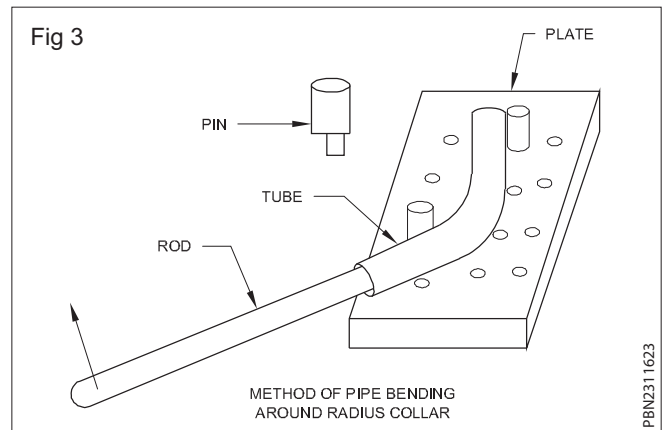
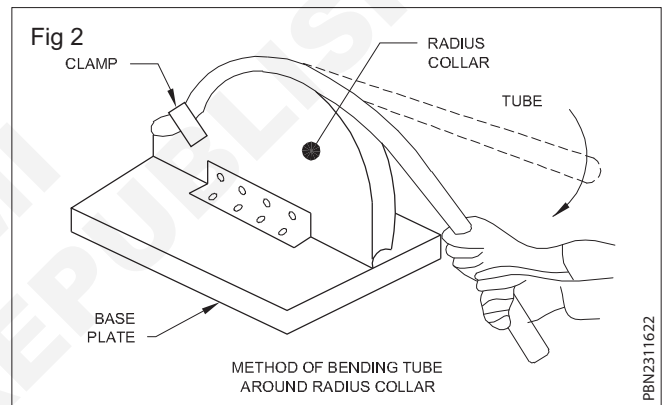
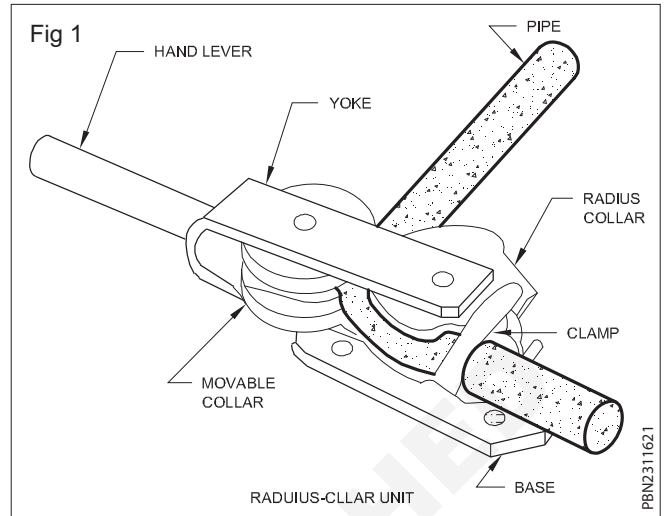
After bending the plugs are extracted or burnt out and the sand is removed. Poor compaction of sand and inadequate or non-uniform heating may cause the formation of folds or even cracking of the pipe.

The most common pipe benders are listed here.

Portable hand operated pipe bender (Fig 1, 2 & 3)

The portable hand-operated pipe bender consists of the following parts.

Method of bending galvanized and heavy pipes: The most effective way to bend a galvanized pipe is to use a pipe bender. Both automated and manual pipe benders are designed to give you leverage while working on a pipe. In short, these tools lend you the strength you need to safely create a bend in galvanized steel without hurting yourself or damaging the pipe.

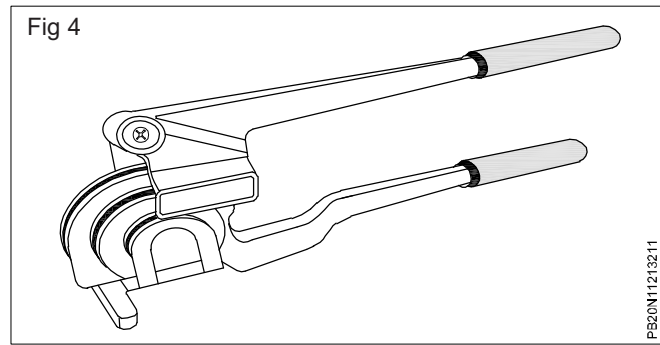


Handheld: Comparatively, handheld pipe benders tend to be less expensive but more difficult to use. You'll need to do a lot of your own math ahead of time if you want your handheld bender to serve you well.

Induction Bending: To induction bend galvanized pipe, you can wrap a heating coil around your pipe. Make sure the coil fits the part of the pipe you wish to bend. As soon as the pipe has effectively softened, you can use your hands or a tool to bend it to your preferred degree.

Hot Bending: Hot bending works similarly to induction bending. Instead of fitting your pipe with an induction coil, though, you can instead heat your preferred bend with a blow torch or similar tool. Once the metal is softened, you can fit it with a clamp to ensure an effective bend.

Easy bending of Galvanized pipe: Galvanized pipe is protected by a layer of zinc. This layer keeps the pipe from rusting. While the layer may suffer damage over time, it ensures the pipes' longevity, saving you money and keeping your water and gas running for years at a time.



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Equipment's and tools for hot gas welding and electric hot plate for P.P.R pipe joints

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

- state the polyvinyl chloride (PVC) and types of P.V.C pipes
- state the PPR pipe and table for PPR welding
- state the principles of plastic welding heated tool welding and PPR cutter and PPR welding machine
- state the hot gas welding CPVC and gas heated operated type.

Polyvinyl Chloride (PVC)

- Polyvinyl chloride (PVC) is manufacture from ethylene or acetylene.
- It is essentially consisting of polymerisation of vinyl chloride.
- PVC has to be mixed besides plasticizers, with release agents, stabilizers etc. to make it easily process able.

Uses:

- Non plasticized grades are widely used for the manufacture of pipes and conduits.
- It is used as cable coating because of its high Electrical Resistance.
- Blow molded components are used for replacement of glass for its high transparency.
- Non-toxic products are used for packing foods.
- Manufacture of Toys, dolls, paper coating, lampshade, etc.
- PVC is used for temperature below about 140°F.

Types of P.V.C pipes

- 1 Polyvinyl chloride (P.V.C)
- 2 Poly proylene (P.P)
- 3 Acrylo nitrite butadiene styrene (A.B.S)
- 4 Poly ethylene (P.E)
- 5 Polyamide nylon
- 6 Polyvinyl dichloride (P.V.D.C)
- 7 Acrylics

Poly propylene Random Co-polymer (PPR)

- Latest and advanced Technology using raw material PP co-polymer.
- It is used for cold and hot water system, water purifying, chemical flow, etc.
- Three key parameters for polyfusion welding are
 - i Temperature
 - ii Pressure
 - iii Time

i Temperature

- Temperature around $260^{\circ} \pm 5^{\circ}\text{C}$ to ensure proper plastification of the joint.

ii Pressure

- Weld components need to be inserted into the weld at even pressure and length.

iii Time

- i Warming up time
- ii Adoption time
- iii Connection time

i Warming up time:

Warming up time starts when both components are simultaneously pressed.

ii Adoption time:

Adoption time starts when components are removed from welder.

iii Connection time

Connection time is the components being pushed with each other with lateral pressure.

iv Weld hardening time:

Hardening time is the joint to get cooled and free from physical stresses.

PPR hot plate machine

- PPR pipes are jointed through this method
- Pipe cutter (Fig 2) in used for cutting PPR pipes
- Electric hot plate (Fig 1) is heated through electric connection.
- Polyfusion welder unit are also getting heated through this hot plate.
- Male end of the pipes and female end of the fittings are heated through this polyfusion weder unit are taken out and pressed together to get weld joint.

During the joining method PPR pipe and PPR fittings are pressed with lateral pressure. Do not twist the pipe or fittings while jointing.

Table for PPR Welding

Diameter mm	Melting length mm				
		T1	T2	T3	T4(Seconds)
20	12	5	3	5	2
40	16	12	6	12	4
75	26	30	8	30	6
125	41	60	10	60	8

Principle of Plastic Welding

Any welding process with plastics, involves the use of energy such as in the form of heat.

The heat is used for fusing the base materials.

2 Hot Gas Welding

Hot gas welding which basically consists of using a show of hot gas to soften both filler rod and Bate materials.

This method is used in welding pipe and large tubing.

Plastic Welding process are two types

1 Heated tool welding

In this process the heat is applied to the surface by means of contact of a heat source such as strip heater.

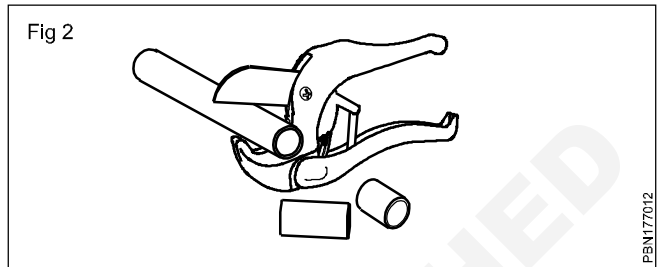
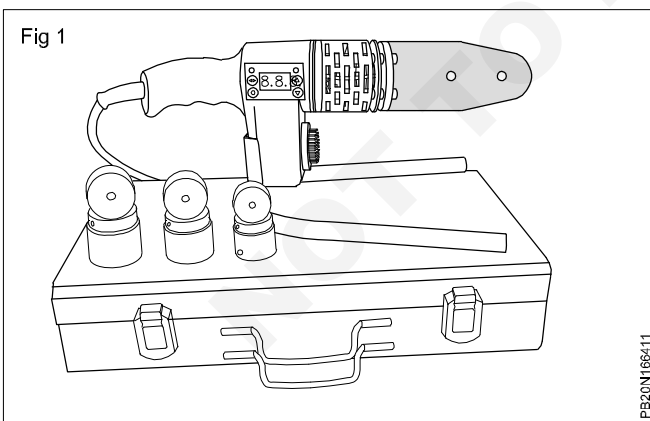
When the plastic is softened, the heat surface is removed and the components are welded is removed and the components are welded is removed and the components are welded.

The temperature of the heating tools should be 200°C to 370°C.

This method is used in welding pipe and large tubing.

PPR Welding Machine (Fig 1)

PPR pipe cutter (Fig 2)



2 Hot Gas Welding

Hot gas welding which basically consists of using a show of hot gas to soften both filler rod and bate materials.

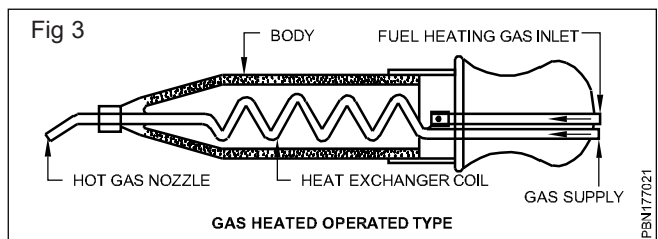
Co-polymer vinyl chloride (CPVC)

- CPC and CPVC are made of the same basic elements.
- CPVC is altered by a free radical chlorination reaction that effectively increases the chlorine content of the material
- CPVC to be used temperatures upto 190°F.
- CPVC pipe is an off-white or yellowish colour.
- CPVC pipe is more suitable for hot water and potable water system

Gas Heated operated Type

i Gas Heated Operated Type

- This is independent of power supply and light in weight.
- Air is suitable heating gas for PVC but nitrogen is used for oxygen sensitive heating medium.
- The gas heated torches are either propane or butane as fuel heating gas.
- These are used in the field when electricity is not available. (Fig 3)



Types of fittings for different joints and different pipes

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

- state the different fittings used for different pipe joints and their uses
- state the method adopted for flange joint, socket joint with lead
- state the method of detachable joint stone ware socket and spigot cement mortar joint
- state the method of ductile iron pipe joint.

Describe

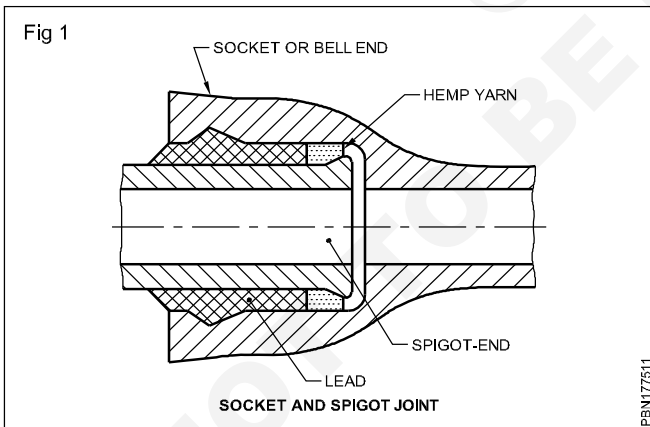
Mainly pipes are used for handling & transporting the water in position.

Pipes are manufacturing in small length of 2 to 6 meters. These small pieces of pipes are then joined together after placing in position, to make one continuous length of pipe line. The design of these joints mainly depends on condition of the pipe.

The pipe joints are classified as follows

- 1 Spigot and socket joint
- 2 Expansion joint
- 3 Flanged joint
- 4 Screwed joint
- 5 Collar joint
- 6 A.C pipe joint
- 7 Solvent cement joint

1 Socket and spigot joint (Fig 1)

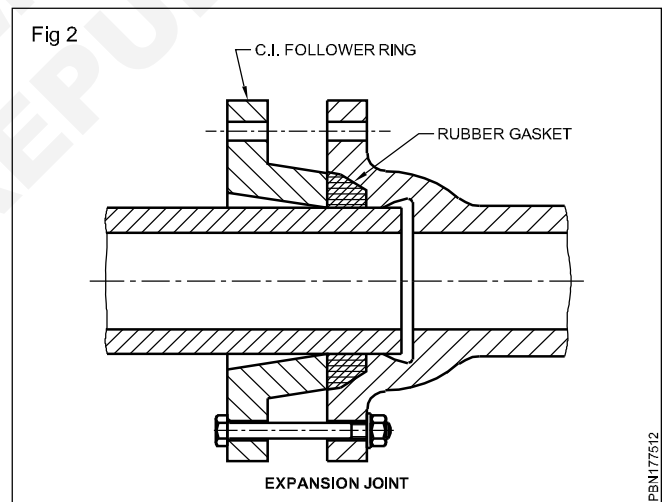


This type of joints are mostly used for cast iron pipes. For the construction of this joint the spigot of normal end of one pipe is slipped in socket or bell end of the other pipe until contact is made at base of the bell. After this yarn of hemp is wrapped around the spigot end of the pipe and tightly filled in the joint by means of yarning iron upto 5 cm depth. The hemp is tightly packed to maintain regular annular space and for preventing jointing materials from falling inside the pipe. After packing of hemp, a gasket or joint runner is clamped in place round the joint so that it fits tightly against the outer edge of the bell. Sometimes wet clay is used to make light contact between the runner and pipe so that hot lead may not run out of the joints space.

The molten lead is then poured into the “V” shaped opening left in the top by the clamped joint runner. The space between the hemp yarn and the clamp runner is filled with molten lead. When the lead has hardened, the runner is removed the lead which shrinks while cooling is again tightened by means of caulking tool and hammer.

2 Expansion joint (Fig 2)

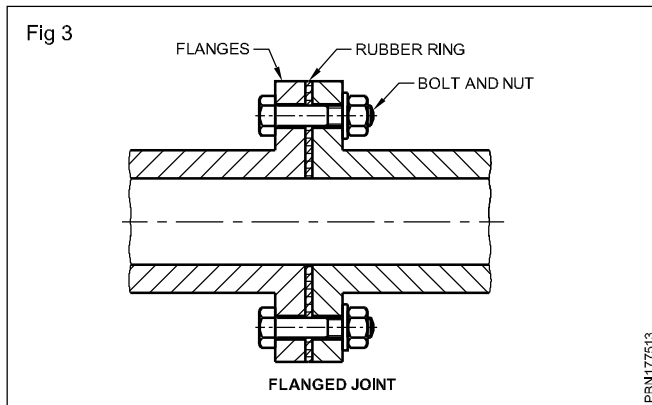
This joint is used at such places where pipes contract due to change in atmospheric temperature and thus checks the setting of thermal stresses in the pipe. In this joint the socket end is flanged with cast iron follower ring, which can freely slide on the spigot end or plane and of other pipe. An elastic rubber gasket is tightly pressed between the annular space of socket and spigot by means of bolts as shown in the (Fig 2).



In the beginning while fixing the follower ring some space is left between the socket base and the spigot end for the free movement of the pipes under variation of temperature. In this way when the pipe expands the socket end moves forward and when pipes contract it moves backward in the space provided for it. The elastic rubber gasket in position keep the joint water tight.

3 Flanged joint (Fig 3): This joint is mostly used for temporary pipe lines, because the pipe line can be dismantled and again assembled at other place. The pipe in this case has flanges on its both end welded or screwed with pipe. The two end of the pipes which are to be joined together are brought in perfect level near one another and after placing one hard rubber washer between flanges are bolted. Placing of washer or gasket of rubber, canvas, copper or lead between the two ends of flanges is very necessary for securing a perfect water tight joint. This

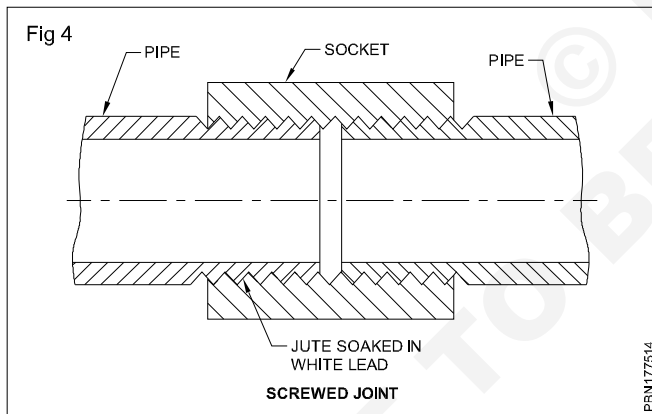
joint cannot be used at such places where it has to bear vibration or deflection of pipes. (Fig 3)



These joints are commonly used for joining pumping station, filter plants, hydraulic laboratory boiler, house etc. where it may be necessary occasionally to dismantle and reassemble the pipe line. If the steel pipes are to be jointed by these joints, it is better to screw the separately cast flanges on the pipe and then they are joined.

4 Screwed joint (Fig 4)

This joint is mostly used for connecting small dia. cast iron, wrought iron and galvanised pipes. The ends of the pipe have threads on outside while socket or coupling has threads on the inner side. The same socket is screwed on both the end of the pipe to join them, for making water tight joint zinc paint or hemp yarn should be placed in the threads of the pipe before screwing socket over it. (Fig 4)

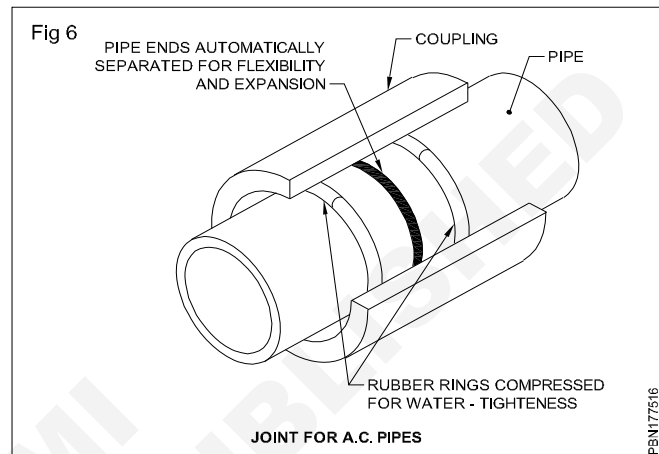
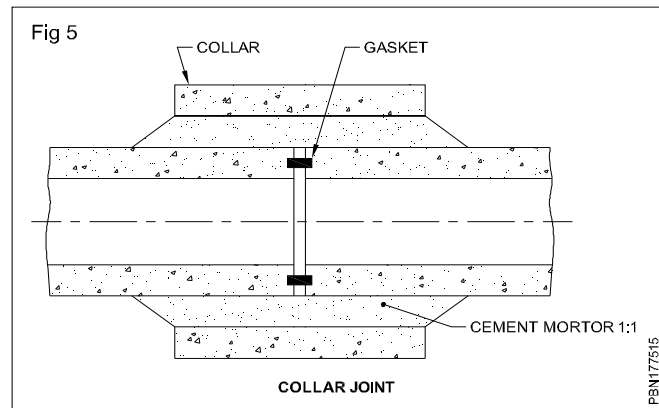


5 Collar joint (Fig 5)

This type of joints are mostly used for joining big diameter concrete and asbestos cement pipes. The end of the pipes are brought in one level before each other. The rubber gasket between steel rings and jute-rope soaked in cement is kept on the groove and the collar is placed at the joint so that it should have the same lap on both the pipes. Now 1:1 cement mortar is filled in the space between the pipes and the collar as shown in (Fig 5).

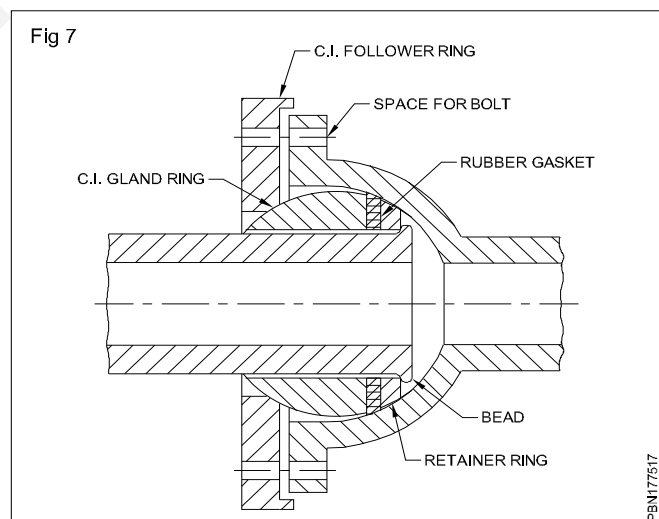
6 AC pipe Joint (Fig 6)

For joining small diameter AC pipe the two ends of pipes are butted against each other then two rubber ring will be slipped over the pipes and the coupling will be pushed over the rings as shown in (Fig 6).



7 Flexible joint

Sometimes the joint is also called bolt and socket or universal joint. This joint is used at such places where settlement is likely to occur after the laying of the pipe. This joints can also be used for laying pipe on curves, because at the joints, the pipe can be laid at angle. This is a special type of joint. (Fig 7)



The socket end is cast in spherical shape as shown in (Fig 7). The spigot end is plain but has a bead at the end, for the assembling of the joint. The spigot end of one pipe is kept on the spherical end of the other pipe. After the retainer ring is slipped which is stretched over the bead. Then a rubber gasket is moved which touches the retainer ring. After its split cast iron gland ring is placed. The outer surface of which has the same shape as inner

surface of socket end over this finally cast iron follower ring is moved and is fixed to the socket end by means of bolt as shown in figure. It is very clear that if one pipe is given any deflection the ball shaped portion will move inside the socket and the joint will remain water proof in all the positions.

8 Solvent cement joint: Clean the contacting surface of joint with a clean cloth-Abraze these area with emery paper and again clean it. Apply an even coat of solvent adhesive with a clean dry brush having sufficient width for quick application. Immediately after applying solvent cement, insert the pipe in the socket to its full depth and turn it through 90° angle. Leave joint undisturbed till the joint sets.

Special care should be taken while jointing large diameter or higher class pipe (6 kg/cm² and above). Always use heavy duty solvent cement for such pipes. (Requirement of solvent cement & lubricants are as under)

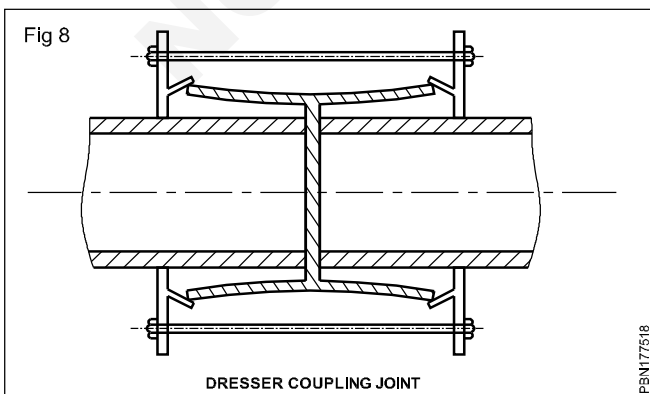
For small breakage of pipe i.e. less than 300mm Ø a piece of pipe bigger than damaged portion can be cut vertically into unequal half. After applying thin coat of PVC solvent cement around the damaged portion and inside the bigger half cut pipe piece, stick it over the damaged portion. If the damage portion is more than 300mm Ø remove the damaged portion by cutting a length of damaged portion plus two times the diameter of pipe. Cut a good piece of pipe equal to length of damaged pipe removed and chamfered ends. Slide one repair coupler to the upper line and one in lower. Place the cut pipe into the gap. Slide the repair coupler at top to down and bottom one up and joint the line.

9 Mechanical Joints

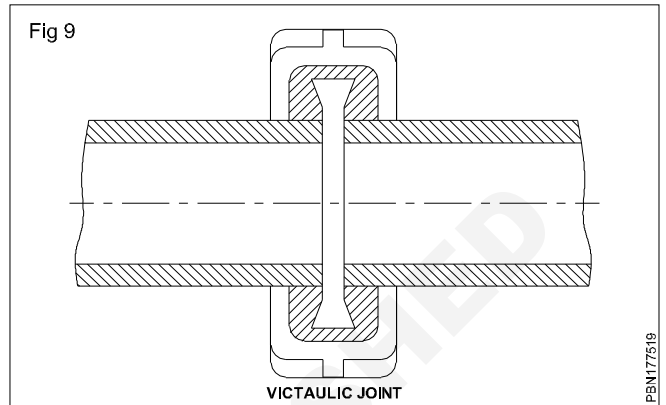
The type of joint is used for jointing cast iron, steel or wrought iron pipes, when both the ends of the pipes are plain or spigot. There are two types of mechanical joints.

a **Dresser-coupling:** It essentially consists of one middle ring, two follower rings and two rubber gaskets. The two follower rings are connected together by bolts, and when they are tightened they press both the gaskets tightly below the ends of the middle ring. In this way the joint remains watertight.

These joints are very strong and rigid, and can withstand vibration and shocks upto certain limit. These joints are most suitable for carrying water lines over bridges, where it has to bear vibrations. (Fig 8)



b **Victaulic-Joint:** In this type of joint a gasket or leak proof ring is slipped over both the ends of the pipes as shown in the (Fig 9). This gasket is pressed from all sides on both the pipes by means of half iron coupling by bolts. The ends of pipes are kept sufficient apart to allow for free expansion, contraction and deflection. This joints can bear shocks, vibrations etc. and is used for cast-iron, steel or wrought iron pipes line in expose places. (Fig 9)

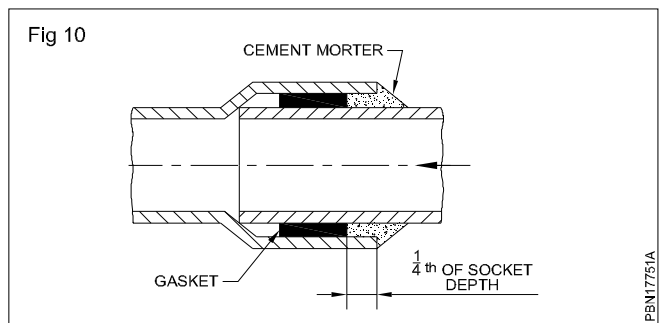


SW pipes: These pipes are manufactured from good quality clay. These clay is molded in the shape of pipe and then heated in the kiln. There interior and exterior surface of pipes which remain exposed after jointing are glazed. The glazes are obtained by the action of fumes of volatized common salt on the material of the pipes during the process of burning. Glazing helps to get smooth inside surface.

Stone ware pipe will have spigot and socket (Fig 1). There will be grooves inside the socket and outside the spigot. Pipes are available for lengths of 600mm and diameter varying from 100 to 600mm. Stoneware concentric taper pipes, tee, junctions bends of 90°, 45°, 22½° etc., are available. Hence jointing is easy.

Stone ware pipe joint (Fig 10): This type of joint is called socket and spigot joint. For this joint spigot end is inserted to the socket end and hempyam (or) gasket soaked in thick cement slurry is placed in the gaps. This hempyarn is caulked tightly by the spunyarn caulling chisel.

Cement mortar of ratio 1:1 is filled in the socket for the 45° angle this is mostly used for underground drainage.

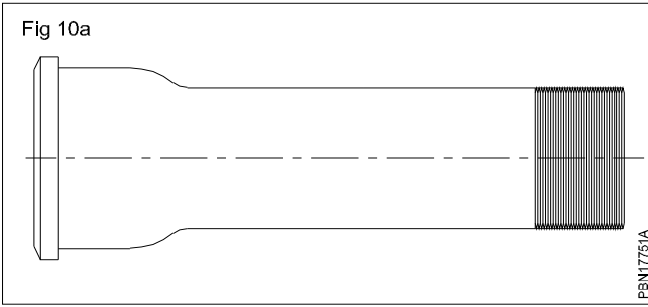


Tests to be conducted on SW pipe are

- Hydraulic test
- Acid resistance test

- Alkali resistance test
- Crushing strength test

Details refer IS 651 (Fig 10a)



Permissible tolerance on internal diameter of pipe are as under.

ϕ	Permissible tolerance
100	3 mm
150	5 mm
200 - 230	6 mm
250 - 350	8 mm
400 - 450	10 mm
500 - 600	12 mm

Plumber should check the following

- Pipes are straight
- Pipes are circular throughout
- Pipes has got required glazing.
- Pipes sounds ringing on knocking.
- There are no obstructions inside pipe.

Ductile iron pipe (D.I pipe): Ductile iron pipe is sized according to a dimensionless term known as the pipe size or nominal diameter.

Individual lengths of ductile iron pipe are joined either by flanges, coupling

Flanged joints: Flanges are flat rings around the end of pipes which mate with an equivalent flange from another pipe the two being held together by bolts usually panned through holes drilled through the flanges.

A deformable gasket, usually elastomeric, placed between raised faces on the mating flanges provides the seal.

Flanges are designed to a large number of specifications that differ because of dimensional variations in pipes sizes and pressure requirements and because of independent standards development.

A flanged joint is rigid and can bear both tension and compression as well as a limited degree of shear and bending.

It also can be dismantled after assembly. Due to the rigid nature of the joint and the risk of excessive bending moment being imposed it is advised that flanged pipe work is not buried.

Spigot and socket joint: Spigot and sockets involve a normal pipe end the spigot being inserted into the socket

or bell of another pipe or fitting with a seal being made between the two with in the socket.

A large number of different socket and seals exist. The most modern is the push joint (or) slip joint

Where by the socket and rubber seal is designed to allow the pipe spigot to be after lubrication, simply pushed into the socket. Push joints remain proprietary designs.

Also available are locking gasket systems these locking gasket systems allow the pipe to be pushed together but do not allow the joint to come apart without using a special tool or torch on the gasket

In the late 1950's ductile iron pipe was introduced to the market place featuring higher strength and similar corrosion resistance compare to cast iron.

An expected life span of 100 years, using evolved laying practices had an estimated life up to 110 years.

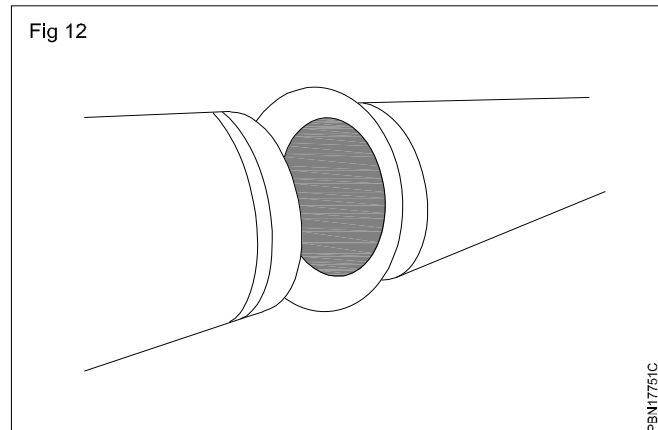
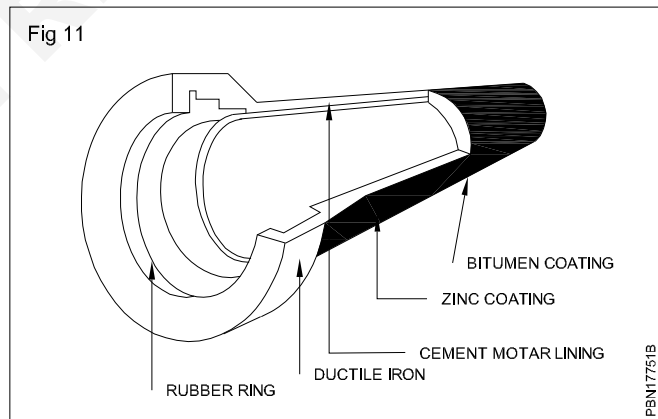
Like most ferrous materials ductile iron is susceptible to corrosion can occur in two ways in ductile iron pipes.

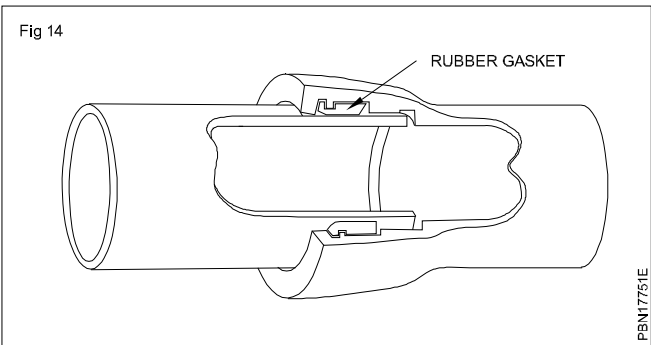
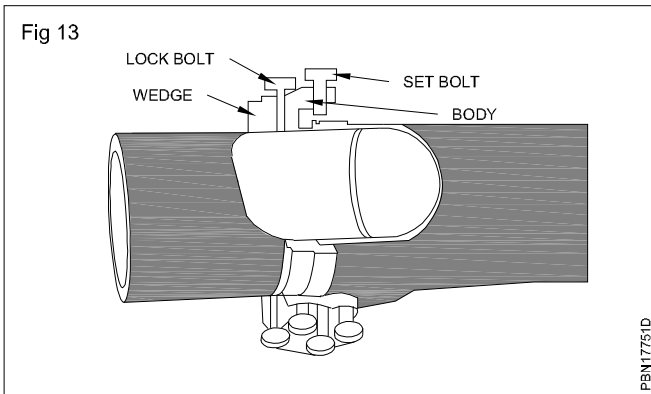
Graphitization and corrosion pitting unprotected pipes in highly corrosive soil tend to have shorter life spans.

Use of polyethylene sleeaking can reduce corrosion by controlling the effect of corrosive soil on piping.

Ductile iron pipe is somewhat resistant to internal corrosion in potable water cement mortar lining is by far the most common port land cement is used the cement mortar in the ratio 1:2 and 1:3:5 There are two types of jointing method.

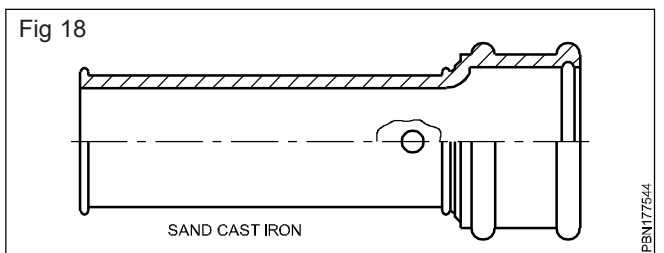
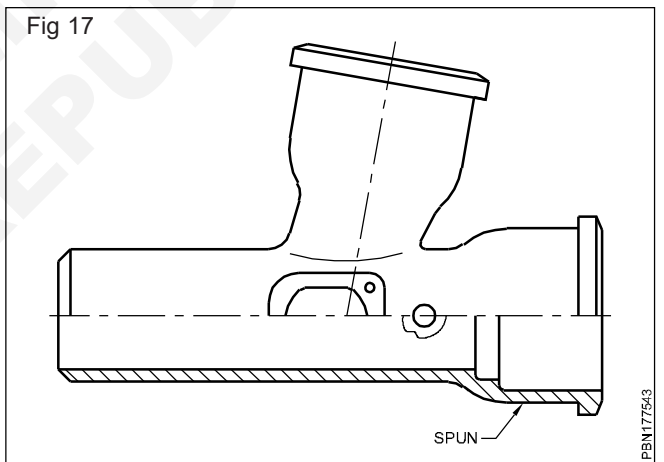
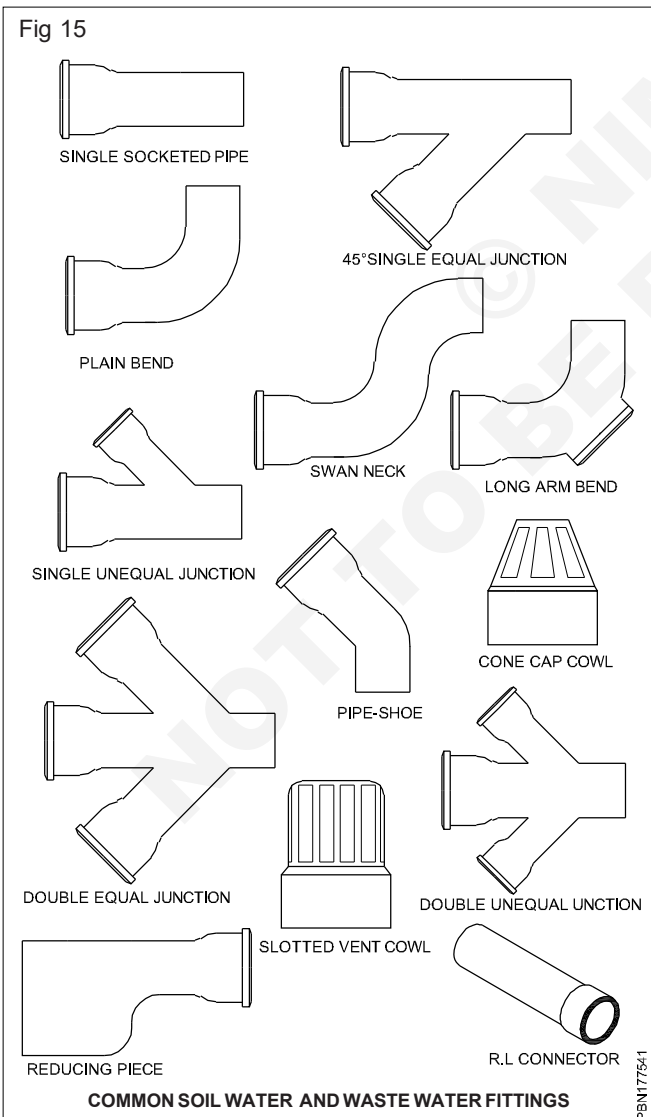
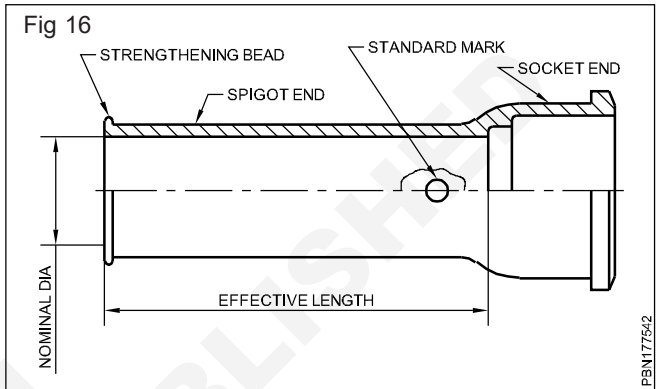
Ductile iron (DI) Pipe Joints (Figs 11,12,13 &14)





Sand cast iron pipes

Sand cast iron spigot as socket soil and waste and ventilating pipes, fittings and accessories should conform to IS 1729. Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes fittings and accessories should conform to IS 3989. These pipes can be recognised by looking at the socket shape. The fittings shall conform to the respective I.S. Specifications to which the pipe itself conform to which they are connected. There should not be any visible cracks, taps and pinholes and it should ring clearly when struck with light hand hammer. These pipes are available at 1.5, 1.75, 2, 2.5 and 3m lengths. (Figs 16, 17 & 18).



The pipes and fittings should be without ears. The pipes and fittings are coated internally and externally with same material at factory.

The access door fittings should be designed so as to avoid dead spaces in which filth may accumulate. Door are provided with 3mm rubber insertion packing and when closed and bolted, the joints should be water tight.

The standard weight and the accuracy of pipes and their tolerance should be as under.

Sand cast iron pipes

Nominal dia of bore mm	Thickness mm	Overall weight of pipe in Kg excluding ear for effective length		
		1.5m	1.8m	2.00m
50	5	9.56	11.41	12.65
75	5	13.83	16.52	18.37
100	5	18.14	21.67	24.15
150	5	26.70	31.92	35.66

Cast iron (Spun pipes)

Nominal ϕ	Thick ness	Overall weight in kg for effective length in meter for				
		3m	2.5m	2m	1.8m	1.5m
50	3.5	13.4	11.3	9.2	8.4	7.1
75	3.5	20.0	16.8	13.8	12.5	10.6
100	4.0	30.0	25.2	21.0	18.8	16.0
150	5.0	56.0	47.0	38.5	34.9	29.5

Table 1

Dimension in mm	Nominal ϕ in mm	Tolerance mm
External ϕ of barrel	50,75	± 3
	100	± 3.5
	150	± 4.0
Internal ϕ socket	All diameter	± 3.00
Depth of socket	All diameter	± 10.00

Pipe fittings

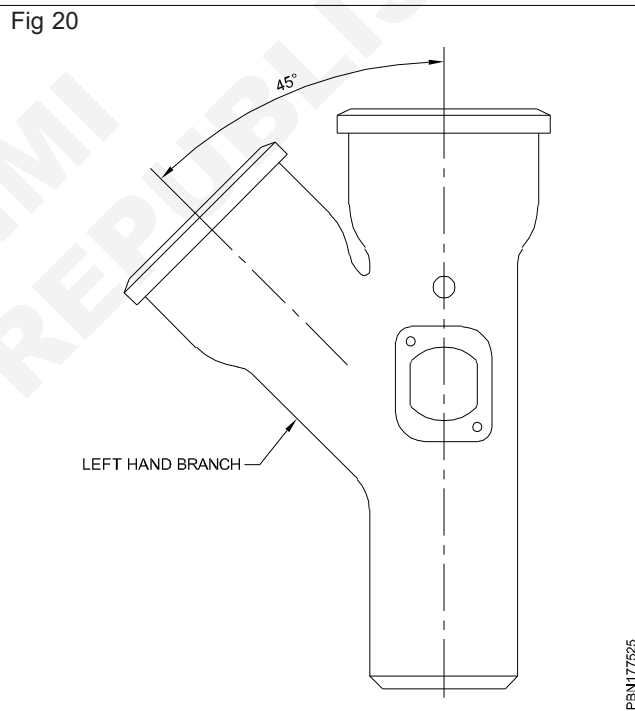
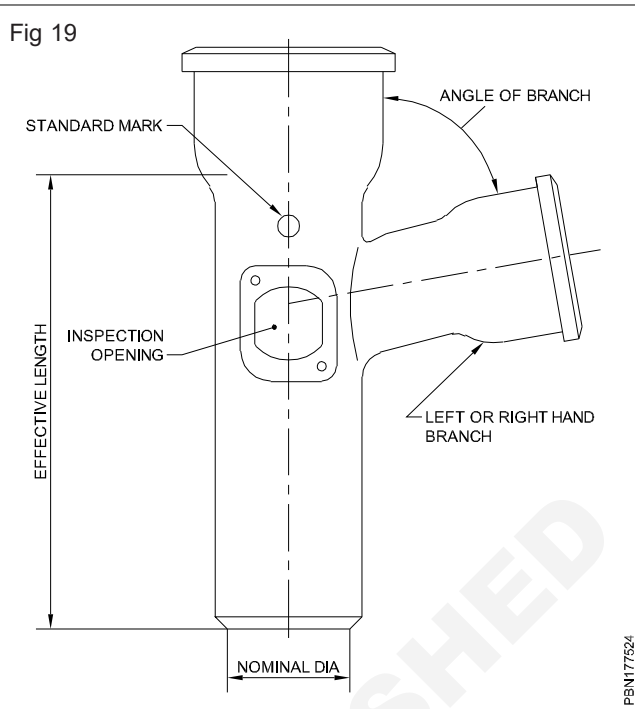
Very extensive range of cast iron fittings is available. Refer manufacturer's catalogues). Care must be taken specifying and selecting the fittings. Always check the following points. (Fig 19)

- Nominal diameter
- Standards mark
- Inspection opening
- Left or right hand branch
- Angle of branch
- Effective length

Specification branches can be handed either left or right. A branch can be used in either position. The hand of the is determined by its position when the branch is from the front.

- Shows a left hand branch (Fig 20).
- Shows a right hand branch (Fig 21).

Some countries, a "branch" may be called a "junction".



Anches can be of equal or unequal diameters and are to receive the discharge from a waste pipe or for a connection to an anti - syphon vent pipe.

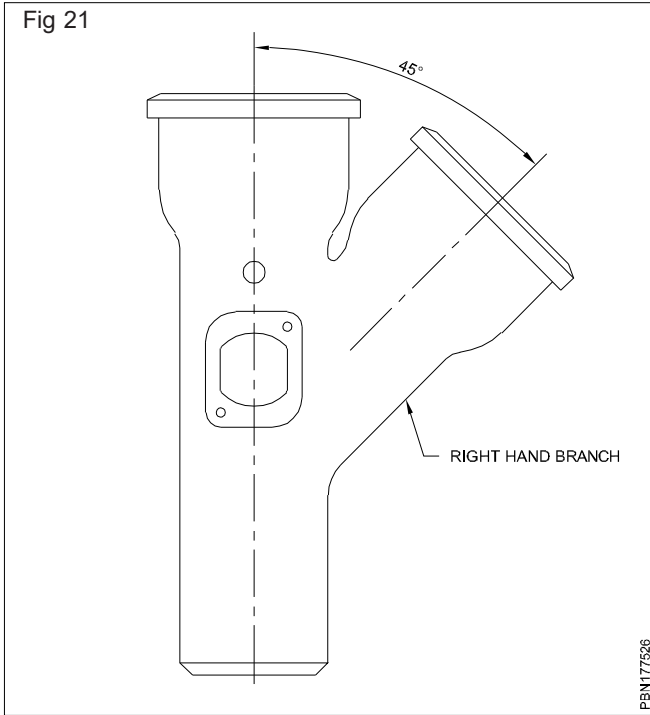
The angles of branches in common use are

- 45°
- 70°
- 80°

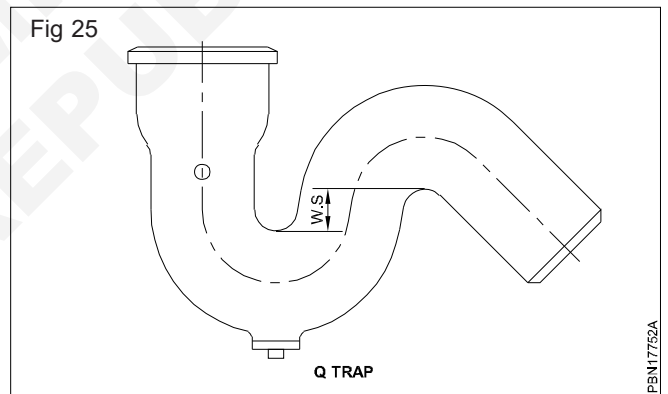
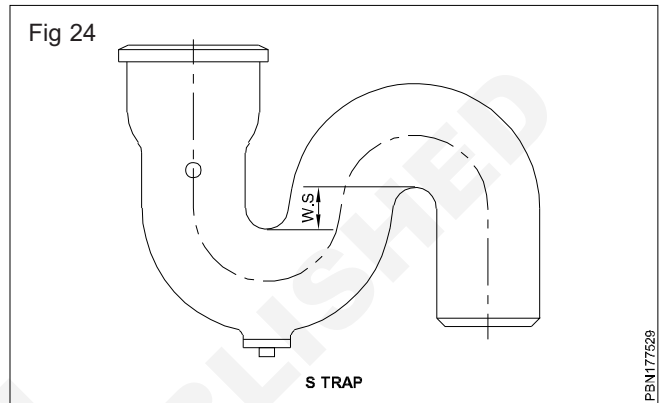
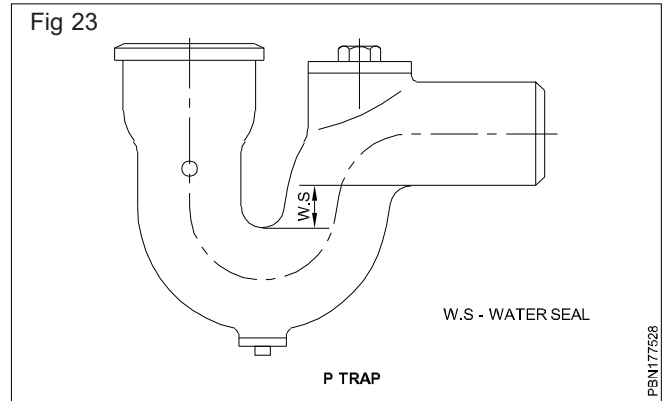
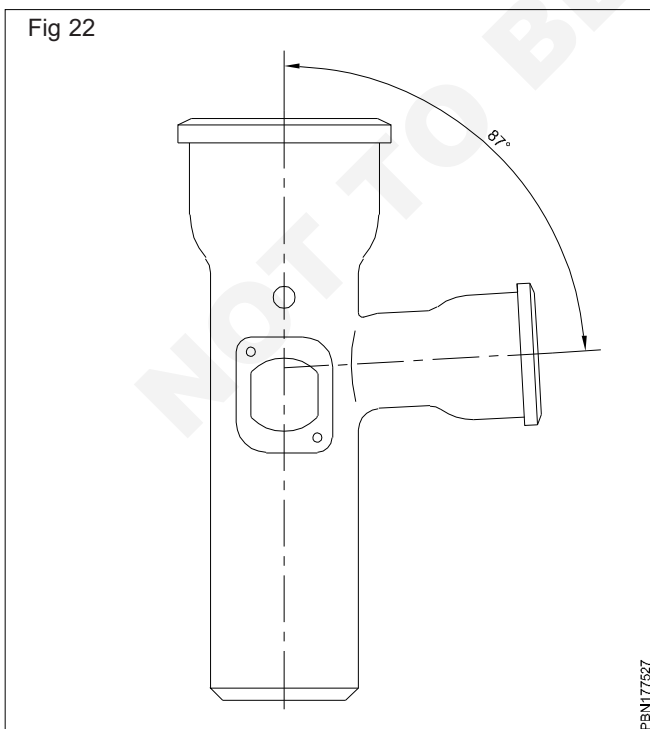
Branches may be equal and unequal.

E.g equal x 50mm

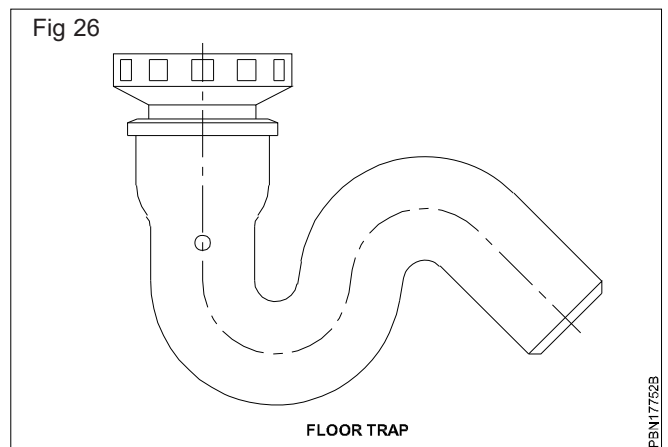
Unequal 75 x 50 mm



Double branches of equal and unequal ϕ with 45° , 70° and 87° , "Y" branches, (Fig 6) invert branches, long arm sanitary branches, bends both large and short radius are used to change the direction of flow. They are available as plain fittings or with inspection openings. The angle of the bend varies from 15° , 30° , 45° , 60° , 70° , 80° , and 87° . By using a combination of bends as $2 \times 45^\circ$ bends a large radius 90° bend can be obtained and it will help for easy flow rather than using 87° bend. (Fig 7) offsets, reducers and tapering pieces are available. C. I traps are fitted in an installation to prevent foul air passing into the building. Three common types of traps are P trap, S trap and Q trap. (Figs 22, 23, 24 & 25).



Floor outlets are fitted areas such as kitchen, bathrooms and corridors. Surface cleaning water is discharged into outlet through a trap as shown in (Fig 26).



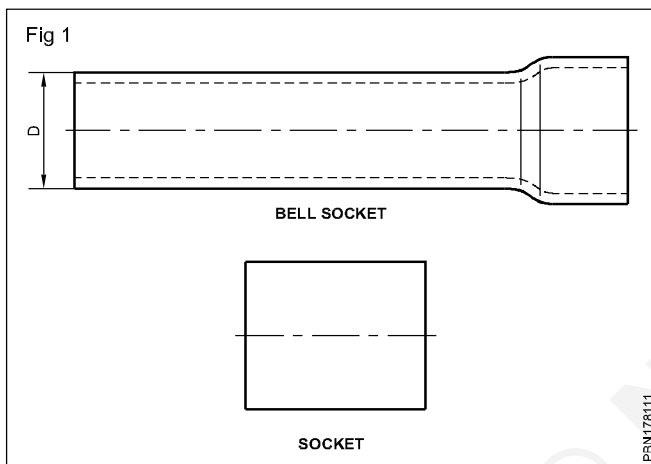
Different kinds of joints fittings and materials in joining pipes PVC/CPVC, PPR and HDPE

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

- state the different PVC fittings used for different purposes
- state the different CPVC pipe and HDPE fittings.

PVC pipes

General: PVC pipes are manufactured using poly vinyl chloride and additives. PVC pipes are available in 6 metres length and the pipe is specified by the outer diameter of the pipe. PVC pipes are available with bell or socket end. (Fig 1)



Advantages

- PVC pipes are light weight.
- They are corrosion free.
- Cost of PVC pipe is cheaper than G.I./C.I./A.C pipes.

Disadvantages

- PVC pipes could not be used for carrying hot water.

Types of PVC pipes

- Low density polyethylene pipes.
- High density polyethylene pipes.
- Polyethylene pipes are normally available in black colour.
- Rigid (unplasticized).

Uses: PVC pipes are used for carrying drinking, waste and rain water.

PVC pipe fitting

Unplasticized polyvinyl chloride (UPVC) pipe: There are two types of pipes as detailed under

Type A for use in ventilation pipe work and rain water application.

Type B: for use in soil and waste discharge system. these pipes should confirm IS13592. The material from which the

pipes are produced consists of Polyvinyl Chloride, additives and stabilizer.

Pipes are available in length of 2,3,4 & 6M either plain or with sliding/grooved sockets. A tolerance of +10mm on specified lengths are permitted. The pipes are designated by its outside diameter. The mean outside ϕ , outside ϕ at any point wall thickness for Type A and B are at Table 1.

Size of pipe mm	Support distance in meter	
	Vertical	Horizontal
40	1.2	0.5
50	1.2	0.7
75	1.8	0.9
110	1.8	0.9
160	1.8	1.0

Fittings used should confirm to IS14735 and rubber ring to IS5382. The pipes and fittings are provided with square groove and special shaped rubber rings. The single socketed pipes cover with plain end duly chamfered at the end. When required lengths are cut from pipe the plain end to be chamfered. The plain end of all fittings are chamfered at the end. The pipes should be supported on the walls with PVC pipe clip and it should be fixed below the socket of pipe or fitting (not on the socket). Maximum spacing of clips shall be as under.

Types of PVC joints and their uses

union (Fig 2)

It is a fitting used to connect two pipes.

It is used

At the beginning of a pipe system inside a room.

For all appliances

Mid way between long pipe line.

Union enables repairs/replacement of the pipe line system, without disturbing the other parts of the system.

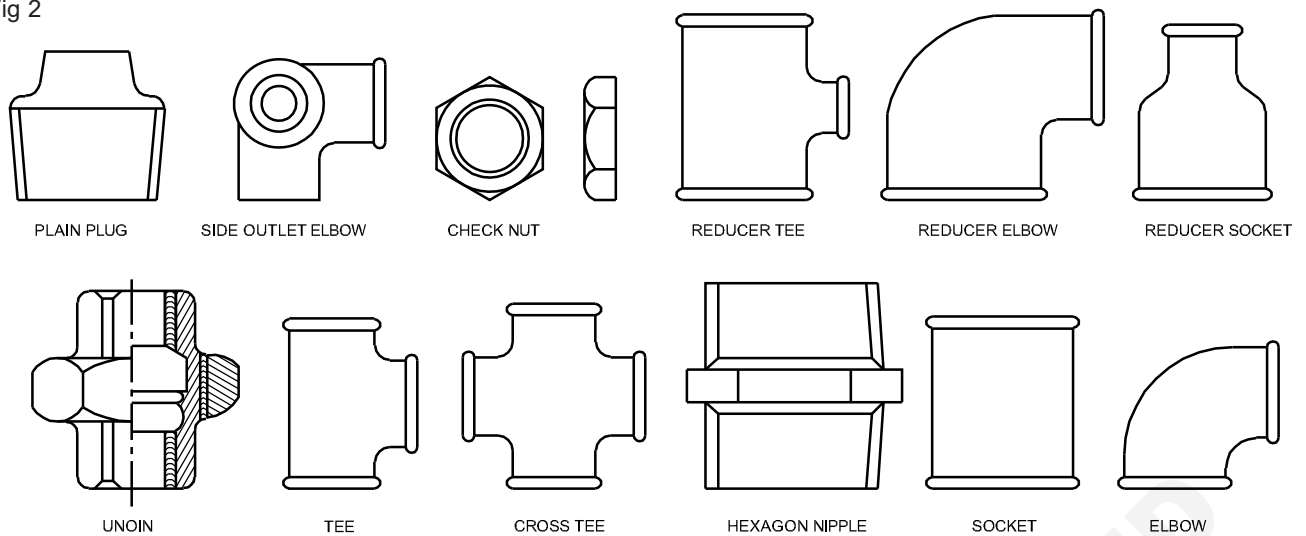
Socket

These fittings are used to connect one length to another, for continuation of the pipe line.

Elbow

It connects two pipes at 90° has a short curvature

Fig 2



PB176121

Bend

Bend connects two pipes at any required angle. It cannot be used in walls because of a layer curvature.

Tee

Tee is a fitting with a side outlet at 90° to the run of the pipe.

Cross Tee

Cross tee is a fitting with four branches arranged in pairs each at right angles to the other.

Reducer

This fitting is larger at one end than the other. It is used to connect pipes of two different diameters by

- Reducer Tee
- Reducer elbow
- Reducer bend
- Reducer socket

Barrel nipple

It is a piece of pipe threaded at both ends and can be used for short extension of the plumbing line.

Double nipple

It is used to connect two fittings within a short distance. It has threads on both sides of the central piece.

Plug

Plug has an exterior pipe thread end and a projecting head for fitting in the socket.

HDPE pipe fittings



PVC pipe fittings



UPVC pipe fittings



CPVC pipe fittings

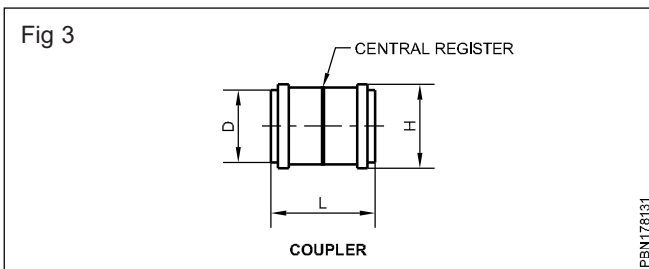


PPR pipe fittings

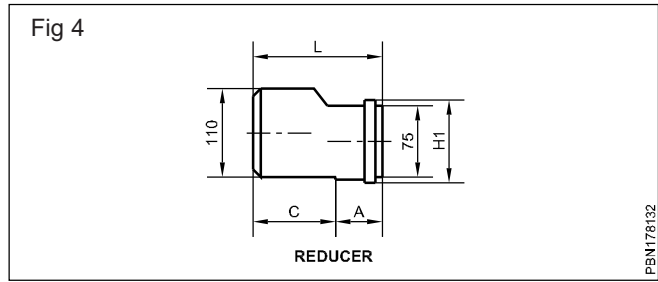


P.V.C Sanitary Fitting for Soil waste and Rain water pipes

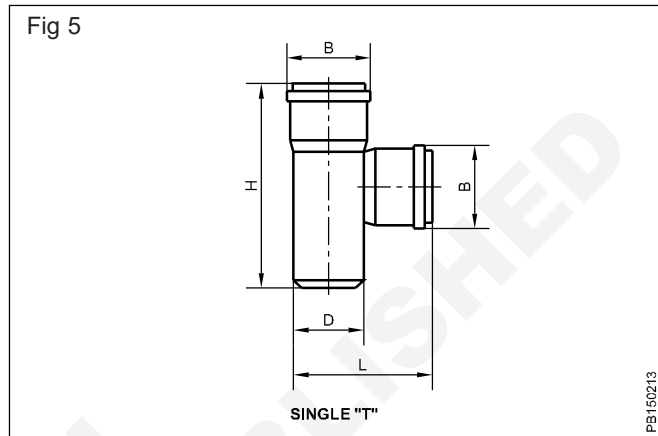
Coupler (Fig 3)



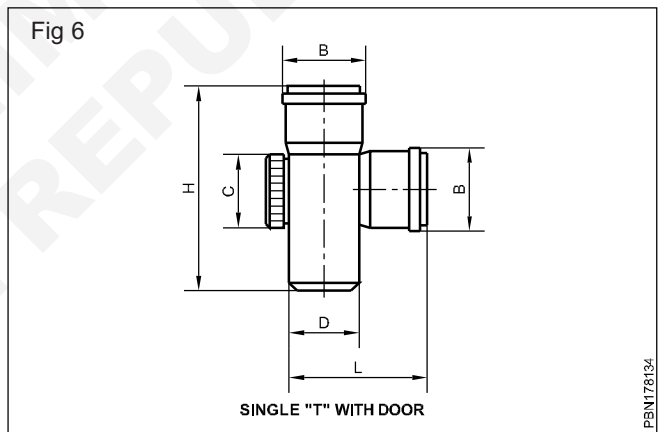
Reducer (Fig 4)



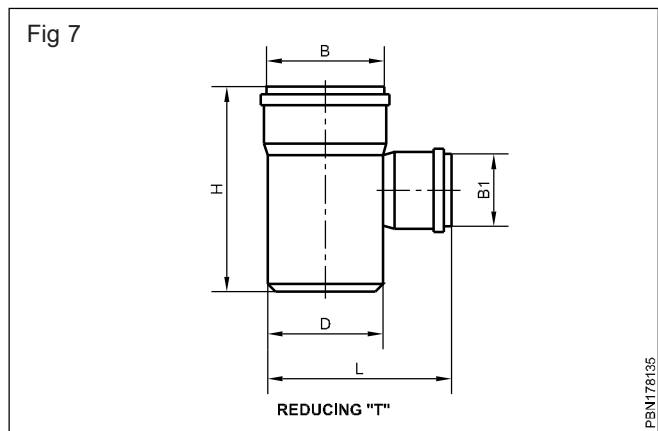
Single "T" (Fig 5)



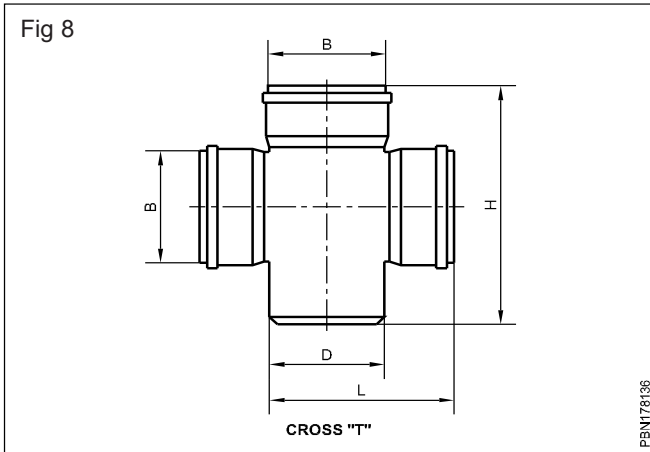
Single "T" with door (Fig 6)



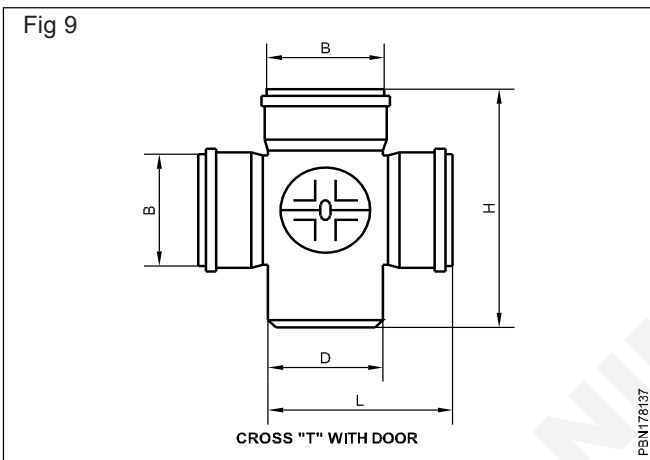
Reducing "T" (Fig 7)



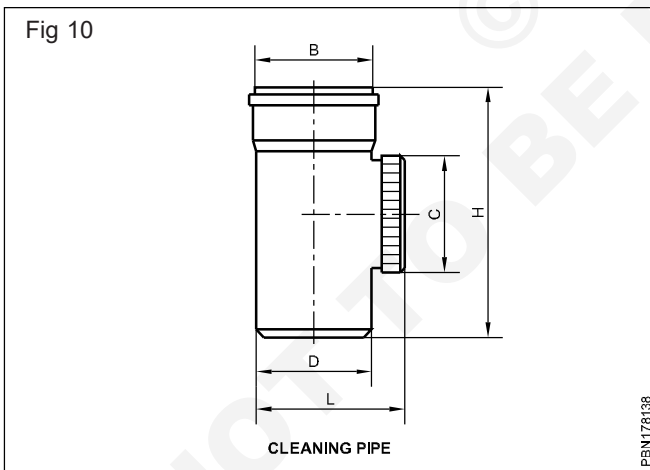
Cross "T" (Fig 8)



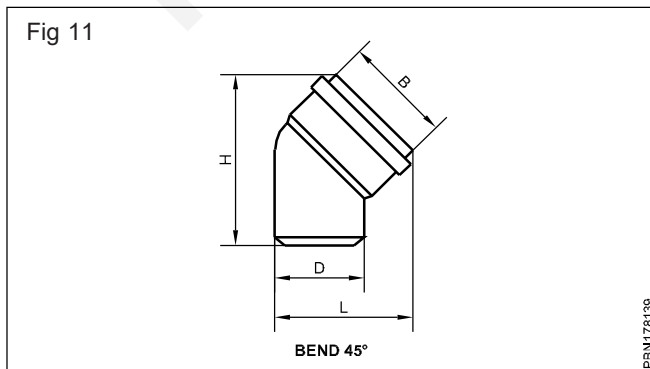
Cross "T" with door (Fig 9)



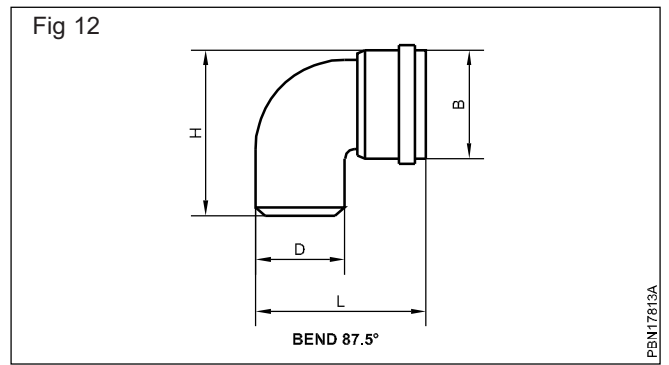
Cleaning pipe (Fig 10)



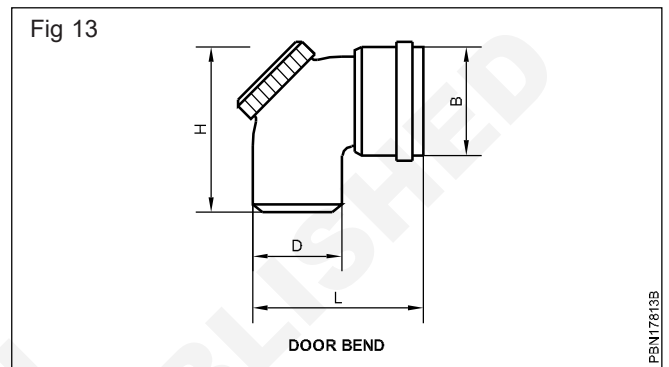
Bend 45° (Fig 11)



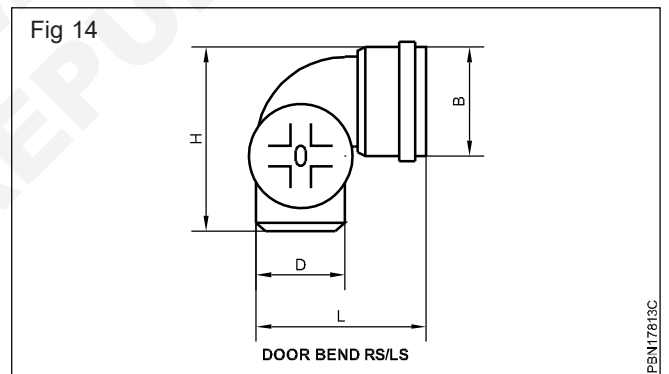
Bend 87.5° (Fig 12)



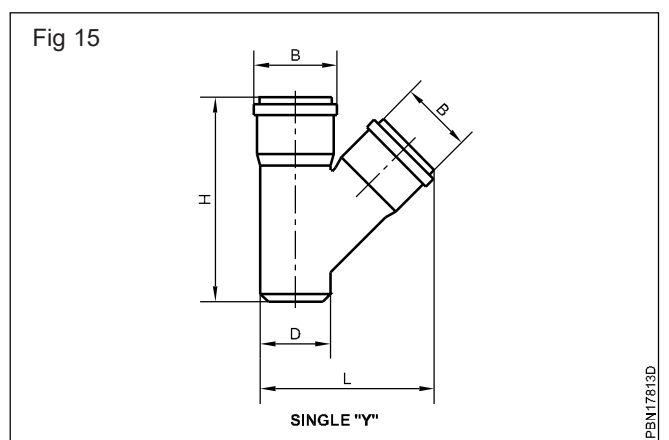
Door bend (Fig 13)



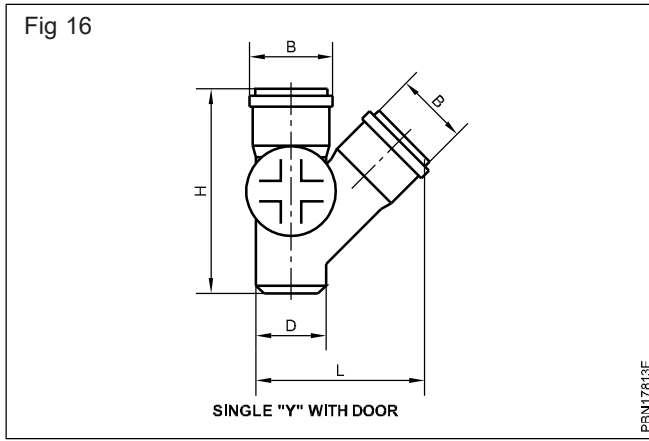
Door bend RS/LS (Fig 14)



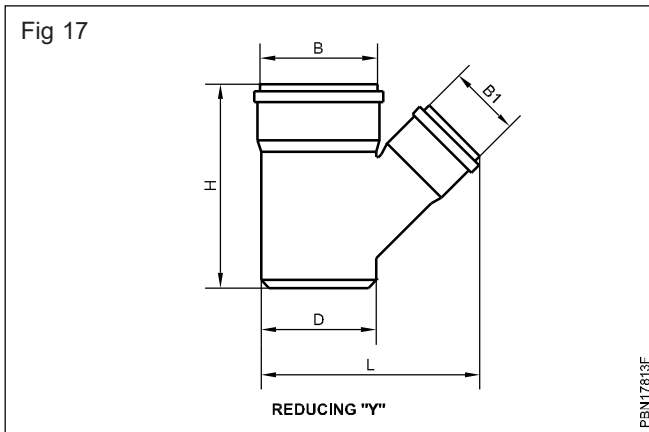
Single "Y" (Fig 15)



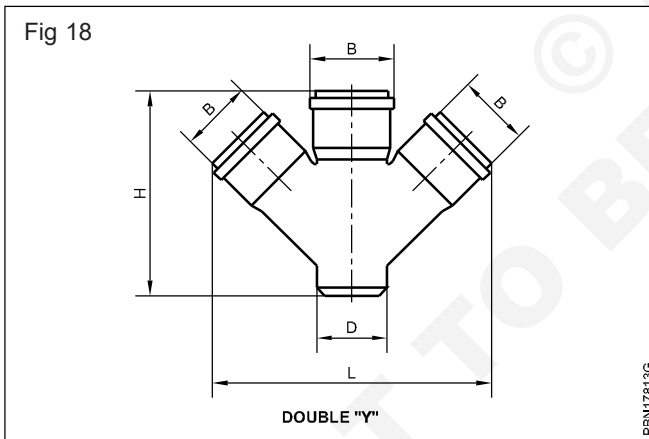
Single "Y" with door (Fig 16)



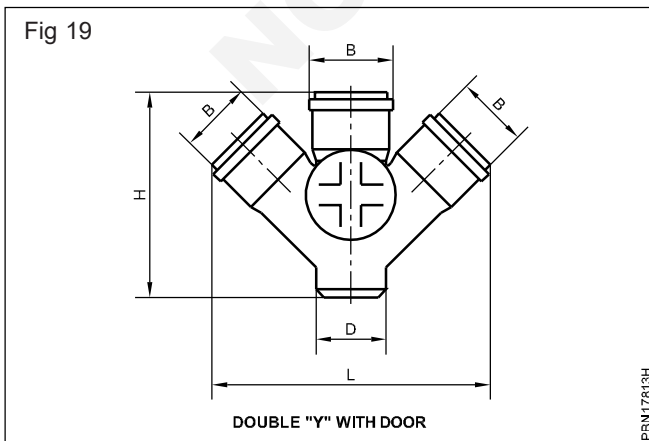
Reducing "Y" (Fig 17)



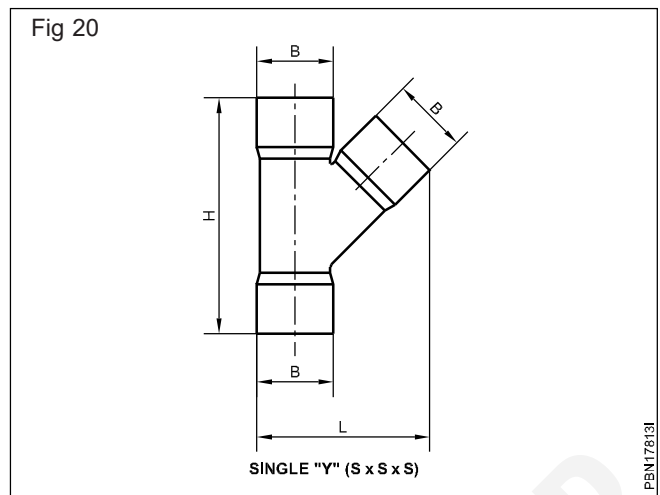
Double "Y" (Fig 18)



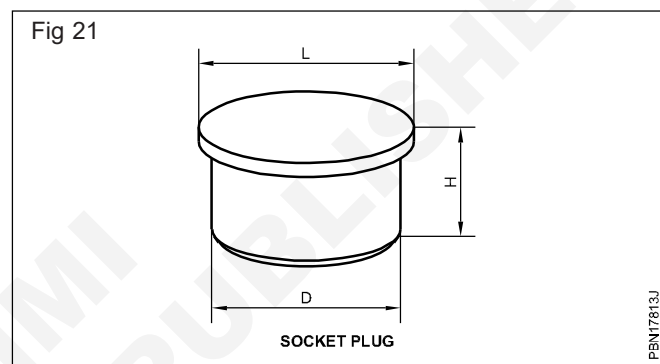
Double "Y" with door (Fig 19)



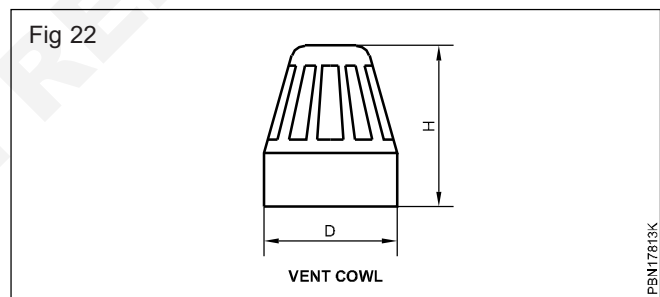
Single "Y" (S x S x S) (Fig 20)



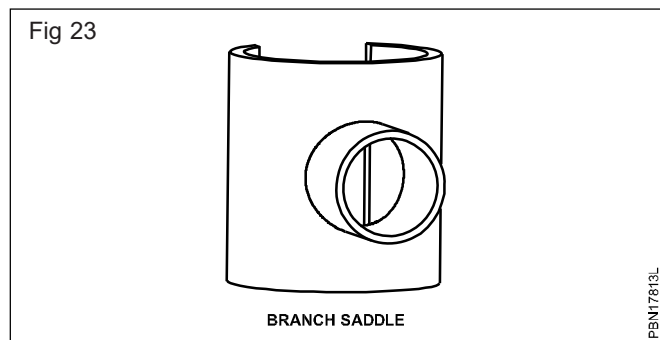
Socket plug (Fig 21)



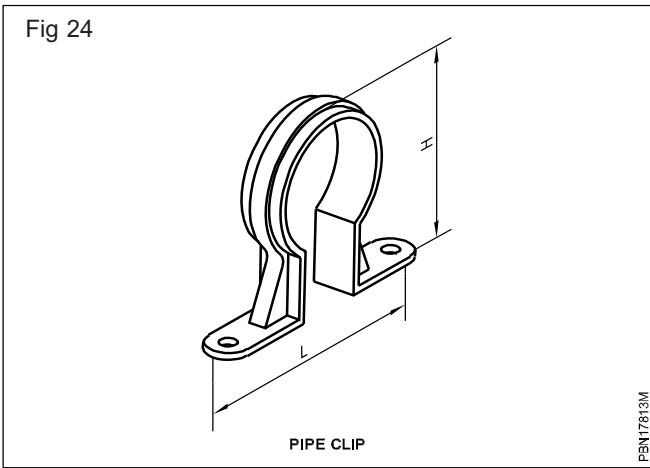
Vent cowl (Fig 22)



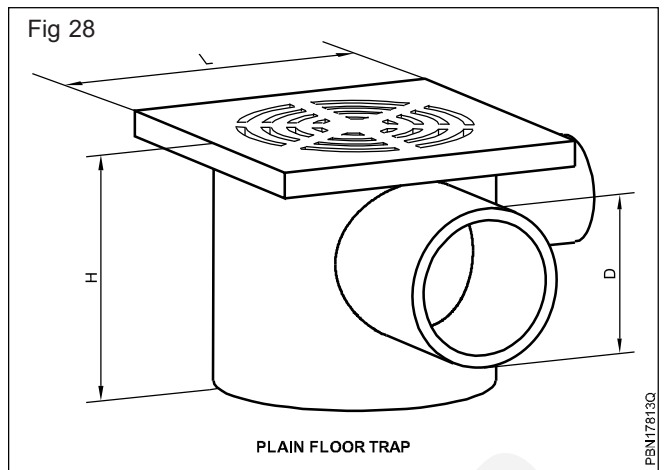
Branch saddle (Fig 23)



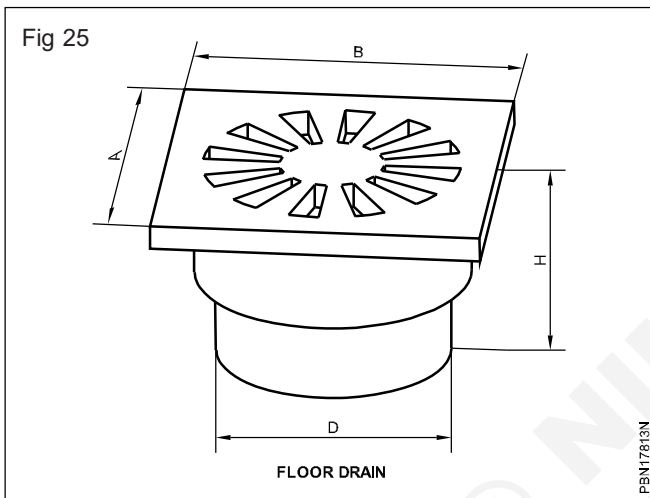
Pipe clip (Fig 24)



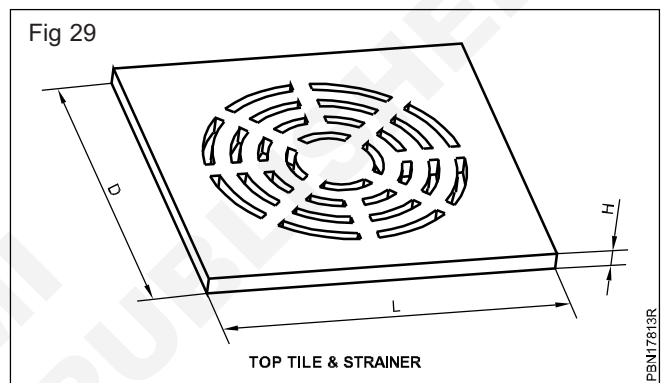
Plain floor trap (Fig 28)



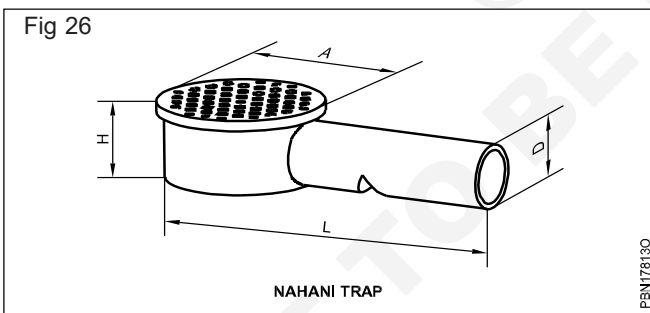
Floor drain (Fig 25)



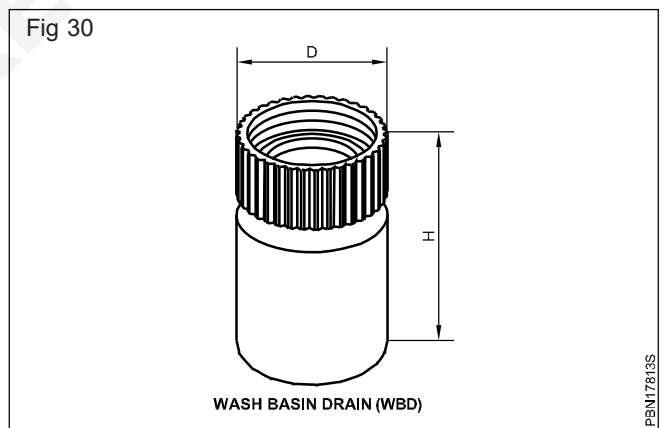
Top tile & strainer (Fig 29)



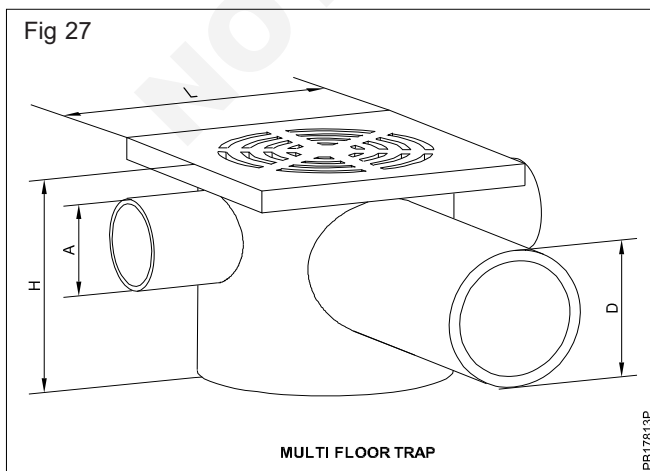
Nahani trap (Fig 26)



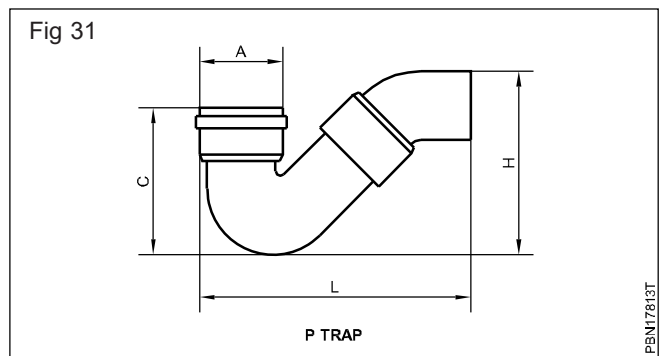
Wash basin drain (WBD) (Fig 30)



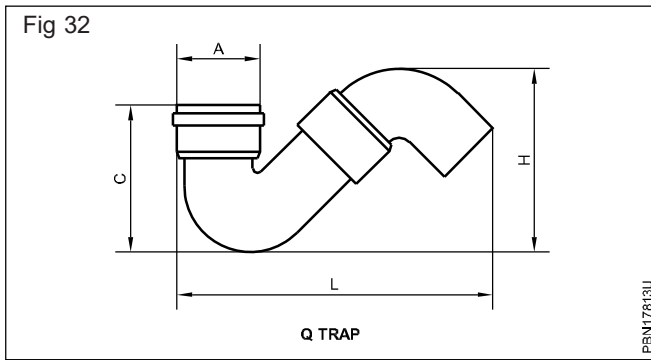
Multi floor trap (Fig 27)



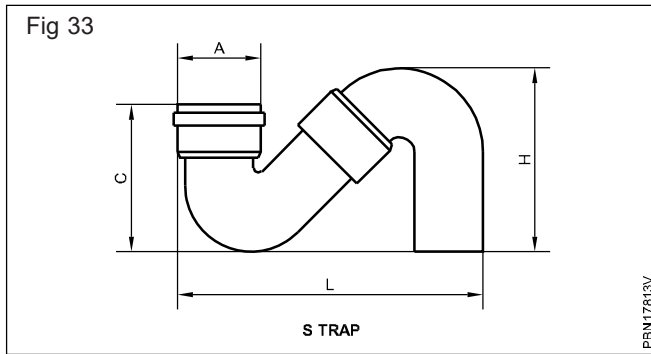
P trap (Fig 31)



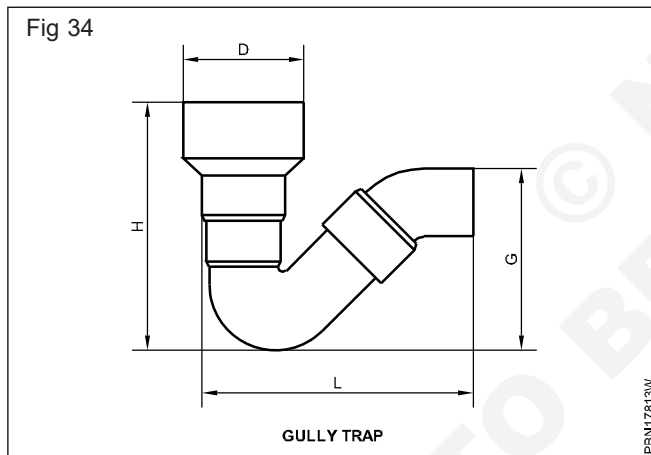
Q trap (Fig 32)



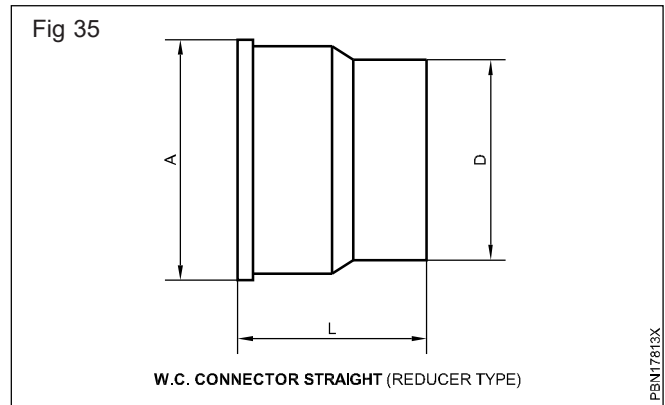
S trap (Fig 33)



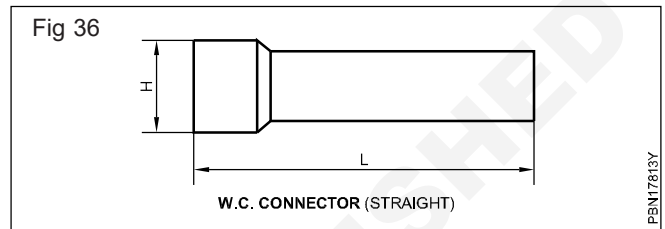
Gully trap (Fig 34)



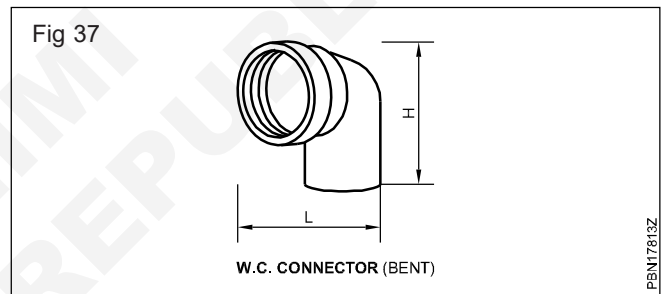
W.C. Connector straight (Reducer type) (Fig 35)



W.C. Connector (Straight) (Fig 36)



W.C. Connector (Bend) (Fig 37)



Composition of water - Sources of water, hard & soft water, temporary hardness and permanent hardness

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

- state the sources of water and its types
- state the contamination of water
- state the soft water and hard water
- state the temporary hardness and permanent hardness.

Source of water

Water is the first necessity wherever there is human settlement. Most of the cities in the world are located along the rivers, due to this reason.

The water supply is designed for an estimated population after 25 - 30 years.

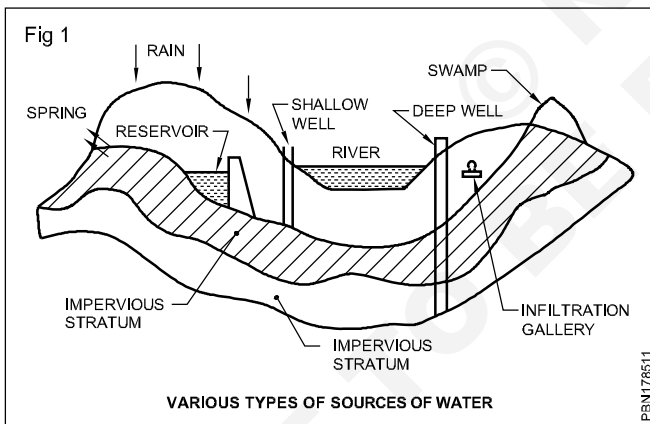
The water is needed for a number of domestic purposes i.e. drinking, washing, cooking and also for industrial purposes like steam generation, dyeing, tanning, brewing etc.

Source of water

Draw of water from river bed

Water for supply to a tank can be drawn from surface or from ground (Fig 1)

The following are the types of ground source



- 1 Well
- 2 Spring
- 3 Infiltration gallery

The surface sources are river, streams, ponds, lake, reservoirs.

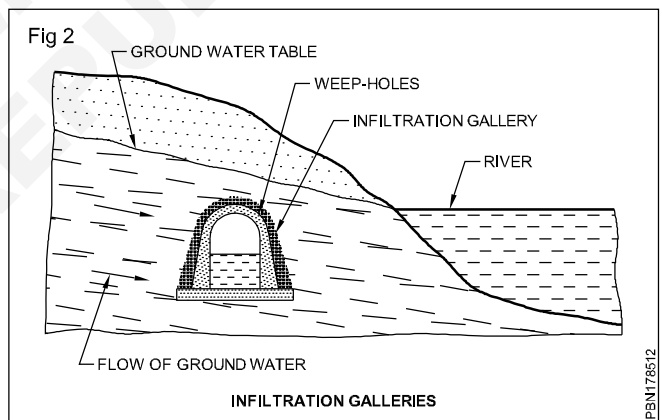
Water can be drawn from river bed from the following ways.

- 1 Intake well
- 2 Weir intake
- 3 Intake well with approach channel
- 4 Pipe intakes

- 5 Cannel intake
- 6 Infiltration wells

Infiltration galleries

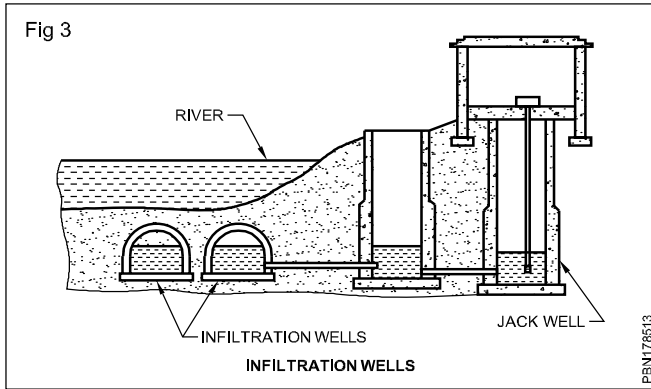
A portion of the rain water that falls on the ground percolates into the ground. This ground water travels towards lakes, river etc. This water is collected by digging trenches or by constructing a tunnel with holes on its sides. These underground used for tapping underground water near rivers, lakes are called infiltration galleries. They are constructed at right angles to the direction of underground water. The water is allowed to enter these galleries from both sides or from one side. (Fig 2). shows the cross section of an infiltration gallery.



The infiltration galleries are constructed with masonry or concrete weep holes of size 5 x 10 cm are provided in the well. Gravel or pebble stones are provided on the sides and top of the galleries to increase their intake capacity. Longitudinal slope is given to the galleries and at the end a sump well is constructed from where water is pumped out.

Infiltration wells

Infiltration wells are similar to infiltration galleries but they are constructed under the beds of rivers and streams. These wells are suitable in places where there are deposits of sand and pores material to a depth of 3 meter and above in river beds. As the water passes through layer of sand, all suspended impurities are removed and the quality of water is better than river water. Large number of wells are constructed in the river bed and connected to an inspection well. The water flows under gravity and the water is pumped from the jackwell. (Fig 3)

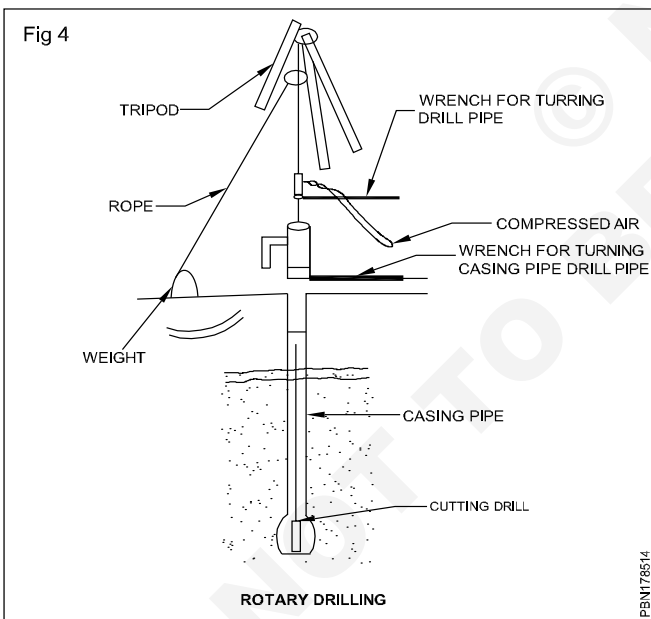


Methods of drilling tube-wells

The followings are the common methods which are used for the construction of tube-wells.

i Rotary drilling (Fig 4)

This method is used in soft unconsolidated alluvial soils. The drill pipe is fitted with a toothed steel bit at its bottom. With the help of wrench the drill pipe is rotated and water is pumped inside the pipe. By rotating the drill pipe the soil is cut by toothed steel bit and the loosened material is carried to the surface by the water through the drill and casing pipe. As the drilling proceeds the casing pipe is also rotated, which sinks in the hole made by drilling pipe. In this way the casing always follows the drill bit very closely and the water continuously lifts the cutting of soil from the well. This method is known as 'Wash boring method' or 'Hydraulic rotary method'.

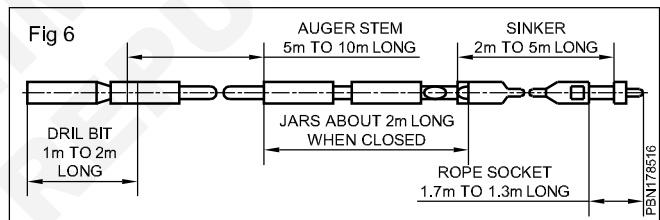
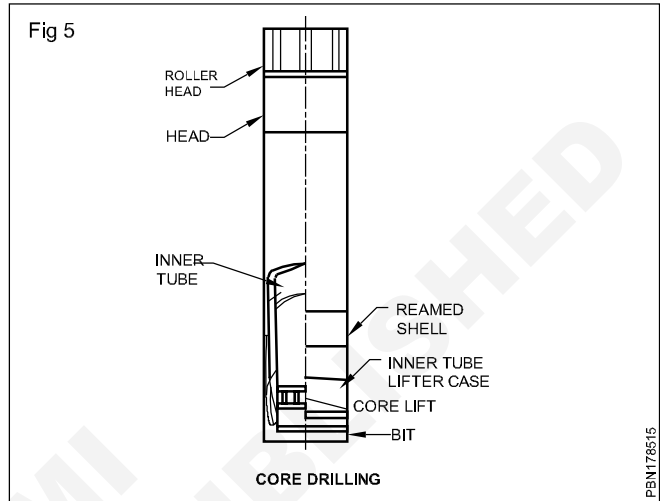


ii Core drilling

While constructing the tube-wells if hard rock comes in the way, the hole in it is drilled by core drilling method. In this method a hollow pipe fitted with a cutter or drill bit is rotated which cuts the hard rock and makes hole. The cut material rises into the hollow portion of the rotating pipe, which can be removed from time to time by taking out the drill pipe. In some cases hard steel shots are poured in the hole of drill pipe which help in drilling. The pieces of hard rock which are taken out on study give the nature of the rock formation and water-bearing stratum met with.

iii Percussion drilling (Fig 5 & 6)

This is standard method of constructing tube-wells in hard rock. In this method hole is drilled by alternately raising and dropping a drill bit on auger stem or string of tools. While falling the bit breaks the rock into small pieces which are removed by means of a sand pump or bailer after wetting the sludge by water. The drill-bit is screwed the auger stem which is connected to a pair of links or 'jars'. The pair of lines is connected to the sinker which is finally fixed to rope-cable. The raising and dropping of drill bit is done by the rope passing over pulley supported on derrick.



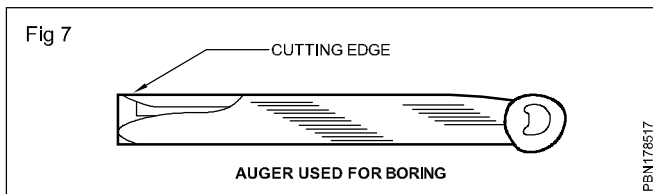
The drilling in loose material such as sand cannot be done effectively with this method, because loose material slumps and caves around the drilling bit. The chisel sharp edge of the drill bit breaks the rock by impact when lifted and draped alternately. The drilling bit is connected with the lowest end of the falling and rising arrangement known as string of tools. The string of tools mainly consists of a roof socket, a sinker, a set of jars, a drill stem or auger stem and drill bit in sequence from top to bottom as shown in figure. The entire assembly weights several tones. The drilling bit is the most important tool because only it actually does the cutting work.

The purpose of the set of jars is to lessen the tools when they stick in the hole. The name of the complete assembly is drilling hence it is double purpose.

During drilling operation the bit makes 40 to 60 strokes per minutes from a height of 50 cm to 100 cm. In the beginning sometimes water is added in the hole to make the drilling operations easy. After drilling every 1 to 2 m depth the string of tools is lifted out and the cleaning of the holes is done by means of bailer, which essentially consists of a pipe with a valve at the bottom. When the bailer is lowered inside the hole the cuttings are filled in it and while lifting the valve prevents the falling of the cuttings from it. After taking out the bailing it is cleaned.

iv Boring (Fig 7)

For the construction of shallow tube-wells in soft stratum this method is mostly employed. In this method hand or power driven augers are used for the excavation purposes. By means of rope the auger is lifted and then allowed to drop, the soil is filled in the hollow portion of the auger, which is removed from time to time. This method is used upto 15 meters depth.



In the methods of boring the correct position of aquifers is also noted. The depth and lengths of water-bearing stratum and hard stratum etc. are correctly recorded in a chart showing various layers met in. With the help of the chart a full length of strainer and blind pipes is lowered inside the casing to the correct depth to that all strainer pipes should be placed against the water-bearing stratum. After the placing of blind and strainer pipes the casing tubes are taken cut. The soil will grip the strainer and blind pipes. To avoid the clogging of strainer pipes generally coarse sand gravel is filled between the tube well pipe and the casing pipe before the removal of casing pipe. This method of pouring sand is known as shrouding and such tube-wells are called shrouded tube-wells.

Contamination of water in a well Water become contaminated there are many ways to become contaminated.

Including sewage leaks, human (or) Animal faces in areas near reservoirs, garbage, Industrial waste and even air pollution which will contaminate water when it mixes with rain.

Contamination: Diseases like typhoid, cholera, diarrhea, dysentery, hook worm and roundworm infestation, and jaundice are communicable from man to man through the medium of faces. The faces of persons suffering from these diseases should not be left exposed for flies to sit upon; or for being washed by rain into stream courses, the water of which are used for drinking; or to allow the edges or worms, present in faces to be hatched in the soil. Diseases like cholera and typhoid are more serious while the worm infestation diseases are more mild in nature. Apart from cases where the persons suffering from these diseases will be well known, there are persons who harbor these pathogenic organisms without suffering from these diseases. Such persons, called carriers, are really dangerous to society. Instead of dealing with the faces of such selected persons alone which is beset with difficulties, if the faces of all persons are properly collected, conveyed and disposed off the chain of transmission will be cut and the diseases will not spread. In towns where the density of population is higher than in rural areas and where there are protected water supply systems, the construction of sanitary latrines is all the more imperative to prevent contamination of food, water and soil which may

engulf the entire urban population in a preventable epidemic.

Impurities of water

Following are the various impurities found in water and their effects:

A Suspended Impurities

- Bacteria - some cause disease.
- Algae, Protozoa - cause colour, turbidity and colour.
- Clay, Silt - cause turbidity.

Soft Water

- When soap is treated with hard water, the soluble calcium (Ca) and magnesium (mg) salts are present.
- React with Sodium palmitate forming calcium and magnesium palmitate.
- In this process of precipitation and consequent wast age of soap will continue till the soluble salts become insoluble salts.
- Now this water becomes soft water.
- The soft water having hardness about 5 to 8 degrees.

Hard water

- Hard water that contains an appreciable quantity of dissolved minerals like calcium and magnesium.
- The hard water having hardness more than 8 degree.

Types of Hardness in water:

There are two types of hardness

1 TEMPORARY HARDNESS:

- The Temporary hardness is known as the carbonate hardness.
- The Temporary hardness is mainly due to the presence of bicarbonates of calcium and magnesium.

2 PERMANENT HARDNESS

- Permanent Hardness is known as the non-carbonate hardness.
- Permanent hardness is mainly due to the presence of sulphates, chlorides and nitrates of calcium and magnesium.

Water - borne diseases are still worldwide killers

According to the world health organization, throughout the world, 4.3 million people, mostly children, die every year from diarrhea caused by water - borne bacteria! That is more than the population of Norway. Other water - borne diseases, such as typhoid, cause seven million deaths and seven billion illnesses each year. Proper water treatment and disinfection of sewage prevent large - scale epidemics.

Water impurities

Water is required for different purposes like

- Drinking and cooling
- Bathing and washing clothes, streets, road etc.
- Heating and air conditioning
- Watering plants, crops
- Fire fighting
- Swimming pools, fountain etc.
- Industrial uses.

Water found in nature is never be hundred percent pure. It contains impurities - water before supplying for public use should be treated and purified. Impurities which are harmful to health are to be removed.

Various impurities found in water are

- Suspended impurities
- Dissolved impurities and
- Organic impurities.

Suspended impurities are bacteria, algae, clay, silt etc. Dissolved impurities are calcium, magnesium, sodium metals and gases. Organic impurities contain both suspended and dissolved vegetables, animals.

The presence of metallic iron causes hardness in the water. Water hardness is classified as

- Soft water 0 to 75mg/lit hardness.
- Moderately hard water 75 to 150mg/lit hardness.
- Hard water 150 to 300mg/lit hardness.
- Very hard water 300 and above mg/lit hardness.

Water having hardness does not produce lather with ordinary soap, the fabric of cloth gets spoiled, pipe lines and pipe fixtures get choked, scale formation in steam boilers, water heaters and also create problems in the manufacturing process of textiles, ice, paper etc.

Temporary hardness can be removed by boiling and by addition of lime. Permanent hardness can be removed by in the soda process and base exchange process.

In the lime soda process, soda ash is added in lime.

It has the following advantages

- Economical
- Lesser quantity of coagulants are required.
- Reduction in corrosion of pipes.
- Mineral contents in water is also reduced.
- Iron and manganese are partly removed.
- Partly removes pathogenic bacteria.

The disadvantages are

- Require skilled operators.
- Place required for disposal of sludge.
- Water is not good for laundry work.
- Incrustation of pipes.

Base exchange process is also known as zeolite or cation exchange process. The hard water is allowed to pass through the ca and mg. Cation get replaced by sodium from the exchanger and water becomes soft.

Advantages

- Very compact and efficient unit.
- No sludge is formed.
- Removes iron and manganese.
- No incrustation of pipes.

Disadvantages

- Creates objectionable residual in industrial or boiler feed water.
- High turbidity water cannot be efficiently treated.

Quality of water

The objective of water treatment is to ensure that water supplied is:

- Free from pathogenic organisms.
- Clear palatable and free from undesirable taste and odour.
- Of reasonable temperature.
- Neither corrosive nor scale forming.
- Free from minerals which could produce in desirable physiological effects.

The above objectives are achieved by establishing minimum standards of quality for public water supply.

Physical and chemical standards

Sl.No.	Characteristics	Acceptable	Cause for rejection
1	Turbidity	2.5	10
2	Colour	5	25
3	Taste and odour	Unobjectionable	Unobjectionable
4	PH value	7 to 8.5	< 6.5 or > 9.2
5	Total dissolved solids (mg/l)	500	1500
6	Total Hardness (mg/l) (as CaCO ₃)	200	600
7	Chlorides (as Cl) (mg/l)	200	1000
8	Sulphates (as SO ₄)	200	400
9	Fluorides (as F) (mg/l)	1	1.5
10	Nitrates (as NO ₃)	45	45
11	Calcium (as Ca)	75	200
12	Magnesium (as Mg)	>30	150
13	Iron (Fe)	0.1	1.0
14	Manganese (as Mn)	0.05	1.5
15	Copper (as Cu)	0.05	1.5
16	Zinc (Zn)	5	15
17	Phenolic compounds (phenol)	0.001	0.002
18	Anionic detergents	0.2	1
19	Mineral oil	0.01	0.3
Toxic Materials			
20	Arsenic (as As)	0.05	0.05
21	Cadmium (as Cd)	0.01	0.01
22	Chromium (Cr)	0.05	0.05
23	Cynides (Cn)	0.05	0.05
24	Lead (pb)	0.1	0.1
25	Selemium (Se)	0.01	0.01
26	Mercury (Hg)	0.001	0.001
27	Polynuclear aromatic hydrocarbons	0.2ug/l	0.2ug/l
Radio Activity			
28	Gross alpha activity	3PCI/l	3PCI/l
29	Gross beta activity	30 PCi/l	30PCi/l

Bacteriological quality

Sl.No.	Organism	Unit	Guideline value
Piped water supplies - water in the distribution system			
1	Faecal coliforms	Number /100ml	0
2	Coliform organisms	Number /100ml	0 in 95% of the samples
3	Coliform organisms	Number /100ml	3 in an occassional sample but in consecutive samples
Un-piped water supplies			
1	Faecal coliforms	Number /100ml	0
2	Coliform organisms	Number /100ml	0

Treatment of water: Type of treatment process will depend on the quality of raw water and standard of water quality required after treatment.

The following treatment processes are used for removing various types of impurities.

SI No.	Impurity	Process used for removal
1	Floating matters like leaves, dead animals	Screening
2	Suspended impurities like silt, clay, sand etc	Plain sedimentation
3	Fine suspended matter	Sedimentation with coagulation
4	Micro organisms and colloidal matters	Filtration
5	Dissolved gases tastes and odors	Aeration and chemical treatment
6	Pathogenic bacteria	Disinfection

A well-equipped laboratory is required at the treatment plant to test the raw water and also the treated water. The treatment process can be decided depending on the nature of impurities.

Layout of a treatment plant

- A layout of treatment plant consists of.
- In take work near the source.
- Plain sedimentation.
- Sedimentation with coagulation.
- Filtration
- Disinfection
- Clear water reservoir
- Pumps
- Elevated or underground service reservoir.

Intake work shall be near the source of water. It includes intake well, pumping plant.

Plain sedimentation: Water is retained in a basin to settle down the suspended particle by gravity alone in this process. Continuous flow type basins are provided nowa days. Water flows continuously at a uniform rate of flow.

There are three types of sedimentation tanks. The classification is based on shape of tank and based on type of flow.

- Rectangular tanks
- Circular tanks (either radial flow, circular tank or circumferential flow circular tank.
- Hopper bottom tanks

Circular tanks and hopper bottom tanks are generally not used in plain sedimentation.

Sedimentation with coagulation: Very fine suspended particles cannot be removed by plain sedimentation as it takes long time to settle. Colloidal matters will never settle down by gravity. Such impurities can be removed by sedimentation with coagulation.

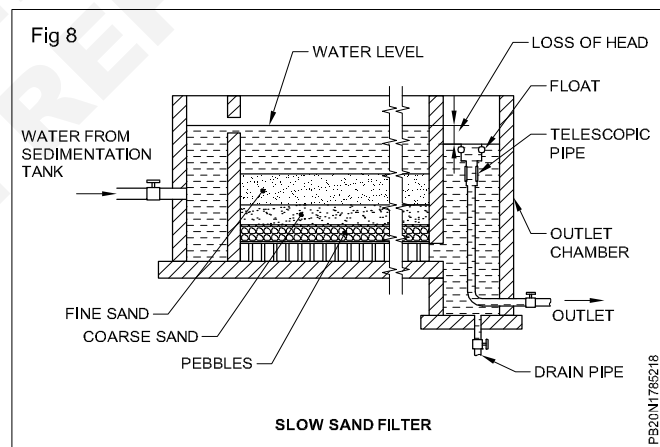
Filtration: Filters are used to remove bacteria colour, taste odours, manganese and produce clear water Filters consists of thick layer of sand and the water is allowed to pass through it.

Filters are classified as:

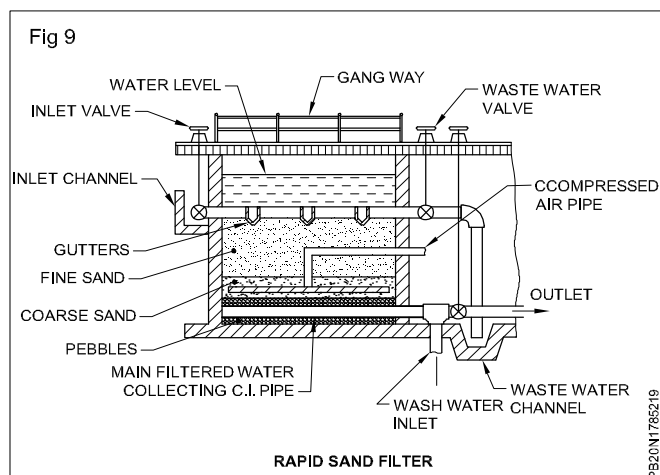
- Gravity filters
 - Slow sand filters (Fig 8)
 - Rapid sand filters (Fig 9)
- Pressure filters (Fig 10)

Slow sand filter (Fig 8)

Water from sedimentation tank enters the slow sand filter through a submersible inlet. Then distributed uniformly over the sand bed without disturbing the sand. During the filtration the filter media gets clogged due to impurities. Then the sand from the top bed to be scraped and replaced with clean sand. As the name indicate the rate of filtration is slow. It cannot remove pathogenic bacteria.



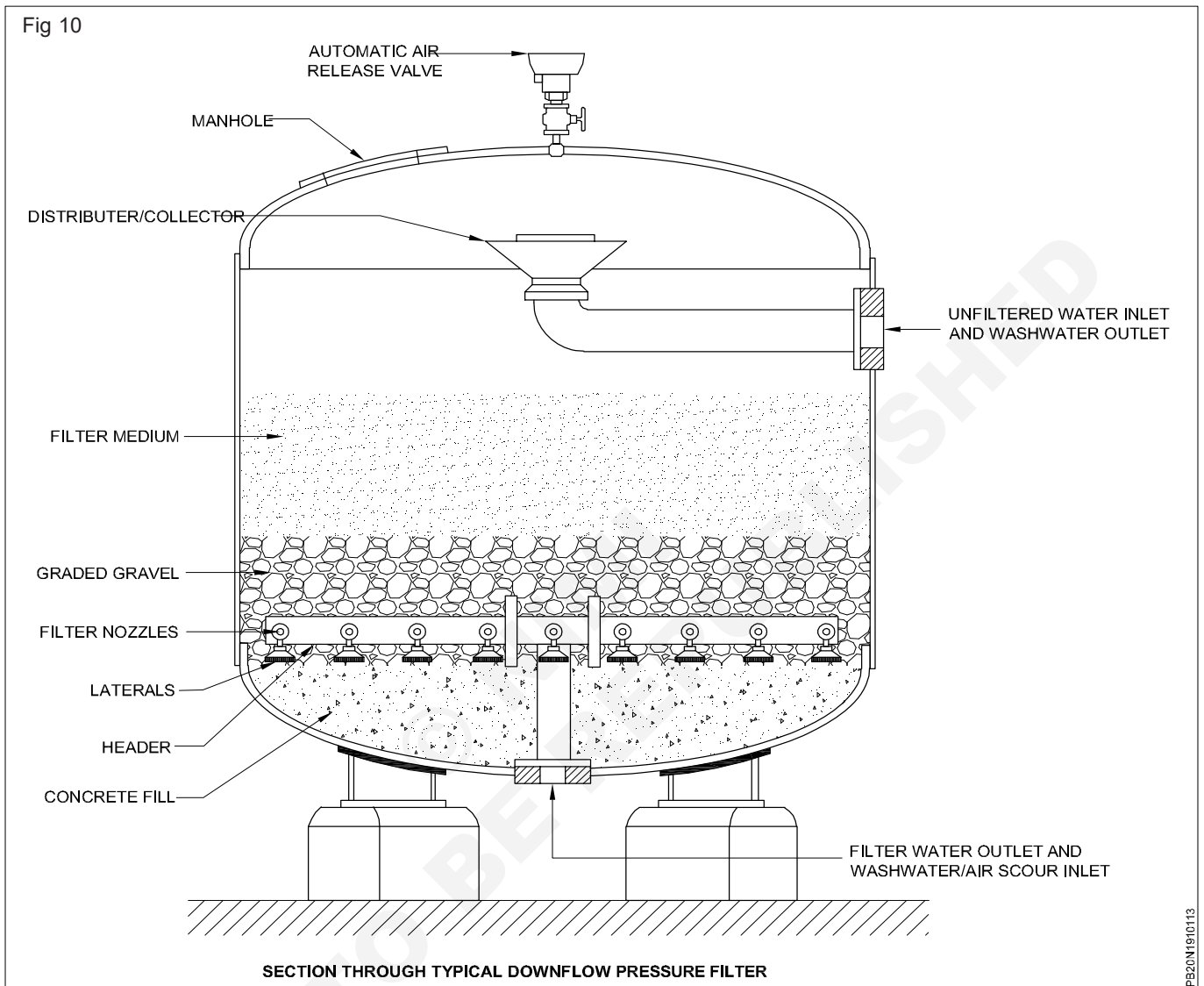
Rapid sand filter (Fig 9)



Operation of filter is all most similar to slow sand filter. Outer chamber is fitted with filter rate controller. When the filter bed gets clogged, it is removed by washing. Washing is done by the back flow of water through the sand bed.

Washing of filter is done generally after 24 hours and takes about 10 minutes.

Pressure filters (Fig 10): The water passes through sand bed under pressure greater than atmospheric. These filters are used on small industrial plants. These are not economical on large scale. The cleaning of filter bed is done by back washing similar to rapid gravity filter.



Comparison between slow and rapid gravity filters.

SI No.	Item	Slow sand filter	Rapid gravity filter
1	Area	Requires very large area	Requires small area
2	Quantity of sand	Requires considerable quantity of sand	Requires less quantity of sand
3	Quality of sand	Finer filter media of 0.2 to 0.4 effective size and 2 to 4 uniformity coefficient	Slightly coarser filter media of 0.36 to 0.6 effective size and 1.2 to 18 uniformity coefficient
4	Quality of raw water	It may not be treated with chemicals but should not have turbidity more than 50 ppm	Treatment with chemicals is essential
5	Flexibility in operation	Not possible	possible
6	Rate of filtration	100 - 180 litres/m ² / hour	4000-5000 litres/m ² / hours

SI No.	Item	Slow sand filter	Rapid gravity filter
7	Size of one unit	30m X60m	6m X 8m X to 8m X 10 m
8	Distribution of grain size	Uniform	Smaller at top and coarsed in bottom
9	Underdrainage system	Open jointed pipes or drains covered with blocks porous plate bottom concrete ridge and valley bottom etc.	Manifold and pipe laterals. vitrified tile blocks, the wheeler filter bottom the
10	Period of cleaning	1 to 3 months	24 to 48 hours
11	Method of cleaning	Scraping 2-3 cm sand from the surface and replacing it with new sand	By back washing with water under pressure, with or without compressed air agitation before washing with water
12	Skilled supervision	Not required	Essential
13	Loss of head	15 cm to 75 cm	2m to 4m
14	Penetration of suspended impurities	Very small only a dirty layer is formed at the surface	Very deep
15	Amount of water required for washing	0.2 to 0.6% of filtered water	2 to 4% of filtered water
16	Overall cost of unit	More, because large land and much quantity of materials are required.	Cheap and economical
17	Cost of maintenance	Small	More
18	Efficiency	Efficient in removal of bacteria and suspended matter	Cannot remove all bacteria, disinfection necessary, removes colour, odour and taste.

Disinfection

It is the processes of killing infective bacteria from the water. The chemicals or substances which are used for killing the bacteria are called disinfectants.

Disinfection of water can be done by the following methods.

- By boiling water
- By ultraviolet rays
- By the use of iodine and bromine
- By the use of ozone
- By the use of excess lime
- By the use of excess lime
- By the use of potassium permanganate
- By plain chlorination
- By application of gaseous chlorine
- By application of liquid chlorine
- By use of bleaching powder

and impossible to boil water in water works. Disinfection with iodine and bromine are costly, hence not used in water works.

The method of use of ozone can be used only if electricity is easily and cheaply available at the water works.

Disinfection by excess lime require another treatment for reducing pH value for making it fit for domestic use. Hence this method is also not used in water works.

Disinfection by potassium permanganate is commonly used in rural areas for trading individual well water.

Plain chlorination is used where good surface water is available. When water is to be treated in large water works gaseous chlorine is use. It should not be applied directly. It is applied through chlorinator specially designed for this purpose.

Application of liquid chlorine is most effective in disinfection. The rate of application can be controlled manually, automatically or mechanically liquid chlorinators are used for this application.

Bleaching powders are not used in the water works for chlorination as gaseous and liquid chlorine are available in market and they are more effective.

Water Softening Treatment

- The permanent hardness cannot be removed easily from water.

- The special treatment is called as the water softening treatment. The following method of removing permanent hardness.

1 Lime-Soda Process:

- In this process the lime and sodium carbonate or soda.

2 Zeolite Process:

- This is a base-exchange or ion-exchange process.
- The zeolite process are compounds aluminium, silica and soda.
- The naturally available zeolite is green in colour, therefore it is called green sand.
- When the hard water comes into contact with zeolite, the calcium and magnesium are removed and sodium is given in exchange.

3 Demineralisation Process

- A hard water is passed through a bed of resin materials in the hydrogen form.
- Alter some interval of time, the hydrogen contents is exhausted.
- The demineralisation process is mainly used for preparing water to be used for the industrial purposes.

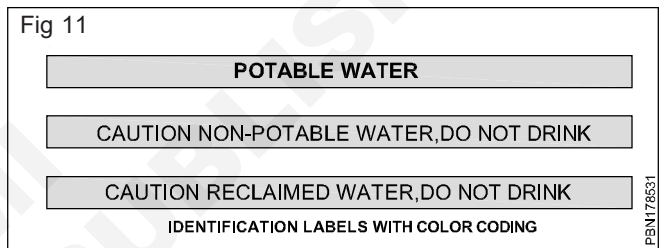
4 Reverse Osmosis: Process

- Reverse osmosis is also known as hyper-filtration.
- Reverse osmosis works on the principle of diffusion.
- Diffusion means the movement of molecules from a region of the higher concentration to a region of lower concentration.
- Reverse osmosis is capable of rejecting bacteria, salts, proteins, sugars.

A guide to good plumbing practices

Alternative source of water may include harvested rainwater and recycled / reclaimed waste water from treatment plants. Catchment area of rainwater for reuse within buildings should be restricted to the roof tops. Provision shall be made for flushing away water collected during initial rains. Rainwater harvested from lawns, building surroundings, roof gardens, balconies, etc. may be used for recharging the ground water table through recharge pits.

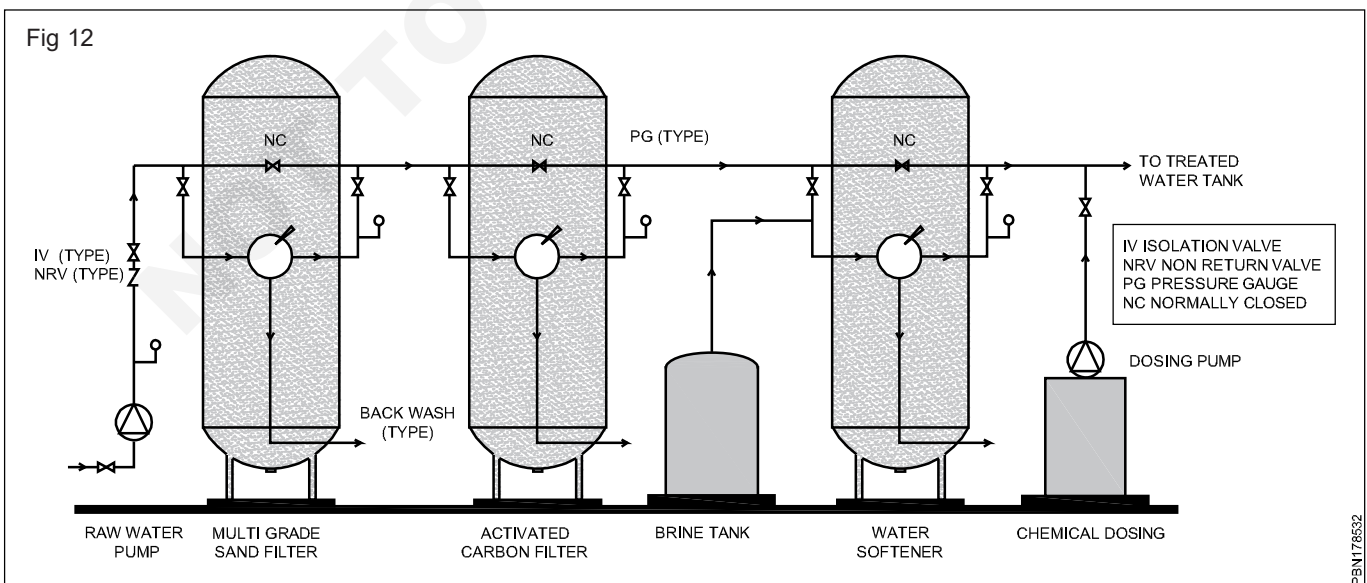
Use of alternative water (recycled water from STP) for flushing is not recommended in hospitals and other health care facilities. When treated effluent is used for landscaping purposes in premises used by children such as schools, additional precautions like colour coding of pipes, visible identification labels, lockable draw - off taps (to prevent unauthorized/ un - intended usage), etc. Shall be strictly implemented. Modern plumbing codes such as UIPC - I provide required information on stringent precautions to be taken when using alternative water sources in any kind of premise. (Fig 11)



Quality of water and treatment

Quality of available water source should be established through a test report obtained from a recognized laboratory.

The extent of treatment shall be determined based on the quality of source water. This may include sand filtration to remove suspended solids, activated carbon filter to remove colour and odour, softening to remove hardness and disinfection (chlorination, ozonization, UV, etc.) to remove bacteria. (Fig 12)



Modern technologies are currently available to treat several impurities through single equipment. Expert advice shall always be sought on selection of appropriate technology / equipment.

Domestic water purifiers incorporating various technologies like cartridge filter, carbon filter, ultra violet (UV) treatment and reverse osmosis (RO) or combinations of the above are currently available. These are generally installed at the point of usage.

Biochemical oxygen demand (BOD)

Brief summary

A measure of the oxygen - consuming life in a water sample. The testing procedure for BOD is the same as for DO, except that the DO sample is fixed in the field then titrated immediately, while the BOD sample is left unfixed and stored for five days in the dark at room temperature. After five days, the sample is fixed and titrated. The results of the test are subtracted from the oxygen level found in the DO test, and the result is Biochemical Oxygen Demand.

Note Do not fix the sample until it has incubated for five days, then fix it just as you would for the DO test.

Back ground

The bacteria that decompose organic materials (such as aquatic plants and sewage) consume oxygen. The amount of oxygen consumed over a fixed period of time in a controlled environment indicates the amount of organic matter - or biodegradable waste in the water. That measure is called Biochemical oxygen demand, or BOD. High BOD indicates the amount of organic matter - or biodegradable waste - in the water. That measure is called Biochemical Oxygen demand, or BOD. High BOD indicates pollution Low BOD suggests good water quality. If BOD is high, it is because bacteria living in the water used up the oxygen as part of the process of decomposing organic material. Thus, the BOD serves as an important clue to water quality.

Interpreting BOD results	
1 - 2 ppm	Very clean water, little organic decay
3-5 PPM organic	Moderately clean water, some decay (Probably from plant life)
6-9 PPM	Much organic decay (Possibly from algae blooms)
10 + PPM	very unhealthy levels of organic decay (often from untreated sewage)

In lieu of the traditional test, therefore, this kit contains a digital tester. Two electrodes on the tester measure the water's conductivity in microsiemens (s). A microsiemen is a micromho per centimetre, and a micromho is the inverse of a microohm (One one - millionth of an ohm). (Notice that the "mho" in micromho is "ohm" - the measure of resistance - spelled backwards.

Dissolved solids in water raise its conductivity. Multiplying the water's conductivity by a specific factor, gives the total dissolved solids in parts per million. The factor varies according to the solids dissolved in the water, and it ranges between. 5 and 9. This test uses a factor of 5. Your results will be reasonably accurate using that factor.

- When testing fresh water for TDS, the procedure is as simple as putting the meter into the sample, taking a reading, and multiplying by 5. The result is TDS, measured in ppm.
- If the meter reads "10" the conductivity is higher than the range of the tester, and you will have to dilute the sample and follow the directions for testing brackish or sea water.
- Tap water and bottled water contain some dissolved solids (Usually > 100 PPM). When making a dilution you must use demineralised water that you can make by using the demineralizer bottle included in the kit.
- The test for brackish water or sea water is a little more complicated than that for fresh water. The meter registers conductivity only up to a level of 1900 s (Which equals about 950 ppm of dissolved solids). To test water with conductivity greater than 1900 s, therefore, you must dilute the sample. We recommend a dilution of 1:50.

After measuring the conductivity of the diluted sample, multiply the meter reading by the dilution to find the conductivity of the sample. (For example, if a 1:50 dilution reads 1,100 s on the meter, the conductivity is $1100 \times 50 = 55,000s.$)

Static water pressure and measurement of pressures bursting pressure

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

- state the static pressure uses in plumbing systems
- state the measurement of pressures
- state about the bursting pressures.

Static head

Static head in plumbing installation is defined as the vertical distance / elevation between two points in a water distribution system, expressed in meters. Static head is one of the parameters in determining selection of pumps.

- Solar hot water systems
- Heat pumps

Current statutory regulations in many parts of the country mandate usage of non - conventional energy sources like solar energy to meet part of the hot water generation.

Hot water distribution system shall generally be similar to domestic cold water distribution system except that recirculation pipe work shall be added for instant availability of hot water and conservation of energy. The system shall include pipe work, isolation valves, automatic air vents, drain cocks etc as described for cold water system.

Additionally, supply and recirculation pipes will require thermal insulation to prevent loss of heat. Pipe work at large centralized hot water generator (s) will also require specialized equipment such as expansion vessels.

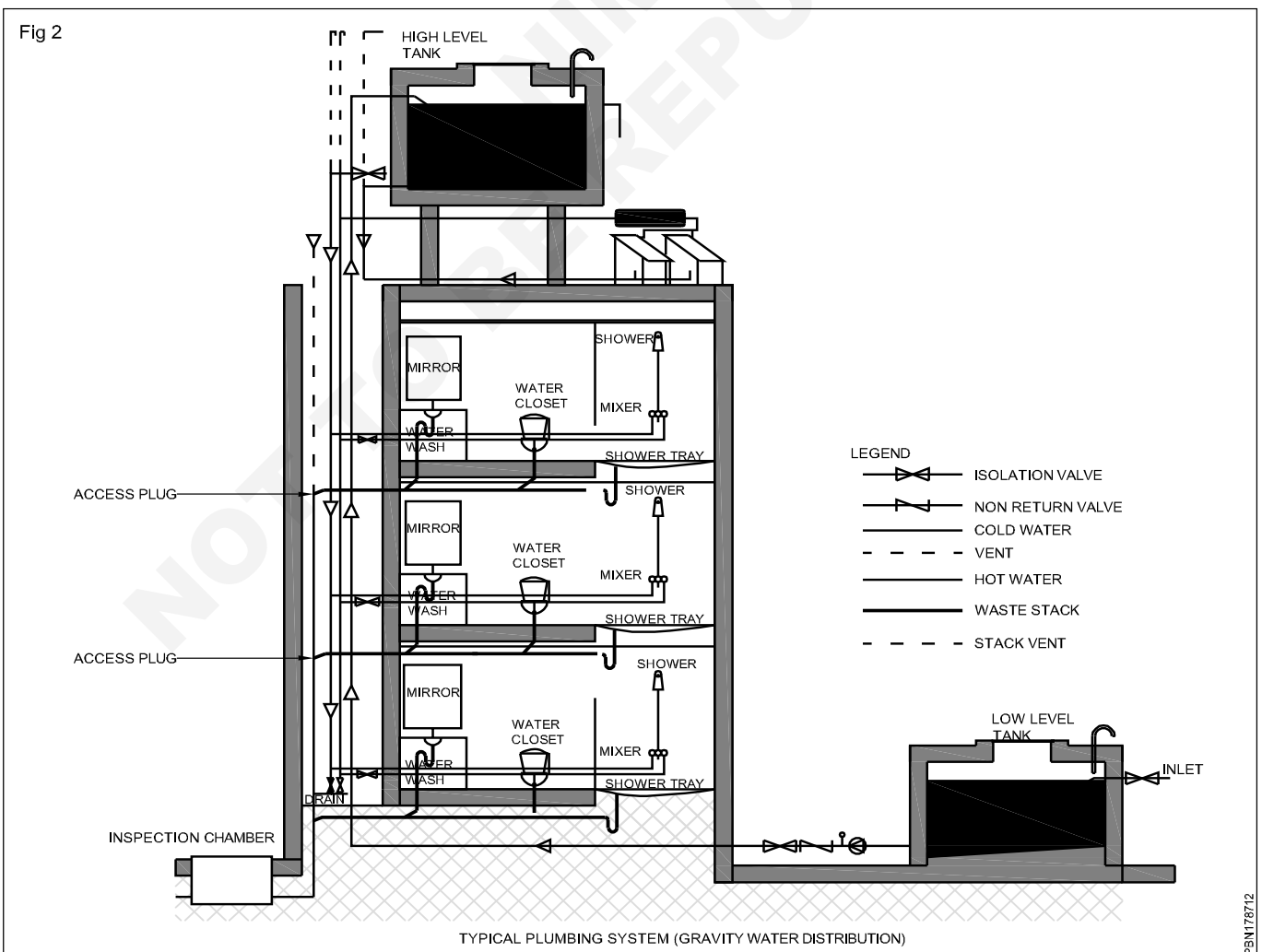
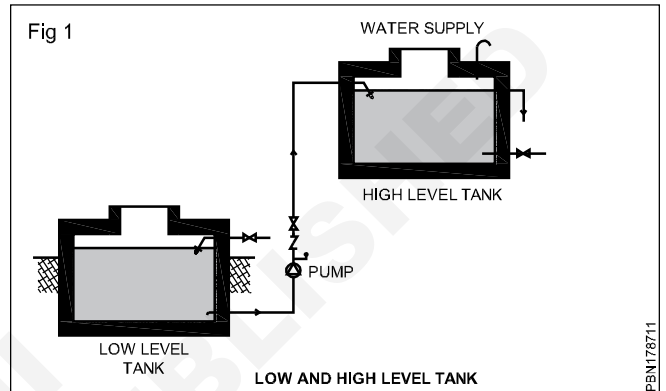
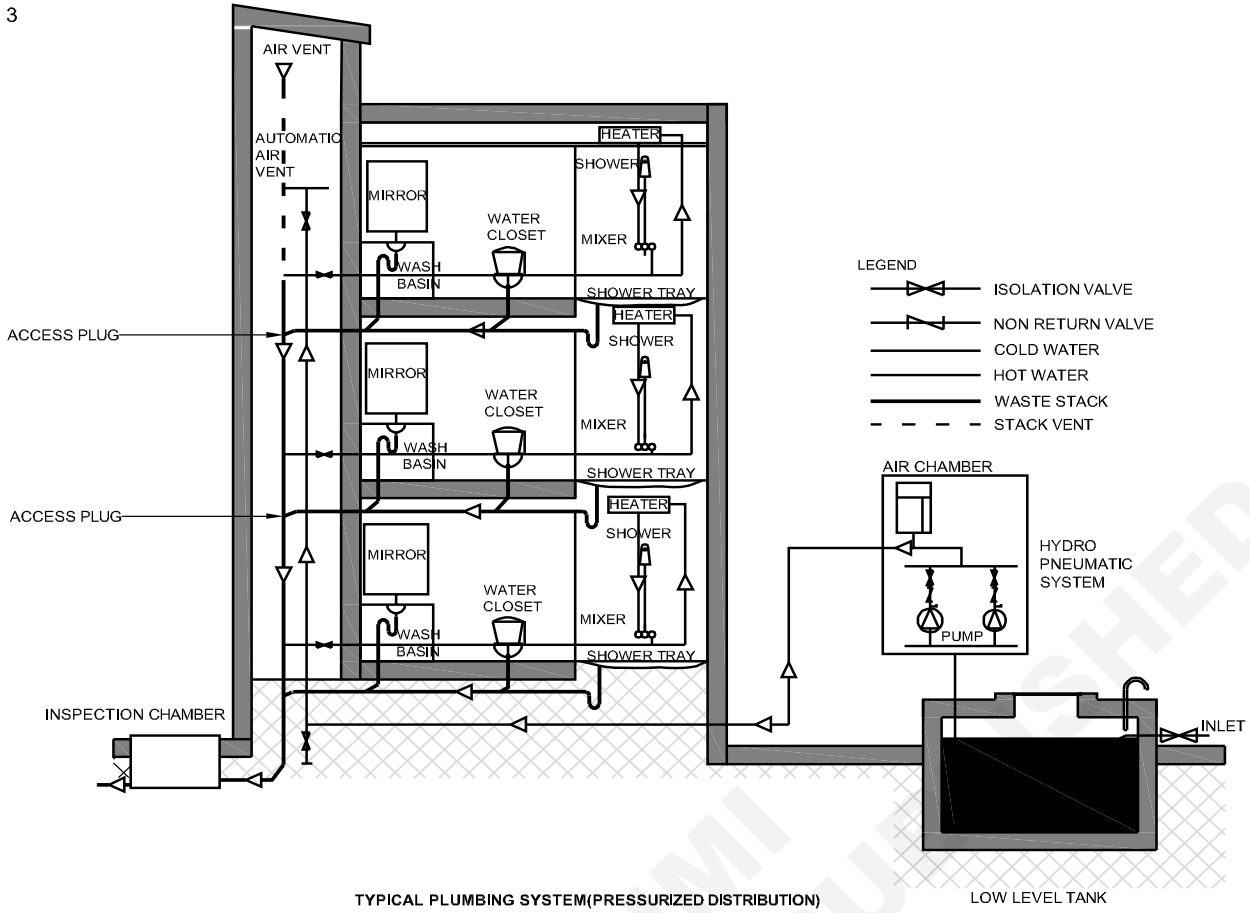
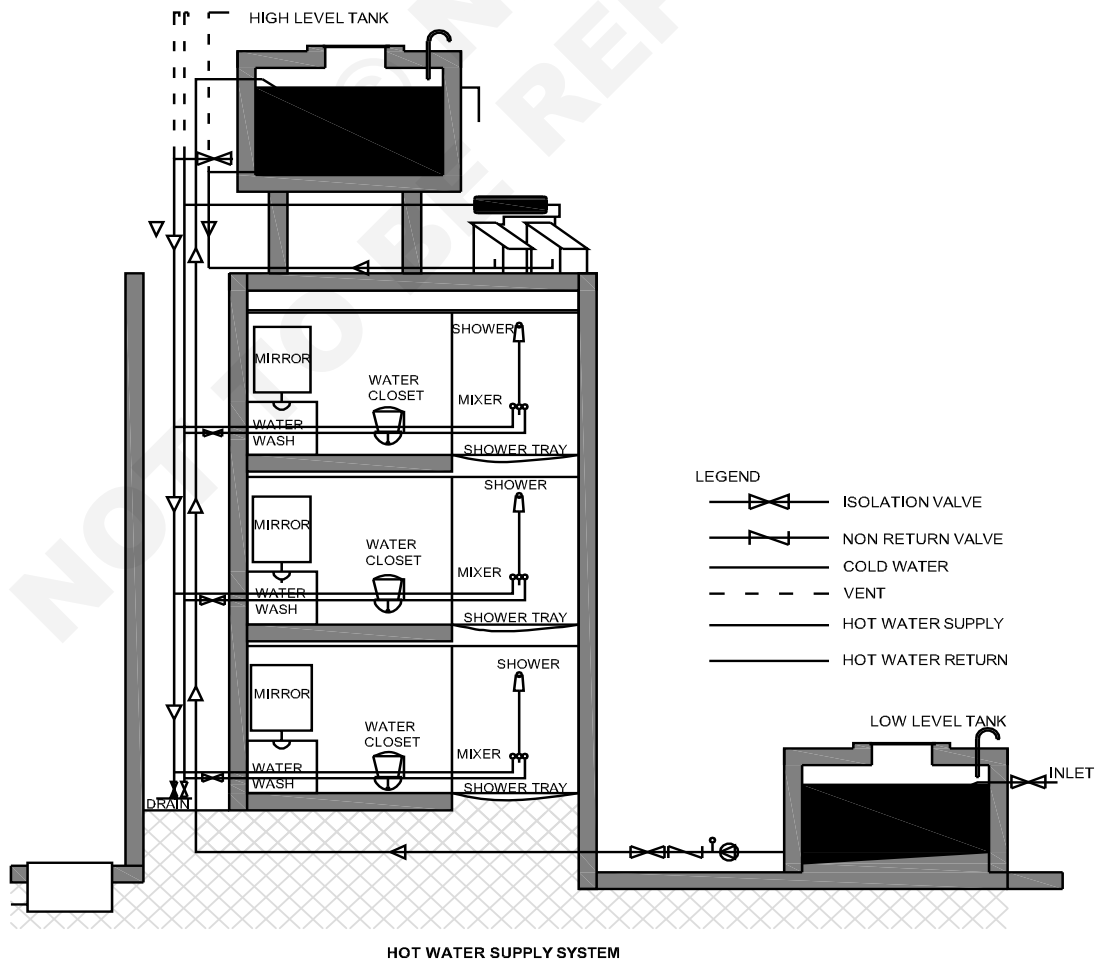


Fig 3



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Fig 4



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Expansion of water on freezing and heating

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

- **state about the expansion and freezing**
 - **state about the water pressure**
 - **state about the temperature**
 - **state the effect of water and frost on materials.**
-

Water

All the water that has ever or will ever exist on earth is already here. Ninety - seven percent of that water is in the world's oceans; two percent is frozen; and less than one percent of the world's water is accessible fresh water! It is imperative that we zealously protect the earth's water supply. Once a water source, such as a river or ground water aquifer, is polluted, it could remain contaminated for a very long time. Protecting water is of the utmost importance because life on earth could not exist without water.

Water is the only substance that expands when it freezes rather than contracting. A volume of solid steel weighs more than an equal volume of molten steel. Ice, on the other hand, floats. Imagine how the world would differ if ice were heavier than water: as bodies of water froze, the ice would sink, sending warmer water to the surface where it too would freeze. Whole bodies of water would freeze solid, and life on earth as we know it could never have evolved. As it is, fortunately, a floating layer of ice protects under water life from the severe cold rather than threatening it.

Water pressure

Water pressure is the force required to ensure desired flow of water at user points. Water pressure in distribution systems is commonly generated by static heads from elevated tanks. Where the pressure thus generated is found inadequate, booster pumps are installed. Fixtures such as single lever mixers, thermostatic mixers, flush valves, etc. require a minimum working pressure for satisfactory operation. UIPC - I stipulates minimum and maximum working pressures of 0.5 bar (5.00 meter water column) and 5.5 bar (55 meter water column) respectively. Where ablution faucets with hand held trigger spray are used, very high working pressures will be uncomfortable for usage. In such cases, simple aerators for pressure and flow regulation can be installed at the ablution faucets.

Temperature

Nature factors that influence water temperature

The size (volume) of the body of water: large bodies change temperature more slowly, so a small stream or pond will vary in temperature more than a large lake or ocean.

The depth of the water: deep waters are cooler because they warm up more slowly; the deeper the water, the less sunlight warms it and the cooler it stays.

The color and turbidity of the water: dark waters convert more sunlight to heat.

The temperature of tributary water: rivers or lakes receiving water from snow - fed mountain streams will stay cooler than those fed by streams meandering through flatlands.

The amount of overhanging vegetation: during the summer, shaded water will stay cooler than water exposed to sunlight.

The direction of a stream: Streams that run south are exposed to more sun than those running east/west.

The latitude, season, and time of day.

Human factors that influence water temperature

Industrial facilities and power plants discharge water used for cooling.

Storm runoff contains water warmed by urban surfaces, such as streets, sidewalks, and parking lots.

Cutting trees along banks exposes water to more sunlight.

Soil erosion increases the amount of suspended solids, making water turbid, and turbid water absorbs more heat from the sun.

Effects of raising water temperature

Warmer water holds less oxygen, yet produces conditions that require more oxygen.

The rate of photosynthesis by a large and larger aquatic plants increases. The result of this increase is a higher level of BOD because of the increased amount of decaying organic material.

The metabolic rates of aquatic organism's increase. As their metabolism increases, they become more active **and** consume more oxygen, reducing the DO level.

Organisms become more sensitive to toxic chemicals, parasites and diseases.

Bacterial (including pathogenic bacteria) and parasites can sometimes grow.

Effect of water and frost on materials

Frost damage can occur as cracks, stone splinters and swelling of the material when water freezes the volume of water increases by 9% when the volumetric moisture content exceeds 91% then the volume increase of water

in the pores of material caused by freezing can't be absorbed by sufficient empty pores.

Effects of frozen pipes:-

- 1 Many people are wondering what could happen if they experience freezing pipes it could lead to huge problems if left unattended
- 2 In order to prevent pipes from freezing make sure properly insulated.
- 3 Experience freezing pipes act quickly discover the possible effects and protecting them.
- 4 Frozen water in the pipes can cause a list of damage
- 5 When water in the pipes freezes, it expands and cracks the pipe.
- 6 Most common effects of pipes that freezes is water damage.
- 7 Pipe freezes and bursts it can release hundreds of gallons of water in short period and cause more damage
- 8 Frozen pipes can be devastating and irreparable if not attended immediately by a professional plumber.

9 Pipes freeze you shouldn't attempt to thaw them out inspects the damage and repairing.

10 Running a space heater next to frozen pipes might temporarily thaw them.

11 Turning up the heat might lead to a burst pipe or other damage.

12 pipe that freeze cause development of mould due to excess

13 Pipe freeze having trouble in defrosting constantly drip for several hours for mold to grow

14 Effects of freezing pipes increases utility costs for adequate heating utility bills will be higher.

15 Frozen pipe causes damage buildings structure repairing cost for damage can be high.

Testing for temperature

Overview

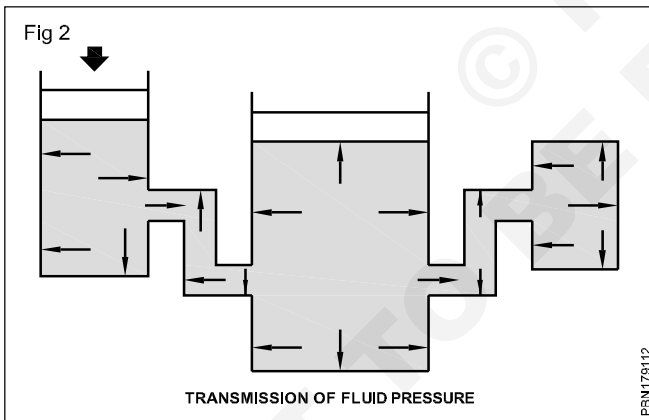
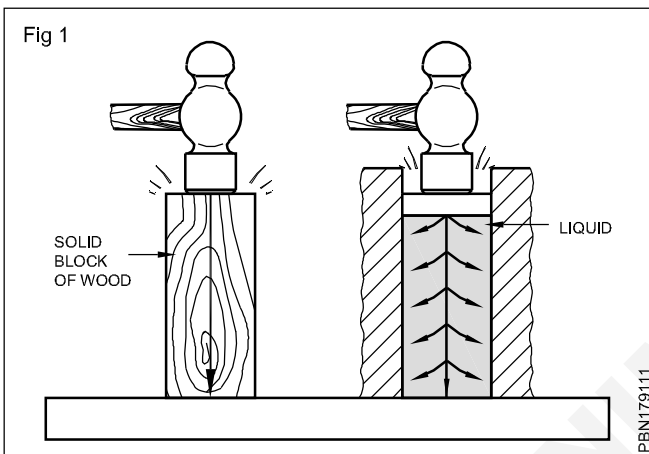
In this test, you will first measure the air temperature. Then you will either measure the temperature of the water at the same location and depth from which the water samples are taken for the other tests, or you will examine variations in water temperature in a body of water.

Bernoulli's principles, pascal's law, pressure of water on the sides of cistern or tank water hammer in pipes

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

- state about pascal's law
- state about bernoulli's principle
- state about the pressure of water
- state about water hammer and its removal.

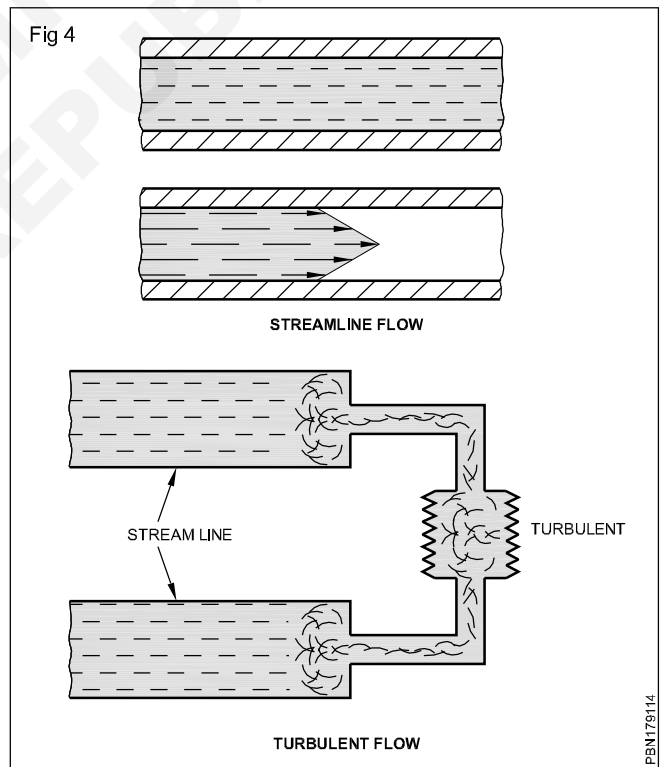
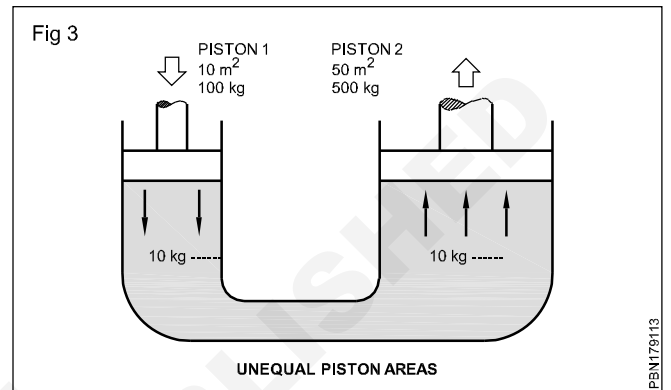
Pascal's Law: It states that the pressure exerted on a liquid is transmitted equally in all the directions. (Fig 1) clearly explains this law followed by (Fig 2).



Thus if small amount of pressure is exerted on a smaller piston as shown in (Fig 3), the higher force can be attained at the larger piston, since the pressure is equally applied on larger area.

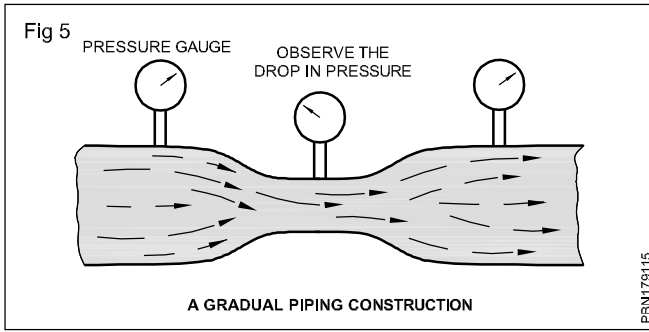
Cavitation: The inter-locked air bubbles and pockets in the hydraulic pipe lines and components is called cavitation. In cavitation the static pressure falls below vapour pressure. The vapour formation condenses resulting in pressure jerks and noise, and heating-up the oil resulting in a turbulent flow. Therefore resulting flow of oil should be a stream line or laminar in the pipe lines (Fig 4).

Bernoulli's principle: Kinetic energy is the energy present in oil by virtue of its motion. Potential energy is due to the pressure. The total energy is the sum of these two energies.



The bernoulli's principle states that the total energy of fluid always remains constant. During the course of flow of liquid, the flow increases and pressure decreases when a restriction is encountered. If the flow decreases, liquid pressure increases. (Fig 5) Depicts this principle clearly.

Effect of heat: Since the liquids (oil) full in containers cannot expand or be compressed on heat, it exerts pressure on the container thus developing unwanted stresses.

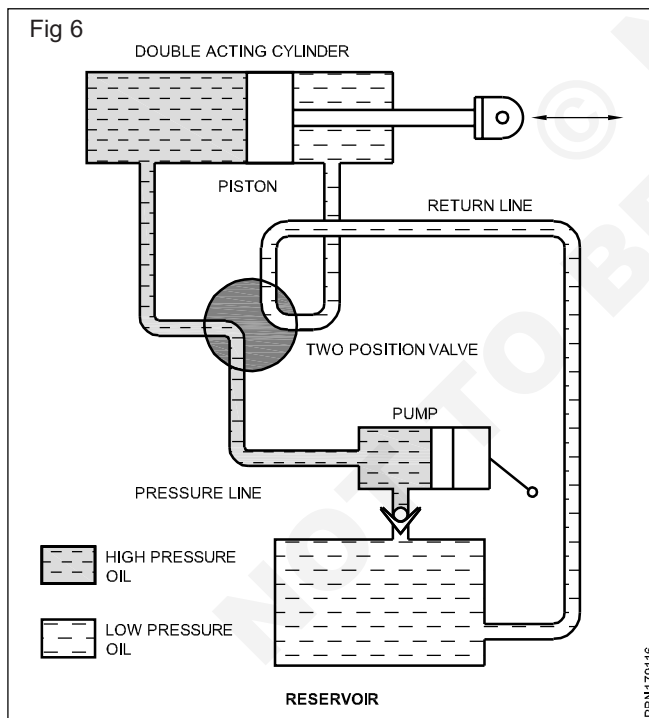


Heat also thins out the oil. The low viscous oil may leak through seals and packings. Heat also causes the deterioration of oil. Hence a suitable cooling system must be provided.

The basic hydraulic system consists of the following elements:

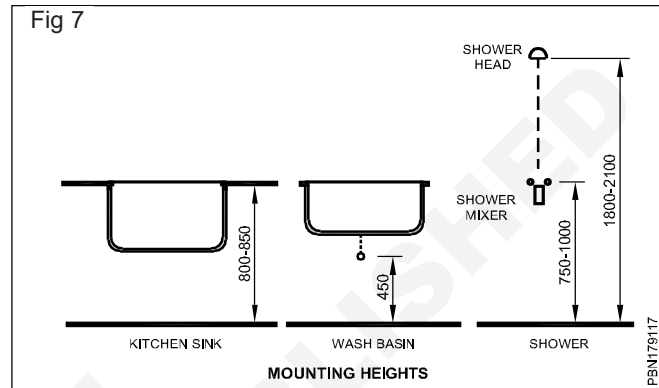
- A reservoir to store the hydraulic fluid.
- A pump to provide fluid pressure to the system.
- A control valve to direct the flow of fluid.
- An actuating unit, such as a cylinder.
- A suitable hydraulic fluid.
- Piping or tubing to circulate the fluid through the system.

But the following components make up actual hydraulic power system (Fig 6) for a safe and greater range of work.



- A reservoir to store the hydraulic fluid.
- A pump to provide fluid pressure to the system.
- A filter to remove dust, chips and other foreign particles from the fluid.
- A pressure-regulating valve, which keeps the fluid pressure in the main part of the system at the proper level.

- An accumulator, which acts as a cushion and prevents large variations in fluid pressure that occurring in the system.
- Check valves, which permit fluid flow only in the desired directions.
- A hand pump for operating the system manually if necessary.
- A pressure gauge, which indicates the amount of fluid pressure in the system.
- A relief valve, which prevents the system pressure from rising too high, if the pressure-regulating valve fails.



Plumbing fixtures and fittings: General - Plumbing fixtures and fittings include water closets, bidets, wash basins, bath tubs, showers, sinks, water heaters, ablution faucets, sink and wash basin mixers and wash room accessories such as towel racks, towel rails, towel rings, toilet paper holders, soap dishes, robe hooks, cloth lines, shower curtain rails, etc.

Public toilets will additionally have urinals, soap dispensers, hand dryers, mop sinks, etc. Generally, drinking water station is also located outside the public toilets.

Prior determination of models and types of fixtures to be used, especially in the case of water closets with their flushing devices, wash basins, bath tubs and shower mixers is of extreme importance. The plumbing connections and subsequent designs of plumbing system will largely depend on this information.

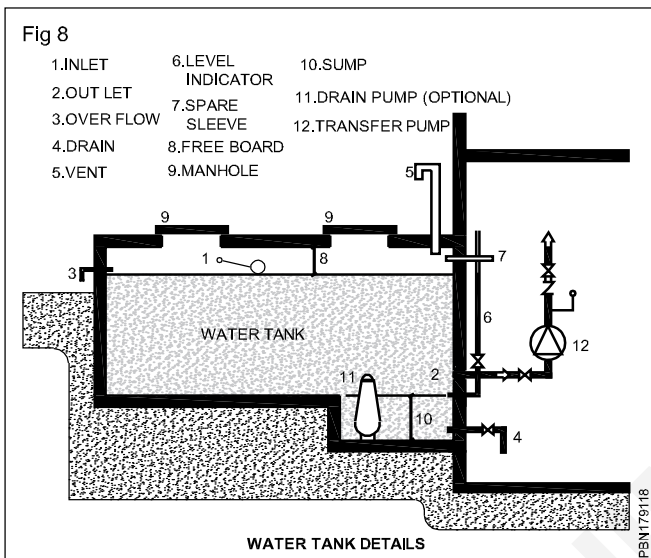
Water closet - Water closets commonly used include the European, Asian / Indian (Squatting) and combination types.

European water closets are differentiated by the mechanism of flushing and / or method of mounting. There are two types of flushing action namely siphonic (where the flushing happens through the force and volume of water used.)

European water closets can either be floor mounted or wall hung. Wall hung closets facilitate cleaning of the floor below the pan. While installing wall hung.

Each tank compartment shall be provided with pipe work including inlet(s) outlet(s), drain, overflow and vent(s) (with insect screens), provisions for level indicator, level controller, etc. A free-board (vertical distance between soffit of the tank a top water level) of 200 to 300 mm shall be provided for installation of float valve, overflow pipe, etc.

Each tank compartment shall have man hole openings of appropriate sizes and numbers, sump (s) at the base for draining the tank. Additional sumps may be required in specific instances for installation of submersible pumps. Minimum size of the man hole opening shall be 560 mm dia or 600 X 600 mm. The numbers of man holes shall be dependent on the length of the compartment. A minimum of two man holes at diagonally opposite ends are recommended for safety reasons. Man hole covers shall be air tight and lockable where required. Selection of man hole covers shall also take into consideration the expected loading factors from regular traffic if any. (Fig 8)



As far as possible water tanks (s) shall be constructed to facilitate draining of the tank and overflow from tank by gravity. Man hole cover shall be adequately raised above surrounding ground level to prevent entry of surface water into the tank. Preferably, water tanks shall not be constructed under car parks, garages, etc. In unavoidable situations where water tanks are constructed below ground, suitably sized submersible pump(s) may be part of the permanent installation to facilitate draining/emptying of the tank.

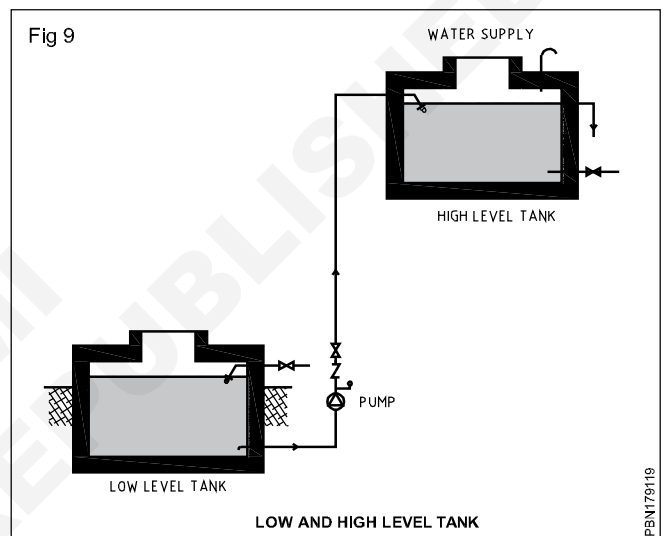
Where possible water tanks shall be constructed with a common wall with pump room/ plant room. The floor of the plant room shall be below the base of the water tank to facilitate flooded (positive) suction to pump. In such situations, draining of the tank, over flow from tank, monitoring of water level in the tank etc can be easily achieved. (Fig 9)

Quantum of storage required shall be based on professional judgment in each instance. The general practice is to provide water requirement of one to two days in low level tanks (s) and half to one-day storage in high level tank (s) where gravity water distribution systems are considered. Where different sources of water with dual piping are provided for flushing and domestic applications, approximately one - third of the total storage shall be for flushing and the rest for domestic application. Considering modern equipment and technologies available, reduction of capacities in high level tanks can be considered to save structural cost of the building. Unless specifically called for, in water distribution systems dependent on hydro -

pneumatic equipment (With standby power supply) a high level tank need not be considered. Level controllers can ensure automatic refilling of the high level tanks through setting the operation of transfer pumps.

Water distribution

Water distribution in buildings and premises can be achieved either by gravitational force from elevated storage tanks (s) or by pumping equipment from low level storage tanks(s) direct to the draw - off points. Plumbing codes prescribe a working pressure of minimum 0.5 bar (5m water column). Where flush valves are used for water, closets, the minimum pressure needs to be 1.0 bar (10 m water column). Maximum working pressure stipulated by modern plumbing codes is 5.5 bar (55 m water column) although most practitioners prefer to restrict the maximum pressure to a lower level.



Water distribution system shall be installed such that they should be self venting and self draining. Dead ends, vertical loops, etc shall be avoided. Automatic air vents or such provisions shall be required at all high points and drain cocks shall be required at the lower points.

Water distribution system shall have provision to isolate pipe work in segments by providing adequate number of valves on branches serving group of fixtures. (Fig 10)

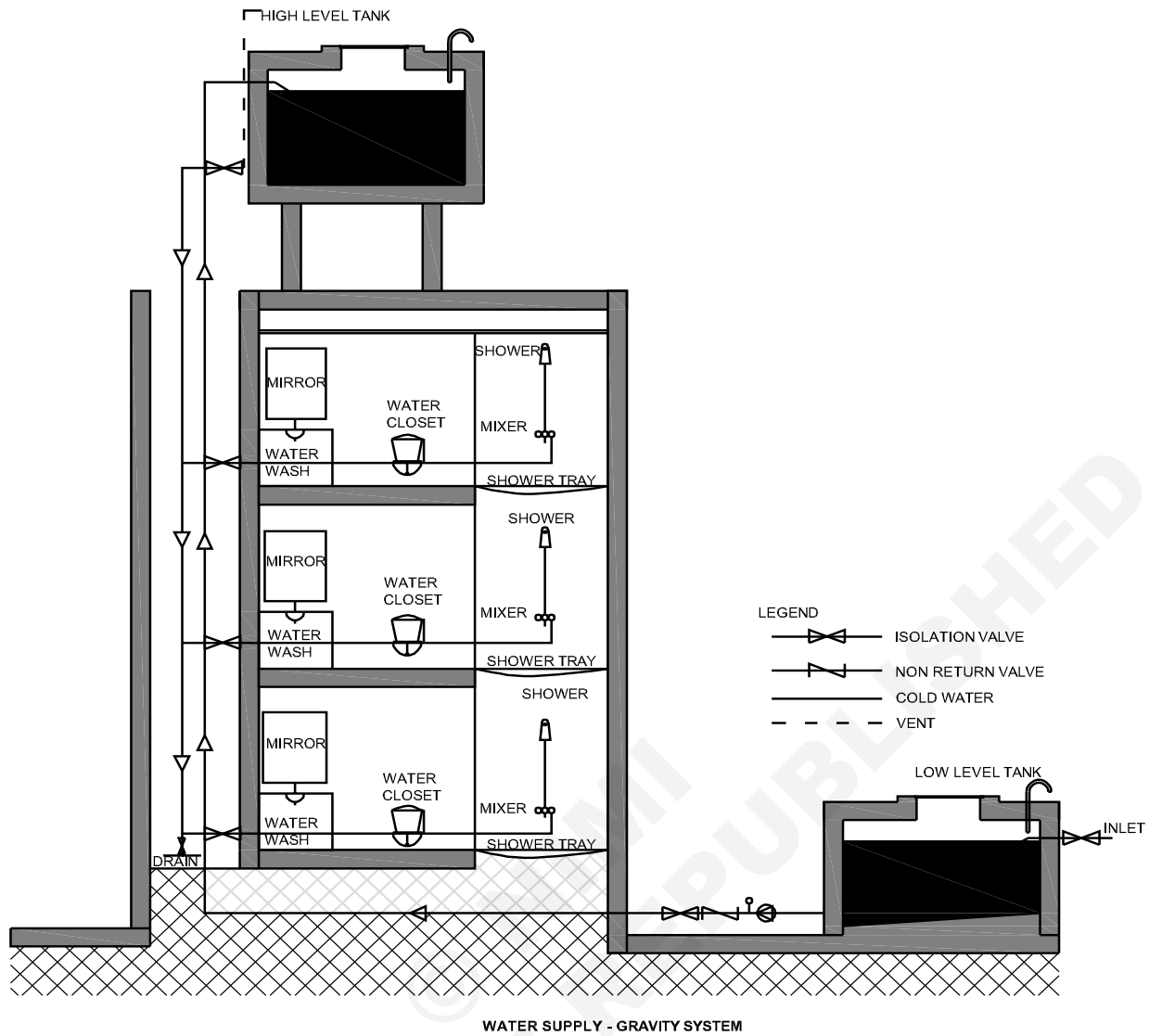
In high rise buildings exceeding, say 10 floors (floor height of 3-3.5 m) the distribution system will need to be divided into vertical pressure zones to ensure desired minimum and maximum residual pressures (the pressure at the draw off point).

In large complexes consisting of several buildings, a network of external water mains with facilities for isolation in segments may also be necessary.

In large network of pipes whether within individual buildings or for large complexes as described in (4.5.5) above, main supply pipes in ring formation will be advantageous to balance pressures at a various locations, to reduce frictional losses and there by achieve reduction of pipe sizes.

On distribution systems with the quick acting valves including flush valves, instances of water hammer and the

Fig 10



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resultant pressure surges will be frequent. Suitably sized engineered water hammer arrestors should be installed at appropriate locations. (Fig 11)

In instances where domestic water is supplied to water bodies, balancing tanks of swimming pools, cooling towers etc appropriate back flow preventers shall be provided to prevent back flow and consequent contamination of the domestic water system.

In determining pipe sizes, criteria to be considered are working pressure, velocity and flow rate.

Velocities in pipes should be restricted to 2.4 m/sec. However, when copper pipes are used for hot water distribution, the velocity should be restricted to 1.5 m/sec.

while selecting plastic such as CPVC, UPVC, HDPE, PPR, PEX, PB, etc provision shall be made for pressure de-rating at elevated temperatures. Pressure rating mentioned by manufacturers of most plastic pipes is at 23° C.

Air lock in pipes and its removal

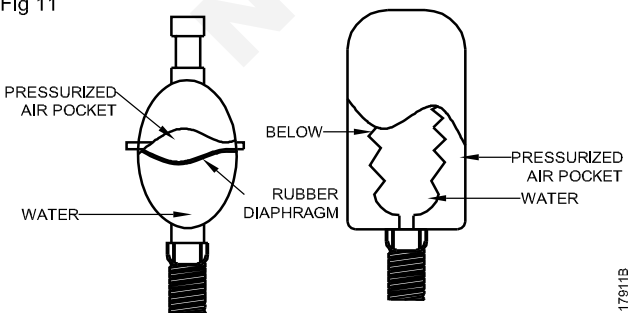
Water Hammer

Some quantity of air is contained in the flowing water and this air tries to accumulate at high points along the water pipe. In order to provide an exit for such accumulated air, the air valves are provided at summits along the water pipe. The air valves should be located at points which are close to or above the hydraulic gradient. If air valves are not provided, there are chances for pipes to be air-locked. The effective area of flow and consequently the discharge through water pipe are greatly reduced due to air-locking.

The provision of air valves along water pipe also helps in admitting air quickly when vacuum occurs in water pipe due to sudden breakdown of water pipe at low points.

An air valve consists of a cast-iron chamber, float, lever and poppet valve as shown in (Fig 1). The chamber may

Fig 11

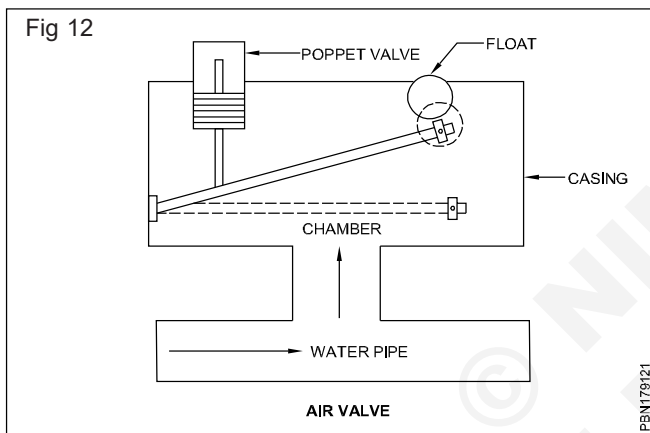


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be circular or rectangular in shape. A poppet valve is a valve that is lifted bodily. The working of the air valve is as follows.

Pipe Appurtenances (Fig 12)

- 1 In the normal condition, the chamber is full of water drawn from water pipe. The float therefore touches the roof of chamber and poppet valve is in a closed position.
- 2 When air from water pipe enters the chamber, it starts accumulating just below the roof of chamber. This accumulation of air makes the lever to work and to bring down the float.
- 3 The pulling down of float by lever operates the poppet valve which is then opened. The air is thus allowed to escape through the poppet valve.
- 4 When air escapes, the water rises again in the chamber and the lever works to rise the float. It ultimately results in the closing of poppet valve before escape of water takes place through it.
- 5 The action of air valve is then repeated.



If water flowing through a tap or valve is suddenly arrested, the water will record in the pipe. Water is practically incompressible and will act like a solid rom induce stresses inside the pipe and it will produce a noise like hammering. It is known as water hammer.

Diameter of pipe in mm	80 to 250	300	400	500	600	700	900	1050-1500
Extra pressure for water hammer in kg/cm ²	8.50	7.75	7.0	6.30	5.75	5.60	4.90	4.90

- The pressure may burst the pipe.
- The bursting of pipe due to water hammer is called expansion.

Water hammer is a phenomenon experienced in distribution systems and is noticed as a loud repetitive noise. Water hammer can result in vibration of pipes, displacement of pipe supports, shaking of faucets and in extreme cases bursting of pipes.

Water hammer is caused by sudden stoppage of flow of water in a pipe as a result of quick closing of a valve, stoppage of pump, etc. Water flow back and forth within the pipe in these situations creates excessive velocities which will continue until a relief is found by way of an air chamber to absorb the pressure surges.

This may rupture the pipe and connected fittings. Water hammer is caused due to the following:

- 1 When valve is closed, instantaneously.
- 2 Power driving the pump fails all of a sudden.
- 3 Pulsation in flow due to reciprocating pumps and hydraulic rams.

This effect of water hammer can be reduced by following measures:

- 1 Provide a surge relief at or near the outlet end.
- 2 Provide air-relief valve of considerably large size.

Safety valve: The valve consists of a disc which is controlled by a spring which can be adjusted for any pressure. When the pressure in the pipe exceeds the valve for which the valve is adjusted, the disc is lifted and the pressure is relieved through cross pipe. The disc again comes to its original position due to the spring.

For the design of pipes, extra pressure due to water hammer is assumed about 8.5 kg/cm² for pipes of 7.5 cm to 25 cm in diameter. The pressure is gradually reduced to 4.9 kg/cm² for pipes above 120 cm in diameter. Allowance for water hammer for various sizes of pipes may be taken as follows:

Soft and hard water

- Water hammer is a pressure which results from sudden stoppage of the velocity of flow of water in a closed pipe.
- When the valve is closed, the pressure is creating due to movement of water.
- The increased pressure from the walls of to pipe to expand.
- This expansion to move in the velocity towards the valve.
- The pipe is expanded under a high pressure than normal.
- These fluctuations of pressure may develop vibrations which may result in sound.

Conventional methods to absorb water hammer used to be provision of air chambers which have been proven ineffective. Engineered water hammer arrestors which contain pre – charged diaphragms an effective solution to this phenomenon. Water hammer arrestors shall be sized appropriately using the fixture unit methods to determine their required capacities.

Water level controller: Water level controllers are used for facilitating the operation of pumps for automatic filling of storage tanks. Level sensors provided at pre – determined high and low levels within water tanks dictate starting and stoppage of pumps. Sensors are also provided in suction tank to prevent dry running of pumps in the absence of water in the tank.

Description and working of water hammer arrester

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

- State about the water hammer arrester
- State about the function of water hammer arrester.

What is water hammer

The noise from banging pipe is caused by shocks of high speed water flowing in the piping system when a fixture is suddenly closed. sudden stoppage of the water (a non - compressible liquid) flowing at a given pressure and velocity causes a surge or spike of water is called water hammer.

Working of water hammer arrester

- A water hammer arrester diminishes the effects of water hammer in the plumbing system.
- After their installaion by moving up and down.
- The pressure and counter pressure of air and water are responsible for this movements.

Functions:

Sometimes the water supply pipeline valve closes quick and prevent the water flowing as a consequence of this, the moment strike the pipe heavily

The water hammer arrester prevents this condition by providing a cushion of air that absorb the momentum.

They need to be installed in areas where faucets and valves are creating noise

The installation usually requires cutting pipes, inserting tees and then installing water hammer arrester.

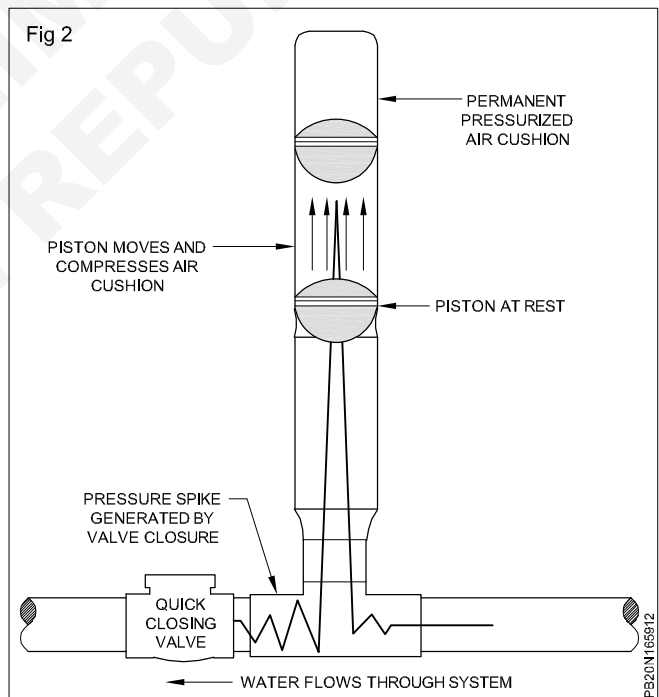
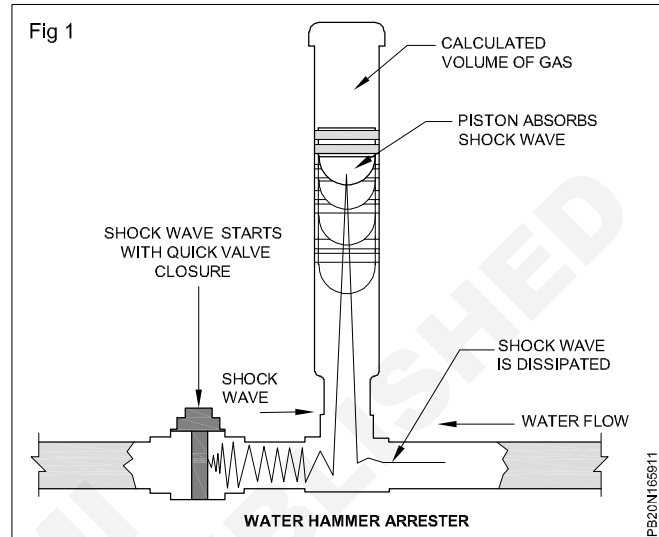
The water hammer arrester is at the end of the branch line between the last two fixtures. The location of water hammer arrester do not exceed 20 feet in length, an additional water hammer arrester should be used.

Water Hammer Arrestors:

Water hammer arrestors are devices that soak up the pressure wave, or water hammer, that happens when a quick closing valves shuts and rapidly stops the circulation of water. Pipe installed vertically and filled with air. The air offers the cushion to take in that water hammer. Because air is soluble in water.

The general guideline is that water hammer arresters are required on all fast closing valves.

Solenoid valves, the electronic snap-action valves that manage water flow to sensing unit faucets, dishwashers washing makers, ice makers and coffee machines. Water hammer arrester shall not be required on any valves where plastic pipe is used for water distribution piping, indicates that they are not required for PVC and PEX.



Use of hummed and asbestos pipes of different sizes

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

- state the necessity of pipes
- describe the hummed pipes
- state the manufacturing method of hummed pipes
- state the classification of hummed pipes
- state the merit & demerit of hummed pipes
- state the specification of hummed pipes.

Necessity of pipes

Water is conveyed or transported from the source to the community through various types of conduits. These may be either open or closed types. Open channels are used to convey raw water from the source to the water treatment plants advantage of using pipe lines is the reduction in conveyance losses, such as evaporation and seepage losses.

These pipes may be precast or cast-in-site. Plain concrete pipe may be used at such places when water does not flow under pressure. These pipes are jointed with bell and spigot joints. Plain concrete pipes are used upto 60 cm diameter only, above it these are reinforced.

R.C.C. pipes are manufactured by the following methods:

- 1 Precast pipes are manufactured in factories and then transported to the site. The reinforcement of R.C.C.

pipe consists of welded steel cylinder with high tension wire wound over it. Normally 1:2:2 concrete mix is used in the manufacture of concrete pipes. Larger diameter pipes are jointed together by means of collar joint with a rubber gasket or fiber filled lead gasket placed between the two ends of the pipes.

Corroded by the water, have long life, above 75 years. The maintenance cost is low. But they are very heavy and difficult to handle and transport. They cannot withstand high pressure and are difficult to repair.

- 2 Thickness of the pipes varies from 25 mm to 65 mm for pipe diameters varying from 10 cm to 120 cm.

Now-a-days restressed concrete pipes are also available in the market.

Indian Standard (IS : 458 - 1961) classifies the hummed pipes into six classes as given in Table 1

Table classification of hummed pipes

Class	Description	Condition where normally used
NP1	Unreinforced concrete, non- pressure pipes	For drainage and irrigation use, above ground or in shallow trenches.
NP2	Reinforced concrete, light duty non-pressure pipes.	For culverts carrying light traffic.
NP3	Reinforced concrete, light duty non-pressure pipes	For culverts carrying heavy traffic, such as railway loadings.
P1	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 2.0 kg/cm ² (20 m head)	For use on gravity mains, the actual working pressure not exceeding 2/3 of the test pressure.
P2	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 4.0 kg/cm ² (40m head)	For use on pumping mains, the actual working pressure not exceeding 1/2 the test pressure.
P3	Reinforced concrete pressure pipes tested to a hydrostatic pressure of 6.0 kg/cm ² (60 m head)	Same as above

Advantages

Concrete pipes have the following advantages:

- 1 They are more suitable to resist the external loads and loads due to backfilling.
- 2 The maintenance cost is low.
- 3 The inside surface of pipes can be made smooth, thus reducing the frictional losses.
- 4 The problem of corrosion is not there.
- 5 Pipes can be cast at site, and hence the transportation problems are reduced.

6 Due to their heavy weight, the problem of floatation is not there when they are empty.

7 Expansion joints are not normally required.

Disadvantages

- 1 Unreinforced pipes are liable to tensile cracks, and they cannot withstand high pressure.
- 2 The tendency of leakage is not ruled out as a result of its porosity and shrinkage cracks.
- 3 It is very difficult to repair them.
- 4 Precast pipes are very heavy, and it is difficult to transport them.

Table 2 gives specifications of ordinary pipes as per I.S. : 458 - 1971

Table 2 specifications of ordinary hummed pipes

S.No.	Category	Diameter in mm	Test pressure in kg/cm ²	Uses
1	Class P ₁	80-1200	2	For use in gravity-mains design pressure should not exceed 1.33 kg/cm ²
2	Class P ₂	80-600	4	For use on pumping-mains designs pressure not to exceed 2kg / cm ²
3	Class P ₃	80-400	6	- do -

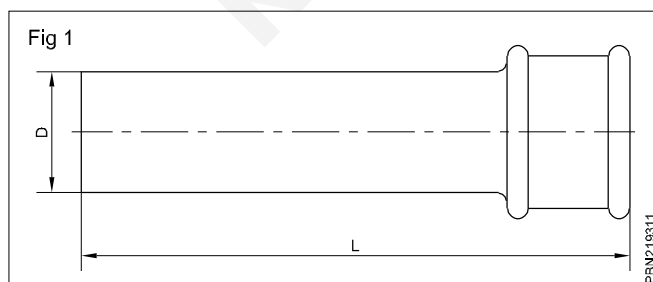
Asbestos pipes

Objectives: At the end of the lesson you shall be able to

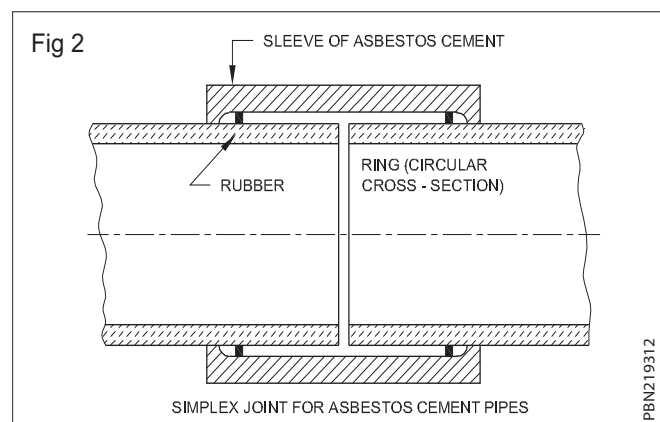
- specify the composition and availability of A.C.pipes
- list the advantages and disadvantages of using A.C.pipes
- list usage of A.C.pipes
- explain classification of A.C.pipes.

AC pipes

General: AC pipes are manufactured from pure asbestos fiber, portland cement and silica under high pressure in machines and are available from 5 cm to 100 cm in diameter and 2 m to 3 m in length. The pipes have socket at one end of the pipe for joining. AC pipes are used for carrying waste water or rain water (Fig 1). joints used in the asbestos cement pipe consisting of a sleeve water-tightness being obtained by two rubber rings compressed between the sleeve and the pipe barrels as shown in Fig 2.



It is resistant to tuberculation, incrustation, soil corrosion and electrolysis and has excellent hydraulic properties. The pipes are brittle and are liable to crack during handling, transportation and vibrations. They cannot be laid in exposed conditions.



Advantages

- 1 It does not corrode.
- 2 Transportation is easy because of its light weight.
- 3 Cost is less compared to GI, CI pipes.
- 4 It is easy to join.
- 5 Cutting and drilling is easy.
- 6 Inside of the pipe is smooth; therefore has good carrying capacity.

Disadvantages

- 1 AC pipes are brittle in nature therefore chances of breaking during handling and transportation is high.
- 2 Damaged pipes cannot be repaired and used.
- 3 Shock resistance is less therefore it should be laid with precautions.
- 4 Use of asbestos cement is banned in many countries on health grounds.

When a sewer has to be laid in a soft underground strata trench shall be excavated deeper. The trench bottom shall be stabilized by the addition of coarse gravel or rock shall be filled in with cement concrete.

The sewer pipes are always preferred to provide concrete bedding in the trench below the pipes.

The centre line of sewers and their grades are transferred from the ground by means of sight rail and boning rod by the following method:

- i Four stout stakes are driven into the ground or pillars.
- ii Horizontal boards called sight rail are fixed over the pillars.
- iii The centre line of sewer is marked on the sight rail and small nail are fixed on the sight rails.
- iv The line joining the top of nails fixed on the sight rails.
- v Fixed at 7.5m centre to centre spacing.
- vi Now a strong cord or wire is stretched between the nails fixed on sight rails. This line is parallel to the grade of the sewer.
- vii Now with the help of boning rods using plumb bob the line and grade to the sewer line.

Smaller size pipes can be laid by pipe-layers directly but heavier and larger size pipes are lowering in the trenches by passing ropes.

It is the common practice to lay the pipes with their socket end up grade spigot end of one pipe is placed in the socketed end of the other. After properly placing and arranging the pipes they are suitably joined.

Classification of A.C. pressure pipes

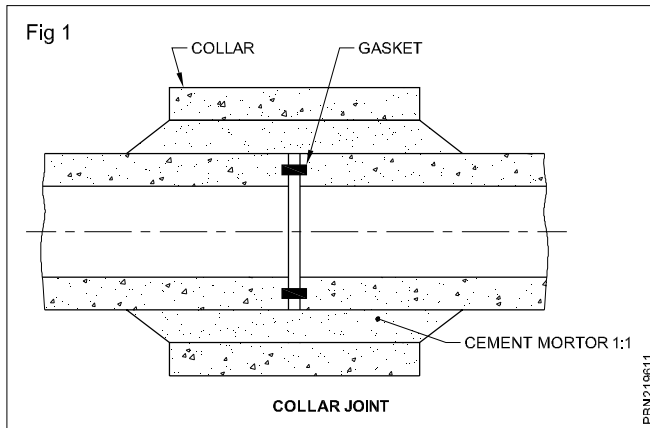
Class of pipes	Class 1	Class 2	Class 3	Class 4	Class 5
Test pressure	5 kg/cm ² (50 m head)	10 kg/cm ² (100 m head)	15 kg/cm ² (150 m head)	20 kg/cm ² (200 m head)	25 kg/cm ² (250 m head)

Method of laying out pipes alignment and joining

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

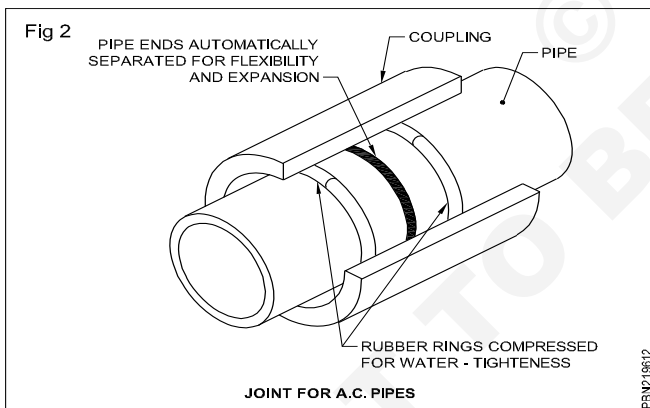
- state collar joint and A.C. pipe joint
- state various types of pipe bedding.

Collar- Joint (Fig 1)



The collars shall be placed symmetrically over the end of two pipes collar and the outside of the pipe shall be filled with hemp yarn soaked in tar or cement slurry well packed and thoroughly rammed with caulking tools and then filled with cement mortar 1:2. sloping at 45° cured for at least 24hours. inside of the pipe perfectly clean.

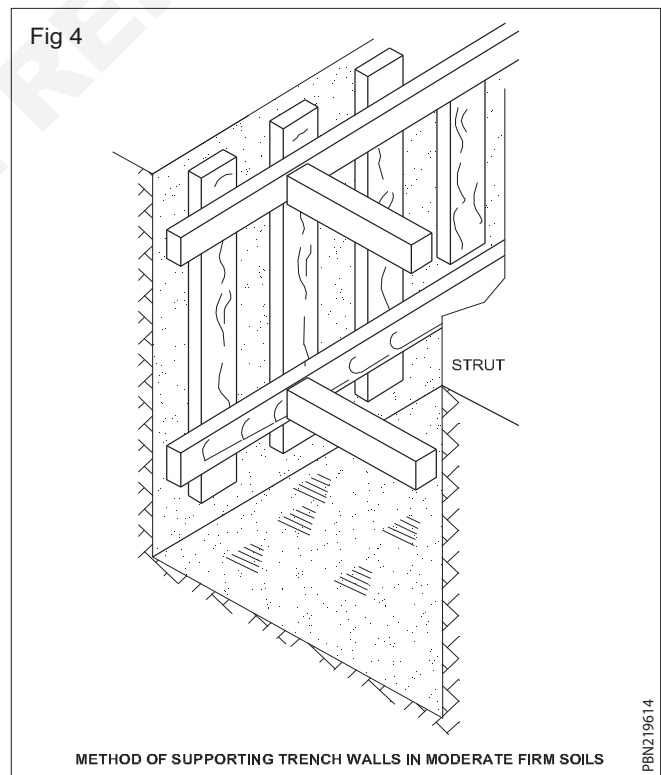
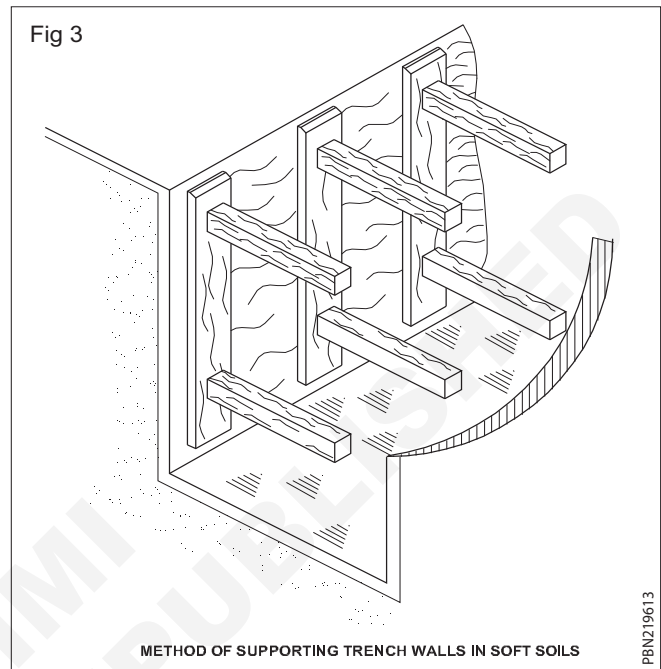
Joint for A.C.Pipes (Fig 2)



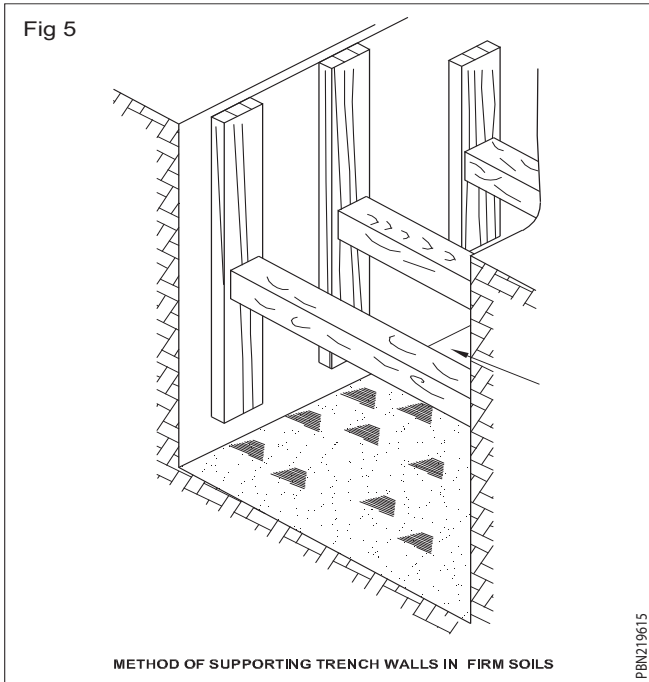
For joining small diameter A.C. pipes, the two ends of pipes are butted against each other, then two rubber rings will be supplied over the pipes and the coupling will be pushed over the ring as shown in Fig 2. The rubber rings make the joint waterproof.

Sewer pipe may have to be laid under the following conditions (Fig 3, 4, 5)

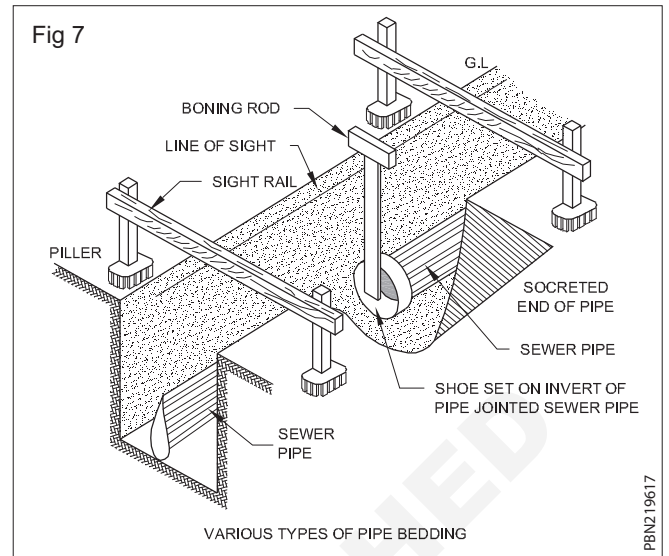
- Culvert condition:** When the pipe is laid it projects wholly or partly above the original surface.
- Trench condition:** When the pipe is laid in a trench According to trench condition is vary firmsoil, moderate firm soil and soft soil.



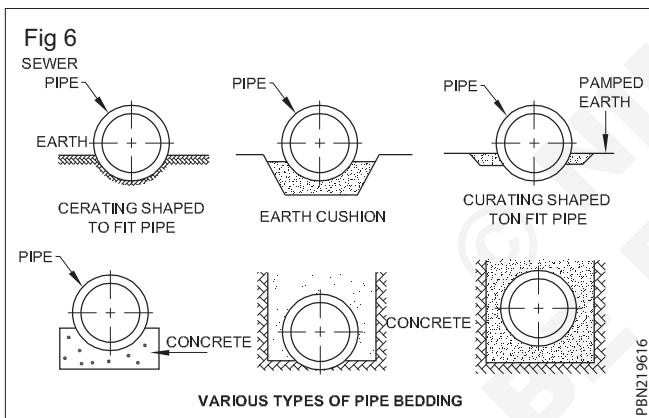
- Negative projecting conditions:** When the pipe is laid the two of the pipes is at an elevation ground surface.



- e Now with the help of boning rods using plumb bob the line and grade to the sewer line is given as shown in Fig 7.



- d **Open condition** : The pipe is laid that it projects wholly or partly above the ground surface. Fig 6 shows various types of pipe bedding usually provided below sewer pipes under various conditions.



Description of various pipe joints - straight, branch Taft blow, expansion joints

Refer R.T. for Ex No. 1.6.41 - 1.6.46

Various pipe fitting joints

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

- state the necessity of pipe fitting joints for pipe line
- state the types of pipe fittings joints
- state the pipe fittings joints.

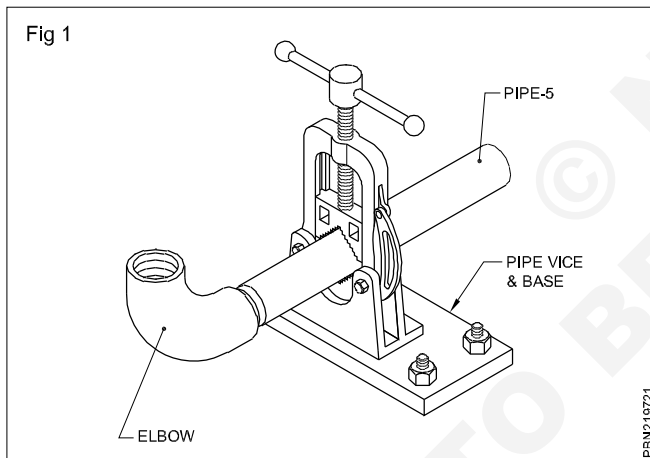
Standard pipe fitting

'Pipe fittings' are attached to pipes in order to:

- 1 Change the direction flow in the pipe.
- 2 Connect a branch with a main water supply pipe.
- 3 Connect two or more pipes of different sizes.
- 4 Close the pipe ends.

Elbows (Fig 1)

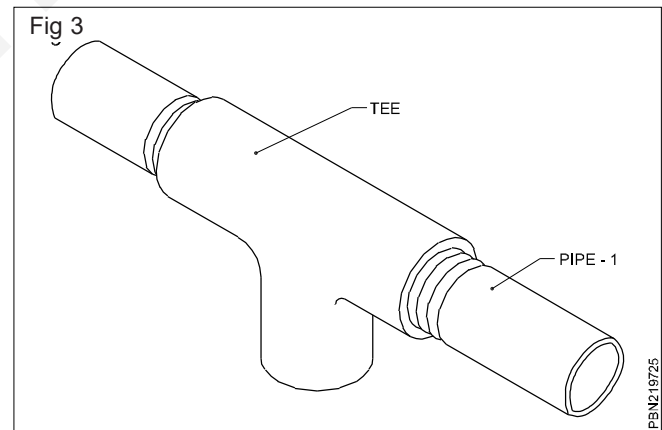
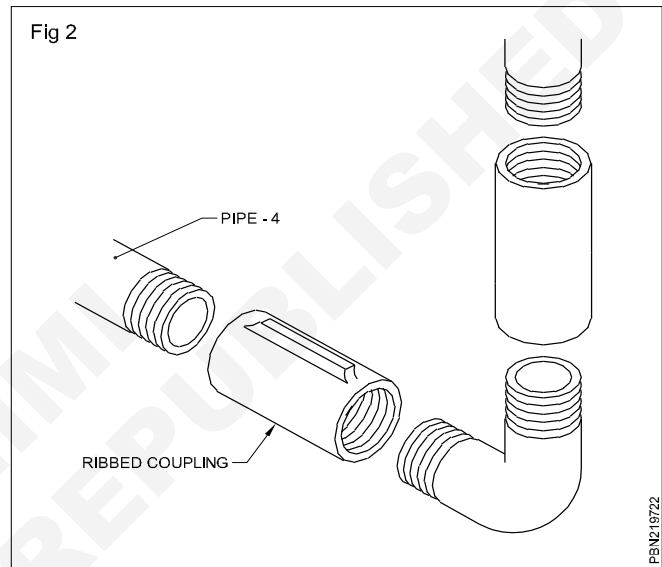
Elbows and bends provide deviations of 90° and 45° in pipe line systems.



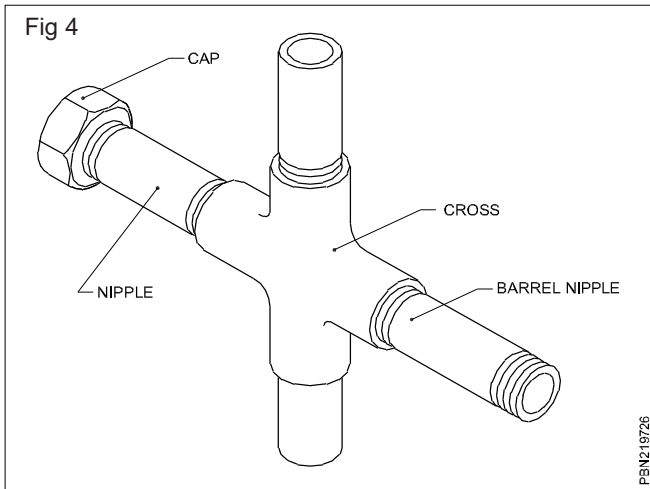
Coupling (Fig 2): An ordinary coupling shown in Fig 2 usually comes with the pipe, one coupling to each length. They are regularly threaded with right hand threads. Another form of coupling called an extension piece.

Types: Elbows, bends, coupling, Tee branch crosses union, Reducer, End plug & cap.

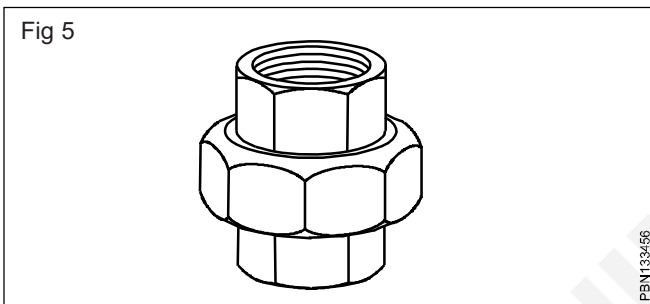
Tee (Fig 3): Tees are most important and widely used of the branching fittings. They are used for making a branch of 90° into the main pipe and always have the branch at right angles. Specified by the size of the pipe. (Fig 3)



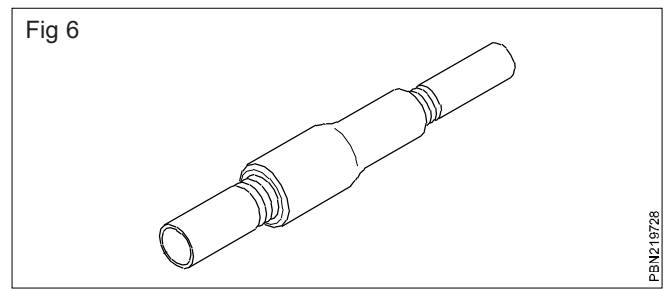
Crosses: A cross is simply an ordinary tee having a back outlet opposite the branch outlet. The axis of the four outlet are in the same plane and at right angle to each other. (Fig 4)



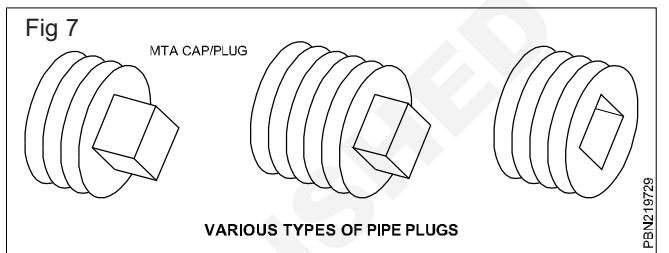
Union: A device used to connect pipes. Unions are inserted in a pipe-line to permit connections with little change to the position of the pipe. When unions are used in pipe lines, it is easy to dismantle and repair. (Fig 5)



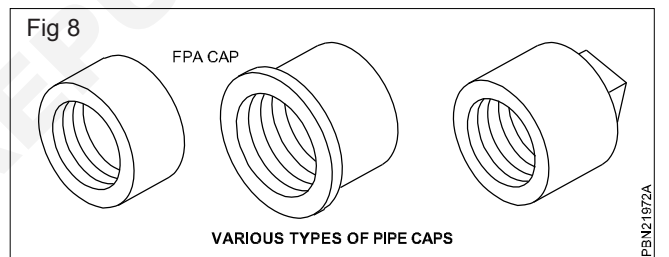
Reducer: A reducer coupling is used to connect two pipes with different diameters. (Fig 6)



Types of pipe plugs: A plug is used for closing the end of a pipe or a fitting having a female thread. Plug are made of cast iron, malleable iron and brass (Fig 7) the various pattern usually a square head for the small sizes and a hexagon head for the larger sizes. Ordinary plug are made on sizes ranging from 6mm to 300mm.



Caps: A cap is used for closing the end of a pipe or fitting having a male thread. Cap like plug are made of cast iron malleable iron and brass. Fig. shows various cap designs. made in size from 6mm to 150mm. (Fig 8)



Solders and fluxes used in joints

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

- describe the solder, and flux
- state the application of solders and flux in different joints.

Solder

Two more metallic element consists lead and tin. The more percentage of lead increases the melting point of solder.

Types of solders

There are two types of solders.

- Soft solder
- Hard solder

Soft solders melting points are below 450° C and hard solders melting points lie above 450° C.

Soft solders

These are alloys of the metals tin, lead, antimony, copper, cadmium and zinc and are used for soldering heavy (thick)

and light metals. Soft solders are used for soldering cast iron, brass, steel, zinc, lead etc.

Hard solders

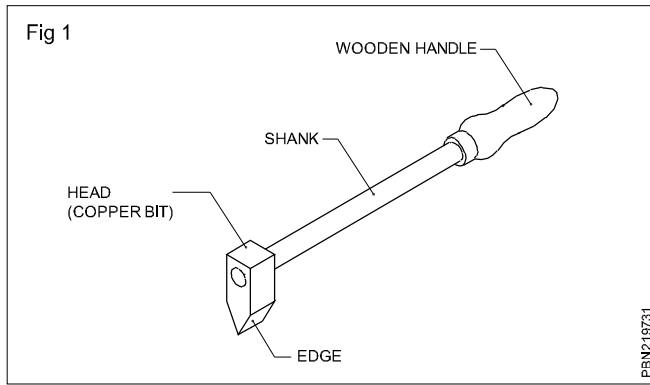
These are alloys of copper, tin, silver, zinc, cadmium and phosphorus, and are used for soldering heavy metals.

Soldering is the process by which metallic materials are joined with the help of another liquefied metal (solder).

The melting point of the solder is lower than that of the materials being joined.

Soldering iron (Fig 1)

The soldering iron is used to melt the solder and heat the metal that are to be joined together.

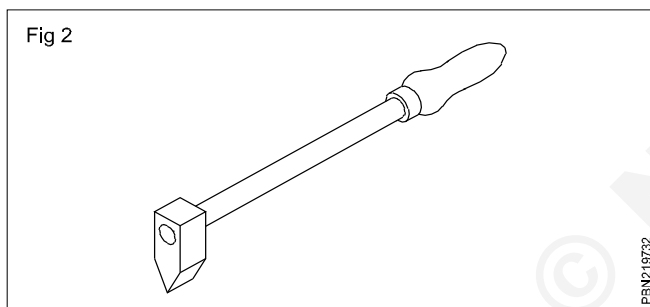


A soldering iron has the following parts.

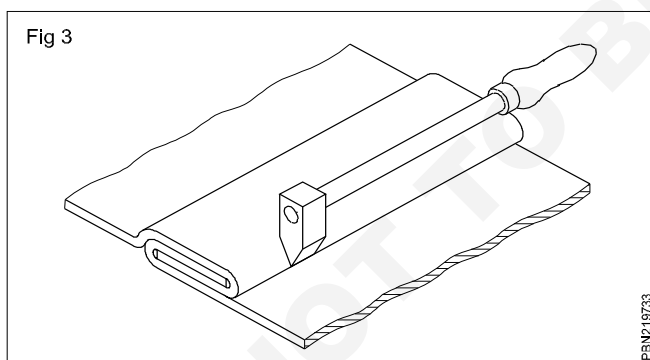
- Head (copper bit)
- Shank
- Wooden handle
- Edge

Shape of head: The head of the iron is made of forged copper.

A Hatchet type soldering as in (Fig 2) has shank fitted at 90° to the head. The soldering edge is 'V' shaped. (Fig 2)



This type is used for straight soldering joints. (Fig 3)



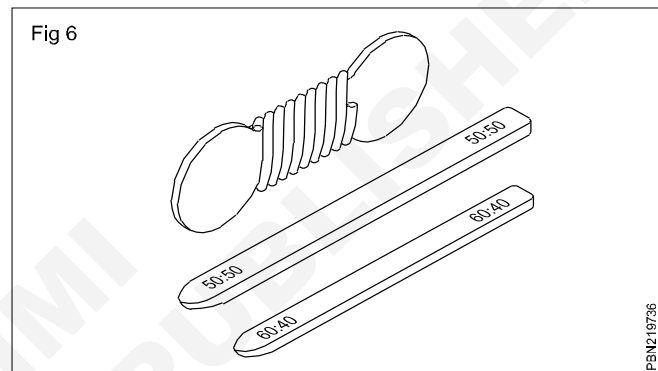
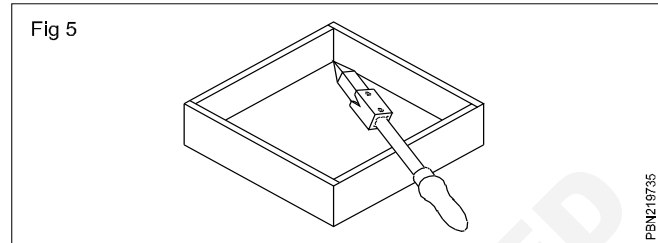
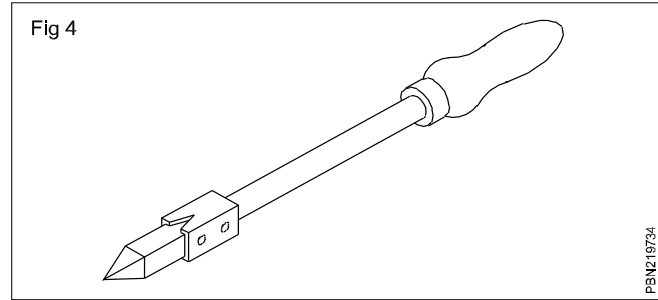
The other type standard workshop pattern soldering iron. (Figs 4, 5) the edge is shaped to an angle on four sides.

Solders are applied in the form of wires, sticks, ingots, rods, threads, tapes, formed sections, powder and pastes. (Fig 6)

Flux

Classes of flux: Flux can be classified into corrosive flux, and non-corrosive flux.

Corrosive flux in acid form washed immediately after the soldering operation.



Non-corrosive flux is in the form of lump, powder, paste or liquid.

Different types of fluxes

Hydrochloric acid: Concentrated hydrochloric acid is a liquid which fumes when it comes into contact with air. After mixing with water, 2 or 3 times the quantity of the acid, it is used as dilute hydrochloric acid.

Hydrochloric acid combines with zinc forming zinc chloride and acts as a flux. used as a flux for zinc, iron or galvanised sheets.

Zinc chloride: It is mainly used for soldering copper sheets, brass sheets and tin plates.

Functions of flux

- Flux removes oxides from the soldering surface.
- It prevents corrosion.
- It helps molten solder to flow easily in the required place.
- It promotes the better joint.

Selection of flux

The following criteria are important for selecting a flux.

- Working temperature of the solder
- Soldering process
- Materials to be joined.

Resin: It is not highly corrosive, it is used as flux for copper and brass. Resin melts at about 80° to 100°C.

Paste: This is a mixture of zinc chloride, resin, glycerin and others and is available as a paste.

It is effective for removing oxidation coating, it is used for soldering small handworks and radio wiring.

Ammonium chloride: This is in the form of powder or lump. It evaporates when heated.

Ammonium chloride, dissolved in water, is used as a flux for soldering steel.

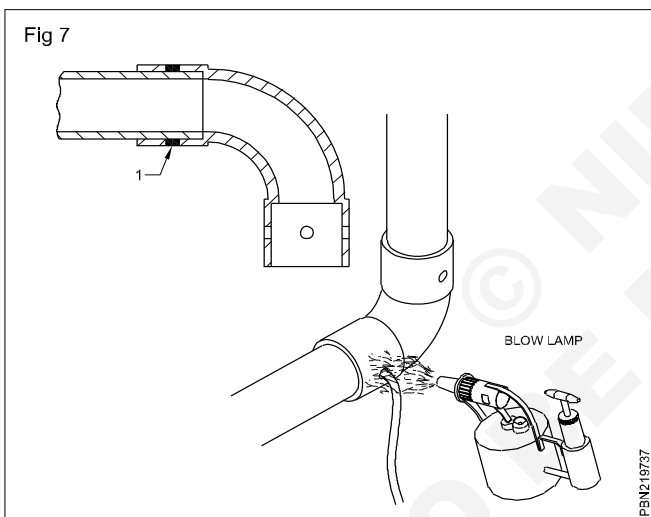
Joints

There are two main types of joints which are used for connecting copper pipes, namely:

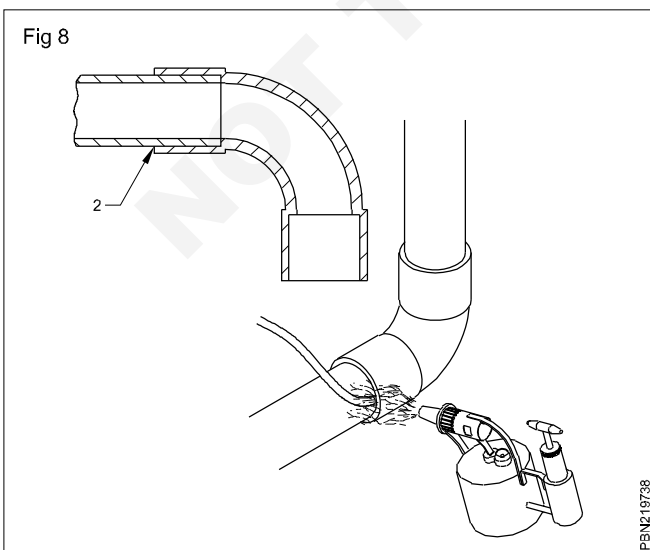
- soft solder capillary joints
- compression joints/flaring joints

There are three different types of soft solder capillary fittings which can be soft soldered in the following ways:

- 1 Solder wire is applied through the touch holes in the fitting. (Fig 7)



- 2 Solder is applied at the mouth of the fitting. (Fig 8)



- 3 A solder is already in the fitting. (Fig 9)

Capillary fittings are so designed that the pipe slides into the fitting forming a double wall of additional strength at the joint.

There are two different joints for which only brass or bronze fittings should be used:

- Flaring joints
- Compression joints

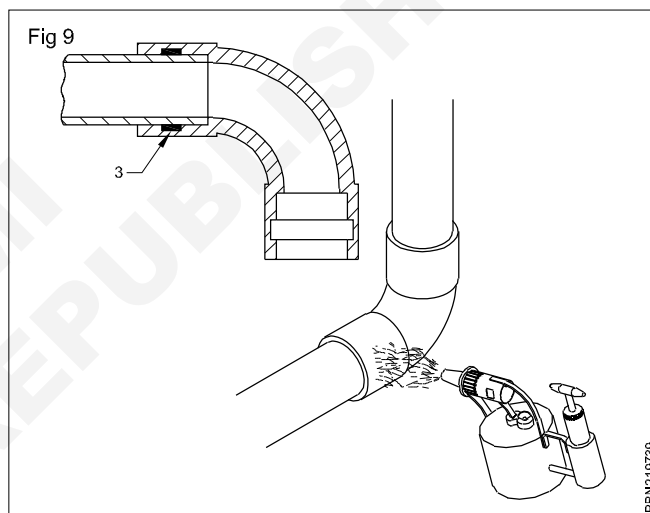
Socket coupling (Figs 8 & 9)

A copper or bronze fitting that is used to connect two pipes. This fitting can be connected using the following methods:

- 1 Soldering
- 2 Flaring or compression

Select solder

For potable water systems, lead-free solid core solder



Description of Plumber's materials lead, tin, zinc, solder, copper red lead etc., and their uses

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

- state the nonferrous metals its uses
- state the properties of metals
- state the alloy of metals and its uses.

Copper: It is one of the important non-ferrous metal today. Copper is a better conductor of heat than steel.

Copper alloys: Copper alloys contain either two or three components. The alloying components are zinc, tin, nickel, aluminium and iron.

Brass: These alloys contains copper and zinc. This metals are used for making water tap, valve etc.

Tin: The most important mineral is tin-stone (SnO₂) alloys varying percentage of tin+copper+lead.

Lead: The commonly used metals and the softest of the heavy metal. Lead is poisonous and should not be brought in to contact with food. Pure lead is used for roof coating lead plumbing as an alloying metal. Molten lead is used for lead caulking in cast iron pipe. Sometime this metal converted in lead wool, waste water pipe vertical joint formed with lead wool.

Gunmetal: This metals consists of copper and tin. This metals are alloy metal commonly used for making vessels, especially in making valves

Zinc and alloys: Zinc is commonly used for coating a steel to prevent corrosion. Examples are steel buckets, galvanized, roofing sheet etc.

Aluminium: Aluminium is a non-ferrous metal which is extracted from "BAUXITE". Aluminium is white or whitish grey in colour. Aluminium has high electrical and thermal conductivity. It is soft and ductile and has low tensile strength.

Metals	Melting point
Copper	1083°C
Brass	983°C
Bronze	1005°C
Lead	327°C
Zinc	420°C
Tin	231°C
Aluminium	660°C

Water supply systems of a small town

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

- list the sources of water for a water supply system
- list the various steps in treatment of water
- list and explain the system of distribution and water supply lines.

There are two systems of water supply.

- 1 Continuous
- 2 Intermittent

In the continuous supply system, water is available to consumers through out the days. In the intermittent supply system, water is supplied during fixed hours and for the remaining period the supply is shut off.

Intermittent supply has many disadvantages

- 1 Water has to be stored for nonsupply hours

- 2 Water will not be available for fire extinguishing if fire breaks out during non supply hours.
- 3 The size of the pipes are required to be larger.
- 4 There is chance of wastage of water as the taps may be left open during non-supply hours.

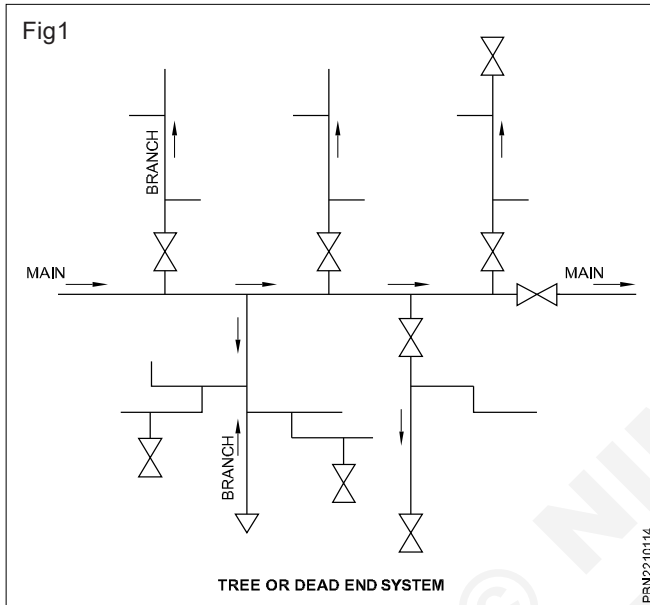
The only advantage is that water can be supplied to high level areas also with adequate pressure as different areas of the town may be supplied with water in different hours.

However, in India generally intermittent supply system is followed.

The water supply distribution systems are laid in the following forms.

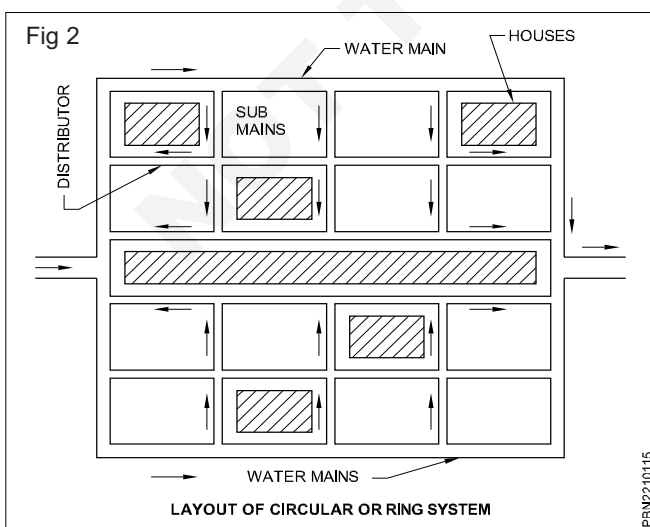
- 1 Tree or dead end system
- 2 Circle or ring system
- 3 Grid iron system
- 4 Radial system

Tree or dead end system: In this system the main line is laid along the main road. Branch lines are taken in many places along the road and there are many dead ends in the system. (Fig 1)



This system is suitable for towns growing irregularly. The dead ends cause stagnation of water. This system requires less number of valves and design of pipe sizes is easy.

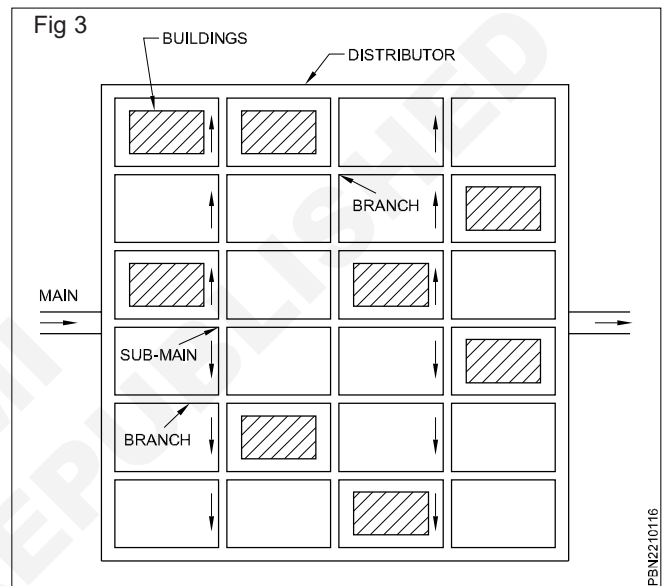
Circle or ring system: Each locality of a town is divided into square or circular blocks and water lines are laid around the circumference of the square or circle. The branches, sub mains are laid along the inner roads. (Fig 2)



At the sub main and branches are interconnected end cross point gets supply from two directions.

This system is suitable for towns having well planned roads. This system involves many valves and more pipe length but the design of pipe is easier.

Grid iron system: In this system water mains and branches are laid in rectangles (Fig 3). The lines are so interconnected so that in case of repair at any point, the water is available from other direction. There are no dead ends and water is kept in good circulation. In case of fire, water is available from all directions. This system involves large number of valves and exact design of pipes is difficult. It is the most widely used system and is best suited for planned cities with road of rectangular pattern.



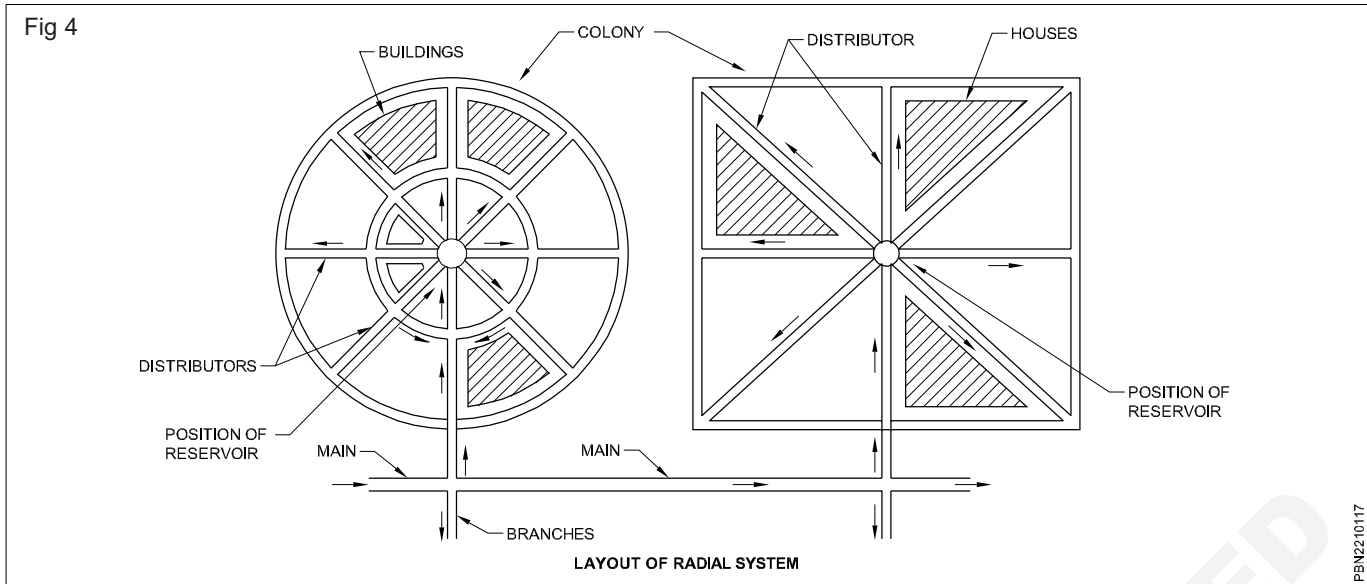
Radial system: In this system the supply lines are laid radially from the middle (Fig 4). It gives quick service. This system is suitable for towns with a radial layout. The design of pipe sizes is also easy.

Contamination of water: The water may contain organic and inorganic impurities in the form of suspended and dissolved states. Harmful living organisms like bacteria may also be present. Therefore the water is to be treated according to the use for which it is supplied.

The raw water is treated in a number of ways. The water for drinking purposes is treated in the various steps listed below.

- 1 Screening
- 2 Plain sedimentation
- 3 Sedimentation with coagulation
- 4 Filtration
- 5 Aeration and chemical treatment
- 6 Disinfection

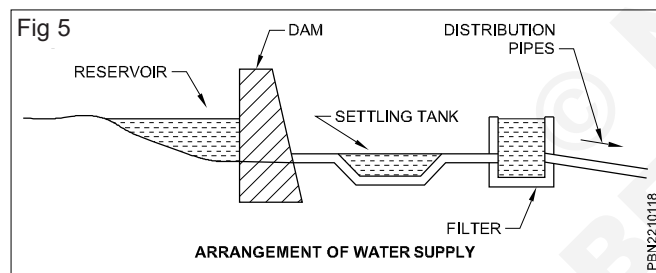
All the above steps may not be necessary and different treatments are given depending upon quality of water taken from different sources.



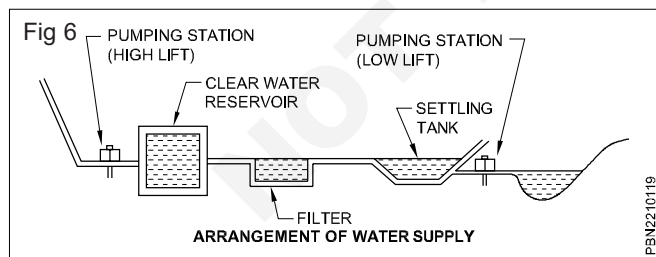
Then the treated water is supplied to the consumers using the following system of distribution.

- 1 Gravity system
- 2 Pumping system
- 3 Dual system

Gravity system: In this system the source of supply is at higher level than the town. The water flows in the main due to gravity. (Fig 5). In this method no pumping is required.



Pumping system: In this system, the water is pumped direct to mains from the treatment plant. Because of direct pumping, required pressure is maintained in this system. (Fig 6).



Dual system: This system is also known as combined gravity and pumping system. In this system, the pump is connected to the main as well as to an elevated tank. This system is more economical and reliable. The water from the source is carried to the treatment plants through open earthen channels, masonry or concrete chambers, cast iron/steel/galvanized iron/concrete/R.C.C./PVC pipes.

In India, the water distribution lines generally laid with cast iron pipes for street mains and G.I pipes, PVC pipes are used for the building connections. The connection between the service pipes and street mains is through ferrules. Ferrules are made of brass or copper.

Treatment of Water

Type of treatment process will depend on the quality of raw water and standard of water quality required after treatment.

The following treatment processes are used for removing various types of impurities.

A well-equipped laboratory is required at the treatment plant to test the raw water and also the treated water. The treatment process can be decided depending on the nature of impurities.

Description and types of pumps viz, suction pump, centrifugal pump etc.,

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

- describe necessity of pumps
- explain types of pumps
- state classification of pumps.

Pump is a device used for pumping

It is also necessary when its require to increase the pressure in pipe lines.

Purpose of pumps

To lift the raw water from the source of supply, such as lake, reservoir, river or well.

To lift the treated water to overhead tanks or reservoir.

To deliver treated water to the consumer's taps at reasonable pressure.

To boost the line pressure.

To supply water under pressure for fire hydrants.

For miscellaneous operations at the water treatment plants, such as (i) for back washing of filters ii) for pumping chemicals and (iii) for dewatering of tanks, basins, sumps, etc.

Types of pumps and their choice

Pumps can be classified on the basis of the following

- i Mechanical principle of operation,
- ii Type of power required, and
- iii Type of service called for.

a Classification based on mechanical principle of operation

Based on the principle of operation, pumps can be broadly classified into the following four types

- i Displacement pumps
- ii Centrifugal pumps
- iii Air lift pumps
- iv Miscellaneous pumps.

b Classification based on type of power required:

- i Steam engine pumps
- ii Diesel engine pumps
- iii Electricity driven pumps

c Classification based on the type of service called for:

- i Low lift pumps
- ii High lift pumps
- iii Deep well pumps
- iv Booster pumps

The selection of a particular type of pump depends upon the following factors:

- i Capacity of the pump.
- ii Number of pump units required.
- iii Suction conditions.
- iv Lift (Total head)
- v Discharge conditions, and variations in the load.
- vi Floor space requirement.
- vii Flexibility of operation.
- viii Starting and priming characteristics.
- ix Type of drive required.
- x Initial cost and running costs.

Displacement pumps

Displacement pumps are further classified into two types

- 1 Reciprocating type pump
- 2 Rotary type pump

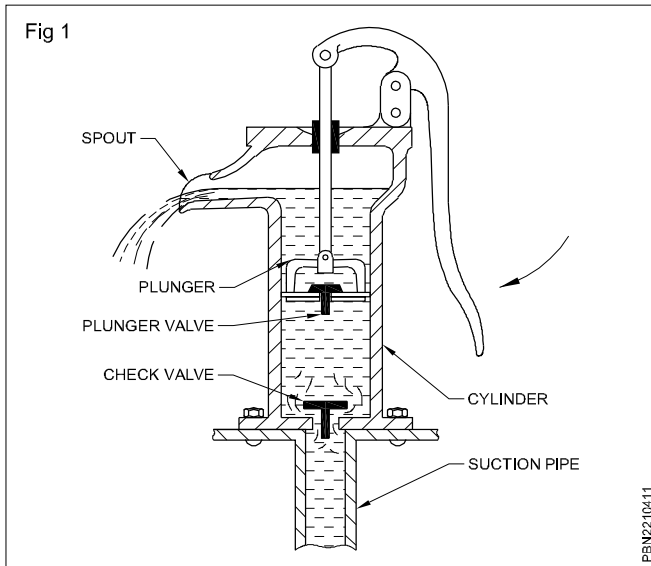
Reciprocating pump: In this type of pump a piston or a plunger, alternately draws water into a cylinder on the intake stroke and forces the water out in the discharge stroke. The back flow of the water is prevented by means of suitable valve.

Reciprocating pumps are of the following types.

- 1 Simple hand-operated reciprocating pump
- 2 Power-operated deep well reciprocating pump
- 3 Single-acting reciprocating pump
- 4 Double-acting reciprocating pump.

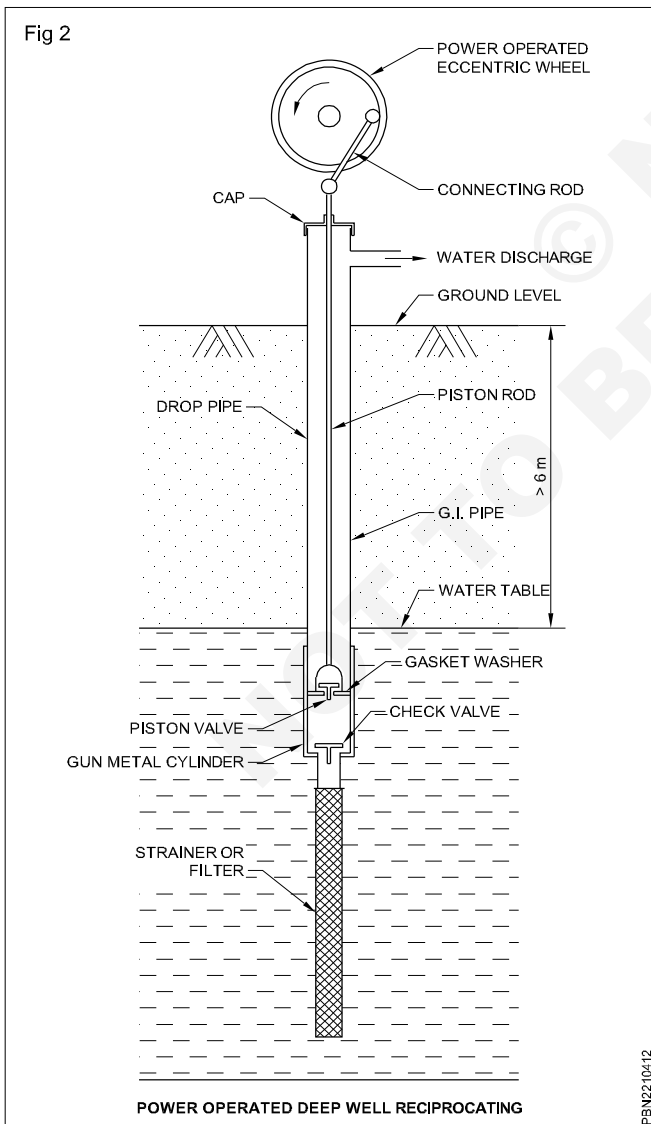
Simple hand operated reciprocating pump: This pump is the cheapest type of pump and it is widely used in the towns and villages in India where water table is about 6.00m from ground level. (Fig 1) In this pump, the piston or plunger moves up and down by means of handle. (Fig 1)

Hand pump operates on this principle. When the piston is raised up, vacuum gets created in the cylinder below the piston, the check valve opens and the water enters in the cylinder. When the piston is lowered, check valve automatically closes, and plunger valve opens and the water enters in the space above the piston. In this way with each downward stroke the water enters above the piston and with each upward stroke the water moves up and starts flowing through the spout fixed for this purpose.



Power operated deep well reciprocating pump: This pump is different from the hand operated pump in the following ways.

- 1 The piston is kept below the water level
- 2 It is power operated instead of hand operated
- 3 No suction pipe is provided (Fig 2) separately.

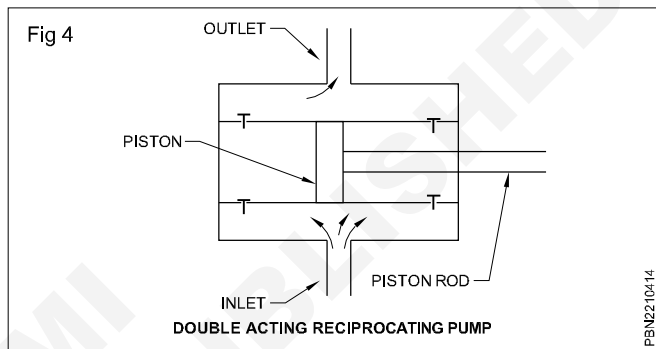


Single acting reciprocating pump: In this pump, a piston moves inside a cylinder with the help of piston rod operated by a wheel through a connecting rod. (Fig 3) There is one suction and one delivery pipe in the cylinder. When the piston moves outwards, vacuum is created, the suction valve open, and delivery pipe is closed. The water enters through the delivery pipe.

When the piston moves downwards, it forces the water in one cylinder to outward through the delivery pipe. Thus water is lifted up but the flow is not continuous. The supply is intermittent only.

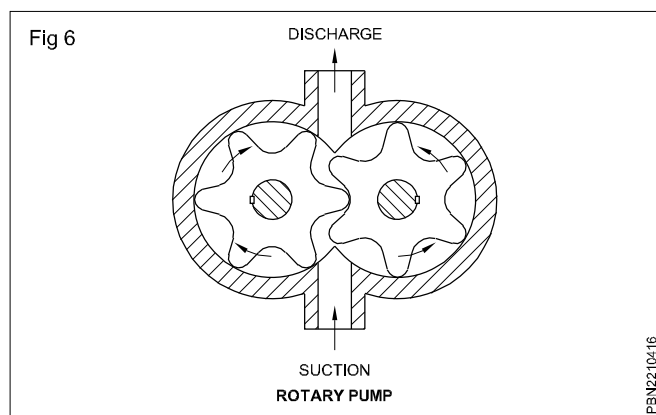
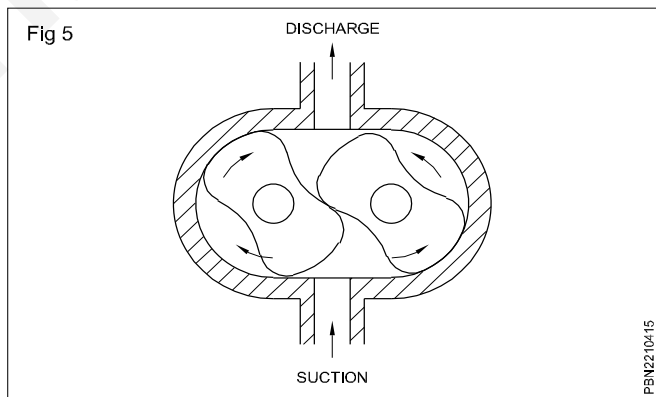
Double-acting reciprocating pump

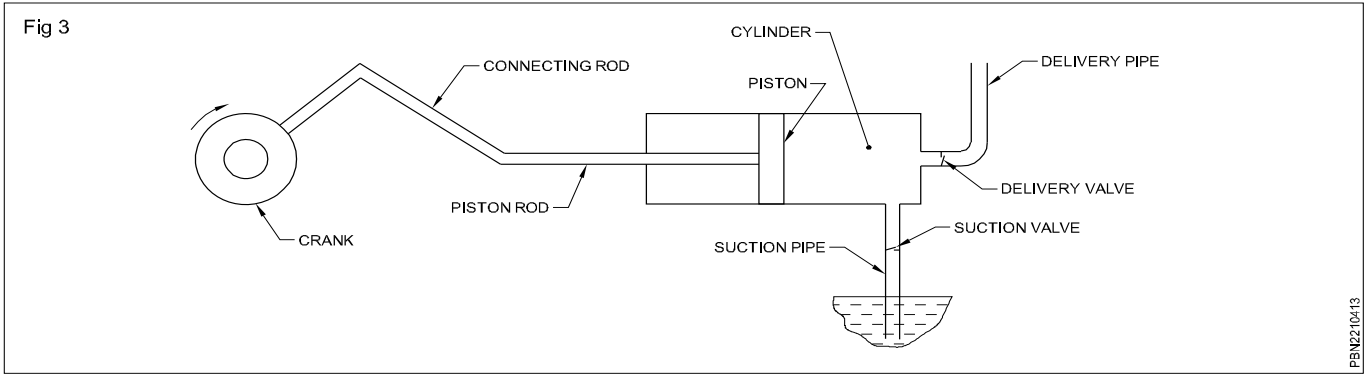
In this pump two suction and two delivery valves are provided in the same cylinder and the water is delivered in every stroke and flow is continuous. (Fig 4).



Rotary pump

This pump has two rotating pistons or gears. It draws water into the chamber and force it continuously into the discharge pipe. It has no valves and hence is easy to maintain. (Fig 5 & 6).

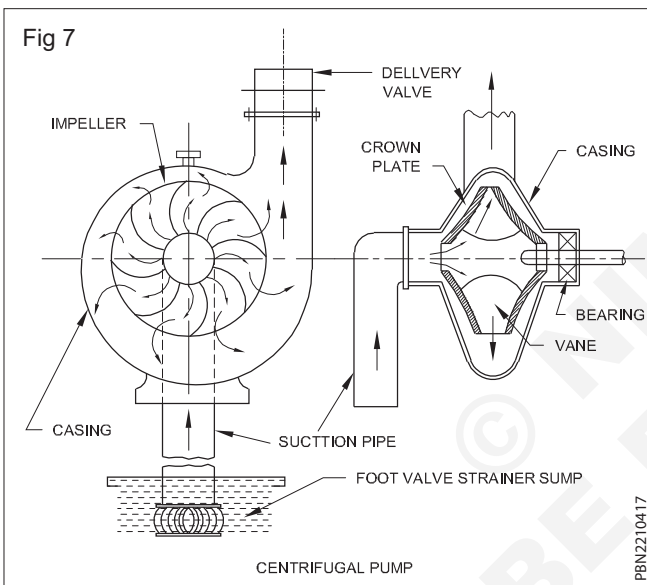




This pump is small sized and suitable for small discharges and moderate heads.

Centrifugal pumps

These pumps work on the principle of centrifugal force and are called centrifugal pump. Water is forced up in the delivery pipe due to the centrifugal force produced (Fig 7).



Centrifugal pumps cannot be started unless it is initially full of water and it require priming.

Components of centrifugal pump

The main components of a centrifugal pump are

- 1 Impeller
- 2 Casing
- 3 Suction pipe
- 4 Delivery pipe
- 5 Delivery valve and
- 6 A prime mover.

The arrangement of these components is shown in Fig 1.

Impeller

Impeller is a rotor, provided with a series of curved vanes or blades. It is mounted on a shaft. This shaft is rotated by a prime mover (such as an electric motor or oil engine)

Casing

The casing surrounds the impeller. It is an air-tight and water-tight casing. The casing is designed with a gradually increasing area. Hence when water flows through the casing, the kinetic energy of water is converted into pressure energy before the water leaves the casing.

Suction pipe

The upper end of the suction pipe is connected to the inlet of the pump. The lower end is submerged into a suction well or sump from which water is to be pumped. The lower end of the suction pipe is fitted with a foot valve and strainer.

Delivery pipe

A delivery valve is provided in the delivery pipe just near the outlet of the pump. It is provided to control (to regulate) the flow from the pump into the delivery pipe.

Working of centrifugal pump

The first step in the operation of a centrifugal pump is priming. Priming is the operation of filling up water in the suction pipe. It is done to remove the air present inside. If any air is present, the pressure developed across the impeller will not be sufficient to suck water from the sump.

When the water is forced away from the centre of the impeller by the centrifugal action partial vacuum is created at the centre of the impeller known as eye. Due to this, water from the sump enters into the eye of the impeller through the suction pipe. Thus water enters and leaves the impeller continuously to maintain a continuous discharge to the required height. The suction head is generally limited to 7.90 m of water to avoid separation or cavitation.

Applications

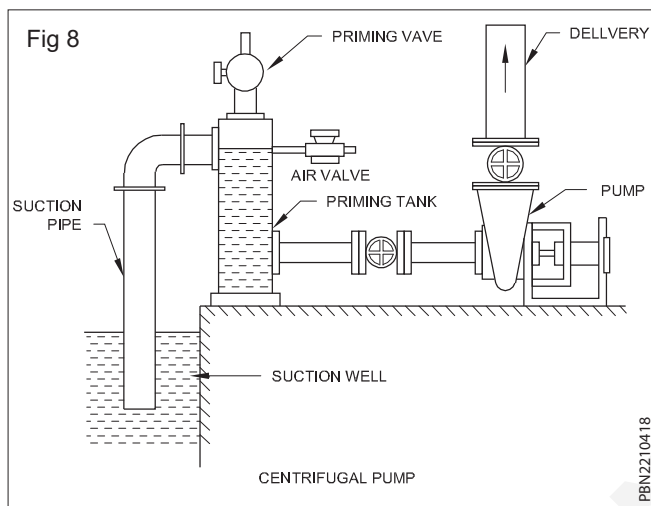
Centrifugal pump is most commonly used in

- 1 Water works,
- 2 Sewage works,
- 3 Irrigation
- 4 Water pressure schemes,
- 5 Drainage,
- 6 Oil refineries etc.

Foot valve and strainer (Fig 7)

The lower end of the suction pipe is fitted with a foot valve and strainer. Both are submerged in water in the sump. A foot valve at the bottom of the suction pipe permits a pump to be filled with water from another source during priming. Foot valve is a non-return valve in which flap swings up and out of the way when the water is flowing up the pipe. A strainer is fitted to the bottom of the suction pipe. It prevents floating rubbish such as leaves, sticks, etc. in the water from entering into the pump. Thus only a clean water can enter the suction pipe through the foot valve. If strainer is not present, these rubbish will pass through the pipe and choke it.

Priming (Fig 8)



Priming is a process of filling up water in the casing and suction pipe of a centrifugal pump for the removal of air before starting it. If any air is present inside the casing, discontinuity of flow may be caused. If the pump is started with air in the casing and suction pipe, there will be only a negligible pressure difference across the impeller. This will not be sufficient to create enough vacuum to suck the water into the casing from the sump and the pump will not work. Hence priming is very essential before starting the pump.

The pumps can be primed in several ways. They are

- 1 Manual priming
- 2 Priming by vacuum and
- 3 Self priming

In manual priming water is poured through the priming cock by a funnel and the air vent in the casing is opened. When all the air has been displaced from the suction-pipe and casing, the cock is then closed and the pump can be started.

In large pumps, priming is done by evacuating the casing and suction pipe with the aid of an air pump or ejector. Thus the water is drawn into the suction pipe from the sump. This is called priming by vacuum.

In self priming the priming is done automatically by having a special reservoir containing water between suction line and pump. Self priming devices are used with big size pump only as it requires large expenses.

Advantages and disadvantages of centrifugal pumps

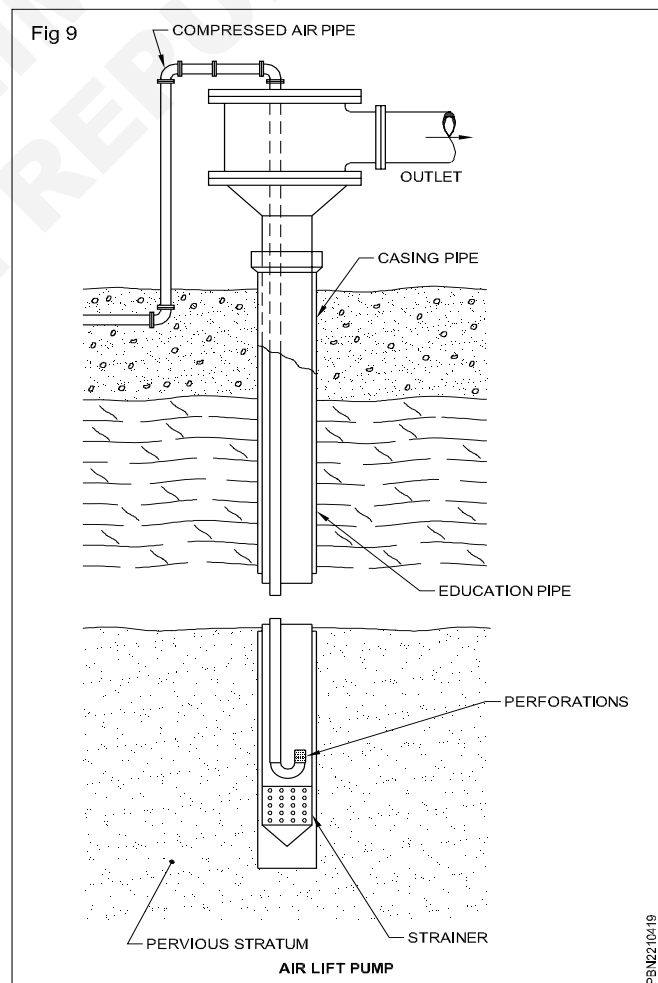
The centrifugal pump has the following advantages:

- 1 Due to compact design, they require very small space.
- 2 They can be fixed to high-speed driving mechanism.
- 3 They have rotary motion due to which there is no noise.
- 4 They are cheap in cost.
- 5 They have simple mechanisms due to which they can be easily repaired.
- 6 They have very simple operation.
- 7 They cannot be damaged due to high pressure.

The following are the disadvantages of centrifugal pumps:

- 1 The rate of flow of water cannot be regulated.
- 2 They cannot be operated without prime movers.
- 3 Their speed cannot always be adjusted to the prime mover without speed regulating mechanism.
- 4 For operation they have restricted suction.
- 5 Any air leakage on suction side will affect the efficiency of the pump.
- 6 They have high efficiency only for low head and discharge.

Air lift pump (Fig 9)



This pump is installed to draw more water from the deep well than any other type of pump. The pump is operated by compressed air and it can lift water from a depth of 150m.

The principle used in this pump is that by mixing water with air in the discharge the density of mixture is less than that of the water itself. As such the pressure of the column of air and water in the bottom of delivery pipe is less than that

of the solid water outside in the well and an upward flow is created.

The pipe is lowered into the water and the compressed air is passed through a rubber tube. The compressor is operated by a small motor. The air pipe is 1/5 to 2/7 of the delivery tube in cross section. A stop valve is provided at the main supply pipe.

Installation of India mark III pump

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

- state the installation of India mark III pump.

Basic features

The India Mark III hand pump can be used in deep-well conditions upto 50 mtrs. The India Mark III hand pump (IS : 13056) is identical in design to the India Mark II deep-well hand pump (IS : 9301) except the open top cylinder, 2 1/2" (65 mm) riser pipe and water tank holder to suit the 65 mm riser pipe (refer to the adjacent figure for sectional details). The India Mark III hand pump has the following lead features.

Pump head

- The pump head is provided with a centre hole of 75 mm dia on the bottom flange.
- The handle assembly has a 70 mm dia bearing housing.
- An additional 6 mm plate welded with guide bush is provided separately.
- Stroke length of 125 is provided.

Water Tank

- Water tank assembly is fitted with 65 mm NB coupling to suit the 65 mm NB GI riser pipe.
- Water tank height has been increased by 25 mm to offer more storage and prevent overflow due to an increased stroke.
- Pedestal height has been reduced by 50 mm to a more convenient pump height for the user.

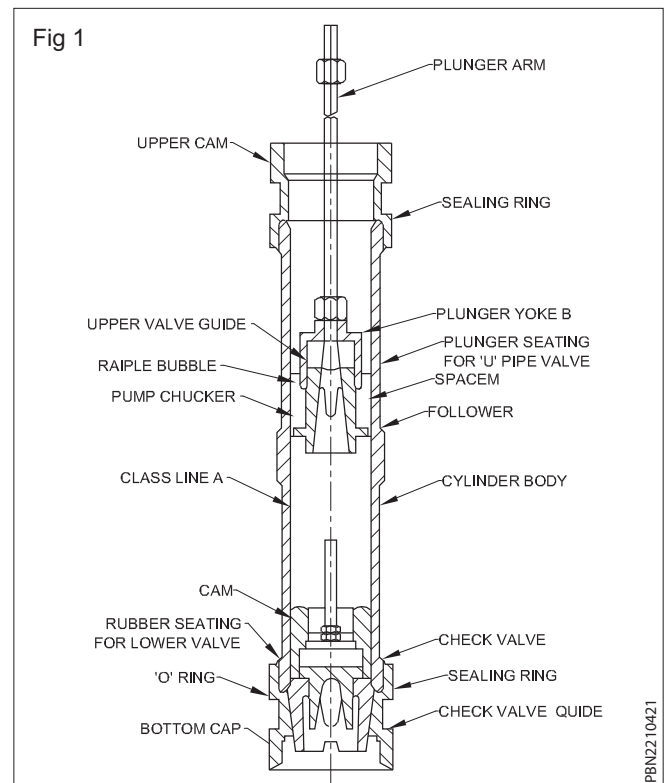
Cylinder

- 65 mm ID cast iron open top cylinder with brass liner is fitted with a bottom end cap to suit check valve and top end cap to facilitate extraction of plunger and check valve assemblies for repairs without lifting the riser main.
- Nitrile rubber washers are provided in place of leather in the piston assembly.
- The cylinder assembly has a top cylinder cap to suit 65 mm NB medium class riser pipe, and the bottom cylinder cap has a conical housing to receive and pick up the check valve. The top end cap is threaded to suit 65 mm NB threads while the lower end cap has 50 mm NB threads for use of short filters. No pipe is required to be installed below the cylinder.

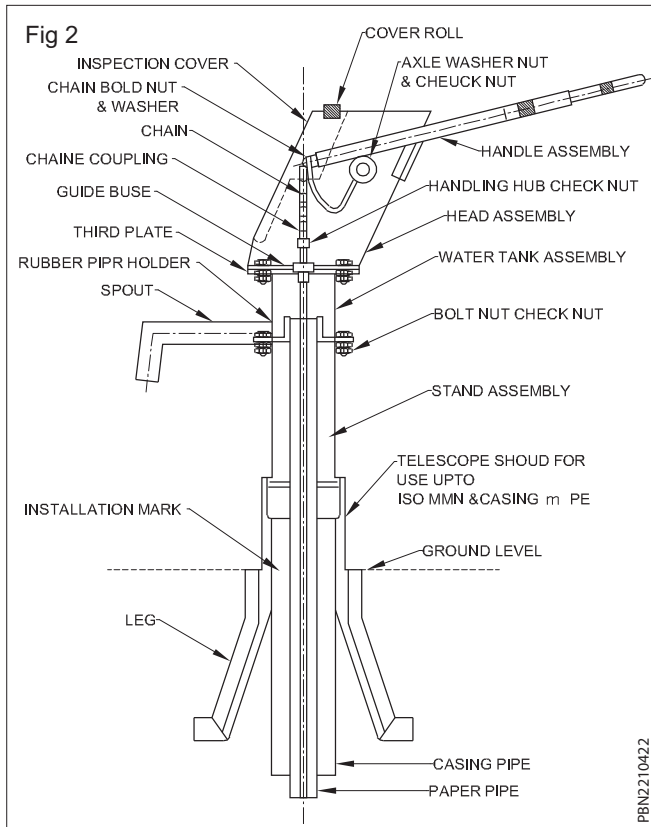
- The cylinder height is increased to 355 mm as against 304 mm for the India Mark II hand pump.
- Upper guide valve and check valve are two piece valves.
- Special design for conical housing and pickup check valve design.
- The spacer is modified with collar to centralise the nitrile bucket washer.

By providing an open cylinder, the connecting rods and plunger assembly with cup washers can be pulled out without removing the riser pipes. This enables easy repair and maintenance work at the village level. Further, by providing an additional plate on the pump head, the complete pump head assembly with the handle can be easily removed and fixed. This also makes maintenance simpler. Even a village mechanic with some skills can repair this pump with simple tools, whereas in other hand pumps, special tools and more trained mechanics are required to carry out maintenance and repair activities.

Sectional details of Cylinder Assembly (Fig 1)



Sectional details of Pump Head Assembly (Fig 2)



Installation of mono block pump

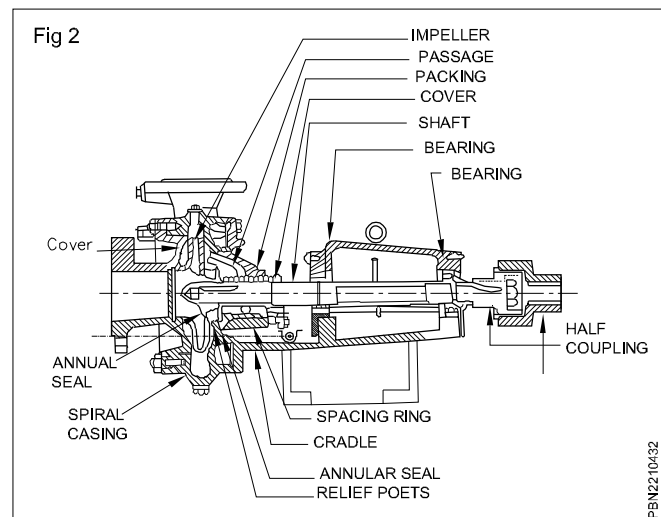
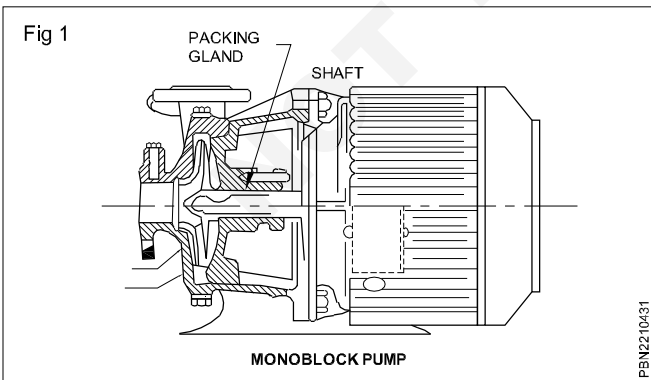
Objectives: At the end of this lesson you shall be able to

- state mono-block pump.

Mono-block pump (Fig 1 & 2)

These pump are very popular these days, because these are economical. In these pumps the impeller is attached directly to the shaft of the flange-mounted motor. This obviates the need for pump bearing and coupling, decreases dimensions and weight. The wheel of this pump is not upload, because there are no parts in the hub or second sealing ring. There fore simple packing gland without a water seal are used in these pumps.

The spiral casing is cast integral with intel and delivery pipes. The mono block pumps are manufactured both with horizontal and vertical arrangement of shafts.



Submersible pump

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

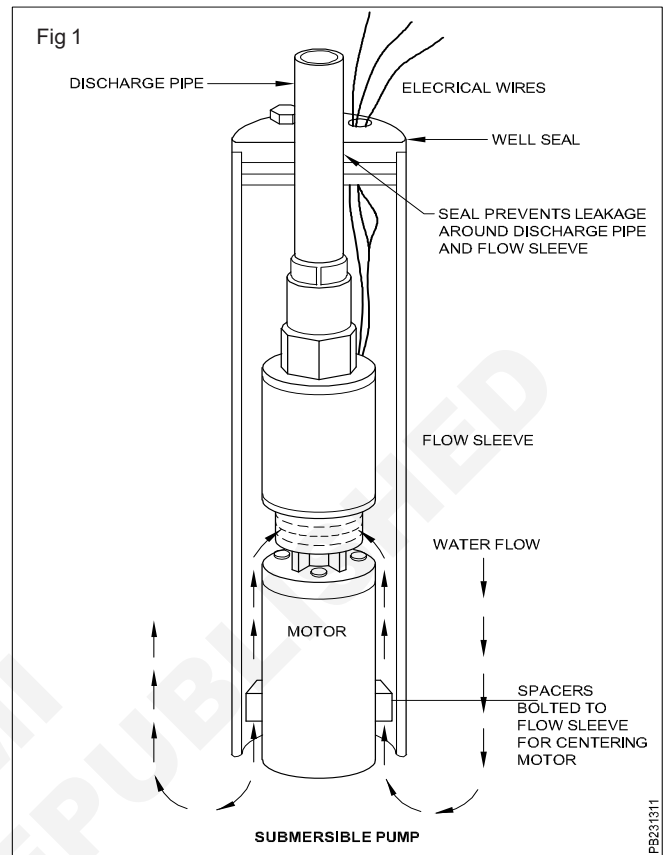
- state submersible pump.

Submersible pump

This pump is designed for delivering water from deep wells or shafts and is also known as well pump. The boreholes are made for diameters from 10 to 35cm and the usual length of the pump varies from 20 to 60 cm. The bore of the pump should be truly vertical.

The bore hole pump is lowered in the main tube well pipe itself. The motor drives should be kept at sufficiently low level so that they remain submerged below water under working conditions. The pump is electrically driven.

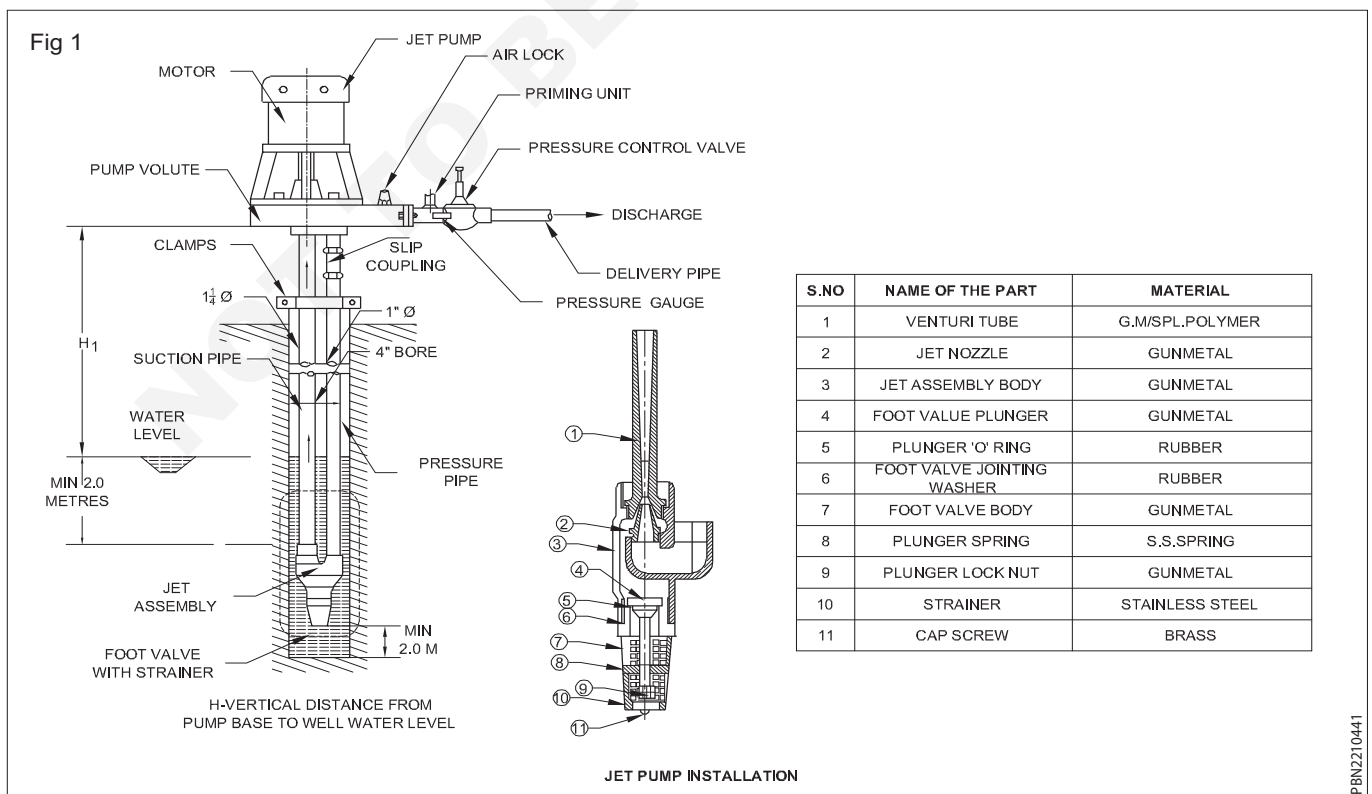
The installation and running cost of the bore-hole pump is higher than an ordinary pump.



Jet pumps

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

- state the jet pumps.



Jet pumps (Fig 1): Jet centrifugal pumps find extensive use in individual domestic tube wells, and are very suitable for lifting water in ordinary three stored houses in areas where water table level is within about 30 m or so from the ground surface. Single stage jet pumps are designed for lifting water with suction lift of the order of 9 to 36m ; while the twin stage jet pumps are designed for suction lift of the order of 24 to 54 m.

Such pumps are compact machines, like monoblock centrifugal pumps and are placed at the ground level. The bore using a jet pump shall, however, accommodate two pipes; i.e., (i) the normal suction pipe; and (ii) a pressure pipe connected to the delivery side of the pump at one end, and to the suction pipe through the jet assembly at the other end near the foot valve inside the bore.

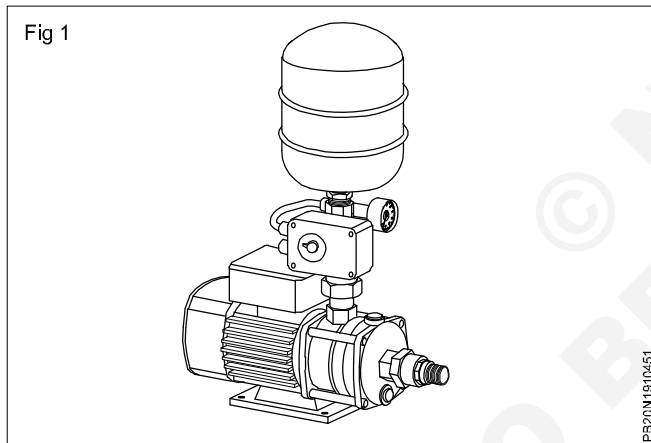
Installation of booster pump

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

- state the booster pump
- state the installation of booster pump
- explain the booster pump assembly
- state the piping of booster pump
- explain the suction lift to the booster pump.

The Water Pressure Booster System is the first booster pump of its kind to be designed for virtually all residential and small commercial boosting applications.

In Pressure Mode, the pump starts with pressure drop and stops on low flow. In Flow Mode, the pump starts and stops by sensing flow. In Conservation Mode, the pump only operates at peak demand, such as multiple showers, bath tubs, dor irrigation systems running. (Fig 1)



A single-speed, totally enclosed fan-cooled motor drives the booster pump with single phase power. It is controlled with one dial, and tells you it is working properly by illuminating a single status light.

Before installation, read the following instructions carefully. Each Dura MAC™ pump is individually factory tested to insure proper performance. Closely following these instructions will eliminate potential operating problems, assuring years of trouble-free service.

***See table on Page 3 for maximum incoming pressure.**

Pump Boost	Amps	Voltage	Power	*Maximum incoming pressure
35 psi	5.5	120 - 60 Hz	½ HP	45 psi
52 psi	7.0	120 - 60 Hz	¾ HP	28 psi
70 psi	4.0	230 - 60 Hz	1 HP	10 psi (For use with holding tank)

Grounding and electrical installation

The pump and control is supplied with a 3-conductor grounding cord. Connect the control only to a properly grounded, dedicated GFCI protected circuit. Do not lift the pump by the electrical cord.

Follow local and national plumbing, building and electrical codes when installing the pump.

Maintain this pump in compliance with the National Electrical Code (NEC) or the Canadian Electrical Code (CEC) and with all local codes and ordinances that apply. Consult your local building inspector for local code information.

Use copper conductors only, and be certain wire and fuses of the correct size are installed.

Do not ground to gas or fuel lines

Installation & location

The pump should be installed in a dry, accessible area protected from freezing temperatures. Proper ventilation must be provided for proper cooling of the electrical equipment.

Follow local plumbing codes. In some cases a dual check valve, reduced pressure zone device, or other equipment may be required.

If your new boosted pressure is greater than 80 psi*, you must install a pressure reducing valve before your pump. Consult local plumbing codes and pressure ratings on your water appliances.

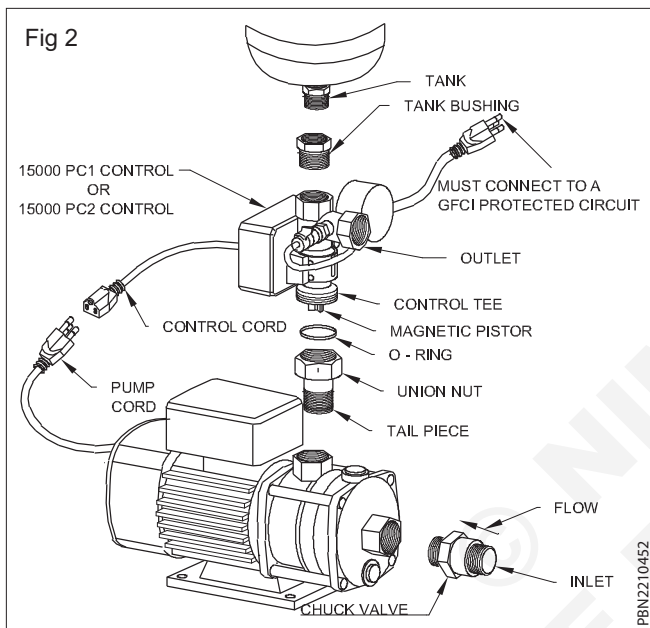
Do not spray water on or near the electric motor or control.

Pump only water with this pump. Do not pump flammable liquids or chemicals. Do not use the pump near gas pilot lights or where chemical or gas fumes are present.

Use of an electric pump with liquids other than water or in an atmosphere containing chemical or gas fumes may ignite those liquids or gases and cause injury or death due to an explosion and/or fire.

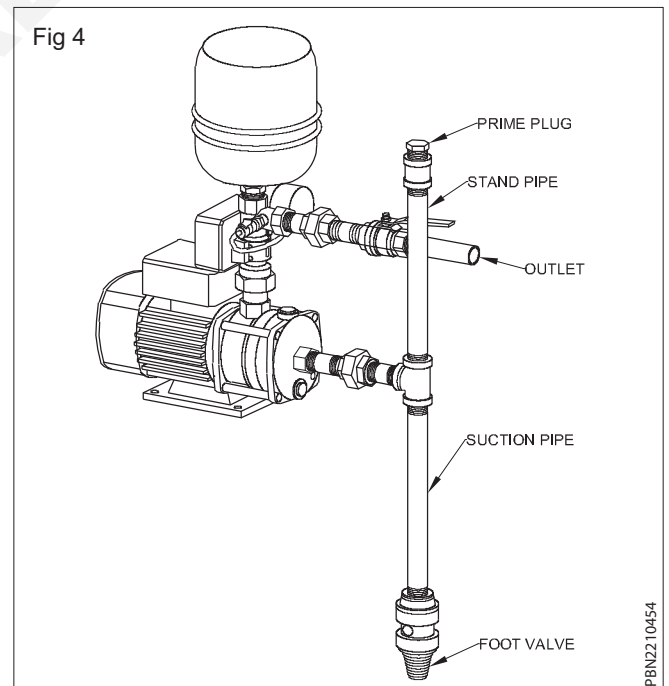
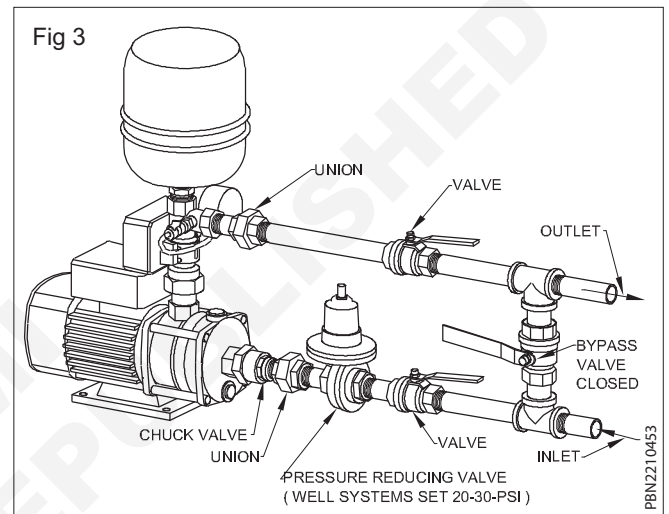
Always install near a floor drain where leakage will not cause damage to homes or property.

- 1 Apply pipe sealant on male threads of check valve. Thread into inlet of pump. DO NOT apply any pipe sealant on pump threads. Excessive pipe sealant or Teflon tape may foul check valves. (Fig 2)



- 2 Make sure arrow on check valve is in the direction of flow. Push inside the check valve to make sure poppet can move. If the check valve is installed in the wrong direction water will not get into the pump.
- 3 Apply pipe sealant on the male threads of tail piece. Install into outlet of pump. DO NOT apply any pipe sealant on pump threads.
- 4 Make sure the union nut is over the tail piece before threading into pump.
- 5 O-ring should be installed in groove on top of tail piece. Then tighten union nut to control tee.
- 6 Apply pipe sealant on male threads of tank bushing. Install into top of control.

- 7 Apply pipe sealant on tank threads and install into top of tank bushing. Only tighten with a wrench on the flats of the tank. The 2.1 Gallon tank included is required for this product to work properly. The air pressure of the tank must be set 2 psi less than the start pressure of the pump.
- 8 Plug the pump cable into the control cord. Do not plug the control into wall yet. Plugging in the control prior to making plumbing connections and priming the pump will cause the pump to run dry and void warranty.
- 9 Rotate control, so front panel and gauge are visible when installed.
- 10 Mount the pump base firmly, and follow piping instructions on next page. (Fig 3, 4)



Repairing of centrifugal pump

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

- state the failure of centrifugal pump
- state the reduced capacity of centrifugal pump.

S. No.	Trouble and Cause	Remedy
1	Failure to pump <ol style="list-style-type: none"> a Pump not properly primed b Suction lift too great c Speed too slow d Motor running in wrong direction 	<ol style="list-style-type: none"> a Be sure that pump case and suction line are full of water. See priming instructions. b Locate the pump closer c Check the voltage at motor terminals and at the meter when the pump is operating. Check for loose connections. If voltage is low, contact your power company. Be sure that wire size is adequate. d Check the wiring diagram on the motor name plate. If it is a 3-Phase motor, refer to the Wiring instructions.
2	Reduced Capacity and / or Head <ol style="list-style-type: none"> a Clogged impeller b Air pockets or leaks in suction line c Strainer too small or clogged d Insufficient submergence of suction pipe e Excessive suction lift f Excessively worn impeller 	<ol style="list-style-type: none"> a Remove and clean b Check the line for air leaks for excessive lift. c Check the end of the suction pipe of foot valve to see that it is not plugged or buried in mud or sediment. When installing in pond or lake, support the suction line so that it will be submerged in water, but not imbedded in mud or sediment. A strainer with greater screen area may be required. d Add sufficient pipe to keep the submerged end well below the water surface. e If caused by suction pipe friction, increase the size of the pipe; otherwise move the pump closer to the water level. f Order replacement parts. See repair list.
3	Pump Losses Prime <ol style="list-style-type: none"> a. Air leaks in suction line. b. Excessive suction lift and operating too near shut-off point c. Water level drops while pumping, exposing suction pipe or strainer 	<ol style="list-style-type: none"> a. Check suction piping. Piping might have frozen, causing it to split. b. Move the pump closer to the water level. c. Check the water supply. Add a length of pipe to the suction line to keep the submerged end under water.
4	Motor will not start <ol style="list-style-type: none"> a. Blown fuses b. No electric current at motor c. Motor hums but will not start d. Motor damaged by lightning or voltage surge. 	<ol style="list-style-type: none"> a. Replace with new fuses. b. The power supply may be off, the connections may be loose or incorrect, or the wire may have been chewed by rodents. c. Turn power off. Check the rotating element of the pump to see that it turns freely. d. Take the motor to any authorized motor repair shop.

Repairing of India mark III pump

Objective: At the end of the lesson you shall be able to

- state the defects causes remedies.

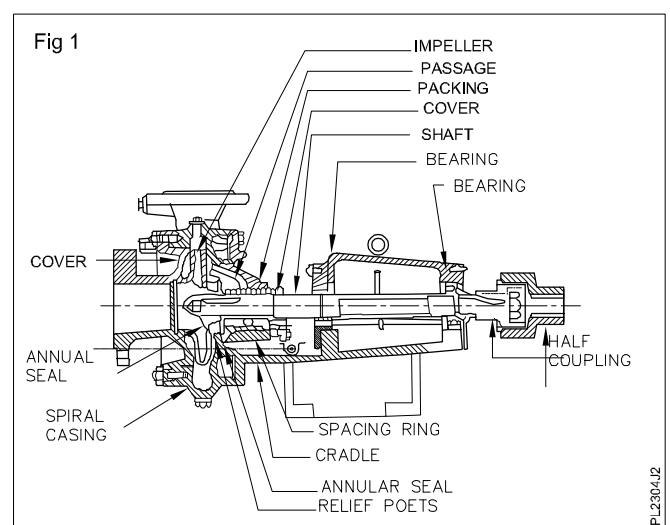
S. No.	Trouble	Cause	Remedy
1	Pump handle works easily but no flow of water	<ul style="list-style-type: none"> • Worn out cylinder rubber cup washers • Valve seats worn out. • Connecting rod joint disconnected • Broken Chain 	<ul style="list-style-type: none"> • Replace rubber cup washers. • Replace valve seats. • Pull out connecting rods and join connecting rods wherever necessary. • Replace chain
2	Delayed flow or little flow of water	<ul style="list-style-type: none"> • Leakage in cylinder, check valve or upper valve • Worn out O ring • Rubber cup washers worn out 	<ul style="list-style-type: none"> • Pull out plunger and check valve assemblies • Replace rubber seats • Replace O ring. • Replace rubber cup washers
3	Folding of chain during return stroke	<ul style="list-style-type: none"> • Rubber cup washers got jammed inside the cylinder 	<ul style="list-style-type: none"> • Replace rubber cup washers.
4	Noise during operation	<ul style="list-style-type: none"> • Bent connecting rod 	<ul style="list-style-type: none"> • Change defective rod.
5	Shaky Handle	<ul style="list-style-type: none"> • Loose handle axle nuts • Worn out ball bearings • Spacer worn out or damaged • Worn out / damaged axle 	<ul style="list-style-type: none"> • Tighten handle axle nuts • Replace ball bearings. • Replace spacer. • Replace axle.

Repairing of mono block pump

Objective: At the end of the lesson you shall be able to

- state the repairing of mono block pump.

- Check mono bloc pump is well installed fix 1.
- Water discharge is not up to required pressure check the pump and pipe line connections.
- Pump should be filled with water otherwise pump will run empty.
- Empty running creates the Airlock on the pump.
- Priming the pump through delivery line and removing airlock.
- Check the foot value for Blockage, Remove the Suction line and clean the strainer and foot value.
- Water not stops in the foot value check the puppet and spring.
- Clean the Dust and other foreign materials and realign the foot value with strainer.
- Worm out sorry or value seat replace with new foot value.



- Check the noise of pump and gland packing water comes through gland packing replace with new gland rope (or) Mechanical seal if Abnormal notice check the Bearing and replace.

Repairing of submergible pump

Objective: At the end of the lesson you shall be able to

- state the repairing of submergible pump.

S. No.	Problem	Cause	Corrective action
1	Your pump delivers little or no water discharge	<p>A. Water level in a low producing well drops to low while pump is operating, causing it to air lock. (Resulting in loss of prime and possibly serious damage to the pump).</p> <p>B. Intake screen is partially plugged.</p> <p>C. Check valve (s) may be stuck.</p> <p>D. Voltage is too low; the motor runs slowly, causing low discharge pressure (head) and high operating current draw.</p>	<p>A. Lower the pump further into the well, but make sure it is at least five feet from the bottom of the well. Install a control valve in the discharge pipe between the pump and pressure tank.</p> <p>Use the control valve to restrict the flow until the discharge rate does not exceed well recovery rate.</p> <p>Warning: To prevent the possibility of dangerously high pressure, install a relief valve in the discharge pipe between pump and flow restriction valve. Relief valve must be capable of passing full pump.</p> <p>B. Lime or other matter in the water may build up on screen. Pull pump and clean screen.</p> <p>C. Make sure that the built-in check valve in the pump and any check valves in the discharge line are free to open properly.</p> <p>D. Have a certified electrician verify voltage at the electrical disconnect box (2 wire) or control centre (3 wire) while the pump is operating. If the voltage is low, the power company may need to raise it or installation may require larger wire. Discuss this with the power company or a licensed electrician.</p>
2	Air or milky water discharge from your faucets	A Well water may be Pumping.	A. If your well is naturally gaseous and your system has a standard tank, remove the bleeder orifices and plug the tees. If the condition is serious, check with certified well professionals
3	Fuses blow or overload protector trips when the motor starts	<p>A. Fuses or wires are too small.</p> <p>B. Low or high voltage.</p> <p>C. Cable splices or motor windings grounded, shortened, or open.</p> <p>D. 3-wire only; Cable leads may be improperly connected in pump control box, pressure switch or fused disconnect switch.</p> <p>E. 3-wire only; There may be a broken wire in the pump control box.</p> <p>F. F. 3-wire only; Starting or running capacitor in control box may be defective or vented (blown out).</p>	<p>A. Replace with correct wire sizes (see table 1 on page 2)</p> <p>B. While motor is running, voltage should not exceed plus 5% or minus 5% or rated voltage shown on motor name plate. Call the electric power company to adjust line voltage if not within these limits.</p> <p>C. Consult certified electrician or service technician.</p> <p>D. Check wiring diagram on pump control box (also see fig 9 on page 9) and color coding of drop cable.</p> <p>E. Employ certified electrician examine all connections and wiring in control panel. If necessary, repair them.</p>

			<p>F. Inspect capacitors, Employ a certified electrician to check capacitors and replace them if necessary.</p> <p>Warning: Hazardous voltage, can shock, burn or cause death. Capacitors may still carry voltage charges even after being disconnected from wiring. Have them checked by a certified electrician.</p>
4	Fuses blow or overload protector trips when motor is running	<p>A. Low or high voltage.</p> <p>B. 3-wire only; High ambient (atmospheric) temperature.</p> <p>C. 3-wire only; Pump control box is wrong horsepower or voltage for installation.</p> <p>D. Wire size is too small. Improperly connected in the pump control box.</p> <p>A. E. Cable splices or motor windings may be grounded, shorted or open-circuited.</p>	<p>A While the motor is running, voltage should not exceed plus 5% of minus 5% of rated voltage shown on motor nameplate. Call your power company to adjust line voltage if it is not within these limits.</p> <p>B Make sure the pump control box is installed out of direct sunlight.</p> <p>C Compare horsepower and voltage rating of motor (from motor nameplate) with those of the pump control box (from pump control box nameplate). These numbers must match.</p> <p>D See table 1 on page 2 of this manual and make sure the wire sizes match specifications in the table.</p> <p>E Consult certified electrician or a service technician to determine if this is the cause of the problem or not.</p>

Repairing of jet pump (multi stage)

Objectives: At the end of the lesson you shall be able to

- state the defects and causes of jet pump
- state the remedial measures to correct the jet pump.

S. No.	Cause of trouble	How to check	How to correct
1	Leak on suction side of system	On shallow well units, install pressure gauge on suction side. On deep well systems, attach a pressure gauge to the pump. Close the discharge line valve. Then using a bicycle pump or air compressor apply about 30 psi pressure to the system. If the system will not hold this pressure when the compressor is shut off, there is a leak in the suction side.	Make sure above ground connections are tight. Repeat test if necessary, pull piping and repair leaks
2	Low well level	Check well depth against pump performance table to make sure pump and ejector are sized correctly.	If undersized, replace pump or ejector
3	Wrong pump-ejector combination	Check pump and ejector models against manufacture's performance tables	Replace ejector if wrong model is being used.

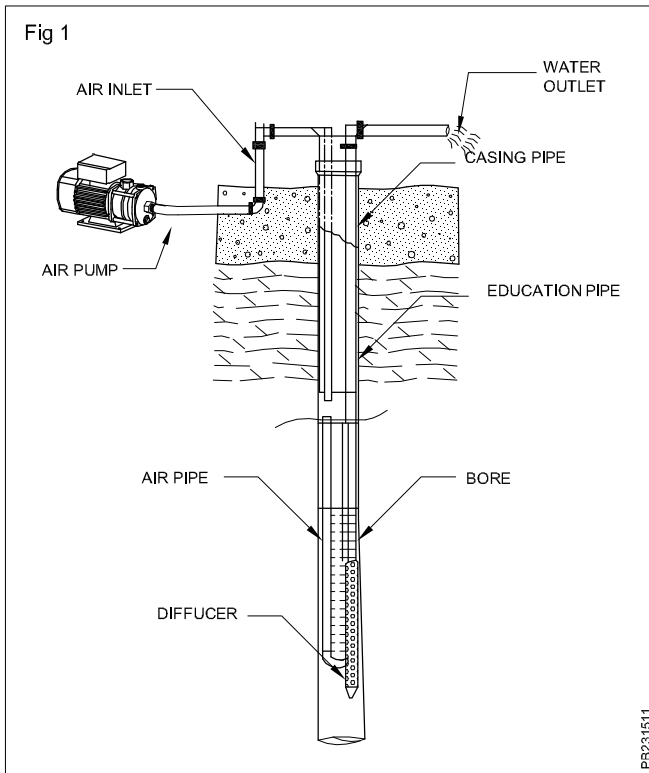
4	Low water level in well	Shut off pump and allow well to recover. Restart pump and note whether deliver drops after continuous operation	If well is “weak” lower ejector (deep well pumps) use a tall pipe, or switch from shallow well to deep well equipment.
5	Plugged ejector	Remove ejector and inspect	Clean and reinstall if dirty
6	Defective or plugged foot valve and/or strainer	Pull foot valve and inspect. Partial clogging will reduce delivery. Complete clogging will result in no water flow. A defective foot valve may cause pump to lose its prime, resulting in no delivery.	Clean, repair or replace if needed.
7	Worn or defective pump parts or plugged impeller	Low delivery may result from wear or impeller or other pump parts. Disassemble and inspect.	Replace worn parts on entire pump. Clean parts if required.

Repairing of air lift pump

Objectives: At the end of the lesson you shall be able to

- state the defects in air lift pump
- state why air flow rate is low.

S. No.	Defects	Causes	Remedies
1	Mounting the motor	Improper mounting the motor <ul style="list-style-type: none"> • Create the vibration pipe joints get damage 	Properly mounting the motor to avoid the vibration use anti vibration pad.
2	Check the oil in the pump	If not maintain oil level in the pump <ul style="list-style-type: none"> • If occur more noise and generate heat source from the pump 	Properly maintain the oil level in the pump for avoiding unnecessary noise and heat from the pump
3	Air filter	Air flow rate is low	To clean the air filter if necessary worn out/damage air filter may be replaced.
4	Air diffuser fitting worn out	Due to pressure of air. Diffuser fitting may worn out.	Properly joint the elbow towards diffuser and nozzle.
5	Failure of bore clamp	Clamp get rust formation	Before assembly apply crease (or) painting the clamp



Repairing of booster pump

Objectives: At the end of the lesson you shall be able to

- state that booster pump will not run and stop
- state that booster pump stops at high pressure.

Troubleshooting

RED light on (or flashing) and pump will not start:

Start pressure set to high. Remove round cover on control and adjust start pressure dial 10 - 15 psi less than maximum boosted pressure as shown on pressure gauge, and push RESET. This unit is factory set at 50 psi.

Water cannot flow through pump to build pressure. Make sure all valves are open and the check valve is in the correct orientation.

If installed in a suction lift application, prime could be lost. Re-prime and check for leaks on suction side. Push the RESET button, the pump will run for 5 seconds, watch pressure gauge to make sure that the pressure is increasing.

Make sure all filters are installed after the pump, Change the filter cartridges regularly.

This can occur if the water supply has been interrupted. The pump will automatically try a restart 15 minutes after a failure. This will occur automatically 4 times, flashing one time for every failed restart, and then a solid RED light will be on.

BLUE light on and pump will not stop: Pump stops on a flow rate less than ½ GPM. This is normal if flow is higher.

Possible leaks in systems such as; running toilets, humidifiers, water softeners, ice makers...

Plastic magnetic piston (inside brass control) could be jammed by excessive thread sealant or debris. Loosen union nut and inspect piston. It should move freely and spring outwards.

To check for water leakage in the house, close the valve after pump. If pump stops, then water is leaking somewhere after this valve. Fix leaks and open valves again.

If the pump has a bypass valve installed, make sure it is closed for normal operation.

Pump starts and stops without obvious use: Small leaks in the system can cause this. Reduce Start Pressure by turning dial to a lower pressure. Then adjust air pressure in tank.

Pump will not start and no lights are on: Take sure pump is plugged into control, and control is plugged into a GFCI circuit. Test wall power receptacle with a light or multi-meter.

If Pump Is Noisy: Be sure the pump is mounted on a substantial foundation. Pipe should be rigid and all connections tight.

Total suction lift or flow is beyond the pump capability and the pump is starved for water.

Pump will not stay primed (Suction lift).

- Check foot valve. Make sure it is clean and sufficiently submerged; but is not in sand or mud.
- Be sure pump is sufficiently primed.

- Check for possible leaks in suction piping.
- Total suction lift may be beyond the pump capability of 20 feet.

Repairing of hand operating pump

Objective: At the end of the lesson you shall be able to
• state the repairing of hand water pump.

Hand pump (Fig 1) (Repairing)

Pump may well installed

While operating water will not flow dismantle the top cover of the pump

Check the plunger set assembly

Cup washer worn out/damaged replace it.

Dismantle the cylinder body

Disconnect the base bolt and nut check the condition of the base washer (or) weight washer / air washer worn out / damaged replace it.

Check the check valve in suction pipe.

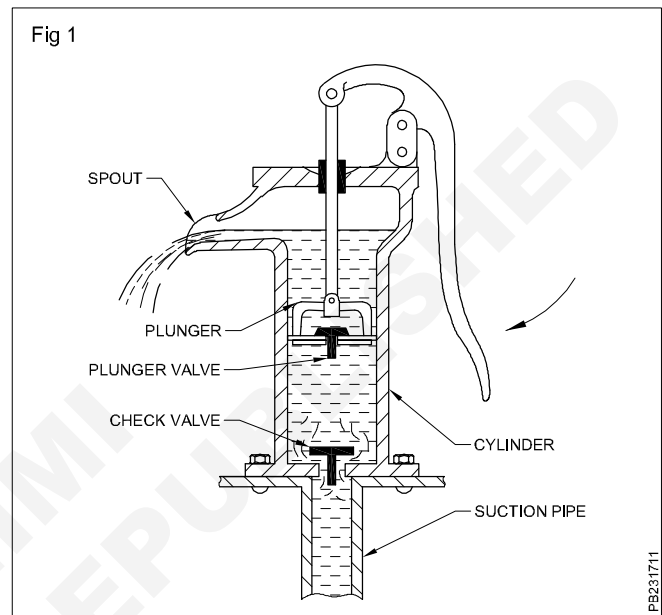
Valve set worn out / damaged it may replace it.

Check the spring, puppet and Lock nut.

Check blocked clean and again check the action of spring, puppet, Locknut and split pin.

Set Base washer opening straight to the handle.

Re align and pour water to check the water leakage.



Operate the hand pump check the Air leak, water flow through the spout.

Repairing of reciprocating pump

Objective: At the end of the lesson you shall be able to
• state the function of reciprocating pump.

Introduction: A pump may be defined as a mechanical device which converts mechanical energy supplied to it (by an electric motor or oil engine) into hydraulic energy.

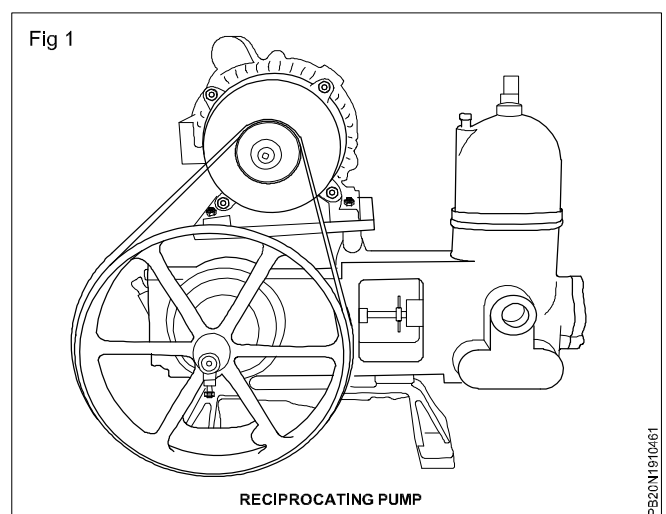
Pump may also be defined as a device used for lifting water from a lower level to a higher level.

Pumps are broadly classified as follows

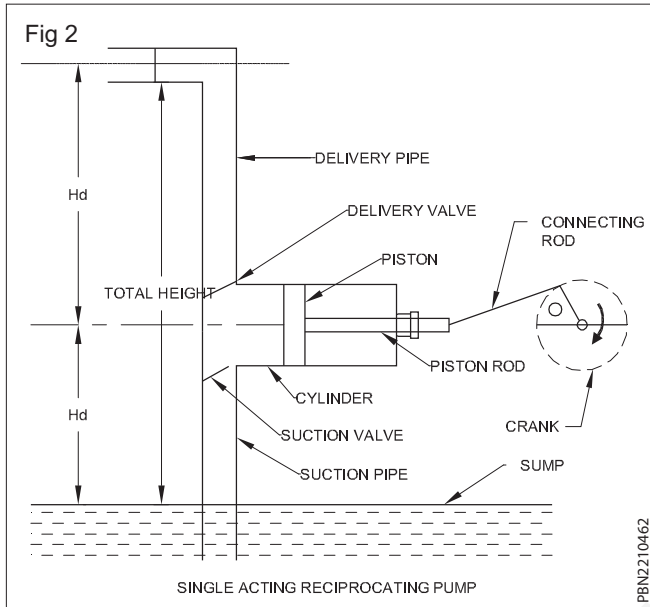
- 1 Positive displacement pumps
- 2 Roto dynamic pumps

Reciprocating pumps (Fig 1)

In reciprocating pumps, the liquid is sucked and displaced due to the thrust exerted on it by a moving piston or plunger. Hence they are also known as positive displacement pumps.



Working of single acting reciprocating pumps: Fig 2 shows a single acting reciprocating pump. It consists a pump cylinder, piston or plunger, piston rod, crank, connecting rod, suction pipe, delivery pipe, suction valve and delivery valve. Suction and delivery valves are one way (non-return) valves. The crank is driven by the prime mover. The rotation of the crank moves the piston to and fro inside the cylinder.



Suction stroke

During the stroke, piston moves to the right and vacuum is created inside the cylinder. Due to this, suction valve opens and the liquid from the sump enters (sucked into) the cylinder through suction pipe and suction valve. Delivery valve remain closed during this stroke.

Delivery stroke

During this stroke, piston moves to the left and forces the liquid out of the cylinder. Due to increase in pressure, the delivery valve opens and the liquid is delivered to the required height through the delivery valve and delivery pipe. Suction valve remain closed during this stroke.

Crank rotates one revolution for completing one suction and one delivery stroke. The same cycle is repeated as the crank revolves.

Applications

The speed of this pump is limited and hence they are suitable for small capacities and high heads. It is generally used for

- 1 Marines (for pumping the water)
- 2 Pneumatic pressure system,
- 3 Pumping feed water to small boilers,
- 4 Pumping light oil

If water not flow of while run the pump

While motor run, check the power transmit to the cam or not.

If its not transmit the power

check the align the V belt flywheel to the cam (proper tension)

While cam is run

- Connect the connecting rod and piston in properly.
- Check the suction valve, delivery valve in the piston
- Connect the connecting rod and cam shaft in properly
- Connect piston and connecting rod in the cylinder with proper stud and screw.
- Check the suction valve if it wornout on damage replace it
- Check the foot valve and strainer if any blockage (or) scaling remove or replace it.
- Check the delivery valve.
- Check the delivery valve any blockage (or) scaling, if possible replace it.
- Check the function of gland bush and rope, if any worn out (or) damage (or) nonflexible.
- if gland rope is good condition it may reassembled by oil soaked. damage/ worn out rope may replace it.

Contamination of water in a well

Objectives: At the end of this lesson you shall be able to
• **state the contamination of a water in a well.**

Water become contaminated there are many ways to become contaminated.

Including sewage leaks, human (or) Animal faces in areas near reservoirs, garbage, Industrial waste and even air pollution which will contaminate water when it mixes with rain.

Contamination

Diseases like typhoid, cholera, diarrhea, dysentery, hook worm and roundworm infestation, and jaundice are communicable from man to man through the medium of faces. The faces of persons suffering from these diseases should not be left exposed for flies to sit upon; or for being washed by rain into stream courses, the water of which are used for drinking; or to allow the edges or worms, present in faces to be hatched in the soil. Diseases like cholera and typhoid are more serious while the worm

infestation diseases are more mild in nature. Apart from cases where the persons suffering from these diseases will be well known, there are persons who harbor these pathogenic organisms without suffering from these diseases. Such persons, called carriers, are really dangerous to society. Instead of dealing with the faces of such selected persons alone which is beset with difficulties, if the faces of all persons are properly collected, conveyed and disposed off the chain of transmission will be cut and the diseases will not spread. In towns where the density of population is higher than in rural areas and where there are protected water supply systems, the construction of sanitary latrines is all the more imperative to prevent contamination of food, water and soil which may engulf the entire urban population in a preventable epidemic.

Impurities of water

Objectives: At the end of the lesson you shall be able to
• **state the impurities of water**
• **classify impurities of water**
• **explain impurities of water.**

Impurities in water

Following are the various impurities found in water and their effects:

A Suspended Impurities

- Bacteria - some cause disease.
- Algae, Protozoa - cause colour, turbidity and colour.
- Clay, Silt - cause turbidity.

B Dissolved Impurities

- Calcium and Magnesium
 - Bicarbonate - causes hardness and alkalinity
 - Carbonate - causes hardness and alkalinity
 - Sulphate - causes hardness
 - Chloride - causes hardness and corrosiveness

- Sodium
 - Bicarbonate - causes alkalinity and softening
 - Carbonate - causes alkalinity and softening
 - Flourides - causes mottled enamel of teeth
 - Chloride - taste

Metals	<ul style="list-style-type: none"> — Manganese — Iron oxide — Lead — Arsenic 	<ul style="list-style-type: none"> - black or brown colour - taste, corrosiveness, hardness and red water - cause poisoning - poisoning
Gases	<ul style="list-style-type: none"> — Oxygen — Carbon-di-oxide — Hydrogens sulphide 	<ul style="list-style-type: none"> - corrode the metal - cause acidity and corrode the metals - cause rotten egg odour, acidity and corrode the metals
C Organic impurities		
Suspended	<ul style="list-style-type: none"> — Vegetables — Animals 	<ul style="list-style-type: none"> - colour, taste and acidity - produce harmful disease germs (dead)
Dissolved	<ul style="list-style-type: none"> — Vegetables — Animals 	<ul style="list-style-type: none"> - produce bacteria - cause pollution of water and produce disease germs

Impurities in water

Impurities in water may be classified by two methods:

The first method divides impurities into organic, inorganic and living organisms. The second classification divides the impurities into:

- 1 Suspended impurities
- 2 Dissolved impurities
- 3 Organic impurities

Organic and inorganic both types of impurities may be in the form of suspended, colloidal and dissolved forms.

Dissolved impurities

The number of dissolved impurities may be very large because water is a very good solvent and can dissolve all the salts to which it comes in contact. Salts of calcium, magnesium and sodium, when dissolved in water cause bad taste, hardness, alkalinity etc. Sodium fluoride causes mottled enamel of teeth. The dissolved impurities may contain organic compounds, inorganic salts and gases, etc. The amounts of dissolved solids is normally expressed in ppm and is obtained by weighing the residue. Left after evaporation from the water sample. Iron oxide and manganese when dissolved, cause odour, taste and red, black or brown colour and produce stains on plumbing fixtures in buildings and on cloths in laundries. Lead, copper, zinc etc. may also be present in dissolved form. Vegetable dyes when dissolved cause acidity and colour. Gases, like oxygen and carbon dioxide, cause corrosiveness and hydrogen sulphide causes smell to rotten egg.

Colloidal impurities

Colloids are particles in a finely divided state. They are neither in suspension nor in solution, but in condition mid-

way between the two. These particles are so small that they cannot be removed by ordinary setting tanks and are not visible to the naked eye. Various theories have been put forward for their non-settlement. But the one which explained here may be the most acceptable theory.

All the colloidal impurities are electrically charged. The electric charge may be due to the presence of absorbed ions on the surface of the particles. Acidic and neutral materials like silica, glass and most organic materials particles have negative charge, while particles of all basic materials like metallic oxides, are positively charged. The electrical charge present on the colloidal particle surface is quite large in relation to the mass of the particle and, therefore, repel one another. It is due to this action that all the colloidal impurities remain motion and do not settle. All the colloidal impurities are usually associated with organic matter containing disease producing bacteria and, therefore, form the main source of all sorts of epidemics. These particles do not respond to chemical treatments which are normally given to water.

The size of colloidal particles is between 1 micron (1=0.000mm) to one millimicron (1=0.00000 mm). Most of the colour of the water is due to colloidal impurities. Their quantity may be determined by colour test.

The effects of various impurities may be summarized as follows:

Suspended impurities

Bacteria - cause disease

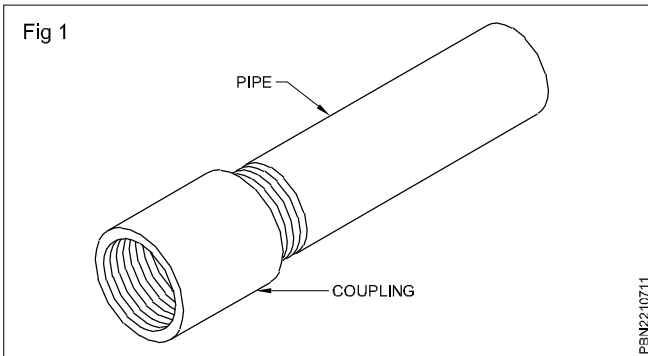
Algae Protozoa, silt, clay etc.- Produce turbidity, odour, and colour.

Descriptions of pipes dies their uses care and precaution

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

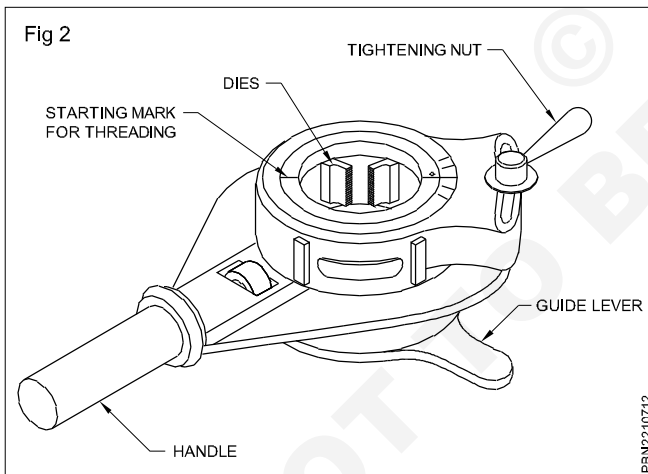
- state the necessity of pipe thread
- state the pipe dies taps & tap wrenches.

Pipe dies: Most of the G.I. pipes that plumbers install are threaded at both ends. The pipes are available in lengths of 6 metres and it will be necessary to cut the pipe to the required length and thread it. (Fig 1)



The threads on G.I. pipes and fittings for water supply systems are the standard pipe threads. External pipe threads are cut by pipe dies available in sizes from 1/2" to 4".

Pipe threading dies (Fig 2)



Pipe threading dies are called stocks and dies. There are two types of stocks and dies, solid and adjustable. The

Metric specification of various pipes

Objectives: At the end of the lesson you shall be able to

- explain metric specification of various pipes.

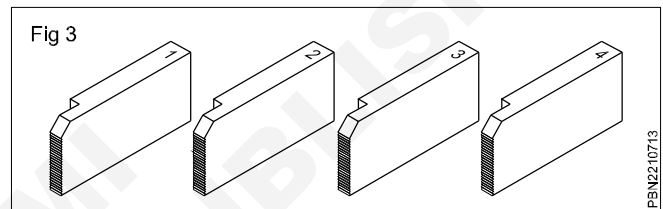
How metric pipe measured?

The metric system labels pipes dia meter in millimeters while the inch/ imperial system labels pipe dia meter in inches. A twoinch pipe does not measure two inches on the outside diameter. But rather measures 60.3mm on the outside diameter.

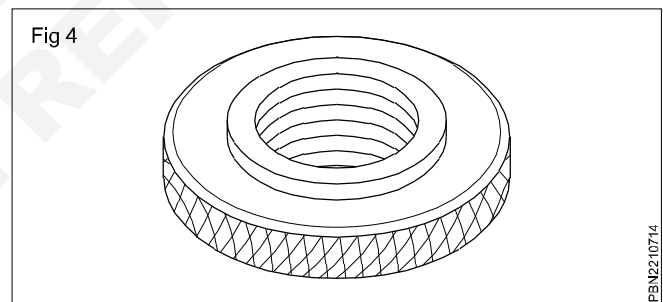
solid type consists of steel die stock or frame with a handle at each end. The dies are fitted into the centre of the frame. This stock cuts parallel threads in this type a separate set of dies is required for each pipe size.

The adjustable die consists of circular die stock with two or four lever handles. Four adjustable dies are held in the stock and each set of dies cuts a range of threads shows an adjustable stock and die. The die stock can be obtained with ratchet lever handles for use in a confined space.

These dies must always be used and stored as a set. (Fig 3)



Pipe threads are usually cut with threading dies and can be checked by using the pipe ring gauge. (Fig 4)



Care and precautions

- 1 Secure the pipe finally in a vice.
- 2 Use a cutting fluid while cutting thread to minimise friction and heat.
- 3 Clean the die frequently with brush to prevent the chips from clogging.

Specification of pipe size

OD and nominal pipe size

Tubing is measured by the outside diameter (O.D) specified in inches (e.g 1.250) or fraction of an inch (e.g 1 - 1/4") pipe is usually measured by nominee pipe size. (NPS)

Measuring pipe thickness

Use a tape measure or ruler to measure the inside diameter of the pipe. Place your chosen measuring tool across the center of pipes inside opening. Read the distance between inside edge of one wall to the inside edge of the opposite wall to get the inside diameter.

Copper tubing uses

It is most often used for heating systems and as a refrigerant line in HVAC systems. Copper tubing is slowly being replaced by PEX tubing in hot and cold water applications.

PVC and CPVC pipes - schedule 40

Nominal pipe size (inches)	Outside diameter (inches)	Minimum thickness wall (inches)
1/2	0.840	0.109
3/4	1.050	0.113
1	1.315	0.133

HVAC is stand - Heating ventilation and air conditions

Generally CPVC is measured by OD which makes its sizing similar to hard copper. PVC is measured by ID which makes its sizing similar to iron pipe.

Black iron pipe

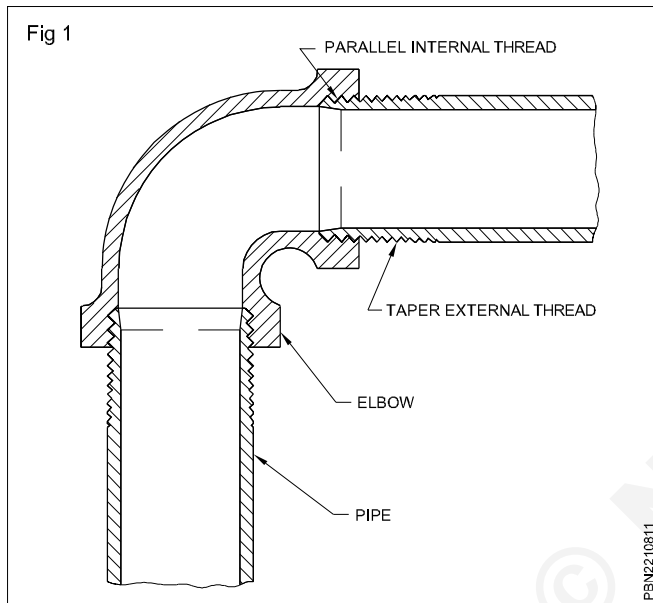
It is used to transport natural and propane gas in residential applications black steel pipe is manufactured as seamless which makes it a better type for gas transportation and fire sprinkler systems since it can prevent fire better than galvanised pipe.

Standard pipe threads

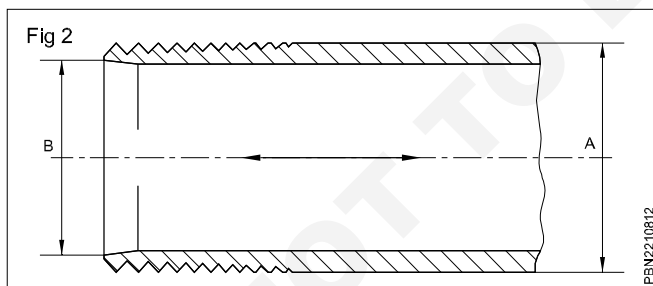
Objectives: At the end of the lesson you shall be able to

- describe pipe threads
- state the B.S.P threads
- state the sealing of pipe joint.

Pipe threads: The standard pipe fittings are threaded to British Standard pipe gauge (BSP). The internal pipe threads have parallel threads whereas the external pipes have tapered threads as shown in Fig 1.



B.S.P. threads: Galvanized iron pipes are available in sizes ranging from 1/2" to 6" in several different wall thicknesses. The table shows outside diameters and threads per inch from 1/2" to 4". (Fig 2)



The next two threads have fully formed bottoms but flat tops. (B)

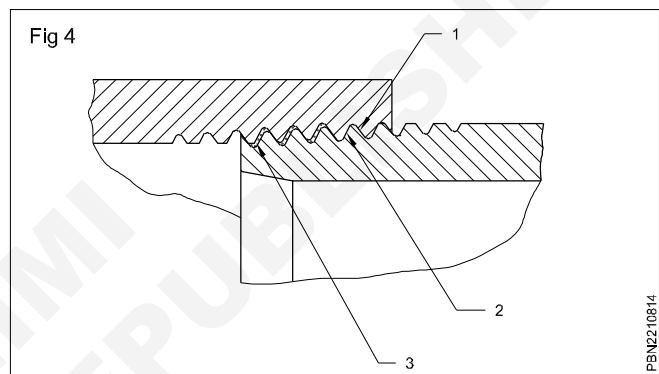
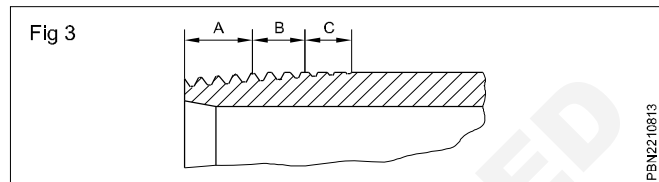
The last four threads have flat tops and bottoms. (C)

The pipe joint shown in Fig 4 consists of the following.

- 1 Parallel female thread
- 2 Tapered male thread
- 3 Hemp packing

The hemp packing is used to ensure that any small space between two metal threads (male and female threads) is sealed to prevent any leakage.

Sealing pipe joint: Fig 3 shows that the pipe has several fully formed threads at the end. (A)



Table

BS 21 - 1973 and IS 2643 - 1964

BSP - Pipe sizes or DIN 2999 (inside) (B)	Threads/ inch	Outside diameter/ mm of the pipe (A)
1/2"	14	20.955mm
3/4"	14	26.441
1"	11	33.249
1 1/4"	11	41.910
1 1/2"	11	47.803
2"	11	59.614
2 1/2"	8	75.184
3"	8	87.884
4"	8	113.030

Uses of threads

Screw threads are used

- as fasteners to hold together and dismantle components when needed (Fig 5)
- to transmit motion on machines from one unit to another (Fig 6)
- to make accurate measurements (Fig 7)

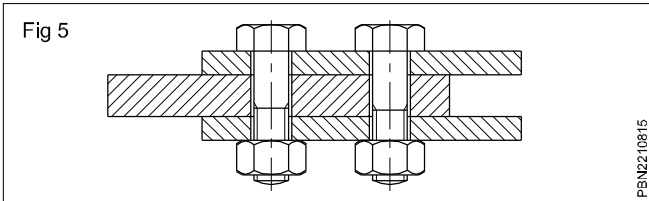


Fig 5

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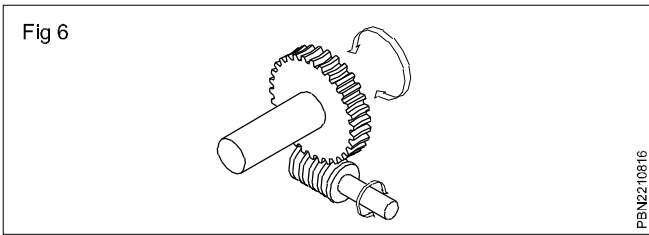


Fig 6

PBN2210816

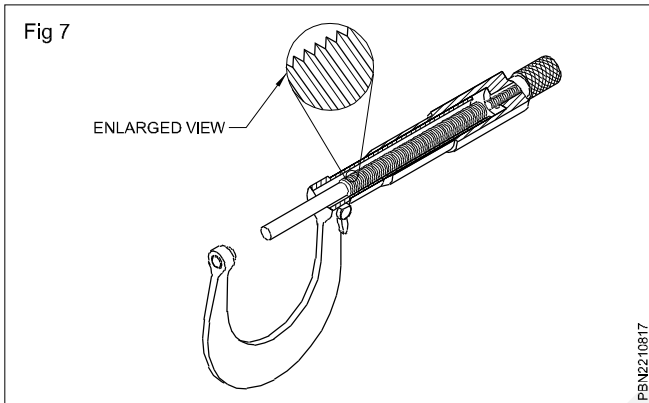


Fig 7

ENLARGED VIEW

PBN2210817

- to apply pressure (Fig 8)

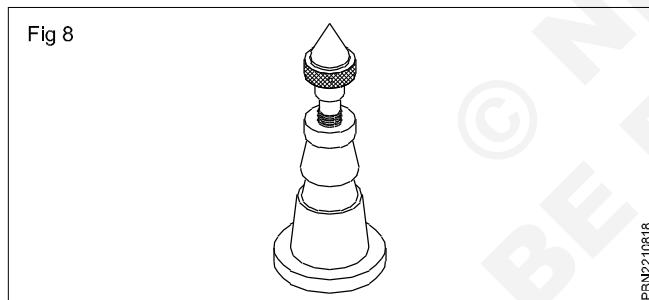


Fig 8

PBN2210818

- to make adjustments. (Fig 9)

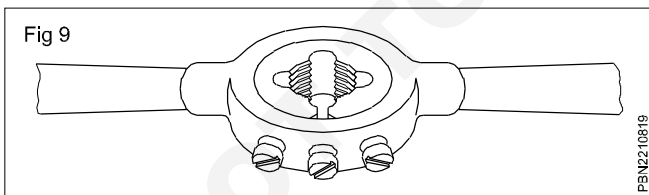
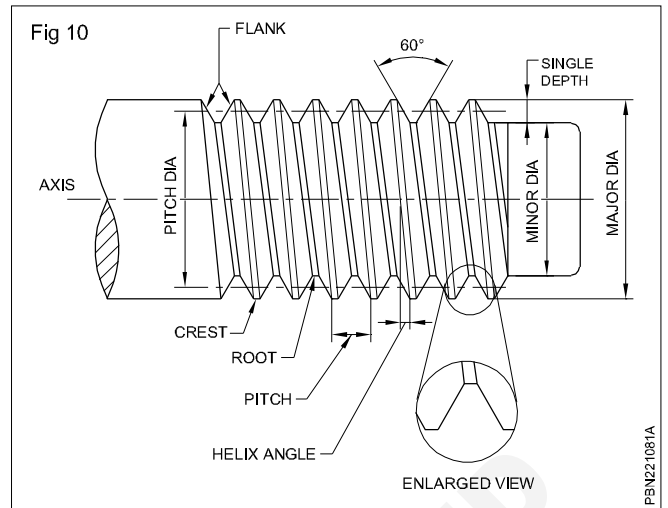


Fig 9

PBN2210819

Parts of a pipe thread (Fig 10)



Crest

The top surface joining the two sides of a thread.

Root

The bottom surface joining the two sides of adjacent threads.

Flank

The surface joining the crest and the root.

Thread angle

The included angle between the flanks of adjacent threads.

Depth

The perpendicular distance between the roots and crest of the thread.

Major diameter

In the case of external threads, it is the diameter of the blank on which the threads are cut and in the case of internal threads it is the largest diameter after the threads are cut that are known as the major diameter. (Fig 10)

This is the diameter by which the sizes of screws are stated.

Method employed for bending, Joining and fixing PVC pipe

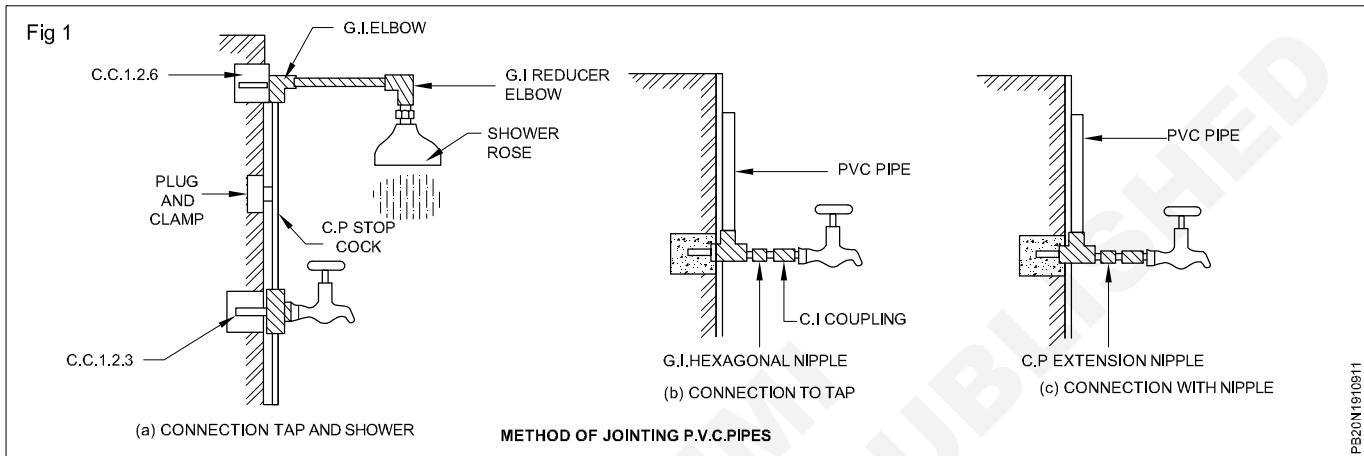
Objectives: At the end of this lesson you shall be able to

- state the laying and jointing pvc pipes
- state the inspection and testing of pvc pipes
- state the pvc pipe repairs.

Laying and jointing unplasticized P.V.C. Pipes (External work) (Fig 1)

Handling and storage

Unplasticized P.V.C. pipes are light in weight material. Reasonable care shall be taken in handling and storage of to prevent damages.



For temporary storage in the field, where racks are not provided care shall be taken that the ground is level and free from loose stones. Pipes stored thus shall not exceed three layers and shall be so stacked as to prevent movement. The pipes shall preferable be stored under shade.

They must be supported at regular intervals for above ground installation;

That allowance must be made, during installation, for their expansion, particularly by using loose clips/clamps;

That a range of specials, and matching fittings must be known and their manufacturers/suppliers listed.

a Trenches

The trench bottom shall be carefully examined for the presence of hard object such as flints, rock projections or tree roots etc. Pipes free from rock and gravel. Back fill 15 cm above the pipe to prevent damages pipes shall not be painted. The width of the trench shall be outside diameter of the pipe plus 30 cm. Pipes shall be laid at least 90 cms below the ground level (measured from surface of the ground to the top of the pipe).

b Jointing with solvent cement joint (Fig 1)

The pipe shall be cut perpendicular to the axis of the pipe length with a metal cutting saw or an ordinary hand saw with small teeth. The total length of insertion socket shall be marked on the pipe and checked how far the pipe end could be inserted into the fitting socket. Attempt shall be

made to push the pipe to the marked distance, if not possible it shall at least be pushed for 2/3 of this distance.

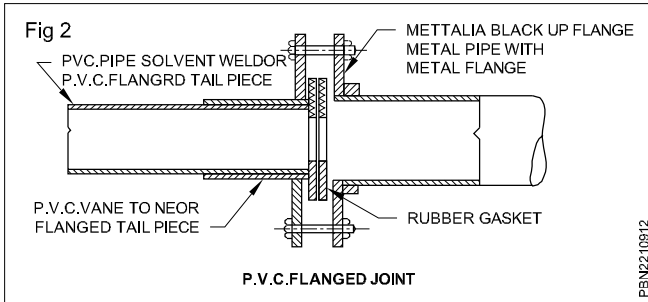
Dust oil, water, grease etc. shall be wiped cut with a dry cloth from the surface. Further the grease should be thoroughly removed with a suitable solvent, such as methylene chloride outside surface of the pipe and the inside of the fitting may be roughed with emery paper.

Generous coatings of solvent cement shall be evenly applied on the inside of the fitting outside of the pipe end upto the marked line with non-synthetic brush. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes. The surplus cement on the pipe surfaces shall be jointing will not be proper and pipe will come out of the fitting.

In summer month's joints shall be made preferably early in the morning or in the evening when it is cooler. This will prevent joint from pulling apart when the pipe cools off at night.

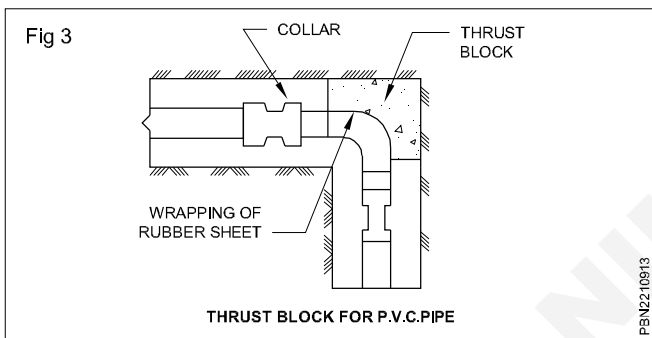
c Flanged Joints (Fig 2)

For jointing P.V.C. pipes particularly of large sizes to valves and vessels and large size metal pipes where the tensile strength is required the joint is made by the compression of a gasket or ring seal set in the face of C.I. flange. Flanges solvent welded to the P.V.C. pipes shall be supplied by the manufactures.



d Rubber Ring Joints (Fig 3)

Rubber ring joints can provide a water tight seal but do not resist pull. As such these may be used only as repairs collar and for jointing pipes larger than 110 mm. The material of rubber ring shall conform to I.S. : 5382 - 1969. The ring shall be housed in a groove formed in plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and the housing. The ring shape and the method of compressing. Rubber rings shall be supplied by the manufacturers.

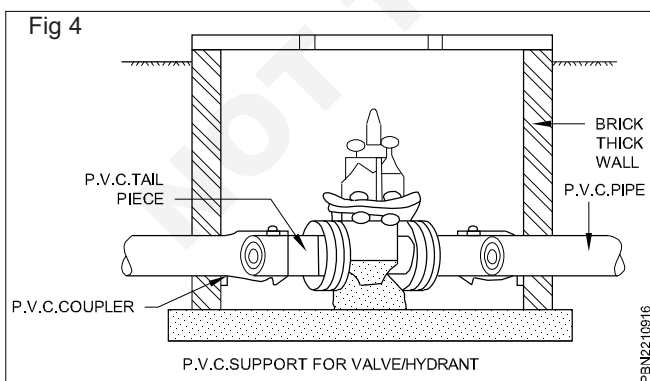


The rubber ring joints can be either of :

- 1 With spigot and socket, or
- 2 With separate collar pieces having two rubber rings, one at either end.

e Supports for Valve and Hydrant (Fig 4)

Valve and hydrant tees shall be supported as shown in ... So that the torque applied in operating a valve is not transmitted to the pipe line.



f Inspection and Testing of P.V. C. pipes

Solvent welded pipe shall not be pressure tested atleast 24 hours after the joint has been done.

All control valves shall be positioned open for the duration of the test and open end closed with water tight fittings. The testing pressure on completion of the work shall not be less than one and a half time the working pressure of the pipes as indicated in table.

Pressure shall be applied either by hand pump or power driven pump. Pressure gauges shall be correctly positioned and closely observed. The systems shall be slowly and carefully filled with water to avoid surge pressure or water hammer. Air vents shall be open at all high points so that air may be expelled from the system during filling.

When the system has been fully charged with water and air displaced from the line air vent shall be closed and the line initially inspected for seepage at joints and firmness of supports under load. Pressure may then be applied until the required test pressure is reached.

Without any additional requirement of make-up-water the test pressure should not fall more than 0.2 kg / cm² at the end of onehour test duration.

Laying and jointing P.V.C. pipes (Internal work)

- a **Clamping:** The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Line or point contact with the pipe shall be avoided. Heavy components such as metal valves shall be individually supported.
- b **Supports:** P.V.C. pipes require supports at close interval. Recommended support spacing's for unplasticised P.V.C. pipes are given in table .. This spacing may be increased by 50% for vertical runs support.

Table

Pipe dia	Support spacing	Vertical spacing
20mm	700mm	1050mm
25mm	750mm	1075mm
32mm	825mm	1240mm
40mm	975mm	1475mm
50mm	975mm	1475mm

It is essential that P.V.C. pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, P.V.C. pipe shall also be checked for its alignment before the clamping. The pipes line will be wavy if the clamps are not fixed keeping the pipe plumb.

c **Connection to a water Tap:** Connection to the water tap shall be made by means of a G.I. adopter Fig 1 G.I adopter shall preferably be supplied by the same manufacturer as that of P.V.C. pipe. In any threaded coupling between P.V.C. and C.I. is preferable that P.V.C. is fitted inside the G.I. fitting. If however greater projection is desired, same shall be achieved by joining a short piece of a G.I. pipe (Nipple) as shown in Fig 1

d **Connection to a Shower Rose: Shower rose connection shall be of G.I. pipes as shown**

e **Connection from Masonry/Concrete Water Tank:** Solvent cement shall be coated on the section of the pipe to be embedded concrete. Fine dry sand and cement mixture shall be sprinkled uniformly around the pipe. This shall give a rough surface which can be safely embedded in concrete, water proofing cement shall be used to close the gap properly.

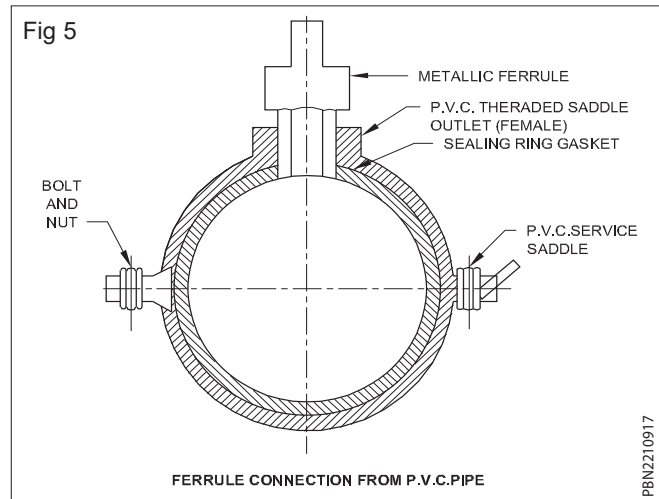
P.V.C. pipes service connection

Either metal or P.V.C. saddles, as specified, shall be used for the off take of service connections from larger bore pipes (50 mm diameter and above). The saddle consists of two half round sections of metal or P.V.C. which are bolted together or held round the pipe by wedge grips. A seal is formed between the saddle and the pipe and the under surface of the upper section. The service connection is taken from a boss on the upper section.

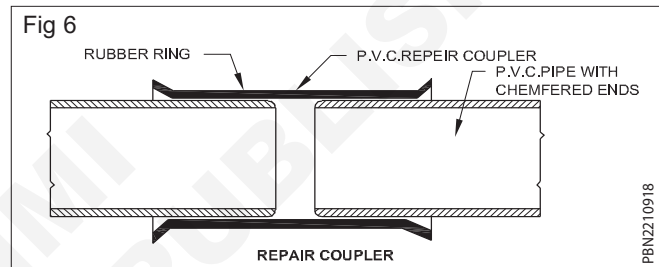
Conventional equipment for tapping under pressure may be used with these service connections using a special trepanning cutter to piece the pipe wall. Ferrules shall not be screwed directly into pipes without the introduction of saddle piece. A typical illustration of a ferrule connection is shown in (Fig 5)

P.V.C. Pipe - Repairs (Fig 6)

Permanent repairs should be made by replacement of the damaged section.



Sometimes, pipes are damaged street repairs a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged pipe. (Fig 6)



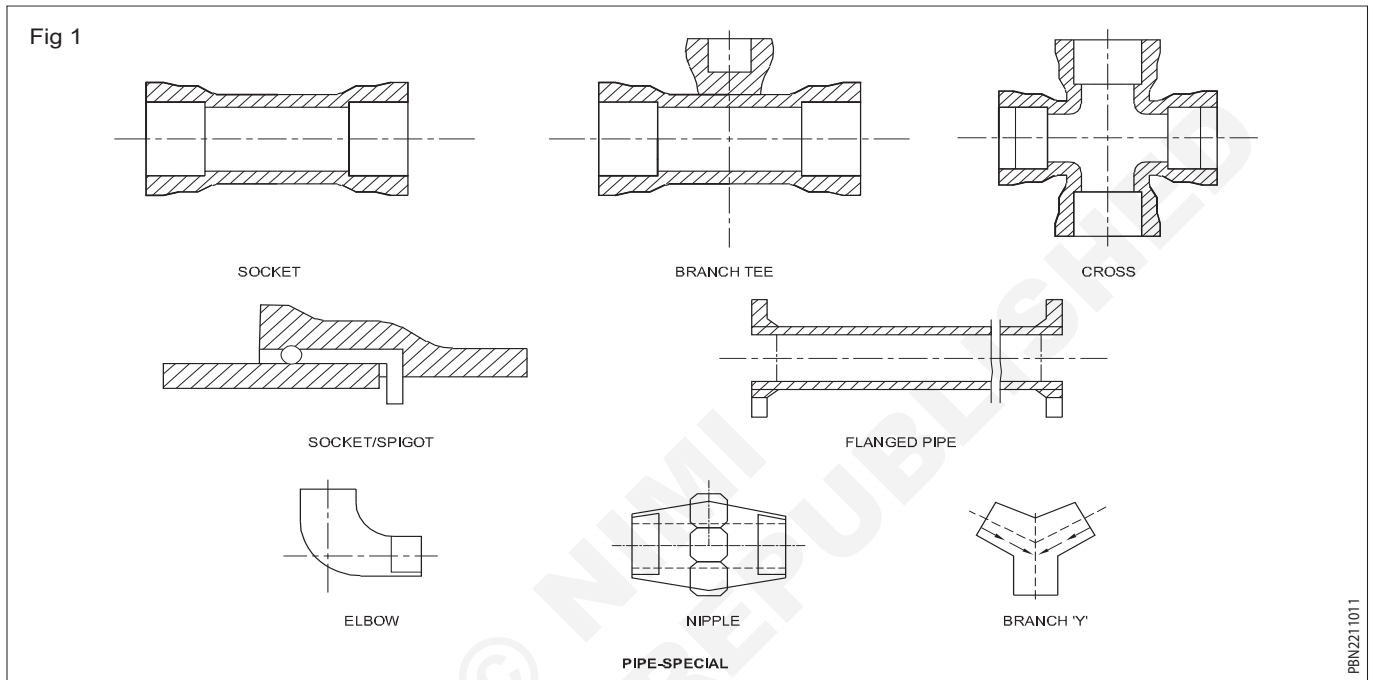
Joining material for water and gas pipes

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

- state the common fittings in pipes
- state the method of fixing ferrules.

Pipe fittings (Fig 1): In addition to the pipes, valves, taps, various types of pipe fittings such as unions, caps, plugs,

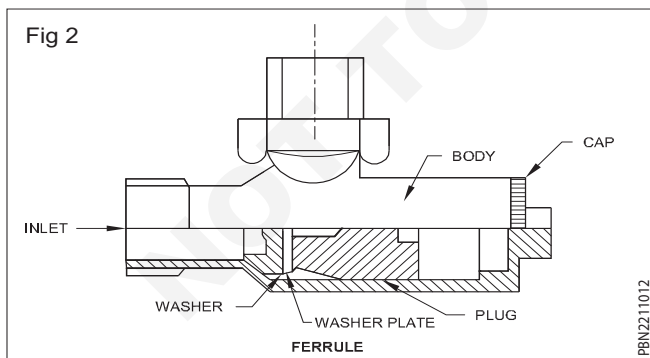
flanges, nipples, crosses tees, elbows, bends etc. are used during laying of distribution pipes.



Common Fittings and Specials

Elbow: A pipe fitting for providing a sharp change of direction in a pipe line.

Ferrule (Fig 2): A pipe fitting for connection a service pipe to a water main.



Fitting: Anything fitted or fixed in connection with the disposal of water

Flange: A projecting flat rim on the end of a valve, pipe etc.

Float valve: A valve in which the closure to an opening such as a plug or gate, is actuated by a float to control the flow into a tank.

Nipple: A tubular pipe fitting usually threaded on both ends and less than 300 mm long used for connection pipes or fittings.

Offset: A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section in a piping system.

Socket: The female part of a spigot and socket joint.

Spigot: The male part of a spigot and socket joint.

Storage tank: A tank or a cistern for storage of water which is connected to the water main by means of a supply pipe.

Union: A pipe fitting used for joining the ends of two pipes neither of which can be turned.

Vertical pipe: Any pipe which is installed in a vertical position.

Method of fixing ferrules (Fig 2): For fixing ferrule the empty main shall be drilled and tapped at 45° to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

Use of blow lamp

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

- explain the uses of blow lamp
- state working of blow lamp.

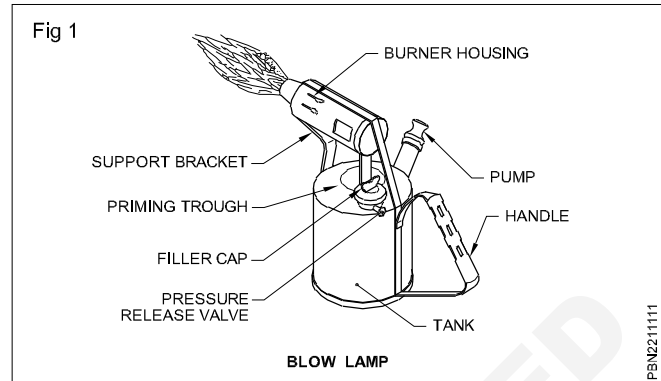
Blow lamp

In blow lamp (Fig 1) the kerosene is pressurized to pass through pre- heated tubes, thus becoming vaporised. The kerosene vapour continues through a jet to mix with a air and when ignited directed through a nozzle, producing a forceful flame.

The flame within the housing provides the heat to maintain vaporisation of the kerosene. The free flame at the nozzle outlet is used to heat the soldering bit.

Blow lamp is a portable heating appliance used as a direct source of heat for soldering irons or other parts to be soldered. Fig 1 shows parts of blow lamp.

It has an tank made of brass, filler cap is fitted at its top to fill kerosene. A pressure relief valve is connected to the mouth to switch ON/OFF and control the flame.

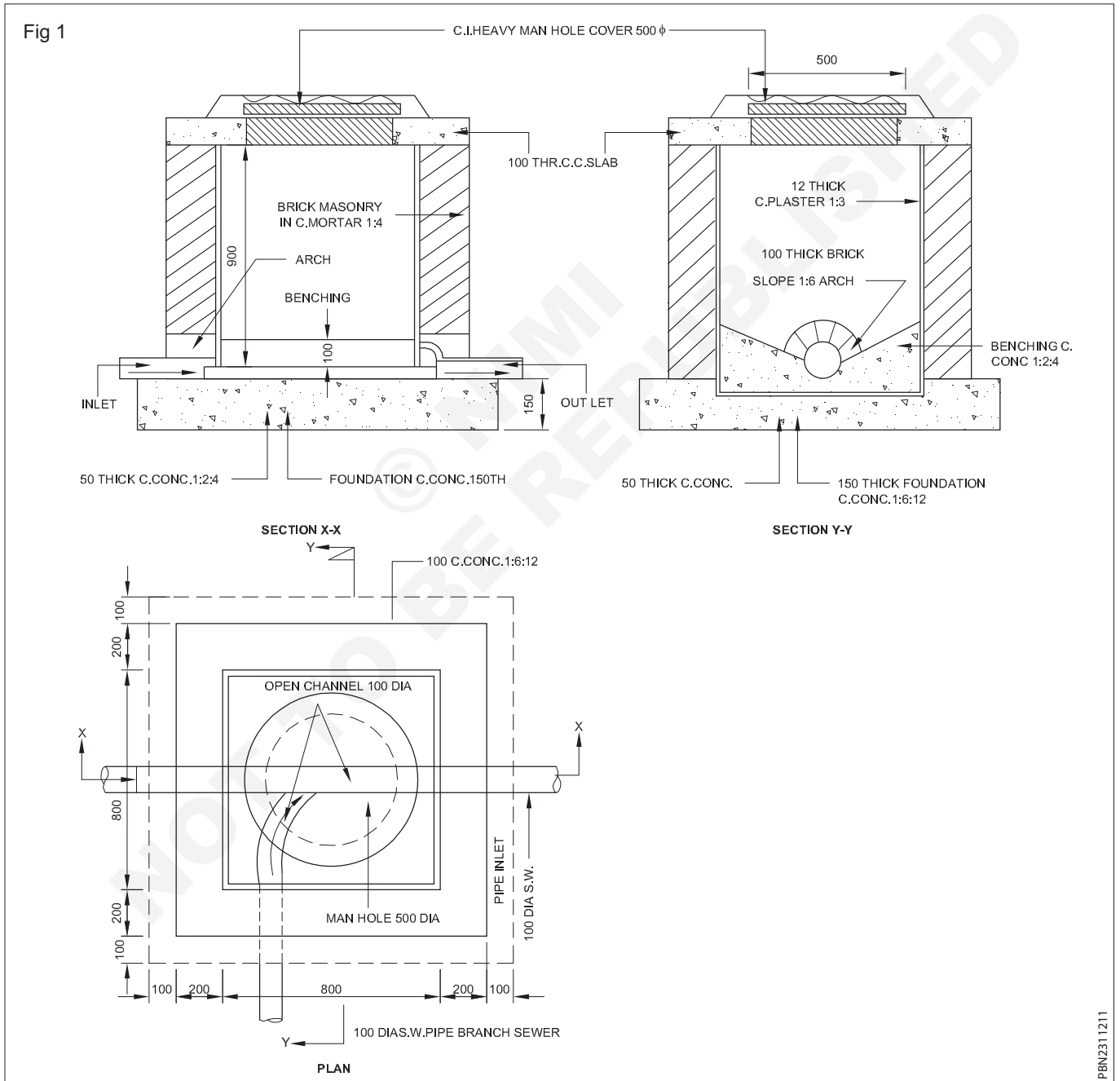


Inspection chamber, septic tank, description of drains, cesspools, soak pits etc.,

Objectives: At the end of this lesson you shall be able to
 • describe inspection camper, septic tank, drains, cesspools, soak pits.

Inspection chamber: It is a water tight chamber constructed in any building drainage system which takes wastes from gully traps/soil pipes and disposes off to manhole with access for inspection and maintenance.

Inspection chamber is provided very near to the gully traps/soil pipe lines of the building and it should be provided within 6 meters from the gully traps. (Fig 1)



Septic tank

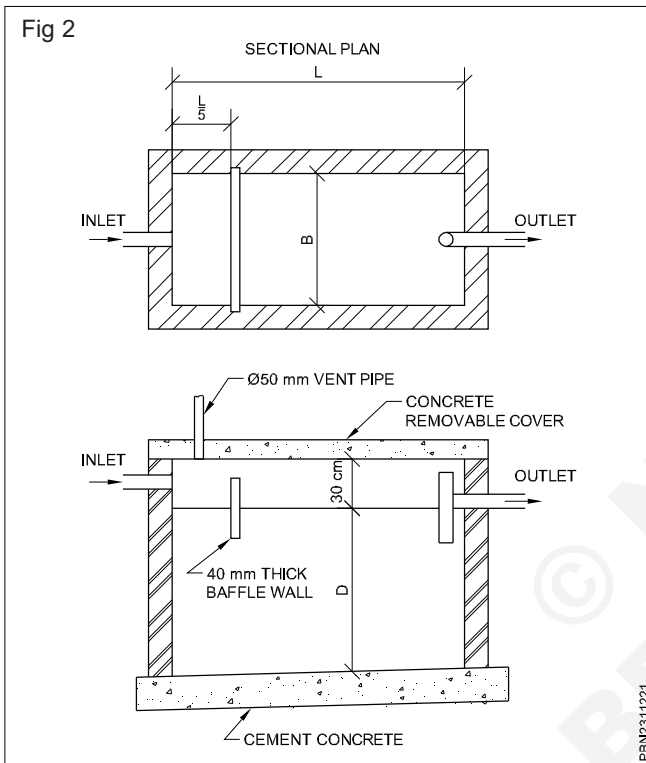
Objectives: At the end of the lesson you shall be able to

- describe the septic tank
- state points to be considered to form the septic tank
- state the construction about the septic tank
- state the specification about the septic tank.

Septic tank: Septic tanks are provided where there is no municipal sewage system.

Septic tanks are recommended for individual houses and small colonies having a population of 300 or less.

Septic tanks are constructed with brick/stone masonry or concrete walls. (Fig 2)



Important points

- 1 The inlet and outlet pipes are to be bent downwards.
- 2 The centre of outlet pipe should be 5 to 7 cm below the centre of inlet pipe.
- 3 Waste water lines carrying excessive detergent and disinfectants should not be connected to a septic tank.

Soak pit

Objective: At the end of the lesson you shall be able to

- state about the soak pit.

Soak pit

This is also known as seepage pit. These are circular pits more than one metre in diameter and 1m in depth below the invert of the inlet pipe. These pits are lined with dry bricks or stone and are filled with brick-bats or coarse aggregate

- 4 A vent pipe (CI/AC/PVC) should be provided on the covering slab (minimum - 100 mm).

The sewage undergoes treatment in a septic tank, the effluent i.e. waste water may still contain toxic and the effluent cannot be considered safe. Therefore, the septic tank effluents are disposed off by soil absorption system. Following are the methods for the disposition of effluent.

Construction details

Following are the construction details of septic tanks:

It is rectangular in plan, the length is usually 2 to 4 times the breadth.

For smaller tanks liquid depth of 100 cm is provided, for large tanks it may be upto 180 cm. Free board of 30-45 cm is provided above the level of liquid for fixing of pipes, scum, gases, etc.

An elbow pipe, usually T-pipe submerged to a depth of 15-25 cm below the liquid level is provided as inlet pipe. More number of inlet pipes may be provided for larger tanks.

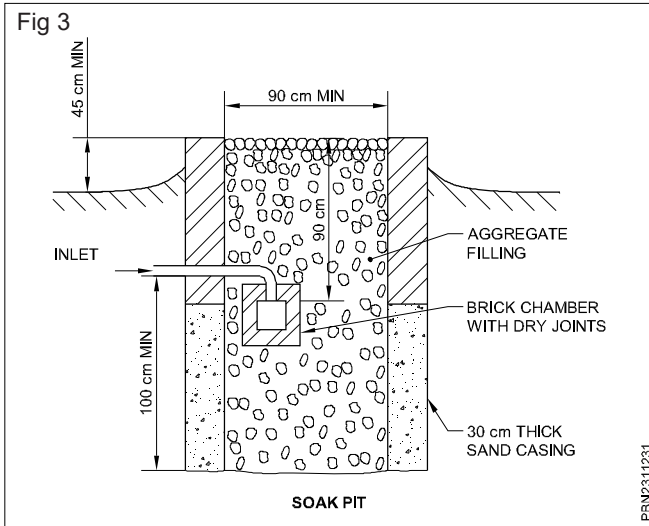
Single elbow or T-shaped outlet pipe is provided. It should also be submerged at least 15cm below the liquid level. For very large tanks, weir type outlet similar to settling tanks are provided.

Usually R.C.C. slab with C.I. manhole covers are provided.

Ventilation pipe of usually 10 cm diameter of A.C. or C.I., is used for taking out the foul smells. Their tops are provided with cowls.

Figure shows the plan and sectional elevation of a septic tank which is most suitable for domestic purposes. The minimum width and liquid depth of the septic tanks should be one cubic metre. The length of tank should be 2-4 times the width. Table 1 gives the suitable sizes of septic tanks which correspond to figure.

more than 7.5cm, size. In the case of large pits the top portion is reduced in size for the reduction in the size of the R.C.C. cover. Fig 3 shows the section through a soak pit.



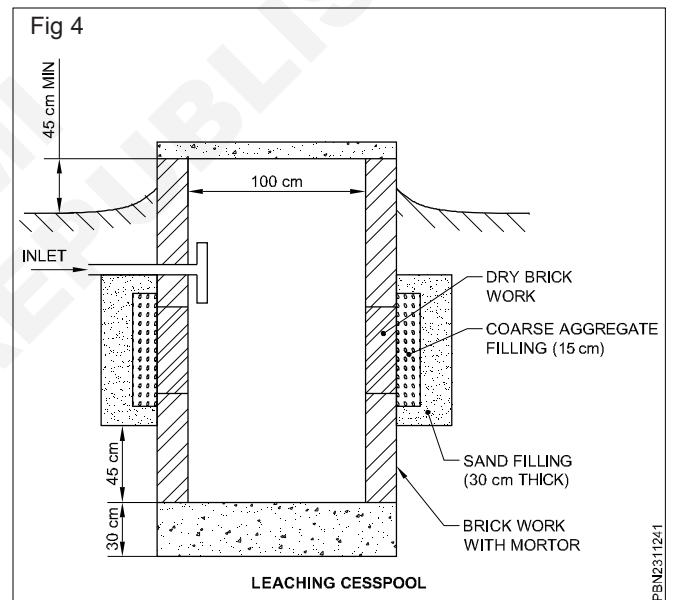
Leaching cess pools

Objective: At the end of the lesson you shall be able to

- state the leaching cess pool.

Leaching cesspool

The cesspool can be used for soaking the effluent of septic tanks. In this cesspool the bottom is made water tight to retain the sewage and sludge while the upper portion is provided with open joints from where the effluent gets dispersed into the surrounding soil. The open jointed lining is surrounded by 15cm coarse aggregate of 4-5cm in size and an outer casing of 30cm thick sand for the better distribution of supernatant effluent in the soil is also provided. Fig 4 shows the section through a Leaching cesspool.



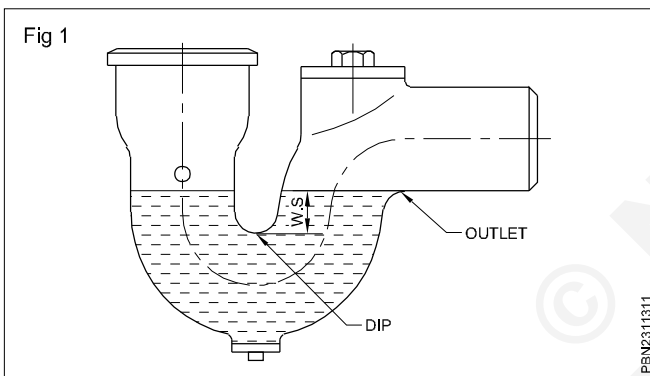
Types of traps

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

- define the traps
- state the uses of traps
- state types of traps.

Definition

Traps may be defined as fittings, placed at the ends of the soil pipes or the sullage pipes (waste pipes) to prevent the passage of foul gases from the pipes to the outside. This is possible because traps does enclose or maintain water seal between the pipe and the outside. This water depth does not allow gases to escape to the outside of the pipe. The efficiency and effectiveness of a trap will depend upon the depth of the water seal. Greater is this depth, more effective the trap will be. This water seal generally varies from 25mm to 75mm, 50mm being quiet common in most of the traps. (Fig 1)



Qualities: A good trap should posses the following qualities:

- It should provide sufficient water seal (50mm - or so) with large surface area. The seal of a trap is the water between the outlet and the dip.
- Its interior should be smooth so as not to obstruct flow and the trap should thus be selfcleansing
- It should be provided with an access door for cleaning and
- It should be made of some nonabsorbent material.

The water seal of the trap can break under the following conditions

- i If there is any crack in the bottom of seal or the joint is faulty.
- ii If for a long time the seal is not in use, its water will evaporate in the atmosphere.
- iii If due to blockage or any other reason there is increase in the pressure of the sewer gases it will pass through the water of seal.

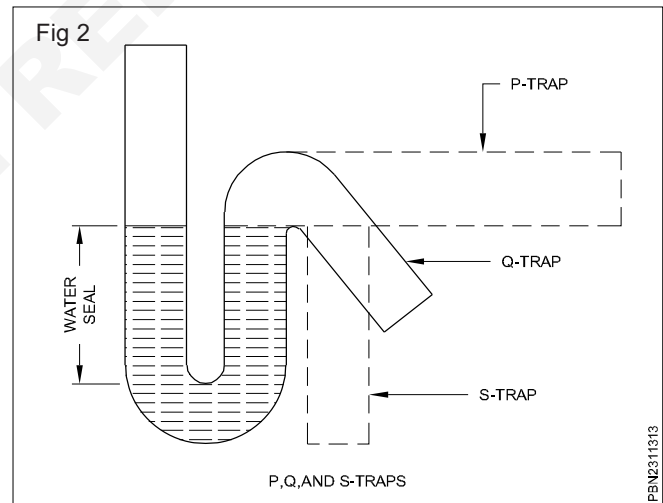
- iv If partial vacuum is created in the sewer fittings, it will suck up the seal water. To avoid the breakage of due to this reason, the portion between the trap and the soil pipe should be connected to the vent pipe.

Types: Depending upon their shapes, the traps may be of three types i.e P-trap, Q-trap and S-trap are used for water closet soil dis charge Fig 2

Depending upon their use, the traps may again be of three types i.e Floor trap, Gully trap and Intercepting trap.

These three different types of traps are briefly described below: 'P', 'Q', and 'S', traps (Fig 2)

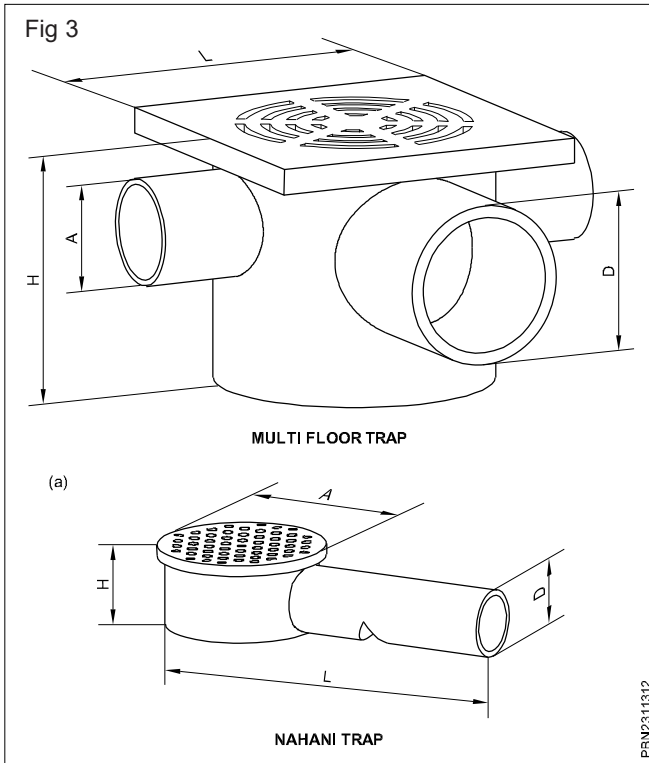
Floor traps (Fig 2): These traps are generally uses to admit waste water (sullage) from the floors of rooms, kitchens, baths, etc. into the said room drain (sullage pipe). These are invariably provided with cast iron or galvanized or stainless steel gratings (Jallis) at the top, so as to prevent the entry of solid and larger sticky matter, into the drain pipe, to avoid frequent blockage.



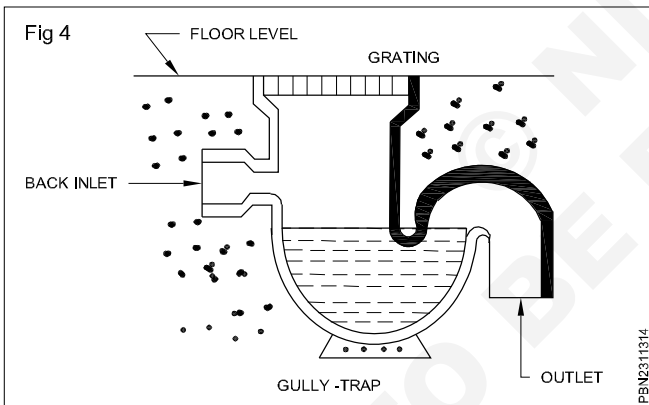
A commonly used trap is Nahani trap. (Fig 3a) for multi in let multi floor trap is used Fig 3

The following types of traps are most commonly used in practice:

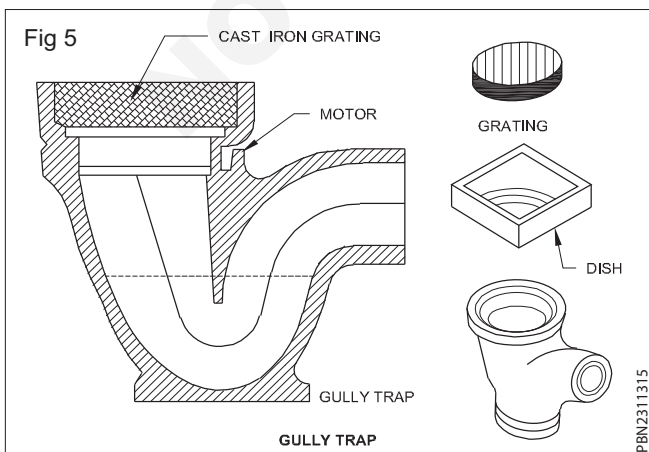
A gully trap or a gully is often provided at the junction of a room or a roof drain and the other drain coming from bath, kitchen etc. The foul sullage from baths, will enter through the side inlet (called back inlet) and the unfoul room washings or rain water from roof or courtyard will enter from the top.



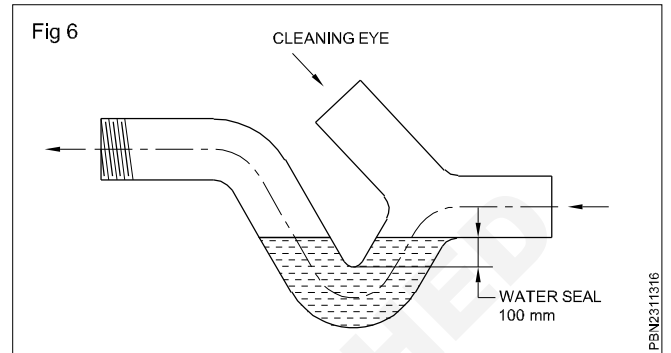
Gully traps may either have a S-trap or a P-trap. The water seal is usually 50mm to 75mm deep. The top of the trap is covered by a C.I grating to exclude the entry of coarser materials to avoid blockage. (Fig 4)



Gully Trap Chambers: The Gully Trap Chambers shall consist of brick masonry chambers suitable for the specified size of the Gully Traps. The traps shall be glazed stoneware of approved make. (Fig 5)



Intercepting traps (Fig 6): An intercepting trap is often provided at the junction of a house sewer and a municipal sewer, so as to prevent the entry of the foul gases of the municipal sewer, into the house drainage system. Either outside in the street or in a corner inside the house boundary. This trap is provided near its top with an access gate or a plug, called cleaning eye for removing silted matter from inside the trap in case of blockage. It has a high depth of water seal, say about 100mm.



Merits of interceptors

Foul gases of public sewer cannot pass through the interceptor, If not provided these gases will enter the vent pipes of the house drainage system, and spread around in the surrounding atmosphere causing serious air pollution.

Harmful pathogenic bacteria contained in the public sewers are thus prevented from entering the house drains, due to the presence of the interceptor.

Demerits of interceptors

If the discharge from house drains is small, the solid heavy matter may be retained in the trap and may start decomposing, producing foul gases.

If the lid or the plug is not fitted properly, or is broken, foul gases from public sewer will do enter the house drain.

Cleaning through the inspection arm of the trap is not easy.

Interceptor itself forms an obstruction to the normal flow of sewage.

Traps for use in domestic waste installations and all other traps should be conveniently accessible and provided with cleaning eyes or other means of cleaning.

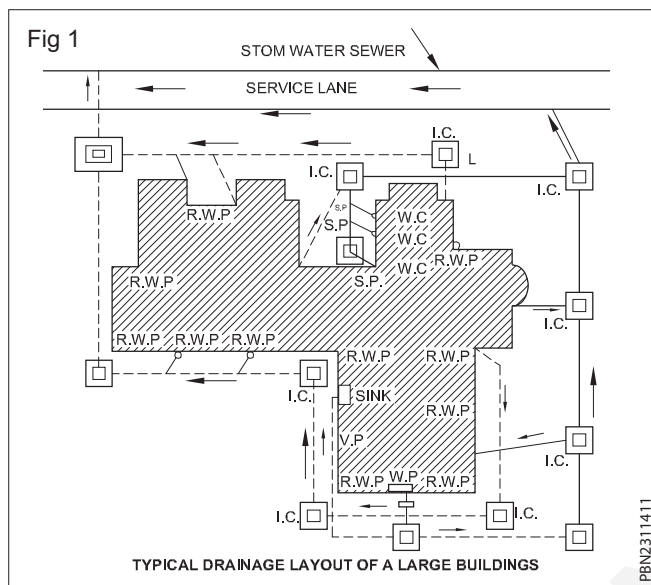
Layout of drainage system

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

- state the necessity and pre-planning of drainage system
- state the factors considered to prepare layout of drainage system.

Before starting the plumbing work it is most essential first to prepare the drainage plans. In the same way as detailed drawings are required before the starting of the construction of building the detailed plans should be prepared.

The following points should be kept in mind while preparing the layout of drainage system: (Fig 1)



- 1 The drains should be laid in such a way so as to remove the sewage quickly from the building. The quick removal is governed by the falls of the pipes. The drains should be laid at such a slope that self-cleaning velocity is developed in them.
- 2 All the drainage system should be properly ventilated on the house side. The ventilation pipe should be carried sufficiently high above the buildings. All the inspection chambers should be provided with fresh air inlets.
- 3 All the drains should be laid in such a way so as to ensure their safety in future.
- 4 The drain should be laid in such a way that in future extension can be done easily if desired.
- 5 All the rain water pipes, sweeping from house and bath water should discharge over gully traps.
- 6 All soil pipes should be carried direct to the manholes without gully traps.

Plumbing Plumber - Drainage system

Related Theory for Exercise 1.9.79

Method of bending pipe by hot and cold method

Refer R.T. for Exercise No. 1.6.34 & 1.6.35

Method of testing drainage lines

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

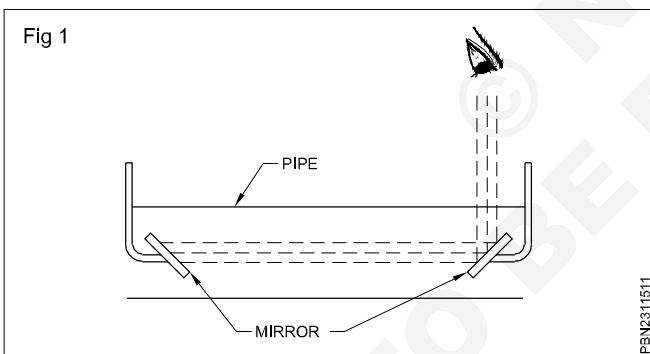
- state the testing of drainage lines
- explain various types of testing in drainage lines.

A wide ranges of testing equipment's are available therefore we should select the equipment required for inspection and testing as per local by law requirements.

The principle methods of soil stack and drain testing are

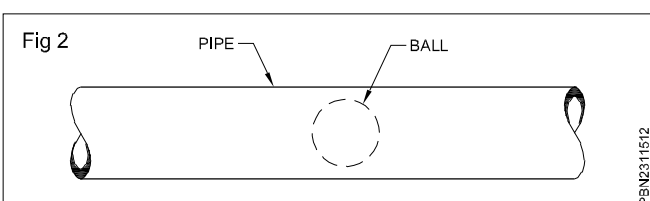
- Mirror test
- Ball test
- Hydrostatic or water test
- Smoke test
- Pneumatic or air test
- Chemical smell test or odour test

Mirror test: This test is applied to check the alignment and condition of the inside of the pipes. Two mirrors are used for the test. They are placed in position through across points and by looking at one of the mirror the condition of the bore of the pipe can be seen as the light is reflected along the pipe. (Fig 1).

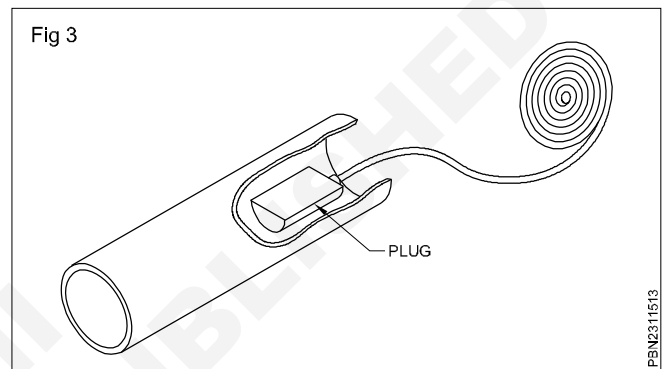


Ball test: In situations where it is not possible to use a mirror test such as bend in the pipe, a brass ball 13 mm smaller than the inside of pipe is inserted in the top end and should roll freely along the bottom or invert of the pipe. If there is an obstruction or pipe is out of alignment the ball will stop, the point where it stops is marked on a rod so that the exact position can be measured off along the pipe. (Fig 2)

- realignment the pipe to the correct fall or
- removing the obstruction.

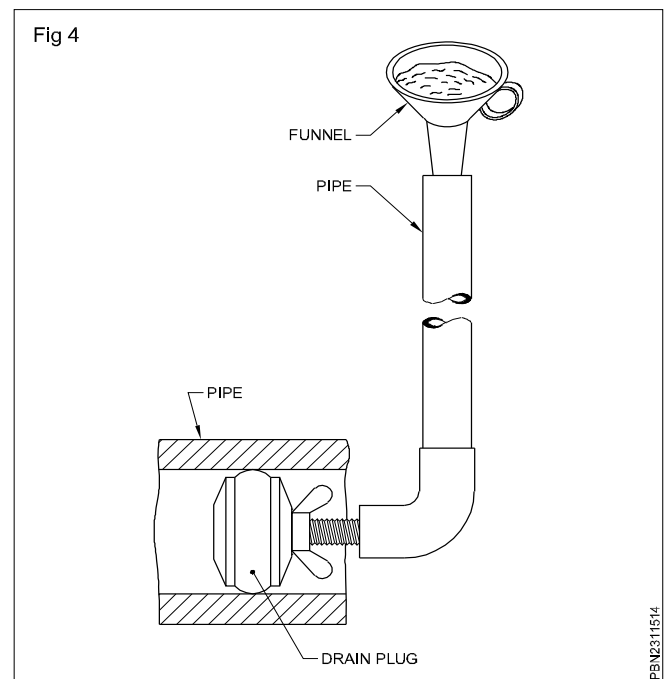


A lead slide or plug: A lead slide or plug can also be used to test for obstruction. A lead plug is attached to a spring steel tape and the plug is then carefully pushed along the pipe until resistance is felt. The tap is then marks and plug withdrawn. This will show exactly where the obstruction is (Fig 3).

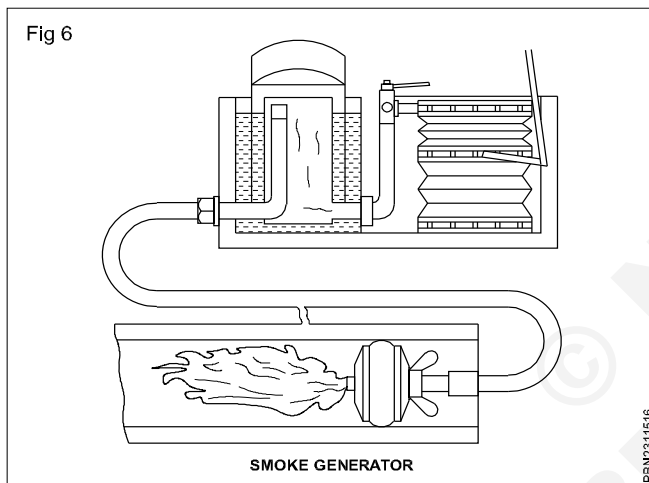
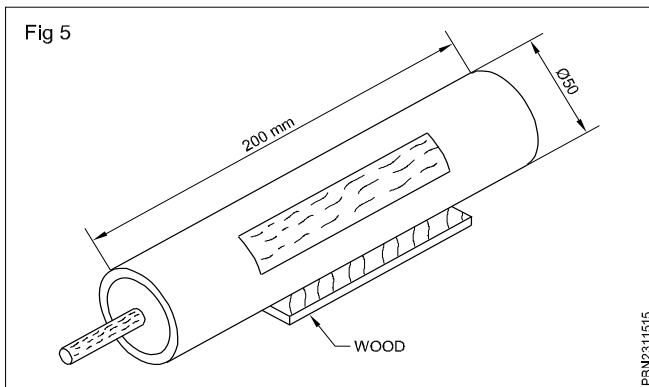


Hydrostatic or water test: The equipment required to conduct this test is drain plug/air bag stopper extrusion tubes, funnel and sight gauge.

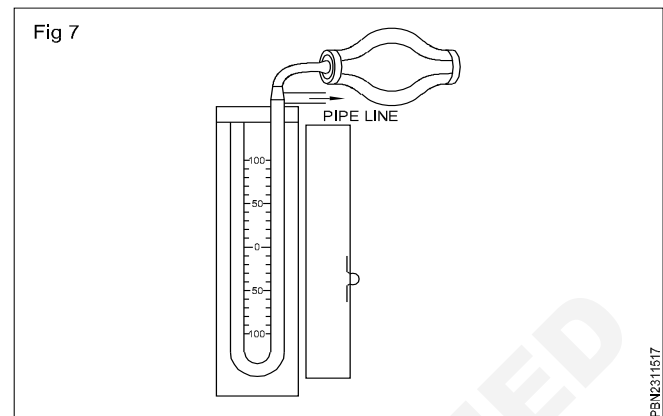
Vertical pipes are temporarily installed on the top end of the installation to provide pressure or head on horizontal pipe and to record level of water. Colored water test is similar to this except that a soluble dye such as fluorescene is mixed with water to easily locate the leak. (Fig 4)



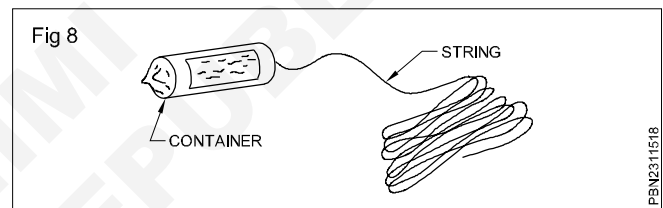
Smoke test: This test is less severe than the water test and is generally carried out where water is not available for apply hydrostatic test. Plug one ends of pipe, other end for testing smoke. After inserting the smoke rocket in pipe the touch paper is producing dense clouds of smoke which travel throughout this pipe work or smoke generator can be used to force the smoke under pressure to pipe. Check the installation for sign of smoke leaking from the joint, plugged end. (Fig 5, 6)



Pneumatic or air test: Air test into the pipe line is similar to smoke test. Connect manometer to pipe line. The hand ballon are pumped to pressure air with the pipe work This should be maintained for a period without dropping back. If the level falls, the leak has to be found and this can be done by applying soap solution on joints. (Fig 7).



Chemical smell test or odour test: A small container filled with strong pungent chemical such as crude oil of peper minit is attached to a long length of string and flushed through a trap into the pipe work pulling on the string opens the container leak is detected by smell. (Fig 8)



Testing of existing connection bath tub, wash basin and sink

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

- state the purpose of drain testing
- state the method of drain testing
- explain the drain testing.

Drain testing: After the drain has been laid and before backfilling, or pouring concretor or granular material round the pipes, it should be tested.

The three main methods of testing underground drains for soundness are:

- 1 Water tests
- 2 Air tests
- 3 Smoke tests

If any leak occurs, the defective pipe or joint should be rectified and the drain again tested. Wherever possible, testing should be carried out between the manholes and short branch drains tested along with the main drainage

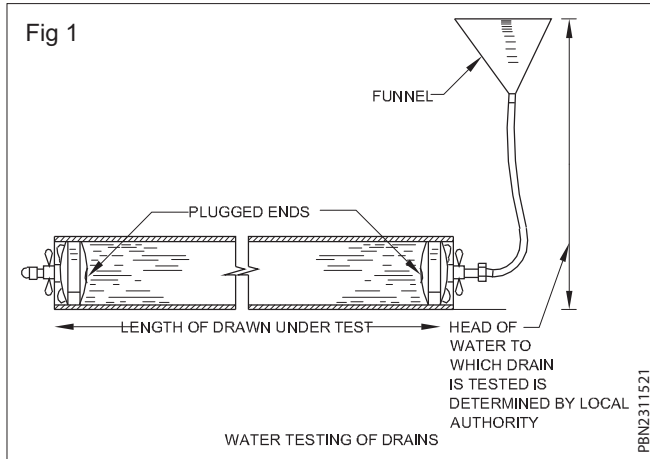
system. The test before backfilling should be carried out the pipe should be supported to prevent any movement.

Water Tests (Fig 1)

- 1 The drain should be filled with water, to give a test pressure equal to 1.5 m of water. Steeply grade drains should be tested in stages, so that the head of water at the lower end does not exceed 4 m.
- 2 The pipeline should be allowed to stand for two hours and topped up with water.
- 3 After two hours the loss of water from the pipeline should be measured by noting the quantity of water needed to maintain the test head for 30 minutes.

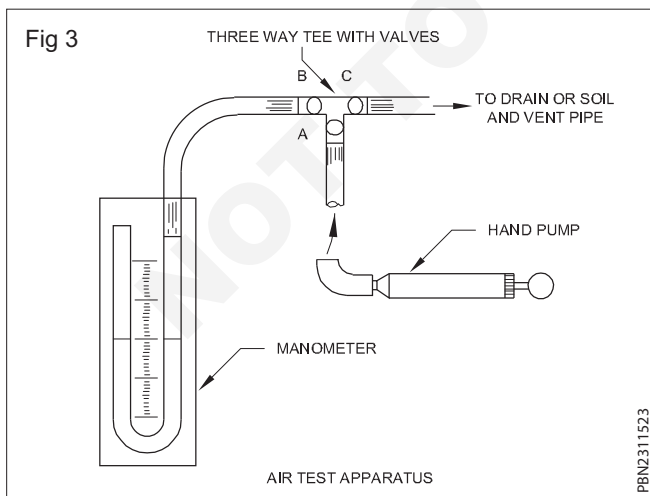
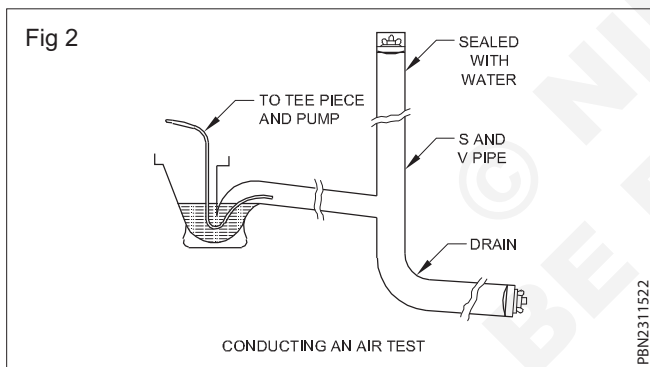
This is due to

- a Absorption by pipes or joints;
- b Trapped Air;
- c Sweating of pipes and joints;
- d Leakage from defective pipes or joints;
- e Leakage from stoppers.

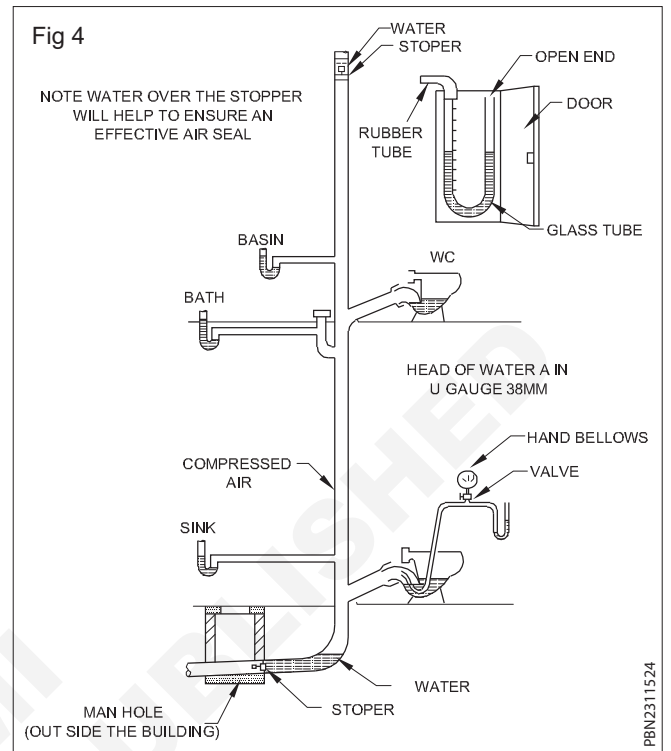


Final Water Test (Fig 2, 3 & 4)

The rate of water loss should not exceed 1 litre/hour for various pipe sizes the rate loss differs.



Air tests: An air test is usually applied if there is insufficient water available for testing, or if there is difficulty in its disposal on completion of the test. Air tests are usually for 10 to 15 minutes, the pressure drop on the gauge must not be more than 25 mm.



An advantage with air testing is that all parts of the drain are subjected to the same pressure.

A tee piece with three valves is connected to a manometer (U-gauge), hand pump and a hose. The hose is passed through the seal of a Gully Trap. With Valves A and C open and Valve B closed, air is pumped into the system.

The air pressure is checked periodically by opening Valve B. When the test pressure is reached, Valve A is closed and Valve B is opened. The air pressure is now recorded on the U-Gauge. If the system is sound the difference in levels in the manometer will be retained. Should there be a leak the levels will return to zero.

Method of dismantling and renewal of the valves and pipes, leaks in pipes and noises in plumbing

Objectives: At the end of the lesson you shall be able to

- state the repairing process of bibcock float valve etc.,
- state the replacing of spindles in the cocks
- State the repairing of gate valve.

Dismantling

The term dismantling implies carefully separating the parts without damage and removing.

Always be well planned before handling in a systematic manner.

Repair of water supply fittings - Bibcock

1 Bibcock is commonly referred as tap and it is the most frequently used water supply fitting.

- 2 There are taps of many designs available in the market. It is advisable to read the manufacturers' instructions also while repairing the taps.
- 3 The defects commonly encountered during the functioning of taps, their causes and remedial measures to be taken are listed below.

Defect	Cause	Remedy
Water flows/drips from the tap even when the tap firmly closed	Worn out defective washer Accumulation of grit, dust or other foreign matter	Replace washer Remove the foreign matter
Water flows from around the spindle or stuffing box	Defective seating Gland nut is loose. the packing in the stuffing box is defective	Reseat tap Tighten the gland nut box. Replace the packing
Difficulty to turn on or turn off the Spindle bent.	Stuffing box packing is dry. some oil. Replace tap.	Replace tap (or) spindle.
Spindle continuously slipping when the tap is turned and tap does not shut off	Spindle thread worn out	Replace tap (or) spindle
There is lot of noise in the tap when tap is turned on	Valve loose on the spindle. Washer loose on the valve	Replace tap Replace washer. (or) replace spindle

Repair of water supply fitting-Flushing cistern and float valve

The commonly encountered defects during the operation of flushing cisterns and float valves, their causes and remedial measures to be taken are listed below:

Defect	Cause	Remedy
Flushing cistern		
Water flows from the over-flow pipe of the cistern	The float has broken (or) slip down	Replace the float
Water flows from the over-flow pipe of the cistern through the float is not damaged	The position of the float valve is not correct	Always adjust the ball valve level to 2.5cm below the level of over-flow pipe

Water is leaking from the cistern -flush pipe junction	Checknut is loose, Checknut washer defective	Tighten the checknut. Replace washer
Float valve Water is running continuously into the bowl.	Auxiliary valve seat has worn out. Bypass is clogged	Replace washer. Clean the by- pass by running a fine wire.

Repairing practice of gate-valve

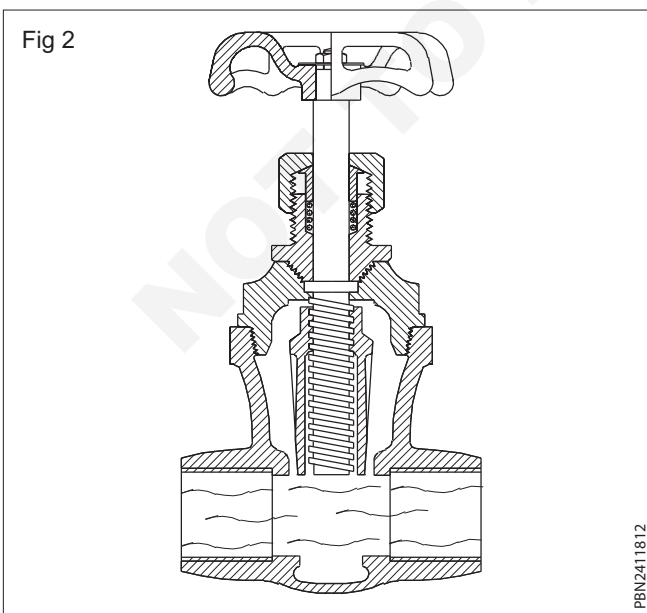
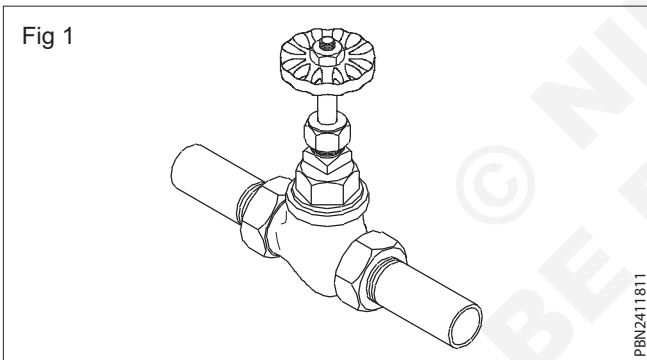
Gate valves is one of the most common valves used in the main supply lines of a water supply system and pump-lines.

The commonly encountered defects during the operation of gate valves, their causes and remedial measures to be taken are listed below.

Gate-valve

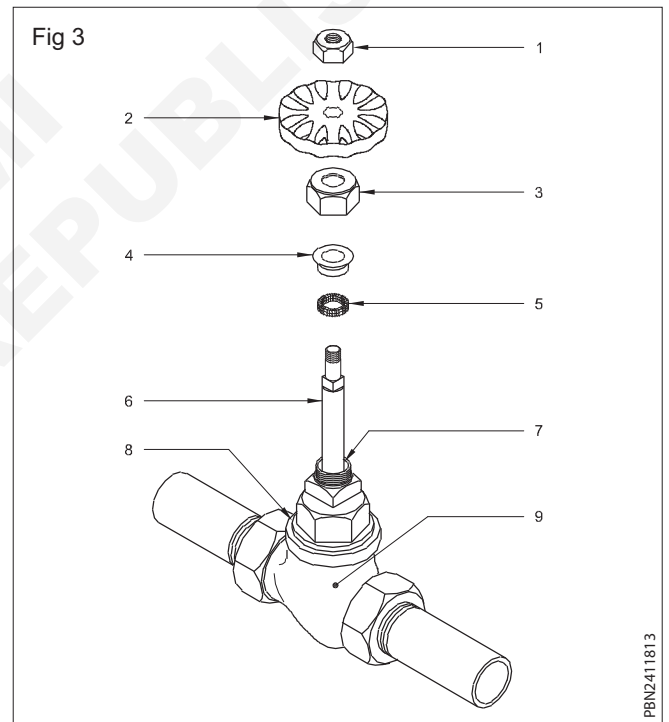
The gate-valve gets its name from the gate-like disc that slides across the path of the flow. This valve provides an unobstructed waterway when fully open. This feature makes the gate-valve useful in large piping installations. It is best suited for main supply lines and pump-lines. It should not be used to regulate flow. It should either be fully opened or completely closed.

It is one of the most common valves found in a water distribution system. (Figs 1 & 2)



Parts of a gate-valve (Fig 3)

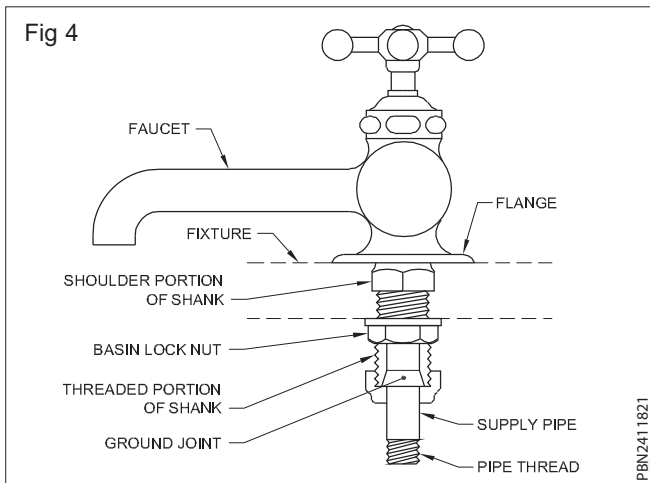
- 1 Hand wheel nut
- 2 Hand wheel
- 3 Gland nut
- 4 Stuffing gland
- 5 Packing
- 6 Shaft or spindle
- 7 Stuffing box
- 8 Bonnet
- 9 Gate - valve body



Defect	Cause	Remedy
Water flow from around the stuffing box screw	Gland nut is loose. The packing in the stuffing box is defective	Tighten the gland nut Renew packing with asbestos hemp and water pump grease
Valve is hard to turn on or turn off Spindle is bent	Stuffing box packing is dry spindle is bent	Tighten the gland nut
Spindle rotates continuously and the gate valve does not close	Spindle thread is worn out badly	Replace the worn-out part

Repairing practice of pillar cocks

Pillar tap (Fig 4)



It is generally of chromium plated brass. Pillar taps of other materials are also available in market. The size is designated by the nominal bore of pipe outlet to which the tap is to be fitted. The weight of CP brass pillar tap of 15mm and 20mm are 650gm and 1175 gm respectively. Pillar tap should withstand an internally applied hydraulic pressure of 20 kg/sq.cm.

Repair of water supply fitting-Stopcock

Stopcock is similar in construction to a bibcock except that it is placed in the pipeline.

The defects commonly encountered during the functioning of stopcock, their causes and remedial measures to be taken are listed below.

Defect	Cause	Remedy
Water drippings stopcock even after it is firmly closed	Worn out defective washer Accumulation of grit, dust, or other foreign matter	Replace washer Remove the foreign matter
Water flows from around the spindle or stuffing box screw	Defective stopcock seat	Reseat stop cock
It is difficult to turn on or tune off the cock	Gland nut is loose The packing in the stuffing box is defective	Tighten the gland nut. Replace the packing.
Spindle slips down continuously when the cock is turned.	Stuffing box packing is dry Spindle bent Spindle thread worn out badly	Renew packing. Replace cock Replace the stopcock

Leaks in pipes and noises in plumbing

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

- state factors affecting leaks in pipes and waste water in pipes
- state the waste water surveys
- explain the methods of waste water surveys
- state the noise in pipe lines.

Factors affecting leakage and wastes in pipes

Following are the main factors which are mainly responsible for the leakage and wastes in the distribution systems:

- 1 **Bad-joint:** If the pipe joints and the connections of various fittings are not done with due care, it will lead to the leakage of water. This leakage can be reduced by doing careful plumbing and better supervision, use of best quality materials and proper checkup and maintenance of the distribution system.

2 Pressure in the distribution system: The leakage in pipe lines will directly depend on the pressure of water, more the pressure more will be leakage. The pipes and other fittings of good quality which can withstand the pressure should be used.

3 System of supply: In continuous system the leakage and wastage of water is more than intermittent system. But in some cases where mostly people keep their taps open, the losses may not be less even in intermittent system.

Unauthorised connection: In some case the water may be stolen by unauthorised or illegal connections, taken from the service lines. It can be detected by proper checking.

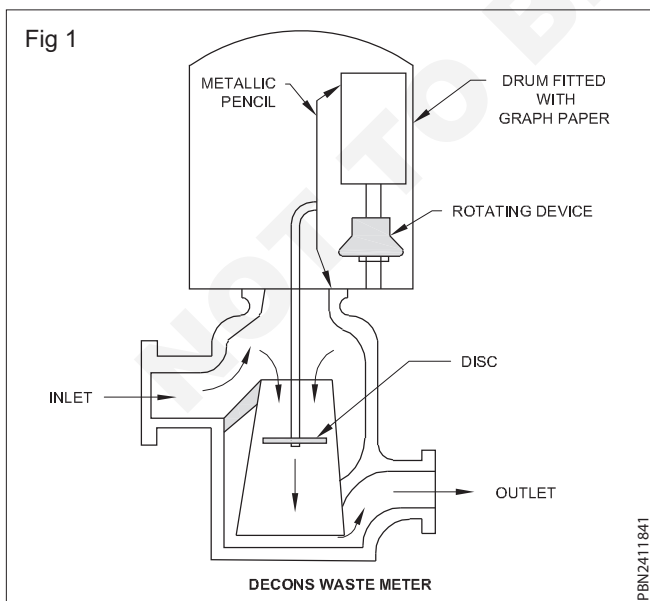
Metering: The wastage can be reduced by metering, because when the people will have to pay the cost of water on meter, they will leave their habit of wastage.

Sounding rod is penetrated in the ground upto pipe line and the inspection is done. To magnify the hissing noise of leaks acquaphone or sonoscope can be used.

By hydraulic gradient line: This method is used in locating the correct position of the leak. First the hydraulic lines are drawn and these lines intersect at the place of leak.

By waste water meters: Generally deacons waste water meter is used for this purpose.

Fig 1 illustrates the essentials of deacons' waste water meter. It consists of a disc held in balance by a counterweight and when water passes, it is forced down. The movements of the disc are directly transferred by a system of levers to a pencil point, which moves on a graph paper mounted on drum. The drum continuously rotates in clockwise direction by a clockwise arrangement. Thus the rate of flow of water is automatically recorded on the graph paper.



All unauthorized connections can be detected by thoroughly inspecting the pipelines and house connections.

Unauthorized connections can also be detected by intelligence department, by investigating through persons.

Leakage and carelessness in private buildings can be detected by inspecting the fittings and pipe joints. The inspections should also be done in nights to check the carelessness.

Waterline: In adequate pressure is one of the complaints. We can have one pipe upto 4 floors with variable diameter or one pipe for ground and 1st floor, and another for second and third floor. Pipes are to be painted on all sides periodically. If painting is peeling off (due to painting when pipe was shining) it should be removed and repainted including a primer coat. When leakages are noticed in G.I pipes remove the defective section of pipe and replace it with a new one. For threaded pipe the simplest way to do this, is to cut the defective section into two with a hacksaw, then unscrew the two pieces from the adjoining fittings without disturbing any other fittings. Connect the new pipe with a union. Copper tube leak can be repaired by soldering. In case of C.I pipe defective pipes are cut and removed and fresh pipe introduced with help of a CI collar and C.I. cut pipe.

Leaking taps: It happens due to defective handle preventing washer from being pressed against a seat. If a tap leaks drop by drop the loss of water is about 3000 litres/months. Washers are available in leather, rubber, ceramic and nylon. The nylon washer are good for cold water.

Shower: It shall be cleared off deposit. Repair the hole with pin. If the shower head clogs frequently due to mineral deposit, unscrew the head and soak them in vinegar. Scrub with brush.

Water hammer: If water flowing through a tap or valve is suddenly arrested, the water will record in the pipe. Water is practically incompressible and will act like a solid rom induce stresses inside the pipe and it will produce a noise like hammering. It is known as water hammer.

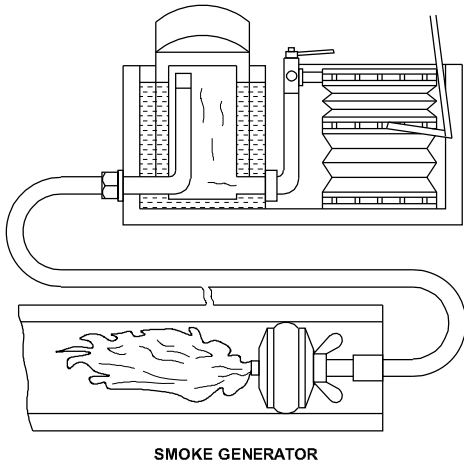
To prevent water hammering, taps and valves should be closed slowly.

The valve consists of one or two floats air relief valve preventing inside the flow. The air openings are provided at the top and the valve is connected to the main. Normally the float chamber remains full of water: but if the air fills it, the float falls due to decrease of water level above which opens the air opening above and the air escapes. Then the chamber fills up with water again and the float goes up and closes the air opening.

Waste water line

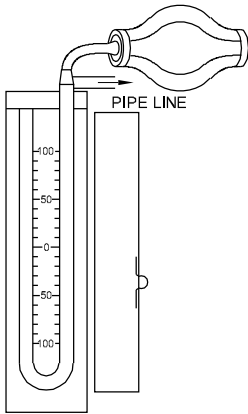
Pneumatic or air test: Air test into the pipe line is similar to smoke test. Connect manometer to pipe line. The hand balloon are pumped to pressure air with the pipe work till the required displacement reading according to local bylaws is obtained. This should be maintained for a period without dropping back. If the level falls, the leak has to be found and this can be done by applying soap solution on joints. (Fig 2 & 3).

Fig 2



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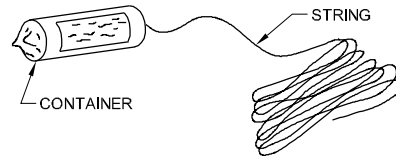
Fig 3



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Chemical smell test: A small container filled with strong pungent chemical such as crude oil or pepper mint is attached to a long length of string and flushed through a trap into the pipe work pulling on the string opens the container - leak is detected by smell (Fig 4).

Fig 4



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Installation of water meters Air lock in pipes and its removal

Objective: At the end of the lesson you shall be able to
 • state air lock in pipes and its removal.

Air relief valve

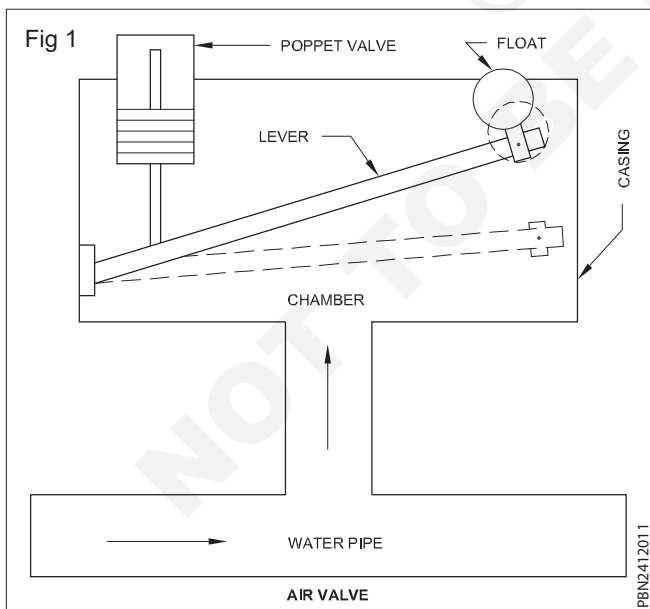
Some quantity of air is contained in the flowing water and this air tries to accumulate at high points along the water pipe. In order to provide an exit for such accumulated air, the air valves are provided at summits along the water pipe. The air valves should be located at points which are close to or above the hydraulic gradient. If air valves are not provided, there are chances for pipes to be air-locked. The effective area of flow and consequently the discharge through water pipe are greatly reduced due to air-locking.

The provision of air valves along water pipe also helps in admitting air quickly when vacuum occurs in water pipe due to sudden breakdown of water pipe at low points.

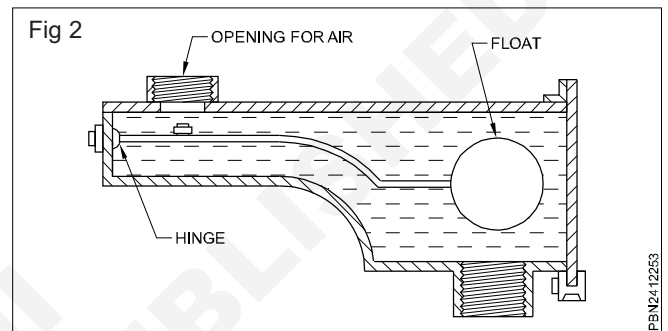
An air valve consists of a cast-iron chamber, float, lever and poppet valve as shown in Fig 1. The chamber may be circular or rectangular in shape. A poppet valve is a valve that is lifted bodily. The working of the air valve is as follows.

Pipe Appurtenances (Fig 1)

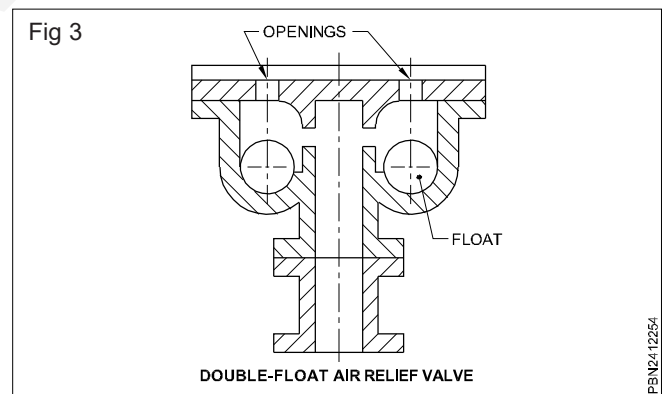
- 1 In the normal condition, the chamber is full of water drawn from water pipe. The float therefore touches the roof of chamber and poppet valve is in a closed position.



- 2 When air from water pipe enters the chamber, it starts accumulating just below the roof of chamber. This accumulation of air makes the lever to work and to bring down the float.
- 3 The pulling down of float by lever operates the poppet valve which is then opened. The air is thus allowed to escape through the poppet valve.



- 4 When air escapes, the water rises again in the chamber and the lever works to rise the float. It ultimately results in the closing of poppet valve before escape of water takes place through it.
- 5 The action of air valve is then repeated.



Installation of water meter

Objectives: At the end of the lesson you shall be able to

- explain water meter
- explain venture meter.

Watermeter

To determine the quantity of water flowing through pipes devices are required which are called meter.

Meters can be classified as follows.

Positive displacement type

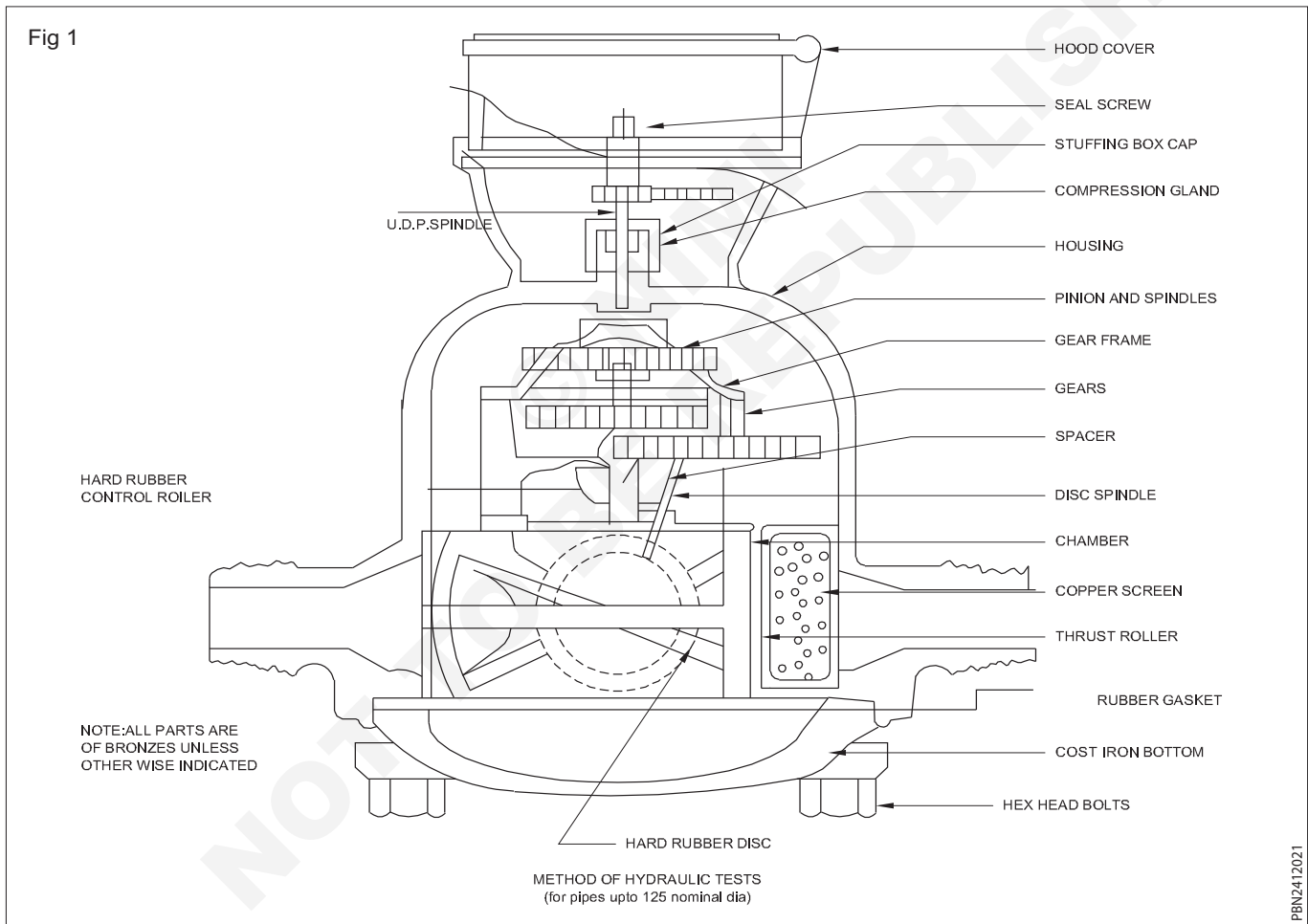
These are used for measuring small flow of water. These are designed on displacement principle These types of meter include rotary, reciprocating, oscillating and notating disc meters.

The installation and maintenance of domestic water meter is governed by IS2004. Testing of the water meter is done as per IS6748.

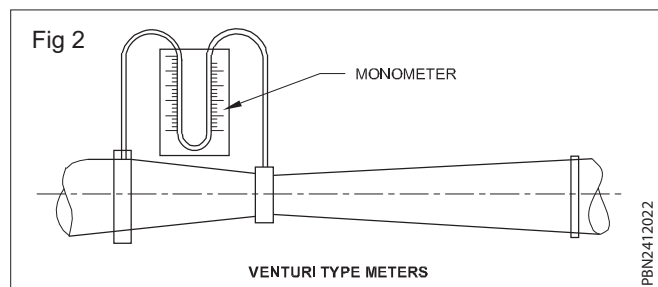
Venturimeter (Fig 1)

These are generally venture or turbine type. It consists of a device by which a vane or propeller turn indirect ratio to the rate of flow of water around the propeller. The venture type meter consists of two tapering cast iron conical pipe one long and other short joined together at their small ends. These meter tubes are connected to an apparatus which measure the difference of water level between them. By means of an automatic device a graph is recorded of the discharge passing through the venture tube. Such meter are usually provided at the head of main water supply pipe.

These are covered by IS: 2401-1973.



The meters are housed in meter boxes at a slightly higher level to prevent flooding of the chamber during rains. The position of water meter is to be as shown in Fig 2. The method of testing water meters (domestic type) is given in IS: 6784-1973. (Fig 3)



Size 1 shall be suitable for the installation of water meters of nominal sizes 15, 20 and 25 mm and Size 2 for meters of nominal sizes of 40 and 50 mm.

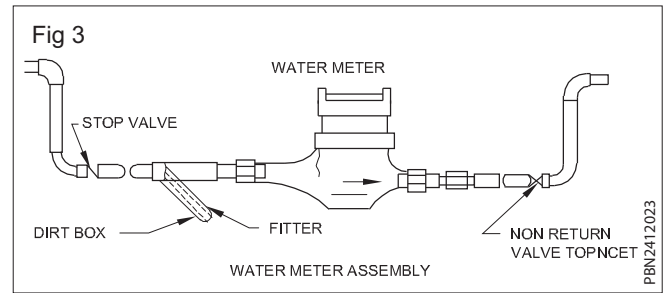


TABLE 2
Nominal capacity of water meters

Nominal size of meter (mm)	Semi-positive type (liters)	Discharge per hour
		Inferential type (liters)
15.....	2,000	2,500
20.....	3,400	3,500
25.....	5,500	5,500
40.....	10,000	16,000
50.....	15,000	23,000

Description of cocks and valves - their types materials and advantages for particular work

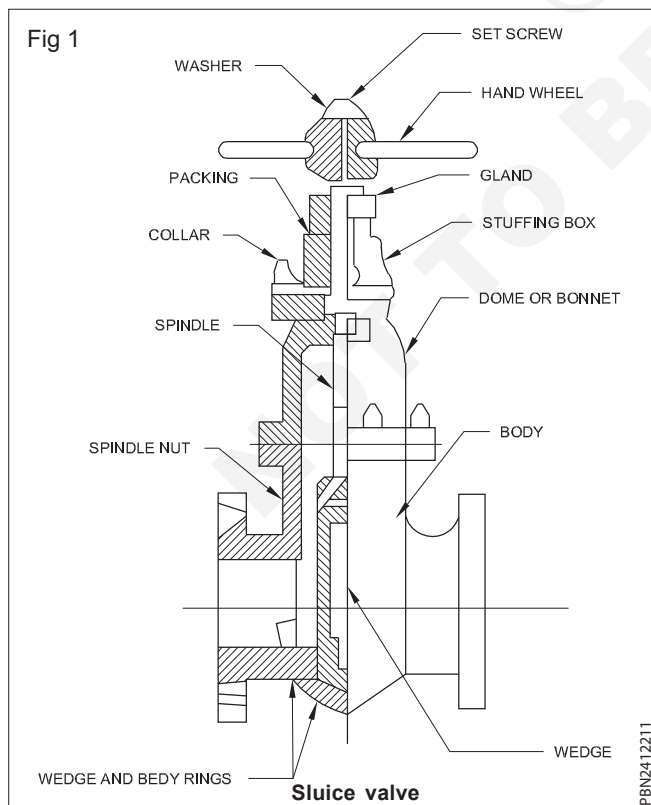
Objectives: At the end of this lesson you shall be able to

- State the construction and uses of sluice valve, gate valve Mud valve, globe valve, Non return valve, check, Valve and other Valves
- State the purpose and Jointing
- State the different type of cocks
- State the uses of different cocks in water supply lines
- State the merits of cocks and valve.

Valve

In water works practice to control the flow of water, to regulate pressure, to release or to admit air, to prevent flow of water in opposite direction and for many other purposes valves are required.

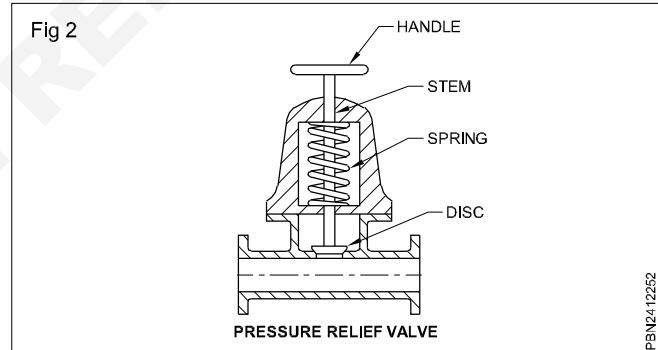
Sluice valve: The sluice valves are made from grey cast iron. The valves are used in a pipe line for controlling or stopping flow of water. These valves are operated in underground chamber, and are open or closed through gearing. The body domes cover wedge gate and stuffing box shall be of good quantity CI. The spindle of bronze, the nut and valve seats of leaded, tin bronze. The bodies spindles and other parts shall be truly machined with surface smoothly finished. The valve shall be marked with an arrow to show the direction of turn for closing of the valve. This valve surface box should be of CI well-made and free from casting and other defects. The boxes shall be coated with black bituminous composition. (Fig 1)



The fixing of the valve should be done by means of bolts, nuts and 3mm rubber insertions or chemically treated compressed fiber board 1.5mm thickness.

They are generally placed at a distance of about 150 to 250 m interval and at all junctions. location of sluice valve at an interval of one kilometer on long straight mains.

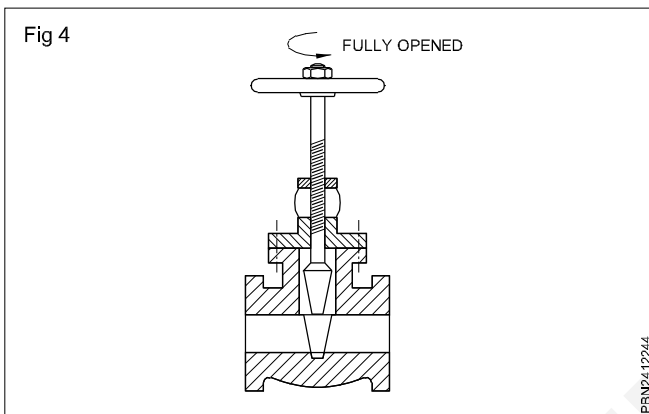
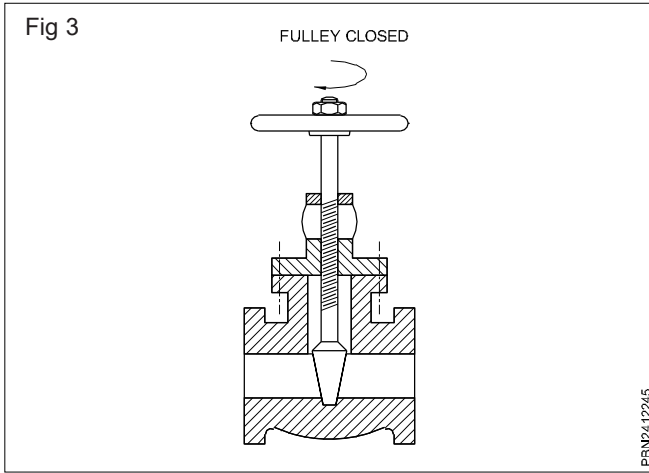
Pressure relief valve: These valve relieve high pressure in pipe lines (Fig 2) such type of valve which is intended to release excessive pressure that may build up in a closed pipe. It essentially consists of a disc controlled by a spring which can be adjusted for any pressure when the pressure in the pipe line exceeds that desired pressure, the disc is forced off from its seat and excessive pressure is relieved through cross pipe after the disc comes down automatically due to force of spring.



Gate-valve (Fig 3,4) (or) Main valve

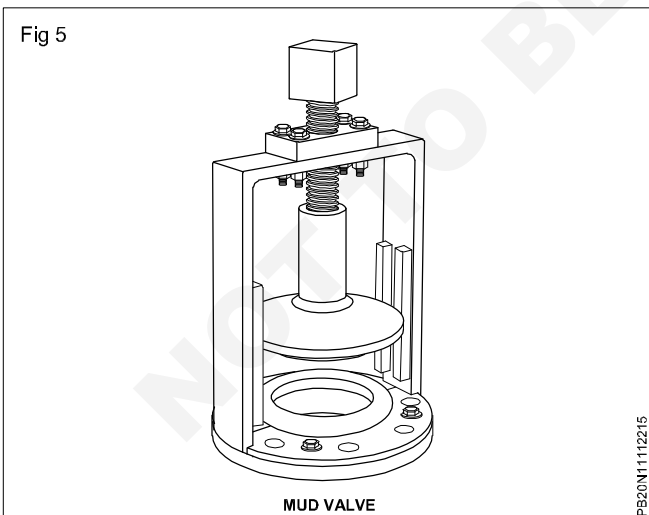
The gate-valve gets its name from the gate-like disc that slides across the path of the flow. This valve provides an unobstructed water way when fully open. This feature makes the gate-valve useful in large piping installations. It is best suited for main supply lines and pump-lines. It should not be used to regulate flow. It should either be fully opened or completely closed.

It is one of the most common valves found in a water distribution system.



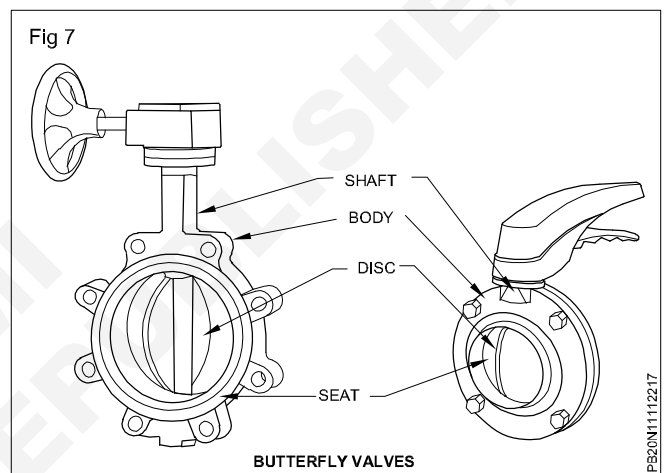
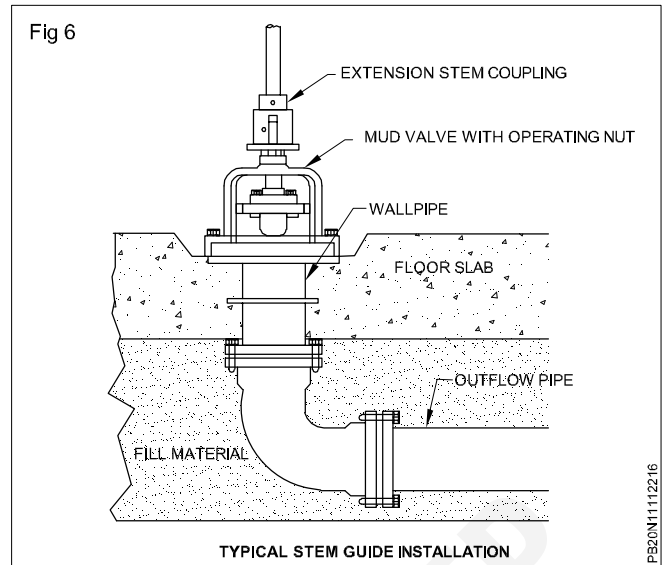
Mud valve

This valve is shown in Fig 5. It is used for removing water and mud or sludge from the bottom of the reservoir. It is very simple type of valve. This valve is fitted at the bottom of reservoirs. It consists of a circular disc which when on lifted from the seat, mud or sludge is drained off from the tank. (Fig 6)



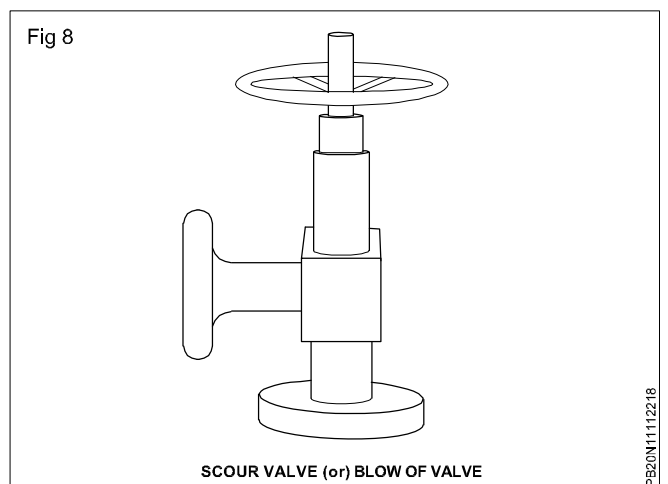
Butterfly Valve

- This type of Value are now - a- days so familiar.
- It is fixed in the water line to arrest (or) to Control the flow of water Fig 7
- Due to its design maintenance is so easy.



Scour valve (or) blow off valve Fig 8

- 1 These are similar to blow off valves and operated by hand



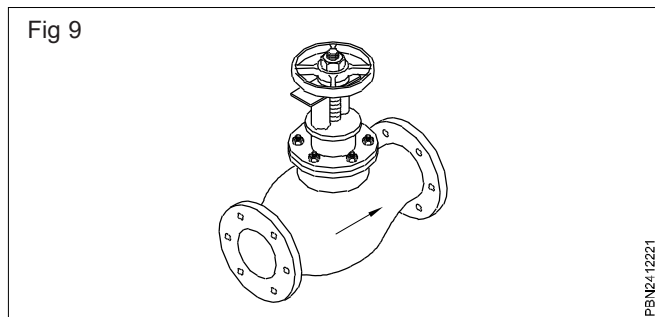
- 2 It is placed at dead ends or lowest point in the mains
- 3 They are provided to remove the sand and silt deposited in the pipe line.

Wheel valve (or) Branch valve (or) Globe valve (Fig 9): Globe valves are widely used in most piping systems for controlling air, steam and water. The globe

shaped body of the valve has a partition in it. This partition closes off the inlet side of the valve from the outlet side. (Fig 9)

The upper side of the opening is ground smooth.

A rubber disc or metallic disc is attached to the end of the stem which presses down against the smooth opening when the handle is turned clockwise. This closes the valve and stops the flow.



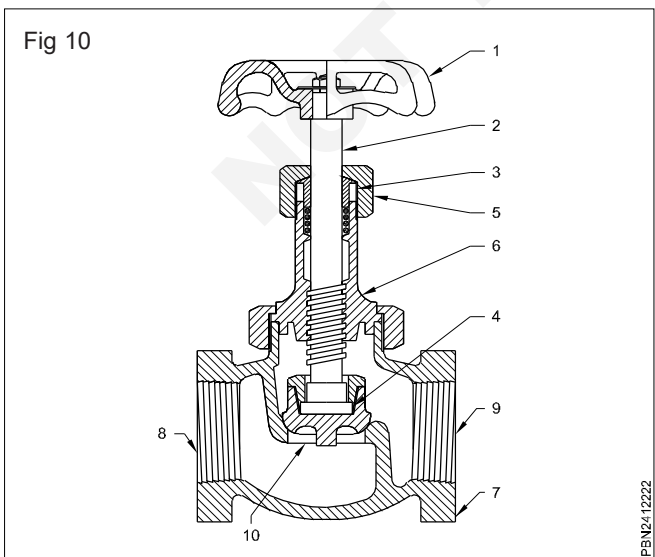
The top of the housing is hollowed out to receive some packing material. This packing should be replaced if the valve begins to leak between the packing nut and the valve stem.

Advantages: The major advantages of the globe valves are as follows.

- The critical parts such as washer, seat and packing can be replaced.
- The valve permits accurate control of the flow of water.
- The valve can be used repeatedly, because it can be repaired easily.

The globe valve consists of the following parts. (Fig 10)

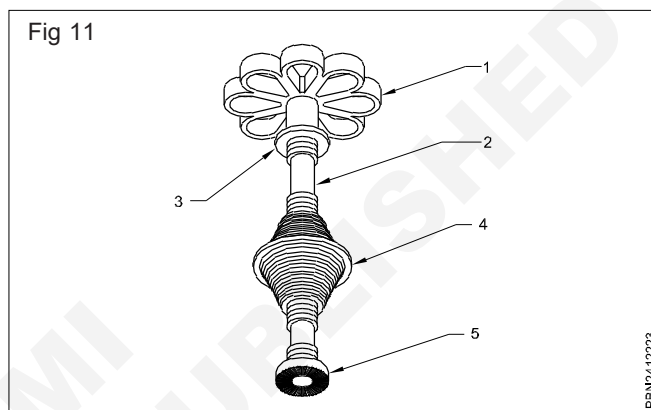
- 1 Hand wheel
- 2 Shaft or spindle
- 3 Gland nut
- 4 Stuffing box with packing
- 5 Bonnet
- 6 Threaded portion of spindle



- 7 Metal valve or disk holder with rubber washer
- 8 Inlet
- 9 Outlet
- 10 Valve seat

Reseating tool (Fig 11): The parts of a reseating tool are as follows.

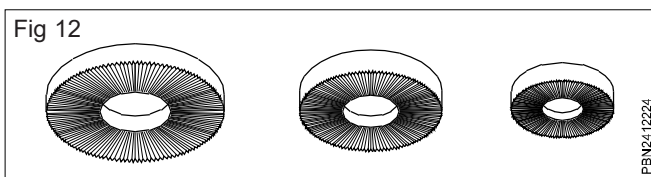
- 1 Hand wheel
- 2 Shaft or stem cone
- 3 Feed screw or collar
- 4 Tapered adapter
- 5 Cutters (inter-changeable)



This is used to level and clean the valve seat area. The reseating tool has a steel shaft with a round handle on one end and a cutter on the other.

The cutter can be changed to the size required and is held down to the seat by a feed screw.

The tapered adapter cone has threads on both sides and is reversible. The threads on one side of the adapter are from 3/8" to 1 1/4". The reseating tool has three or four different cutters having sizes 3/8", 1/2", 3/4" and 1". (Fig 12)



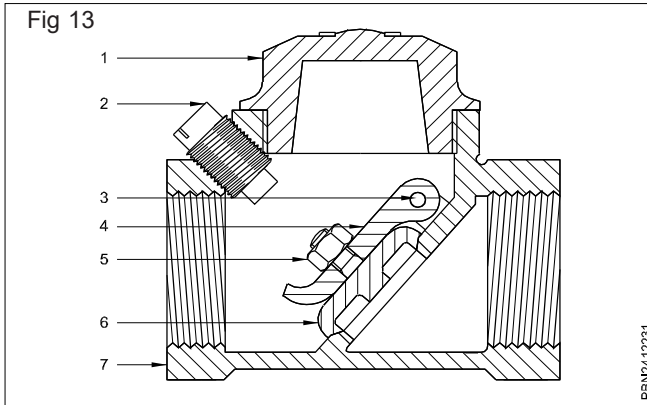
Non-return valve/check valve

Non-return valve: Water supply piping systems are used several mechanical devices to control and regulate the fluids and gases flowing through them.

The non-return valve allows one-way flow in water supply or drainage lines. It is also called a check valve. Valves are made of cast iron, brass, bronze or plastic. (Fig 13)

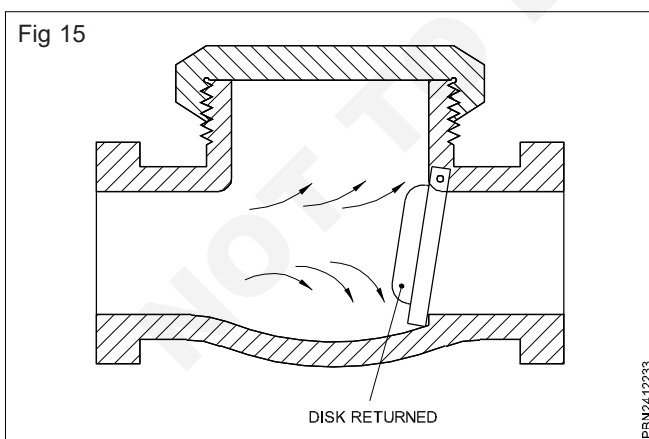
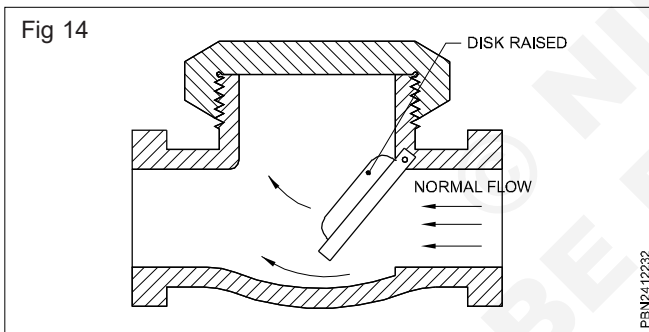
Sometimes two or more different kinds of materials are used on a single valve. There are many types of check valves available in the market.

The swing check valve consists of the following parts. (Fig 16)



- 1 Cap
- 2 Stop plug
- 3 Hinge pin
- 4 Hinge
- 5 Disc hinge nut
- 6 Disc
- 7 Body

In the swing check valve, the flow of a fluid or gas in one direction lifts the disc and allows one-way flow only. The return of the disc to its seating position prevents the flow in the reverse direction. (Figs 14 & 15)

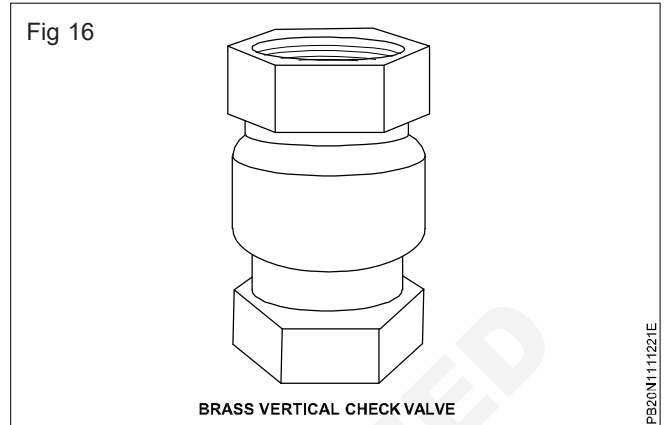


In the ball-type check valve, the flow of a fluid or gas in one direction lifts the ball; when the pressure is released the ball falls against its seating and prevents flow in the reverse direction.

Brass vertical check valve (Fig 16)

- Check Value Vertical:

- This type of valve is fixed in vertical position. Fig 16
- To be fixed with arrow mark direction.
- Arrest backflow allow water in one direction only.
- Especially used in Drinking water hand pump.



Fire hydrants and their fittings

Hydrants

These devices are used for tapping water from mains for fire extinguishing, street washing, watering gardens, flushing sewer lines and for so many other purposes. These are generally provided at all junctions of roads and at 100-130 meters apart along the roads.

In the case of fire breakout in a locality, the firefighting, squad connect their hose with the fire hydrant and do the extinguishing of the fire by sprinkling water over it. For sprinkling the water over the high store of the buildings, fire hose is attached to the fire engine, while develop the required pressure in the fire hose. Usually the pressure head in the nozzle of the fire hose is kept about 35 m. The diameter of the fire hose nozzle is about 28 mm.

Generally the following pressure is maintained in the pipe lines at fire hydrants position.

- 7 - 14 m head of water, if pumped through motor.
- 35 - 50 m head of water, if no pumps are used and water directly flows through the hydrants to fire.

Following are the requirements of a good hydrant:

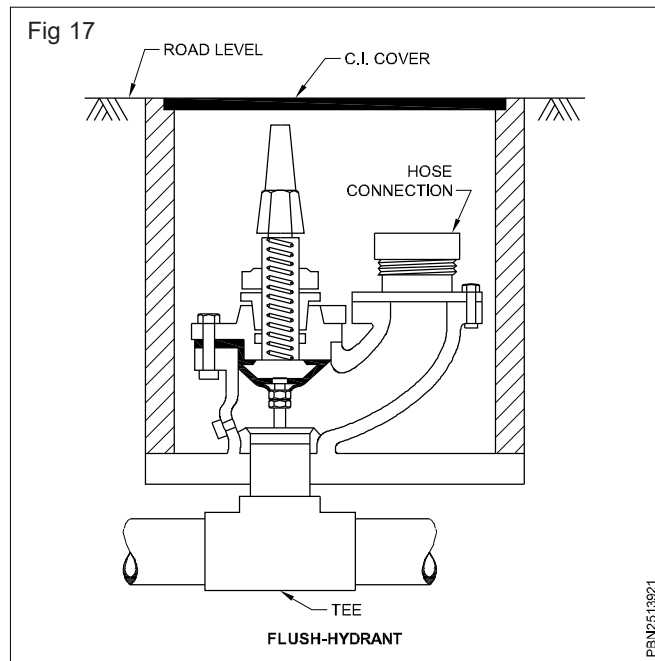
- i It should be easily connectable to the hose pipe.
- ii It should be cheap in cost as well as maintenance.
- iii It should be easily detachable during the panic atmosphere of fire in the locality.
- iv It should be reliable and should not go out of order during fire and operation.

Hydrants are of two types

- a Flush hydrant
- b Post hydrant

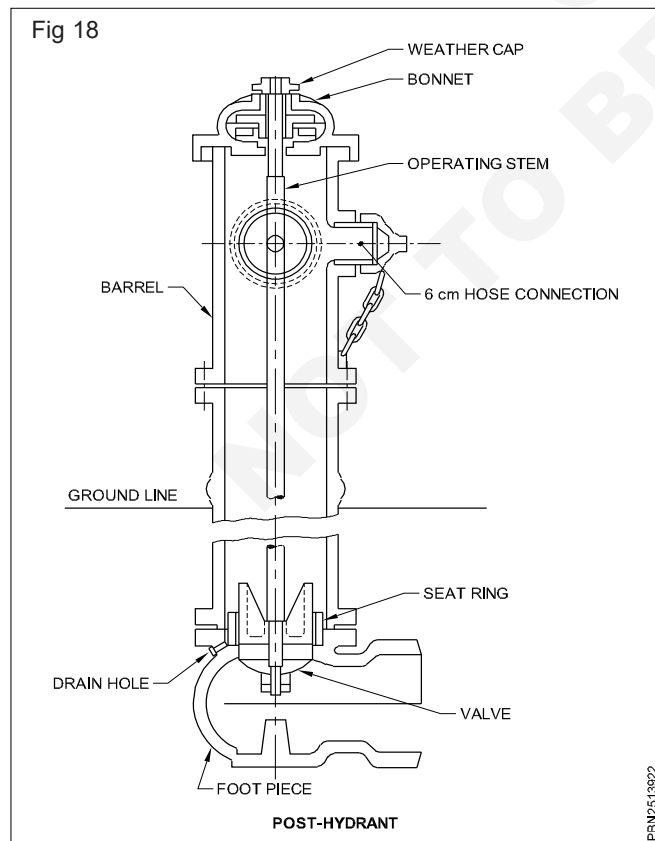
Flush Hydrant (Fig 17): It is installed in an underground brick chamber flush with the foot path. It is covered from

the top by a C.I. cover. To locate the position of this hydrants even in darkness, some distinct sign is provided near it at the side of road with letters 'F.H.' written on it.



Post hydrant (Fig 18)

The barrel of the hydrant remains projected about 60-90 cm above the ground surface. These hydrants have a long stem with screw and nut at the top to regulate the flow of water. The post hydrant is connected to the main pipe, through a branch pipe and it can be operated means of a gate valve. The diameter of the hose is usual 63 mm and the best position of this hydrant is in the back of keep line. (Fig 18)

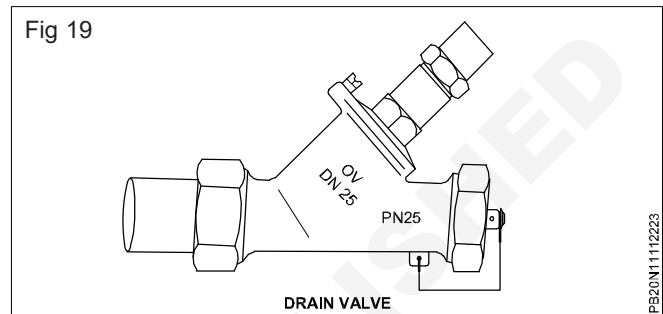


Drain valve (Fig 19)

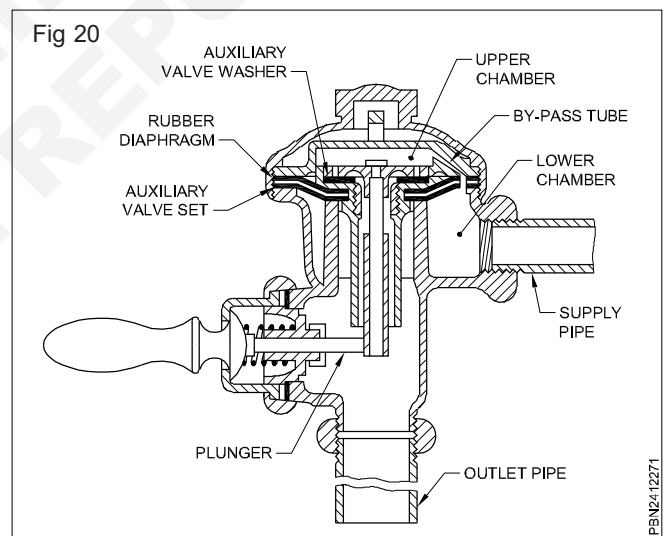
- Drain valves are used in compressed air system.
- These are used to remove slurries to drain from the system
- Also used to drain liquid or gas to be drains from the hot water system.
- Helps to prevent the formation of corrosion and erosion.

Flush valve: Flush valve is non-automatic type of valve. It is widely used in the water supply system for flushing Bowls. (Fig 20)

Flush valves are made of brass/CP brass.

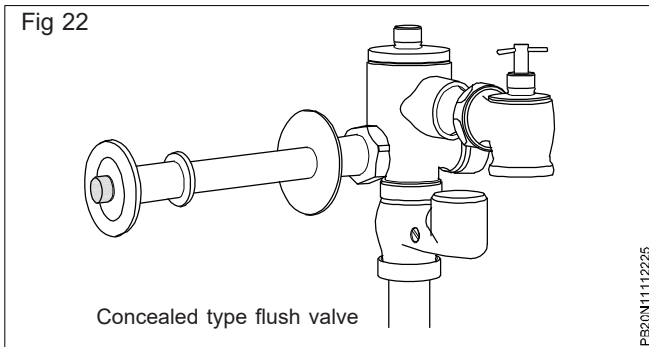
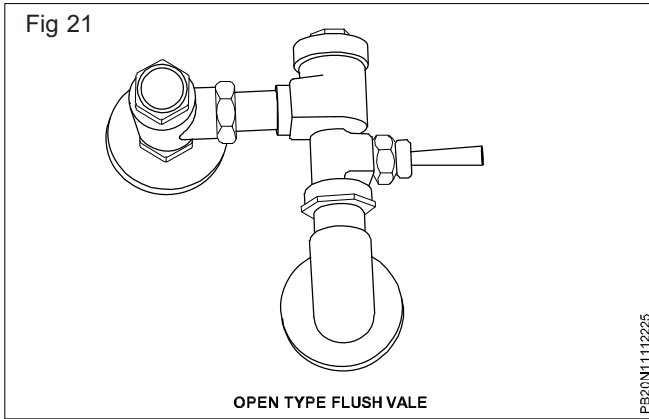


Construction: The flush valve has a diaphragm that separates the valve into an upper and lower chamber. A by-pass equalizes the water pressure on both sides of the diaphragm (Fig 20)



Operation: A slight touch of the handle in any direction pushes the plunger and the auxiliary valve tilts into the plunger. The pressure in the upper chamber is released. (Fig 21)

The pressure on the lower side of the diaphragm than overcomes the reduced pressure in the upper chamber and raise the entire assembly of working parts (auxiliary valve, disc, diaphragm and guide). This allows the water in the lower chamber to spill over into the outer pipe and flushes the closet bowl. At the same time a portion of the water goes up through the by-pass till the water pressure in the upper chamber is again equal to that in the lower chamber. Thus one flushing cycle is completed. (Fig 22)



Float valve: Float valve is automatic type of valve used in the flushing cisterns of closets and in water storage tanks.

Function of float valve: The function of a float valve is to shut off the water supply to the tank, when the water level reaches a pre-determined level.

Process (Fig 23)

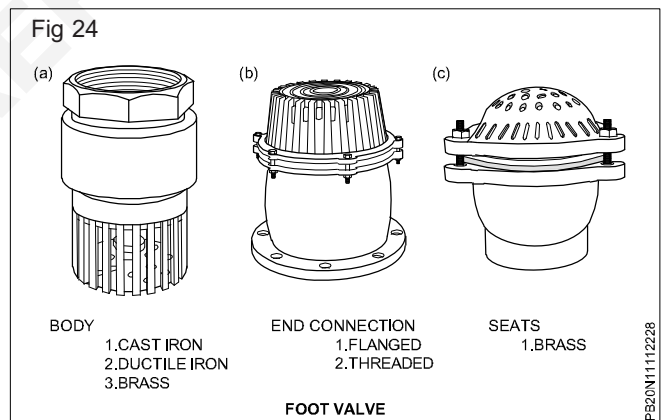
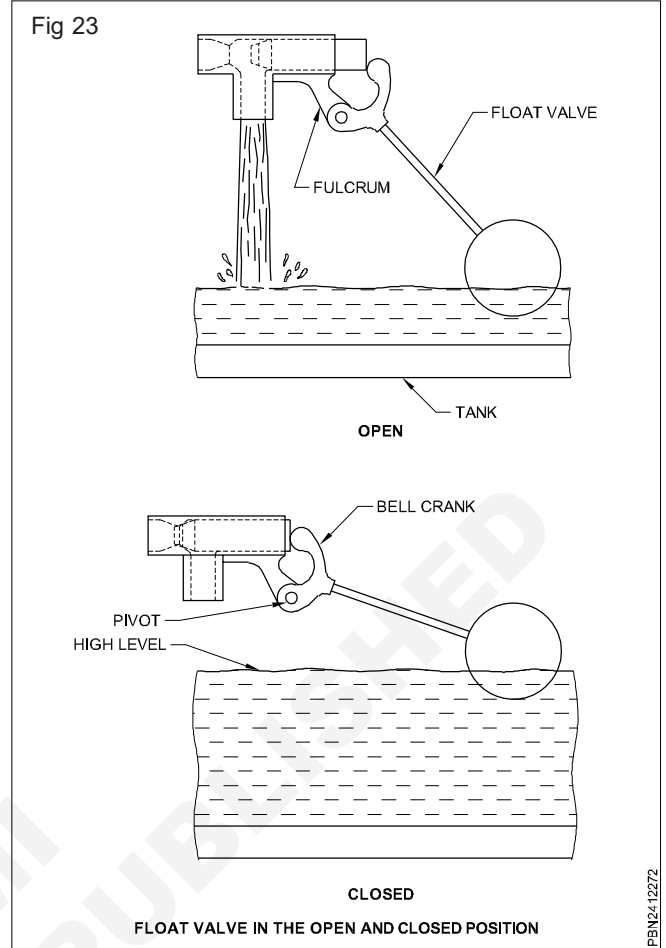
- 1 GUN METAL - Foot valve with strainer.
- 2 CASTIRON - Foot valve with strainer.
- 3 DUCTILEIRON - Foot valve with strainer.

Foot valve (Fig 24)

- 1 These foot valves are used in the pump set suction line. (fig a,b,c)
- 2 These valves are essential to maintain the water level in the suction lin.
- 3 Strainer are used to protect Dust, silt, leaves and other foreign substances entering the suction line.
- 4 If pump runs without water flow strainer gets blocked should be cleaned.

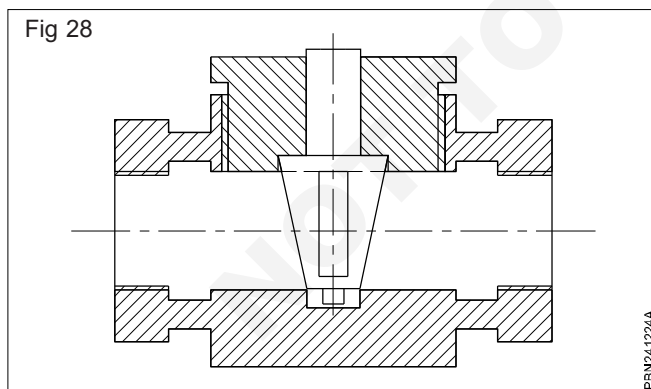
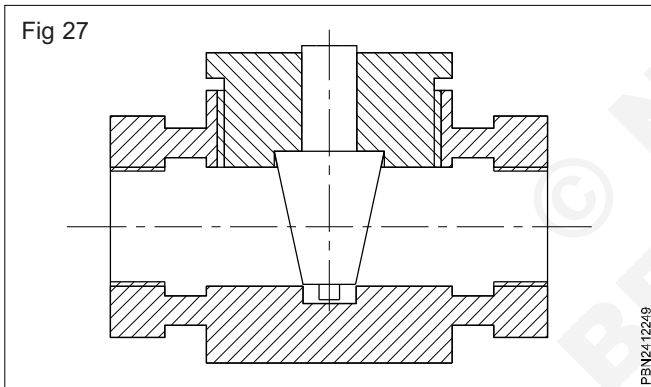
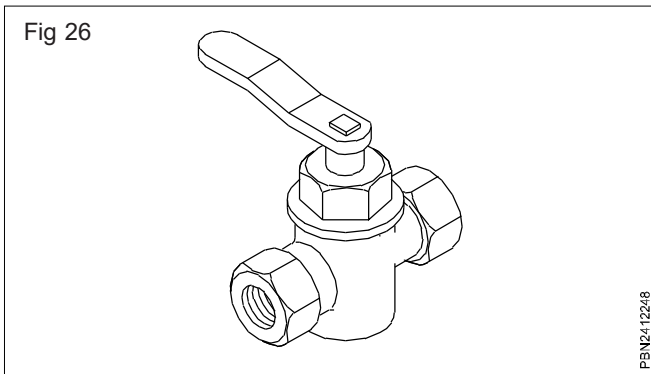
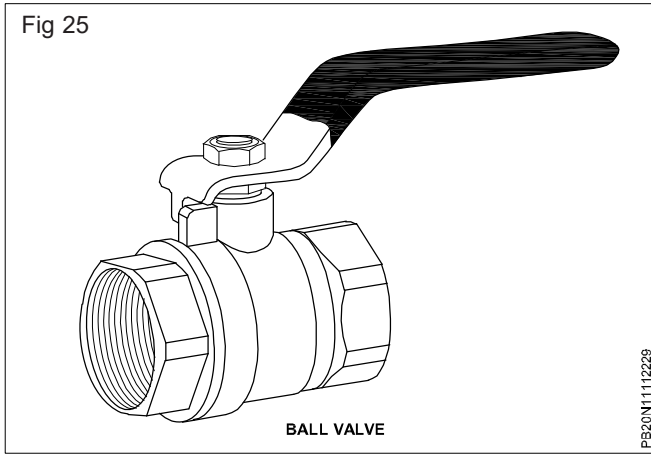
Ball valve

- 1 Ball valve are used in water supply lines for builders.
- 2 These valves are now - a days so - familiar for its simple operation.
- 3 This functions like plug valve.
- 4 Made of Brass, PVC, UPVC.



- 5 Consist of Lever Handle, Lock nut with washer, Spherical with through hole in centre, Talon O rigs.
- 6 Handle parallel to pipe line means close.

Plug-cocks: Plug-cocks are suitable for high pressure applications. A parallel, tapered or spherical plug, pierced with a hole equal in area to the bore of the pipe, is turned in the body to permit or prevent flow from one side of the plug to the other. (Fig 26, 27 & 28)

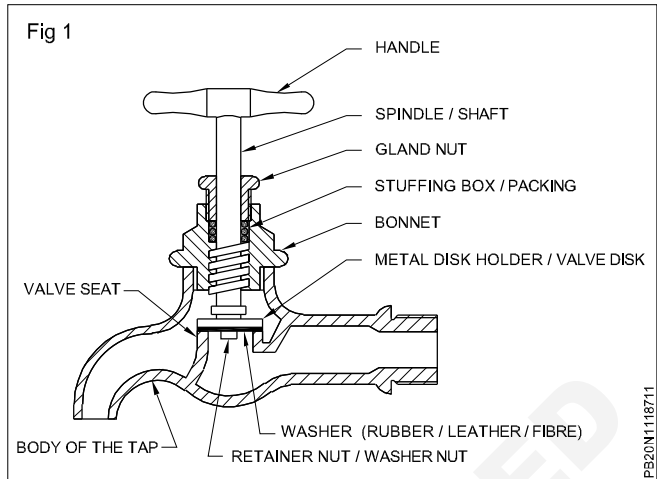


Types of cocks:

1 BIBCOCK (or) STOP TAP (Fig 1)

A BIBCOCK is a valve with suitable means of connection, for insertion in a pipe line for controlling or stopping the flow. The standard size of the bib tap should be designated by the nominal bore of the pipe cutlet to which the tap is to be fitted. Bib taps and stop taps shall be of following sizes.

8mm,10mm,15mm,20mm,25mm, Washers for taps selected leather, rubber-asbestos composition or other equality suitable material.



C.P. Angle cock fig 2 a & 2 b

This valve is so essential to provide inlet connection to all sanitary fittings like flush tanks, wash basin, Health faucet

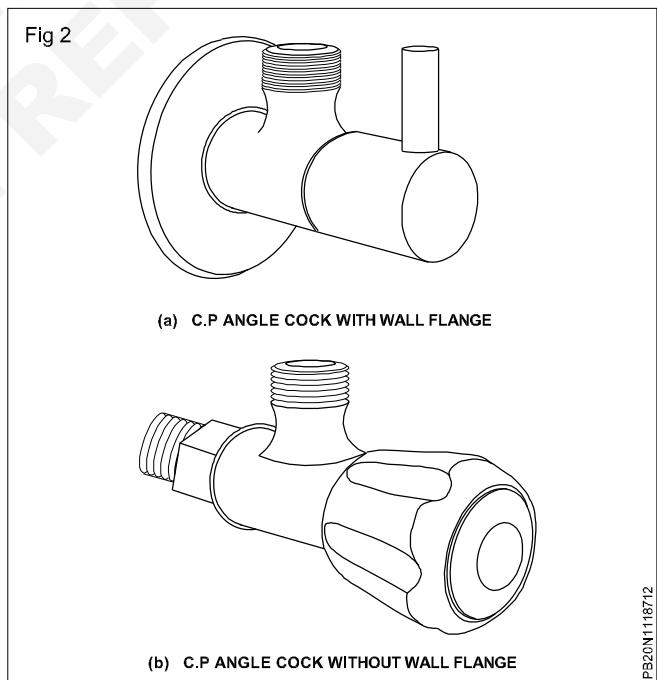
Also - for the inlet of geyser, washing machine etc.,

Available with (or) without wall flanges

With wall flange Fig 2a without wall flange Fig 2b

Made of brass and coated with chromium plating

Common available size is 15 mm fig 2a&2b



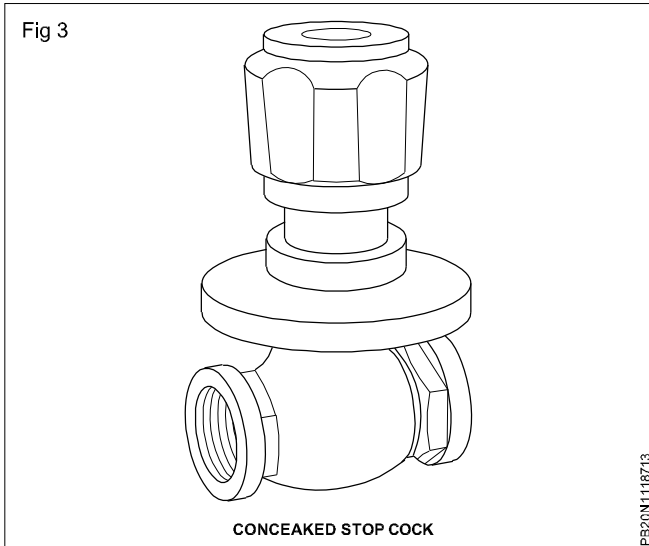
CONCEALED STOP COCK

This cock is used in between pipelines.

Generally used in concealed shower connection

Made of Brass and visible portion is coated with chromium plating. Arrow mark is provided

Available with wall flange in size 15 mm, 20 mm, Fig 3



C.P 2 in 1 BiB. cock Fig 4

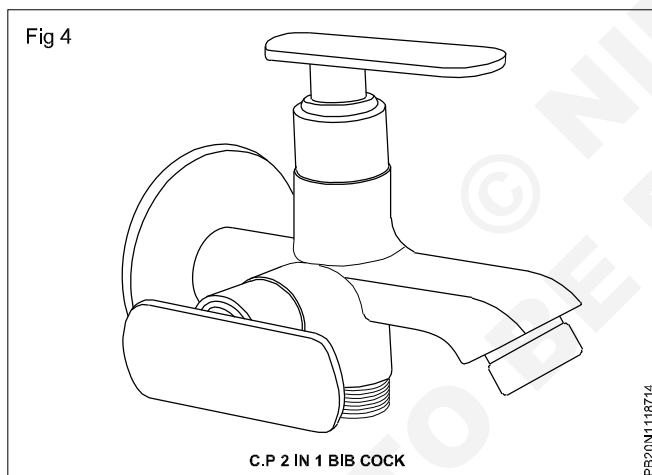
This type of tap is used for double purpose

Made of brass and coated with chromium plating.

Used in bathroom and toilets

In bathrooms telephone hand shower is connected

In toilets health faucet is connected with holders available in size 15mm Fig 4



C.P. 2 in 1 ANGLE COCK (Fig 5)

This 2 in 1 angle cock is used for Geyser outlet connection

Made of brass and coated with chromium plating

Available with wall flange in size 15 mm

Used to get two hot water outlet with single Geyser for two Bathrooms

Also used in for health faucet and cistern in European water closet (Fig 5)

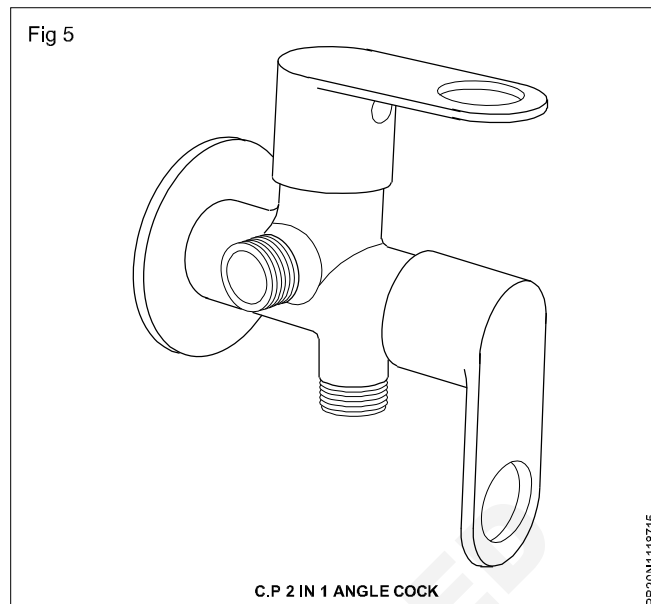
PUSH COCK Fig 6a&6b

This type of tap is belongs to auto closed

Made of brass and crated with chromium plated

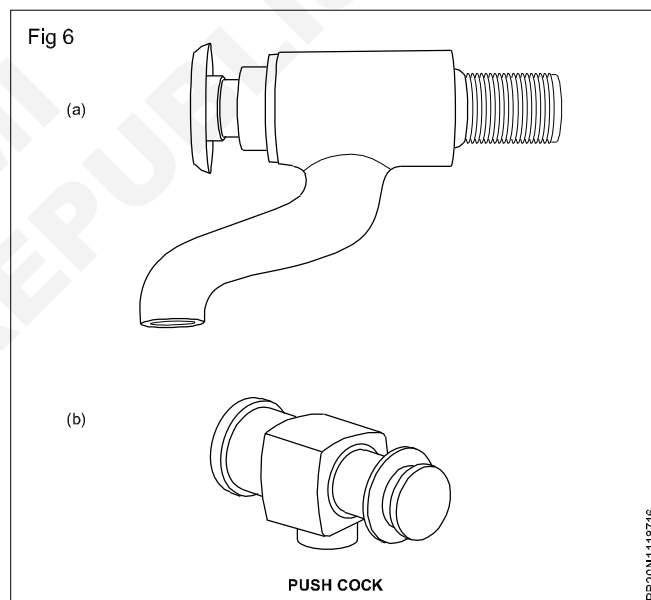
Used for drinking water connection

Prevents water wastages



Available size is 15 mm and 20 mm

They open out when a slight push is given and close as soon as the push is removed fig 6a & 6b



Set closing tap (or) Lift cock fig 7

This tap belongs to auto closed

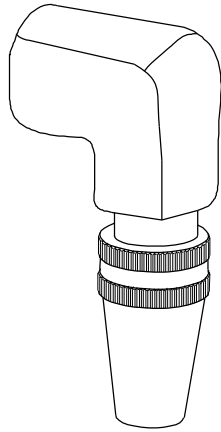
Used in drinking water fountains water coolers and in public drinking water provision

Made brass coated with chromium plating and cast iron

Available in size 15 mm

By lifting water comes out and automatically closed due to gravity

Fig 7



SELF CLOSING TAP (OR) LIFT COCK

PB20N118717

Self-closing Tap cock (or) push cock (Fig 8)

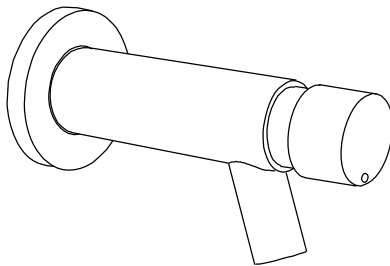
This type of top functions by pushing the head

Belong to automatic closing type

Made of picand brass available with wall flange and in size 15mm .

After pushing automatically closed due to spring Fig 8

Fig 8



SELF CLOSING TAP (OR) PUSH TAP

PB20N118718

Plug cock Fig 9

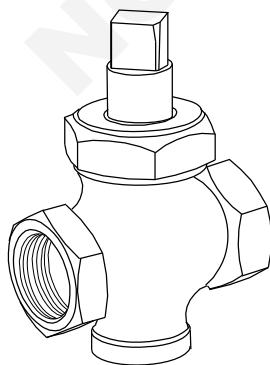
This type of cock is available in cast iron and brass

Cast iron cock are used in water supply line as valve to control (or) close the water supply

Brass plug cock (or) stop cock is used in drinking water service connection fixed before water - meter

Plug cock is also known as stop cock with its head 't' round and square fig 9

Fig 9



PLUG COCK TAP

PB20N118719

OTHER SPECIAL FITTINGS

TELEPHONIC HAND SHOWER (Fig 10)

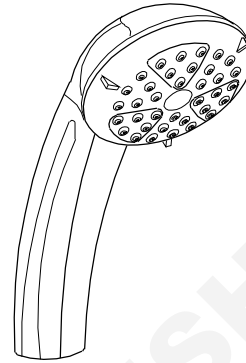
This hand shower is used for bathing (or) three way

Fixed in two-way divertors in bath tubs and shower connection

Available in various models

Made of PVC Brass are crated with chromium plated in size 15 mm Fig 10

Fig 10



TELEPHONIC HAND SHOWER

PB20N11871A

Health faucet Fig 11

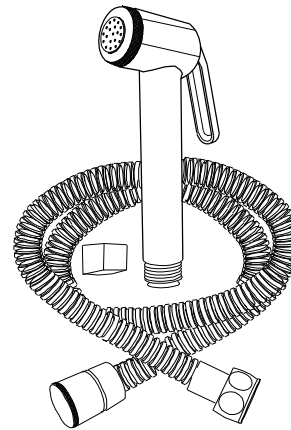
This health faucet are used to clean our body private parts.

Fixed with holders and flexible hose.

Used in toilets at European water

Made of PVC and brass available in size 15 mm.

Fig 11



HEALTH-FAUCET

PB20N11871B

2 in 1 Mixer Tap Fig 12

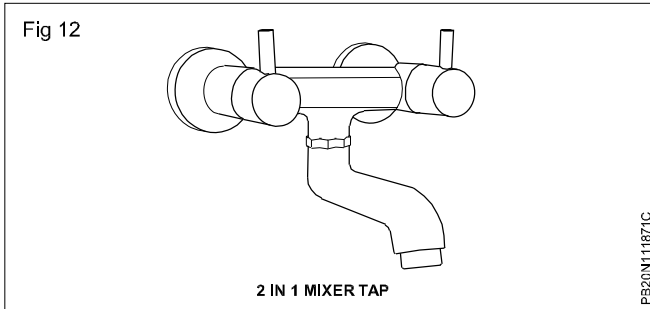
This type of tap Is used for hot and cold water connection

Left side for hot water with red colour indication and right side.

Cold water with Blue colour indication.

Available in various models

Coated with chromium plated available in 15 mm with spout and wall flanges.



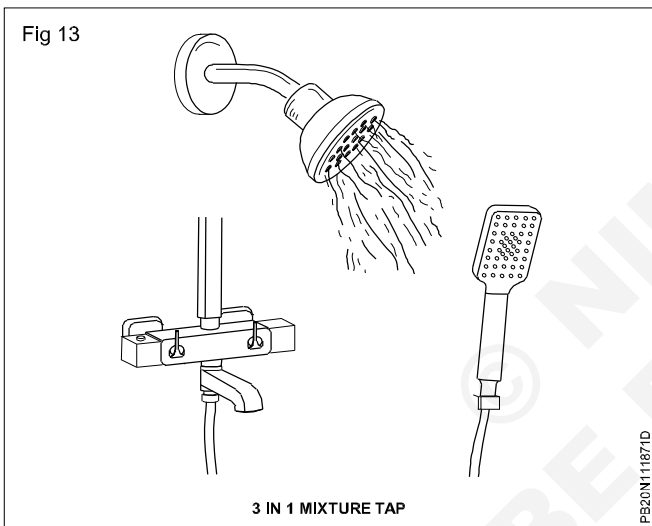
Mixer tap Fig 13

This 3 in 1 Mixer tap is used for hot and cold water connection with overhead shower (or) hand shower as shown in Fig 13

Made of Brass and available in various models with wall flanges.

Size of this Mixer tap is 15 mm

Centre handle act as valve to get water from three outlets. Separate button for hand shower.



GUN-METAL FERRULE (Fig 14)

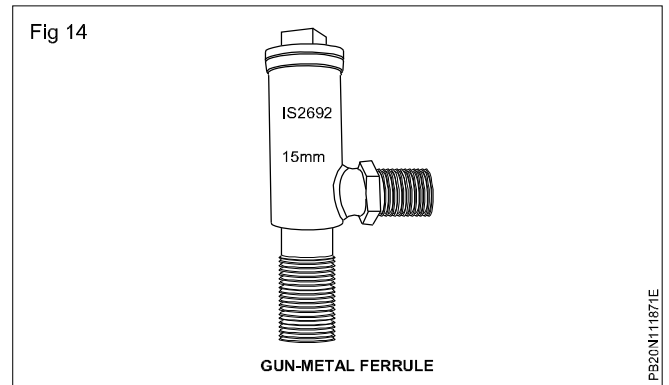
Ferrule is used for getting drinking water

Fixed in water supply mainline in service connections.

Mode of Gun metal to resist corrosion, underground.

Act as a valve by remaining the cap and screwing the inside spindle

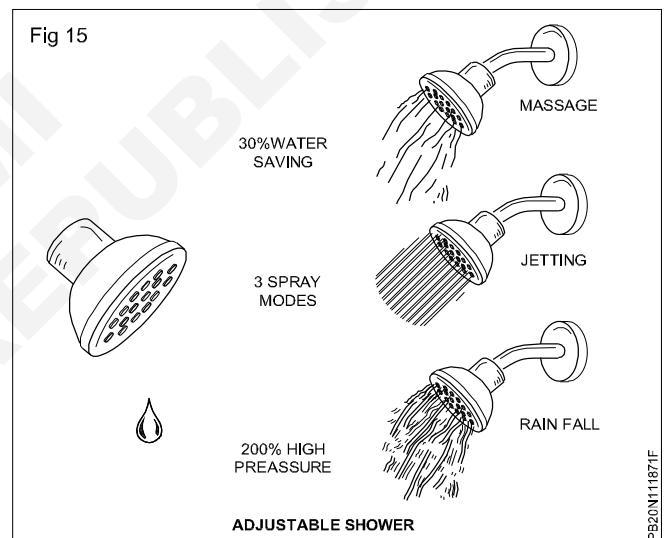
Available in sizes 10 mm, 12 mm, 15mm, 20 mm and 25 mm (Fig 14)



ADJUSTABLE SHOWER (Fig 15)

This fitting is used for taking Bath with different outlets by adjustments as shown in fig 15

Outlet has three adjustments namely message outlet for gentle body wash jetting for gentle body wash and Rainfall for through wash.



THREE WAY (or) TWO WAY DIVERTORS

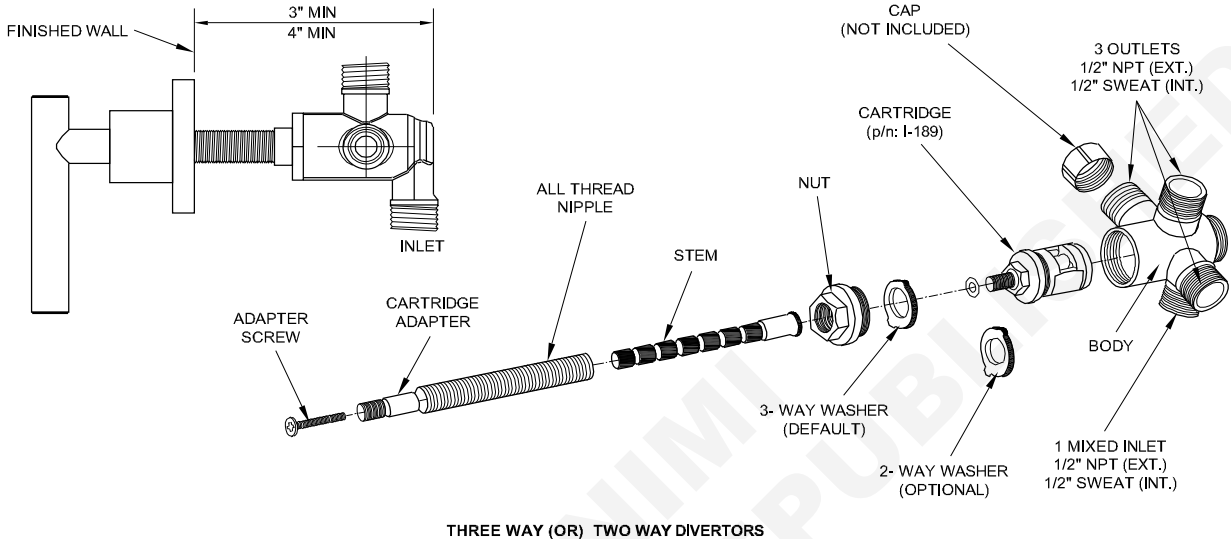
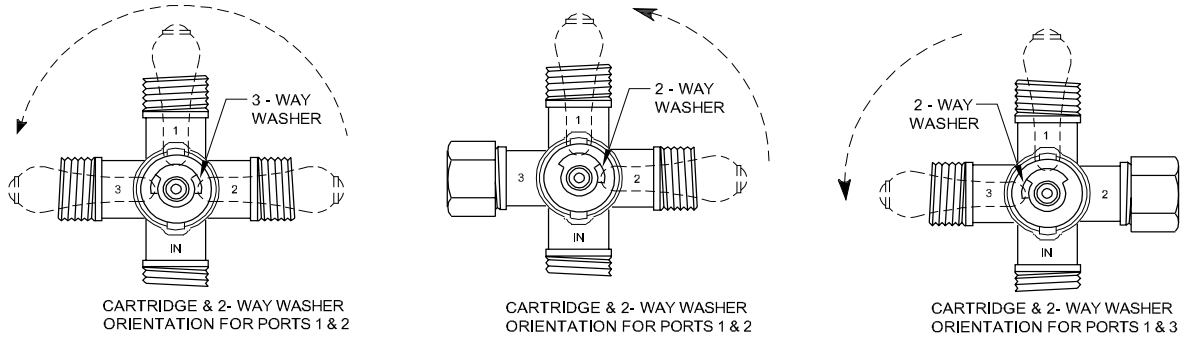
Three way diverter (or) Two way diverter are used in Hot and cold water mixture taps in Bathrooms.

It allows to alternate between any of selected shower outputs (overhead (or) hand shower).

It directs the water from the shower head to each additional accessory, one at a time.

Divertor is not used to adjust the water temperature (or) turn the water. Fig 16

Fig 16



PS20N1187/G

Description and installation of sanitary appliances

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

- State about ablution fittings
- State about soil fittings
- State choosing of sanitary fittings
- State the concealed flushing cistern
- State pipe alignment and slope
- State water hammer
- State water supply storage tanks
- State cleaning and maintenance of storage tanks

sanitary Fittings

In the buildings, various types of sanitary fittings are required to collect the water. These all fittings can be broadly classified as :

1 Ablution Fittings

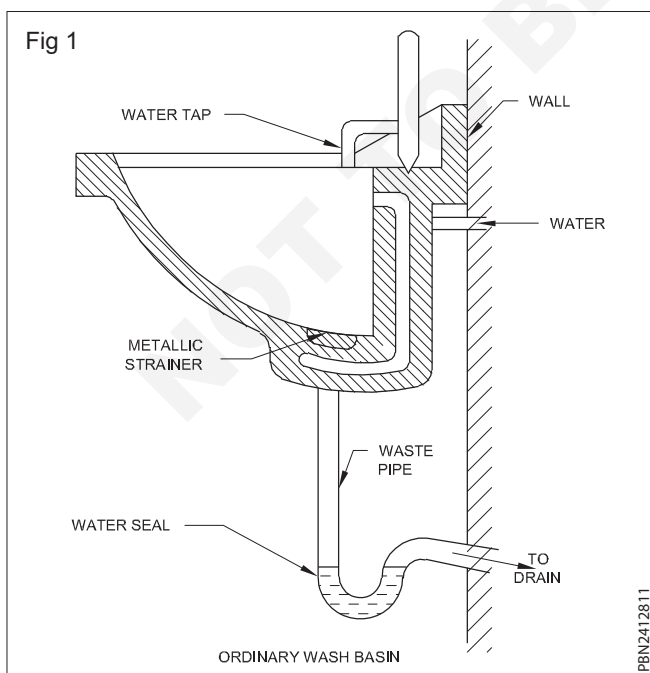
- a Wash basins
- b Sinks
- c Bath tubs
- d Flushing cisterns

2 Soil Fittings

- a Water closets
- b Urinals
- c Bidets

All types of sanitary fittings should be fixed as far as possible against an external walls, so that the apartment in which they are placed can be provided with natural light and air, and also their wastes can be easily collected in drain. The floors of the rooms in which sanitary fittings are fixed should be of a non-absorbent material with curved angles at the junction with walls from sanitary points of view.

Wash Basin (Fig 1)



The wash basins are available in various patterns and size in the market. There are mostly three patterns: (a) Flat

back for mounting on walls, (b) Angle back for fixing at the junction of two walls, and (c) Circular or oval for fixing in tables or rocks. Flat back basins are provided with double or single tap holes. All the wash basins should be of one pipe construction and have should have slotted overflow hole. All the internal angles are designed so as to facilitate cleaning. The wash basins are provided with a circular waste hole in the bottom the basins are provided with an integral soap holder recess with drains into the bowl.

For holding water in the bowl these are provided with tapering rubber plugs, which can be fitted in the outlet. This plug is fixed to a chain secured by a stay. (Fig 2)

The usual size of wash basin are:

Pattern	Size
Flat back (Fig 3)	630 x 40 mm
	550 x 400 mm
Angle back (Fig 5)	600 x 480 mm
	400 x 400 mm
Oval (Fig 4)	570 x 420 mm

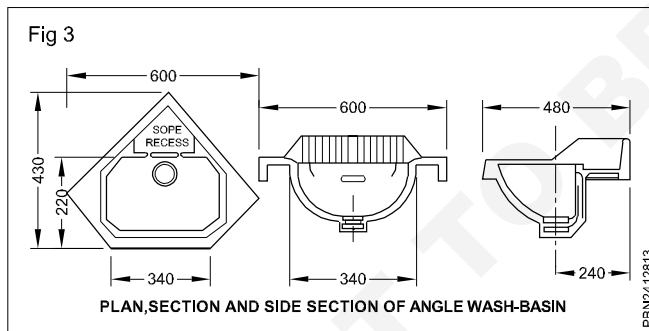
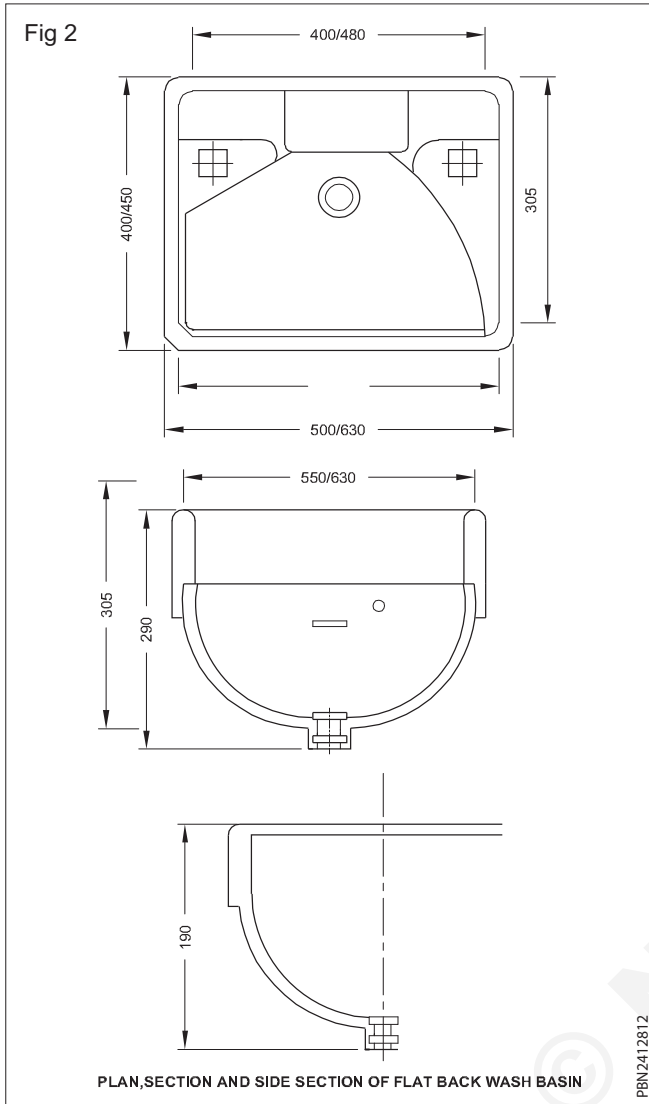
Specifications for wash basins (as per C.P.W.D)

Wash basins shall be of white vitreous China conforming to IS : 2556 (Part I) - 1967 and IS : 2556 (Part IV) - 1967. Basins shall be provided with single or double tap holes as specified. The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole.

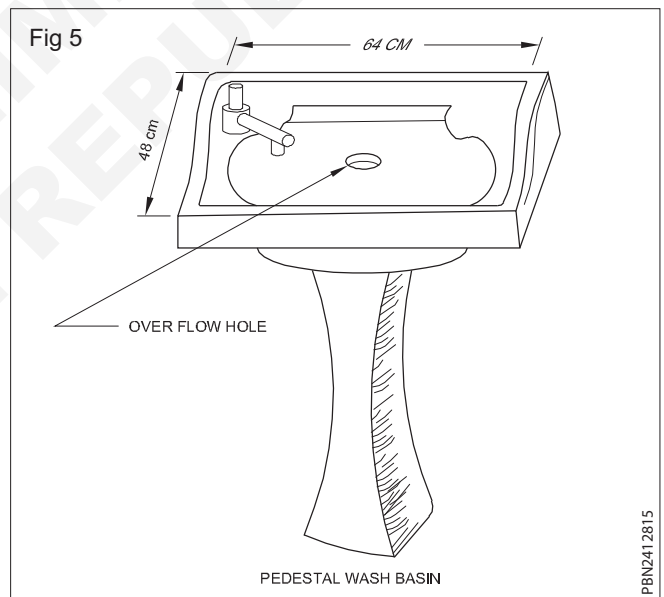
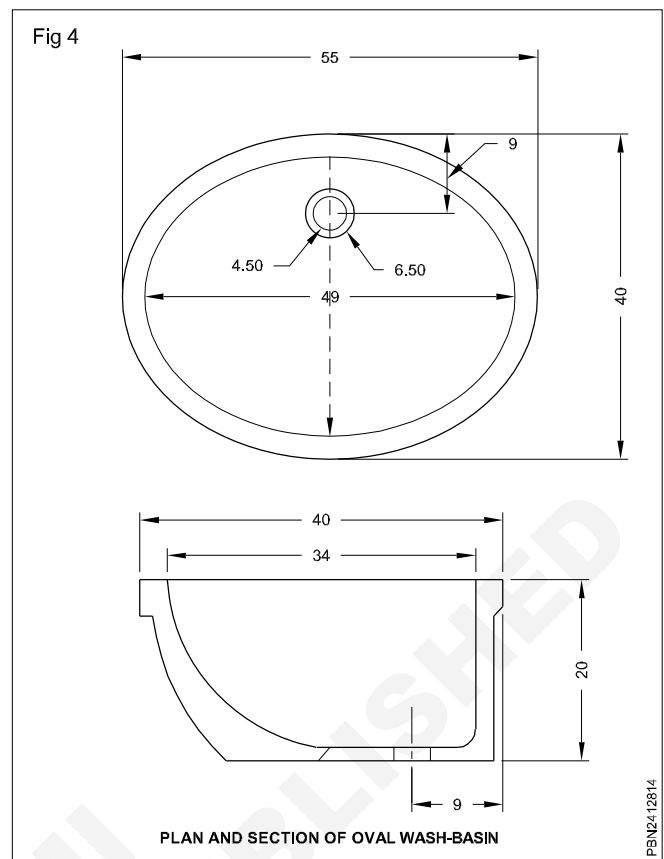
Each basin shall have a circular waste hole each basin shall be provided with a non-ferrous 32 mm waste fitting. The quality of the glazing of the pedestal shall be exactly the same as that of the basin. It shall be capable of supporting the basin rigidly and adequately height from the floor to top of the rim of basin 75 to 80 cm.

All the waste fittings shall be brass chromium plated or as specified

The following tolerance may be allowed on dimensions specified



- a On dimension 75 mm and over \pm 4 percent
- b On dimension less than 75 mm \pm 2 mm
- c Diameter of the waste hole \pm 3 mm



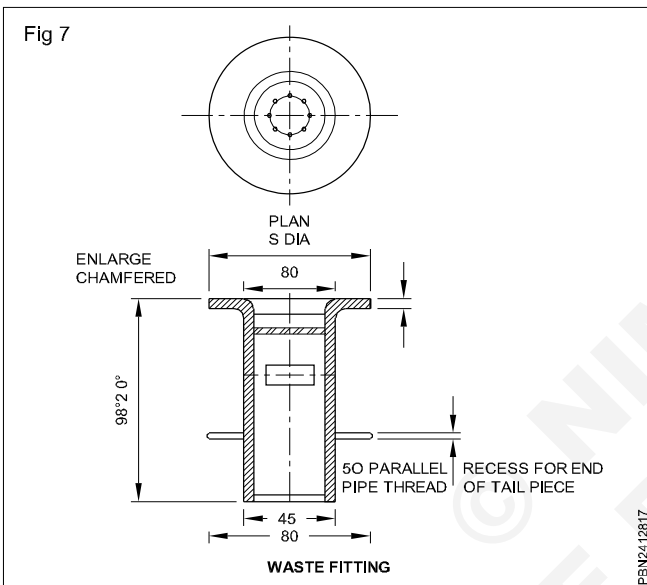
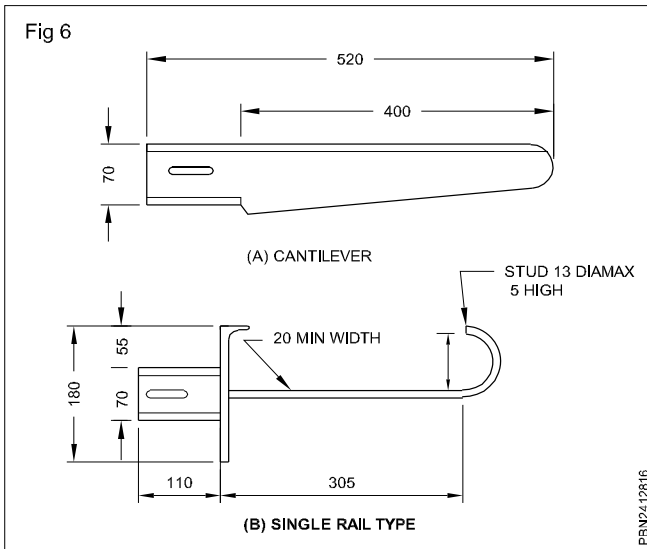
Waste fittings for wash basins and sinks (Fig 6 & 7)

The waste fittings shall be of chromium plated brass. The fitting shall conform in all respects to I.S.: 2963 - 1964.

Waste fittings for wash basins shall be of nominal size 32 mm. Waste fittings for sinks shall be of nominal size 50 mm.

Method of Installation of Wash Basin

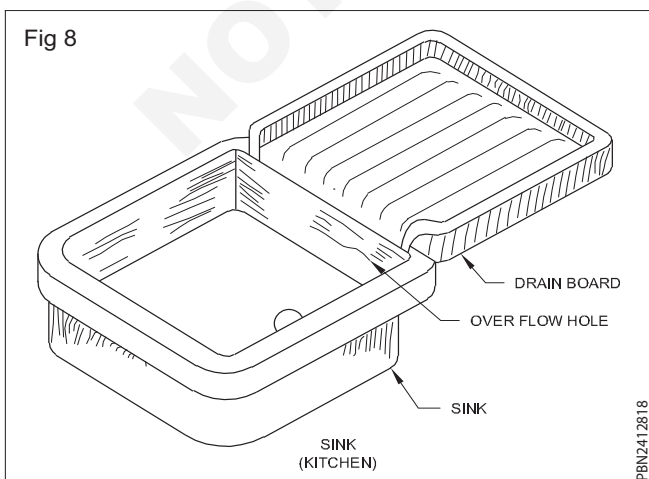
The installation shall consist of an assembly of wash basin pillar tap, C.I. brackets, C.P. brass or P.V.C. union as specified. The height of front edge of wash basin from the floor level shall be 80 cm.



Fixing

The basin shall be supported on a pair of C.I. cantilever brackets in cement mortar 1 : 3 (1 cement : 3 coarse sand), embedded in cement concrete (1 : 2 : 4) block 100 x 75 x 150 mm. The brackets have been shown in Fig 6. Shall be connected to a waste pipe stack through a floor trap on upper floors.

Sinks (Fig 8)

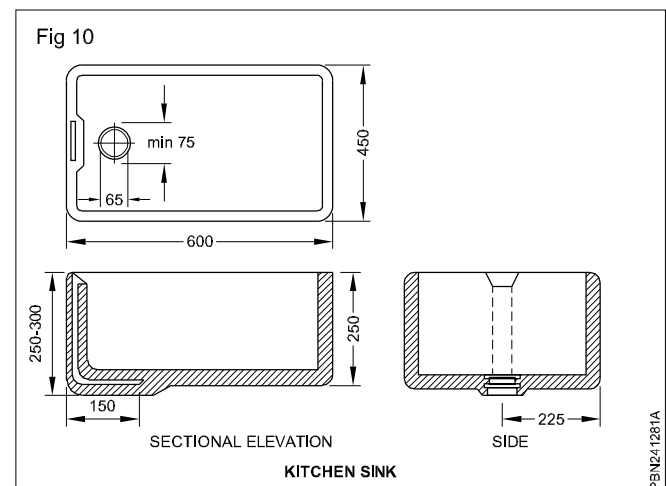
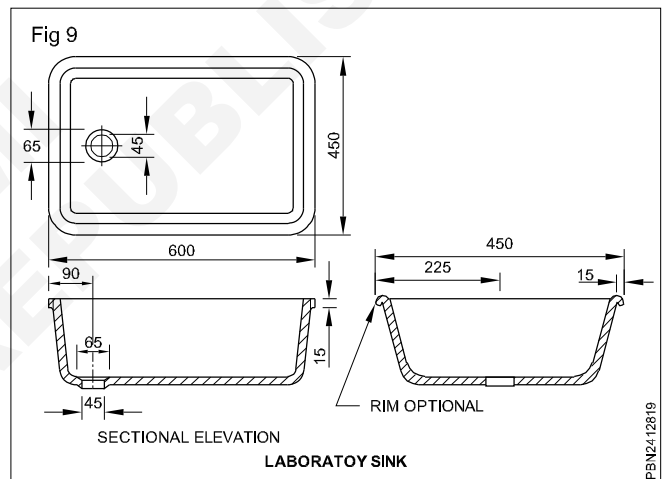


There are rectangular shallow receptacles suitable for kitchens or laboratory. Fig 8 shows a kitchen sink which is mostly used. It is on one piece construction, provided with or without rim.

The floor of the sink is given a slope towards the waste outlet. The sinks are provided with circular waste hole. All the kitchen sinks are provided with a draining board which is fixed on the right of the user.

Kitchen sinks (Fig 9)	600 x 450 x 150 mm
	600 x 450 x 250 mm
	750 x 450 x 250 mm
Laboratory sinks (Fig 10)	400 x 250 x 150 mm
	450 x 300 x 150 mm
	500 x 350 x 150 mm
	600 x 400 x 200 mm

The height of the top of the sink from the floor should be 80 cm.



Method of Installation of sink

The installation shall consist of a assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

Fixing: The sink shall supported on C.I. cantilever brackets, embedded in cement concrete (1 : 2 : 4) block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before the dado work is done. Waste pipe which shall be suitable bent towards the wall and shall discharge into a floor trap. The height of front edge of sink from the floor level shall be 80 cm.

Bath tub (Fig 11)

Bath tubs may be made of various materials, such as enamelled iron, plastic, cast iron porcelain enamelled, marble or fire clay etc. For high class residential buildings marble, plastic or enamelled iron or fibre glass baths are used.

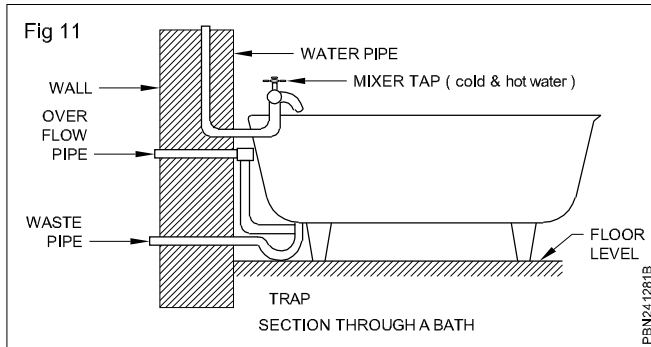
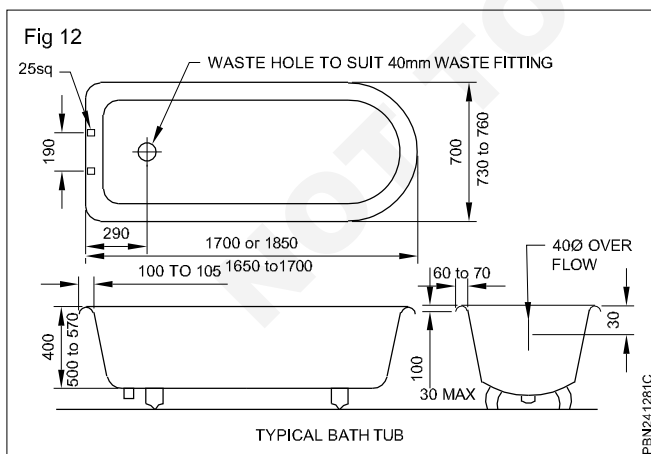


Fig 12 shows the section through a bath. The bath may be parallel or taper, the latter type being more popular. It is provided with one outlet of 4 to 8 cm and one inlet pipe for filling it. In some cases, two taps are provided one for hot and another for cold water supply. The bath should also be provided with one over-flow pipe to take excessive water. The waste pipe of bath is provided with a trap, to prevent the foul gases from entering in the bath-room.

The usual dimensions of bath are: length 1.7 to 1.85 m, width 70 to 75 cm depth near pipe side 43 to 45 cm, overall height with feet 58 to 60 cm.

Specifications of Bath Tub (Enamelled Sheet Steel) (as per C.P.W.D) (Fig 12)



The bath tube shall conform to I.S.: 3489 -1966. The bath tub shall be such as to ensure a suitable finished surface for the reception of the enamel. Any welded surface shall be adequately cleaned off inside and outside the bath tubs.

The interiors of the bath tub shall be adequately and evenly coated with vitreous enamel. The enamelling shall conform to I.S. : 772 - 1973. Thickness of the enamel shall not be less than 0.2 mm and not more than 0.5 mm.

Flushing Cisterns

These are used for flushing water closets and urinals after use. There are several varieties of flushing cisterns. High-level cisterns are intended to operate with a minimum height of 125 cm between the top of the pan and the underside of the cistern. Low-level cisterns are intended to operate at a height not more than 30 cm between the top of the pan and the underside of the cistern. Cistern may be of cast iron, glazed earthenware, glazed vitreous ware or pressed steel or any other impervious material. Now-a-days plastic cisterns are also available in the market.

three types are there

- 1 Low level flushing cistern
- 2 high level flushing cistern
- 3 auto matic flushing cistern

Cistern shall be of cast-iron, vitreous chin or pressed steel and plastic as specified company.

With the requirement 08 IS.744-197, I.S. 2326 - 1970 and I.S 7231 - 1994 respectively

Flush valve refer Ex. 1.11.120

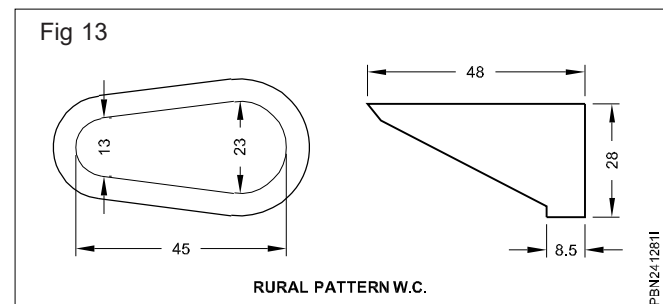
Water closet: This is a sanitary appliance to receive the human excreta directly and is connected to the soil pipe by means of a trap.

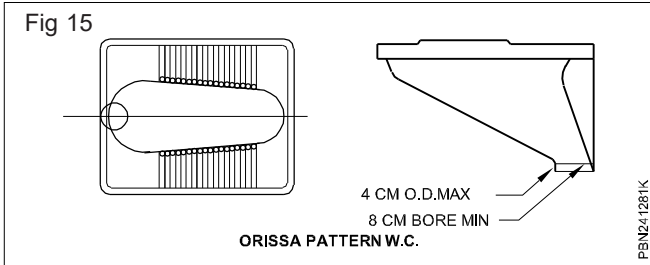
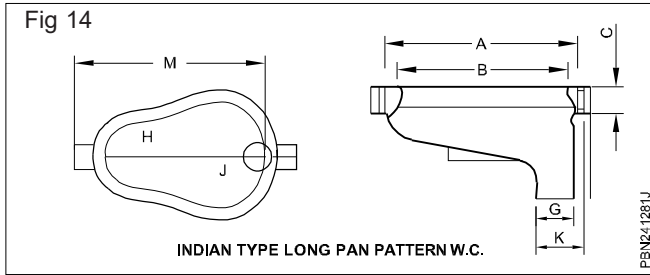
The water closets are classified as follows:

A Squatting types of Indian type water closet

- i Long pan pattern (length 450, 580, 680 mm) (Fig 14)
- ii Orissa pattern (length 580, 630, 580 mm) (Fig 15))
- iii Rural pattern (length 425 mm) (Fig 13)

Fig 14 shows the section through an Indian type water closet. This is manufactured in two different pieces; (a) squatting pan and (b) trap. The pan is provided with an integral flushing rim of suitable type. The inside of the bottom of the pan should have sufficient slope towards the outlet for quick disposal during flushing.





They are made of vitreous china clay. The inner portion is glazed to make it easy in cleaning. The pan is connected to the anti-syphon or vent pipe.

Specifications of Water Closet (as per C.P.W.D)

Squatting pans

Squatting pans shall be of white vitreous china conforming to I.S.; 2556 Part I - 1967 for General requirements and relevant I.S. codes for each patterns as described below :

- i Long Patterns - conforming to I.S.: 2556 (Pt. III) - 1967
- ii Orissa Pattern - conforming to I.S.:2556 (Pt. III) - 1967
- iii Integrated types conforming to I.S.:2556 (Pt. XIV) -1974

Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet shall be in the front, The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. Trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia.

- i The top surface of long pattern pan shall not at any point vary from its designed plane or contour by more than 6 mm for size 580 mm and by more than 10 mm for size 630 mm and measured vertically.

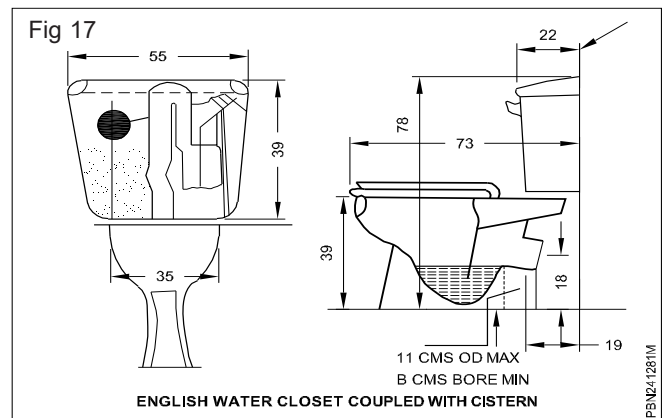
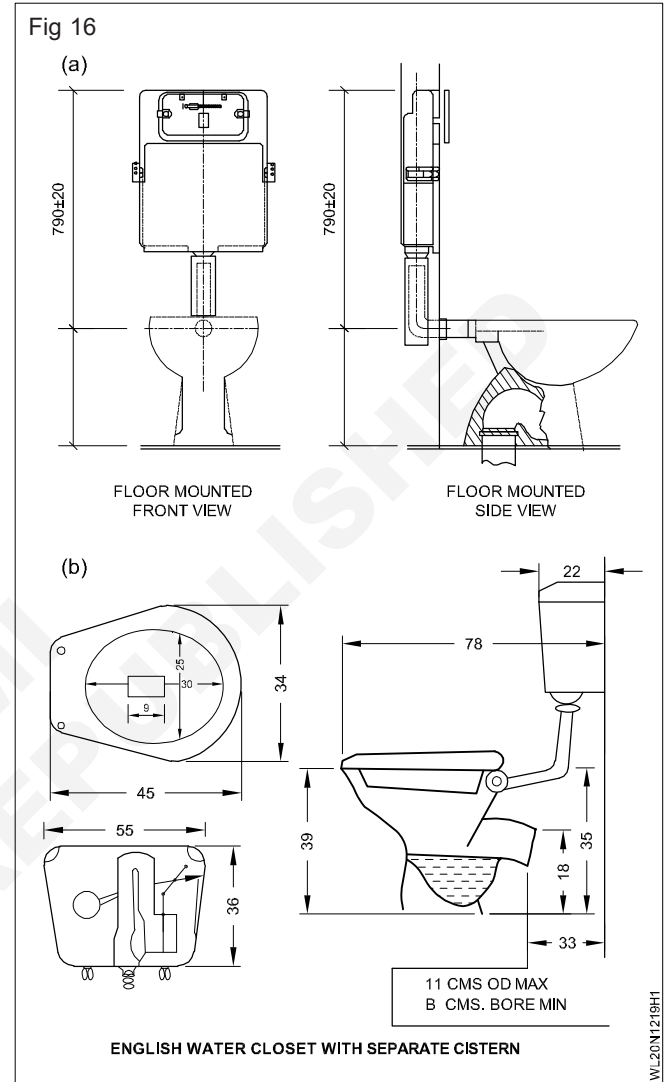
This value shall not exceed 10 mm in case of Orissa pattern pans.

ii European water closet (Fig 16, 17, 18 & 19)

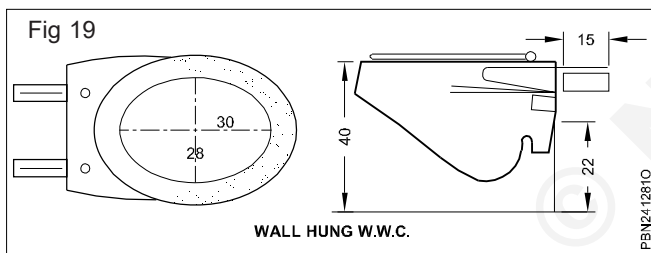
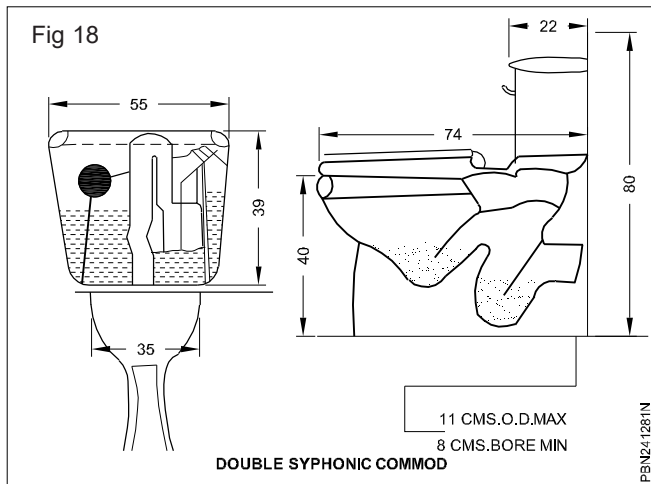
- a On dimension 50 mm and over ± 4 percent
- b On dimension of less than 50 mm ± 2 mm
- c On all angles $\pm 3^\circ$

Fig 16 to 19 shows the section through a wash-down type water closet, which is most commonly used in high class buildings. It is provided with a wide flushing rim and 5 cm trap. It is one-piece construction in which the pan and

trap are not separate. It is provided with an inlet or supply horn for connecting to the flushing pipe. It may be provided with P and S trap as desired. These types of water closets require less space than squatting pattern type and can be flushed by low level cistern. Now-a-days symphonic water closets are very popular, with conceals flush tank Fig 16 a



either 'S' or 'P' outlet with at least 75 mm water seal. Where required the water closet shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 liters of water between the normal water level and the highest possible water level of the water closet as installed.



Description of concealed flushish cistern. (Fig 16 (a))

Concealed flushing system

The concealed flushing system in which the cistern is hidden mostly behind the walls and only the water closet is visible. It is concealed, which means it is hidden behind a cabinet or wall that can be accessed via a maintenance panel.

Benefits

- Save space in the bathroom and good appearance.
- Offer a hygienic option and is easier to clean

De merits:

- They can be expensive
- Only installed with European water closet.

Working of concealed flushing cistern

A concealed tank toilet is where the cistern or the top tank part of the toilet is not visible. The toilet bowl seems attached to the wall and only the flush buttons are visible. This cistern working has normal flushing cistern.

Specifications Seats and covers for water closet

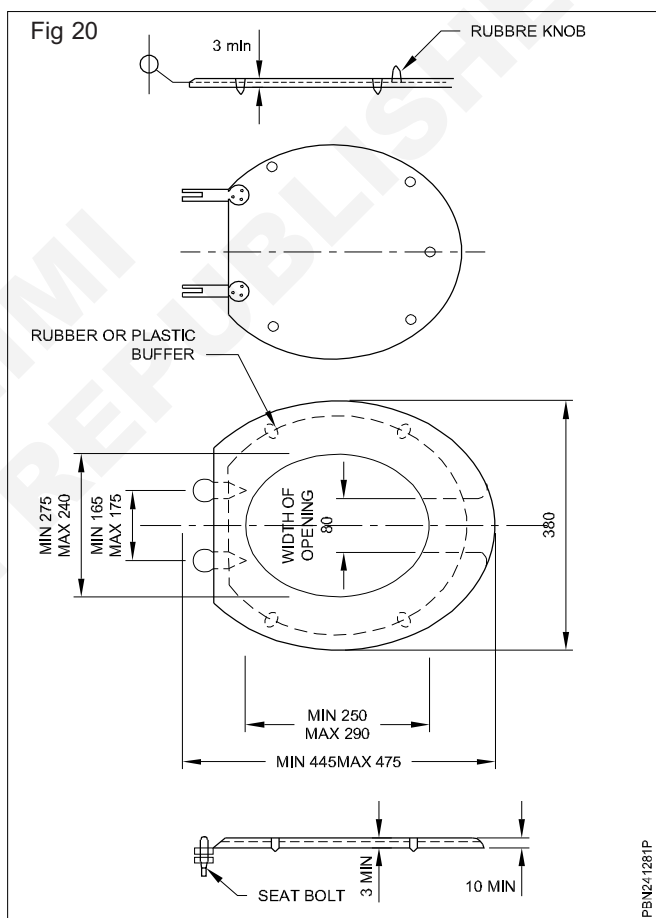
The seat and cover may be of wood or plastic, as specified. Unless and otherwise specified these shall be of closed pattern.

a Wooden seat and cover

These shall be of type I confirms to I.S. : 776 - 1962. These shall be made of timber, such as well seasoned teak wood or mahogany, as specified, and shall have C.P. brass hinges and rubber buffers.

b Plastic seat and cover (Fig 20)

These shall conform to I.S. : 2548 - 1967. These shall conform to I.S. : 2548 - 1967. These shall be made of moulded synthetic materials, which shall be tough and hard with high resistance to solvents and shall be free from blisters and other surface defects and shall have C.P. brass hinges and rubber buffers.



There shall be a 100 mm dia. white glazed vitreous China channel with stop and outlet pieces in front.

Urinals

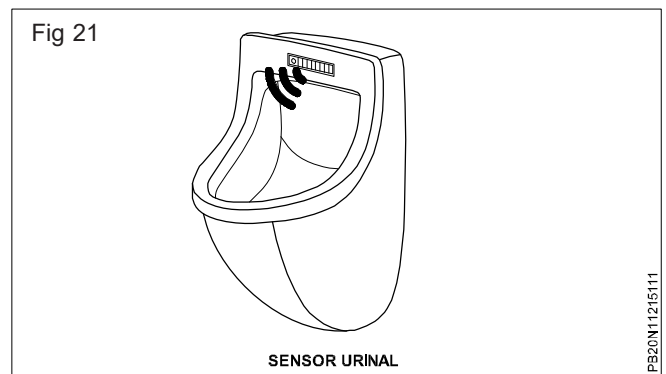
The following types of urinals are generally used.

- Flat back
- Corner type
- Stall
- Half stall
- Squating plate

- Senso type
- Water less urinal

Senso type urinals (Fig 21)

Manufactures from white vitreous china clay. These urinals are fitted with sensors so that automatic flush tank will work only when it is used. Thus there is a lot of saving in water and at the same time immediately after use it is flushed automatically size 61 x 39 x 38cms. (Fig 21)



Sensor system for urinals and wash basin sensor taps

Objective: At the end of the lesson you shall be able to

- explain sensor system for urinals, wash basin, sensor taps and soap dispenser.

Urinal sensor/ flusher

Definition

To keep your bathroom & restrooms Hygienic & safe, you need to use a good automatic urinal sensor and sensor flusher. They are very effective & easy to use while giving you a very attractive appearance.

Touchless urinal sensor/sensor flusher is quite perfect for private bathrooms, public toilets, workplaces and malls.

These sensor urinals / sensor flushers have touch-free features which helps to maintain the hygiene in the surroundings. The best part is that these touch free urinals are found in different designs & shapes and it is backed with intelligent technology & Low power consumption.

They also tend to save water and uses the water only when required.

Also, you can purchase automatic urinal sensor at a very cost effective price.

- Stylish ceramic urinal in white color with embedded sensor for automatic flushing and toilet sensor flushing system
- Deodorize feature of 24 hours voluntarily flush if no use
- False flush protection with live indicator to represent sensing & flush ready modes
- Sense to respect feature to avoid splashing on second person in queue
- 100% hygiene touch free urinal sensor for washroom
- Best price of infrared urinal sensor in Delhi and whole India
- Automatic urinal sensor at high discounts & best price in Delhi, India - with Unmatched deal
- Proper cleanliness

Advantages of getting automatic urinal sensor

- **Proper cleanliness** : An automatic urinal sensor ensures that everything gets cleaned automatically without using the hands. For instance, if a person forgets

to flush the urinal manually, then auto flush sensor feature very well helps to take care of it.

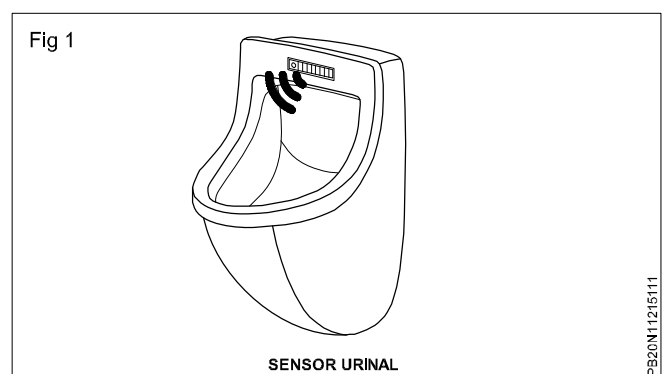
- **Longer lifespan** : The urinal motion sensor are hands free and thus the mishandling & wear and tear is minimized. Hence, the chances of damage gets reduced.

This arguably results in the longer lifespan of the urinal sensor for washroom.

- **Reduction in wastage of water:** One of the major advantage of urinal sensor is that they reduce the wastage of water as compared to manual urinals. Also, there would be delay between one flush to another which ensures that you are not flushing again and again.
- **Easy to use:** Automatic urinal sensor is quite easy to use and thus it is perfect for elderly or young children. The reason is that waste material gets flushed automatically while maintaining the utmost hygiene.

Different types of automatic urinal sensor (Figs 1 & 2)

- Concealed urinal sensors
- Exposed urinal sensors
- Integrated urinal sensors



Neutral features of sensor taps (Fig 3)

Newbies will need a few seconds to realise how to use a touchless tap. A clear sign explaining that it is a motion sensor tap helps to cut down confusion. After such an initiation, visitors will know from then on that automatic

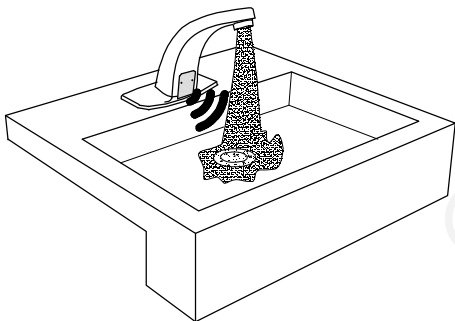
faucets are a possibility in washrooms, like we all did with manual and push taps.

Fig 2



Sensor urinal

Fig 3



SENSOR WASH BASIN

All faucet filters need to be checked regularly, including those inside the sensor tap system. Cleaning tap filters is fundamental before using the electronic tap for the first time and after a water cut.

Since smart taps require power, they will run out of battery eventually. Most models in the market will let staff know the need for a replacement with LED warnings. There are different battery options, but they will last for at least 1 year.

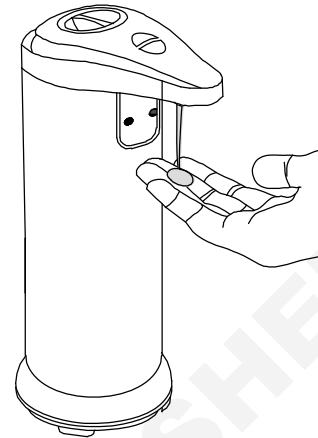
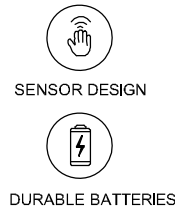
Advantages of getting automatic urinal sensor

- Water conservation
- Energy saving in the long term
- Reduce water bill amount
- Provide cleaner area in the bath room
- Provide dust free prevent cross contamination of users through tap.

Automatic soap dispenser (Fig 4)

An automatic soap dispenser is a device that dispenses a controlled amount of soap solution (or a similar liquid such as a hand sanitizer). They are often used in conjunction with automatic faucets in public restrooms. They function to conserve the amount of soap used and stem infectious disease transmission.

Fig 4



AUTOMATIC SOAP SENSOR

PE20N11215114

Application

The implementation of automatic washroom supplies has increased dramatically. An increasing number of public locations and private institutions have been incorporating touchless technology into their washrooms.

Mechanisms

When washing hands, the user's hands are placed under the nozzle and before the sensor. The activated sensor will further activate a pump that dispenses a premeasured amount of soap from the nozzle.

Radar-based sensor: This kind of sensor sends out bursts of microwave or ultrasound energy and waits for the energy to reflect back. In a stagnant situation, the energy will bounce back in a normal pattern. When hands are placed in the basin, the energy emitted from the sensor will bounce back irregularly which triggers the dispensation of soap. Modern sensors used in electronic faucets, electronic flush valves and electronic soap dispensers use Infrared light with wavelength in the range of 850 nm. The sensor employs an emitter and a collector. The emitter emits pulses of infrared light while the collector, which is positioned to face in the same direction as the emitter, "sits" dormant waiting to sense the emitted pulses. When no hands are present in front of the device, no reflection of light takes place, and therefore, no pulse is sensed. When hands are present in the path of the emitted light, a portions of the emitted infrared light is bounced back in the direction of the collector which then becomes excited by the light (in the event a photodiode is used) and generates voltage to switch the pump on. If a photo transistor is utilized, then the photo transistor, upon sensing the infrared pulse, will simply switch the pump on.

Photo sensor: This mechanism is composed of two parts, a source of focused light (usually a laser beam) and a

light sensor. When the user's hands are placed in line of the beam of light, the pump mechanism is activated by the disruption that is sensed by the light sensor.

Passive infrared sensor: Infrared sensors detect infrared energy that is emitted by one's body heat. When hands are placed in the proximity of the sensor, the infrared energy quickly fluctuates. This fluctuation triggers the pump to activate and dispense the designated amount of soap.

Advantages

Touchless

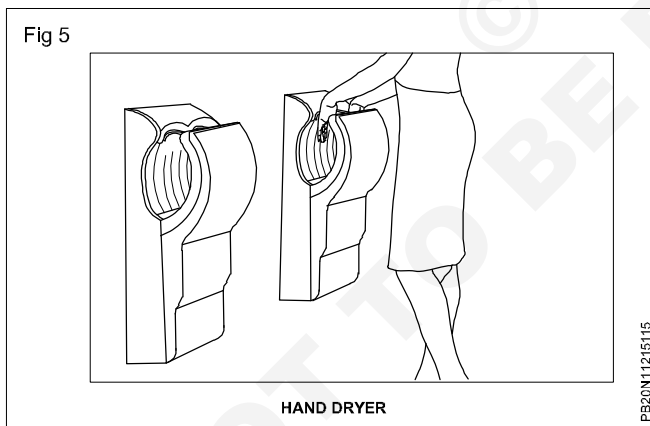
The advancement of the automatic soap dispenser further creates an even more sterile environment. When various individuals use the pump, they will leave behind a variety of bacterial colonies.

Preset increments

Dispensers will only distribute a set amount of soap per motion activation. A predetermined amount to be dispensed can be set to a highly efficient quantity in which waste will be minimal.

Versatility: The mechanisms of the dispenser that work for soap may also work for other liquids: soap, hand sanitizer, lotion, laundry detergent etc. The wide range of possibilities extends the use of the dispenser to various other locations other than the bathroom.

Hand dryer (Fig 5): A hand dryer is an electric machine which might make use of a heating element and an air blower to dry the hands after hand washing. It is commonly used in public toilets as a cost-effective alternative to paper towels.



It may either operate with the push of a button or automatically using a sensor.

Effect on environment: Due to the reduction in litter and waste in comparison with paper towels, which cannot be recycled, hand dryers are claimed to be better for the environment.

Hygiene and health: The World Health Organization (WHO) and the Centers for Disease Control and Prevention both stress the importance of frequent and thorough hand washing followed by their complete drying as a means to stop the spread of bacteria.

A study in 2020 found that hand dryers and paper towels were both found to be equally hygienic hand-drying solutions.

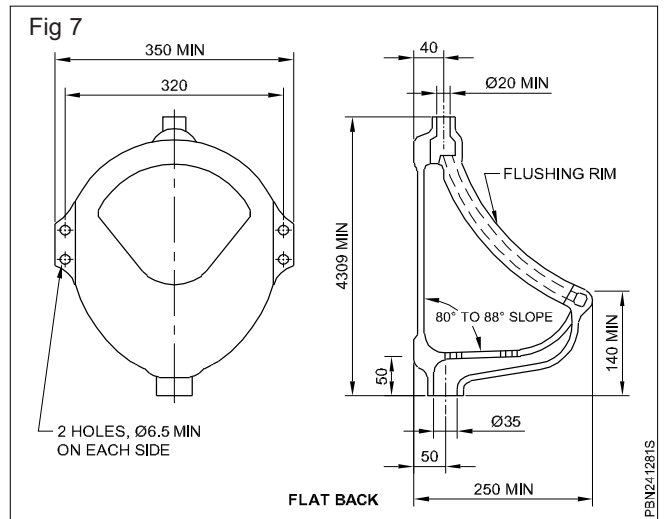
Water less urinals

Aqua free white vitreous chine clay. This can be put into use without water connections size available is 60 x 30 x 31.5cm. it is costly.

Wall flat back urinal/corner urinal (Fig 6, 7 & 8)

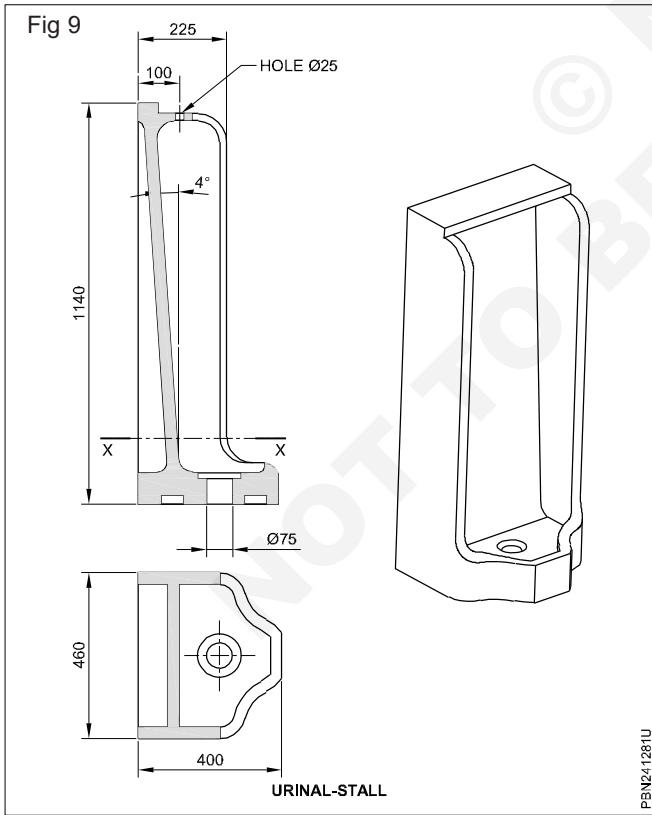
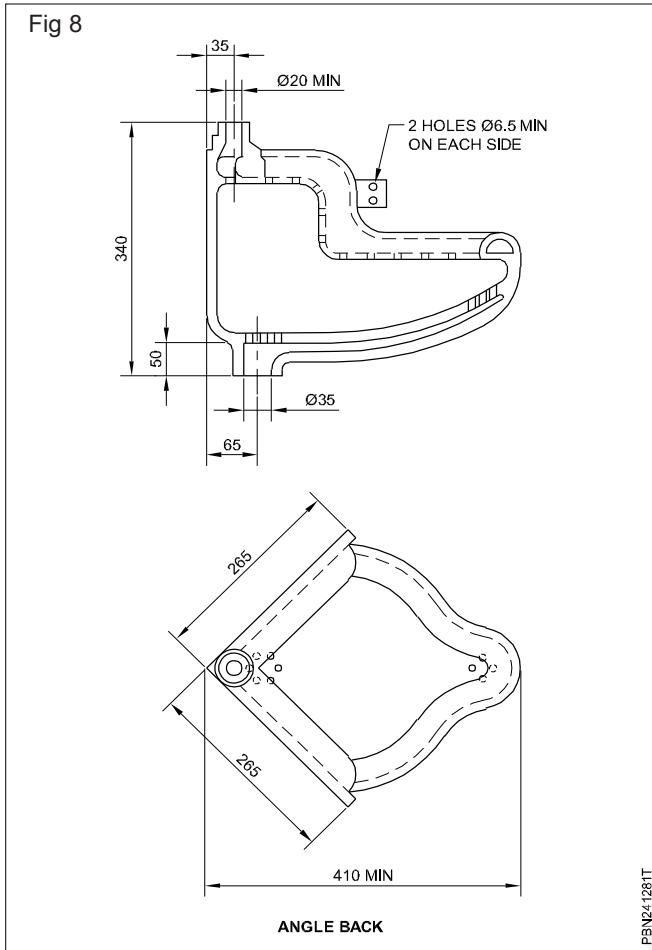


These are manufactured from white vitreous chine conforming to IS2556 (PVI). The urinals are one piece construction. These have two fixing holes of a minimum Ø 6.5mm each side. It has a connect an outlet pipe. Inside surface of urinals are uniformly smooth.



Stall urinal slope (Fig 9)

The stall urinal and its screen are of white glazed fire clay and confirm to IS771 (Part 3 sec 2). It is 1140mm high 460mm wide with 400mm overall depth at the base. Screen are of size 1200mm 15cm wide (overall) and projects 50cm after embedding in the wall. Inside surface of stall and screen are regular and smooth-water spreaders as per IS2556 (PV1se6) is to provided. (Fig 9)



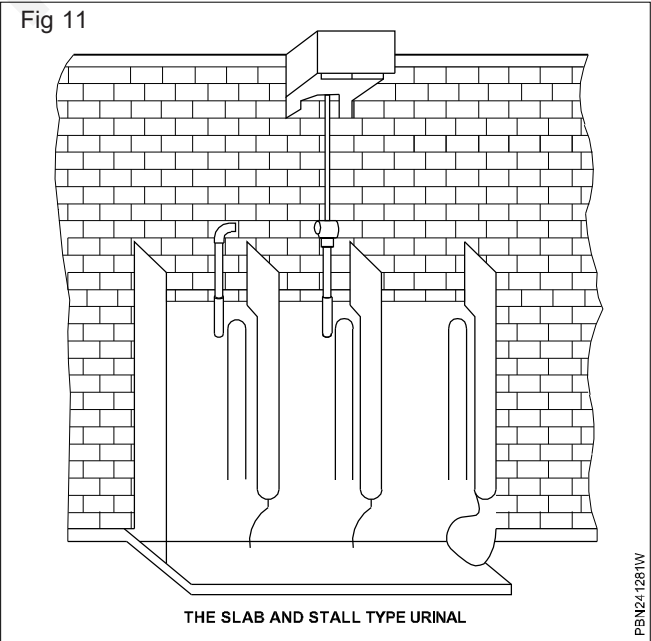
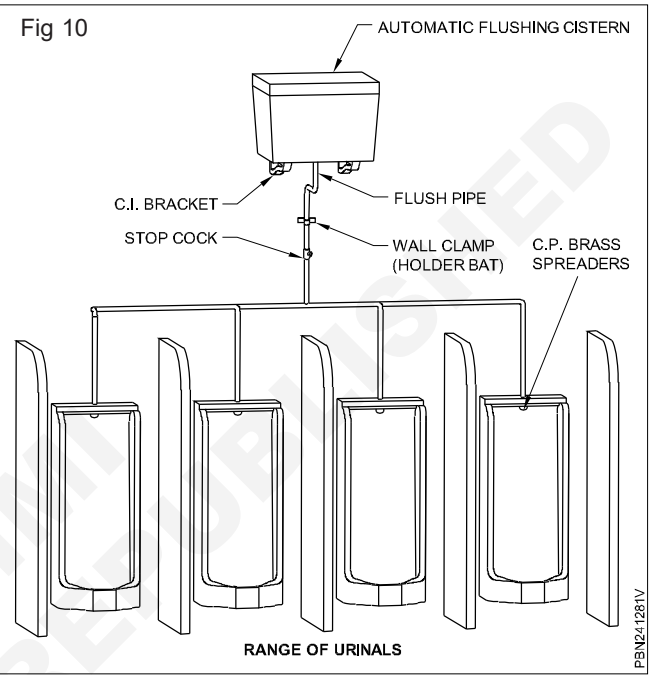
Half stall urinal: These are to be manufactured as per IS2556 (PVI Sec2). They are one-piece construction with or without integral flushing box rim-water spreader shall be provided if integral flushing rim is not provided.

Squaring plate urinal (Fig 10 & 11)

These plates are of white vitreous china conforming IS2556 PI and Part VI sec 3. These are having internal flushing rim with front or side inlet. These are of one-piece construction - urinals are having integral longitudinal flushing pipe which can be connected to flush pipe.

100mm white glazed vitreous china channel with stop and outlet piece in front is also a part of this.

Automatic cistern for flushing are fixed at a height of 1900 from floor to bottom. If urinals are fixed in a row it shall be at 690mm centre to centre.



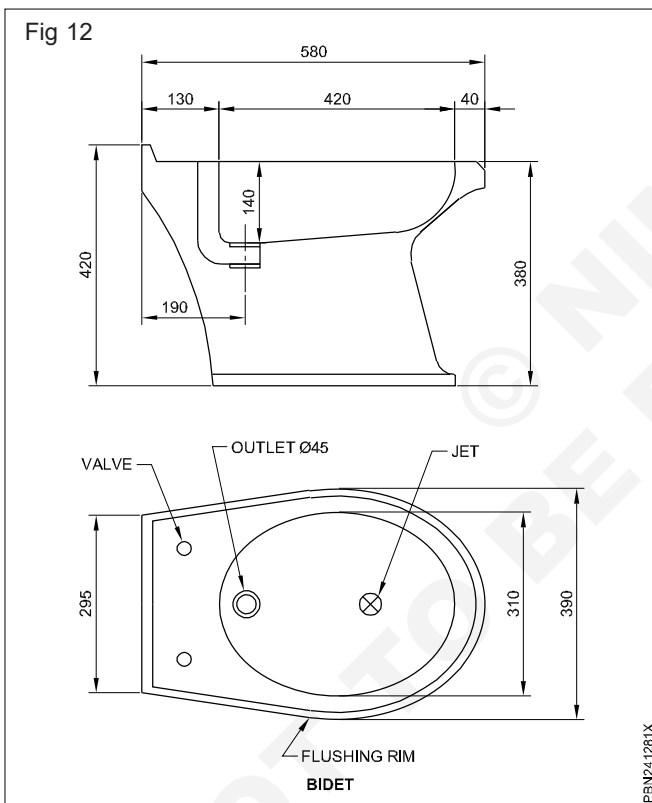
Specifications of urinals

Bowl type Urinals

Urinals basins shall be of flat back or corner wall type lipped in front. These shall be of white vitreous China conforming to I.S.: 2556 (Part I) - 1967 and I.S. : 2556 - (Part VI) Sec. I - 1974. The urinals shall be of onepiece construction. Each urinal shall be provided with not less than two fixing holes of a minimum dia of 6.5 mm on each side. Each urinal shall have an integral flushing rim of suitable type and inlet or supply horn for connecting the flush pipe.

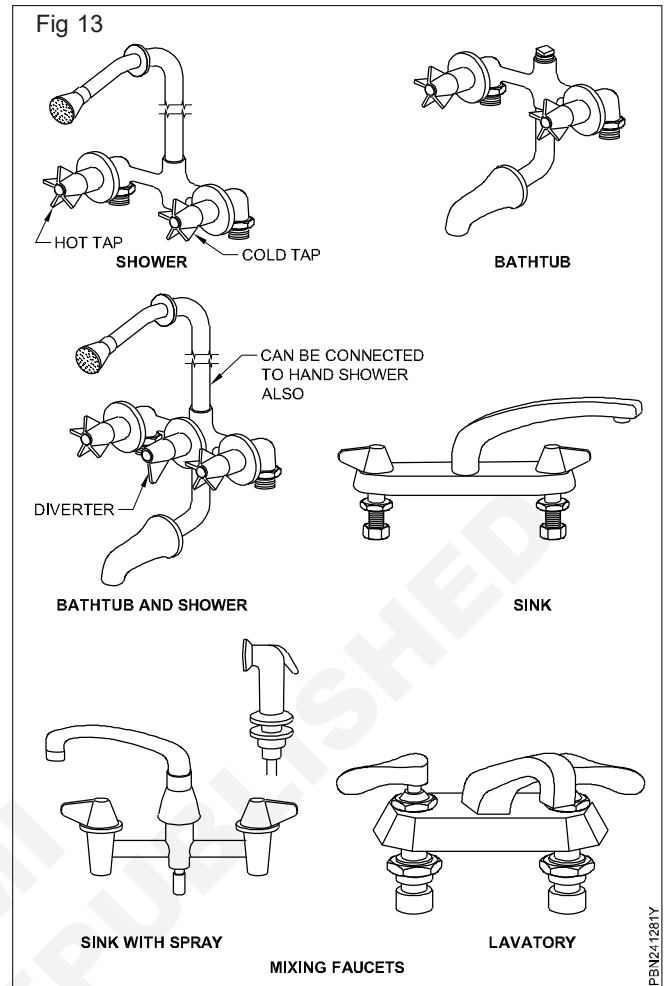
Bidet (Fig 12)

The bidet is pronounced as "beday". The bidet is designed for cleanliness of localized parts of the body especially of genitor urinary cleanliness. The bidet is equipped with valves for both hot and cold water and with popup waste plug, a flushing rim, an integral jet operated by means of valve. When the Jet is "ON" a stream of water flows upward from bottom section of bowl enabling cleaning.



Mixing tap (Fig 13)

When hot and cold water supply is available the faucets used on lavatories, bath tubs, bidet and kitchen sink are to be mixing type. Instead of two separate units one for hot and cold water valves combined with a single spigot. This permits adjusting the temperature of the water to users' preference. Some of the various types of mixing faucets are shown in Figure. Hot water connection is given to the left side of the user and cold water on right side. Hot water taps are generally identified with red spot on top of tap.



Popup waste (Fig 14)

Wash basin having an integral over flow arrangement will have rubber plug and chain arrangement to retain water upto overflow. Instead of rubber plug and chain, popup waste can also be fitted in these type of wash basin. A typical arrangement is shown in the figure. Here the draw stopper is controlled by pushing or pulling the knob located on the tap assembly. Other models are also available in which a lever is rotated to open and to close the stopper.

Requirements for sanitary fittings

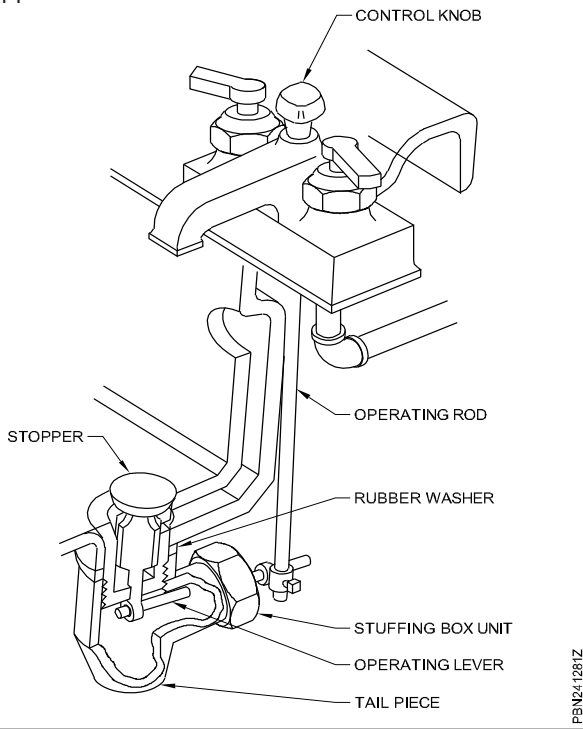
The requirements for sanitary fittings depends on the persons using them and the circumstances, type of building etc. For calculating the number of sanitary fittings required the following table 1 can be used.

General points to be observed when choosing sanitary

Five factors to consider choosing best sanitary ware for your bath room. To achieve that goal here are some tips that wise help you to choose the best sanitary ware for your bathroom that suits your needs.

- 1 Color:** While choosing color you should know how to combine colours that complement each other. 76 yellow/ golden would be the accent color that you want, keeping every thing else white would be good but powder blue cabinets go well with it too. If you are not sure about this, it would be best to stick to white it's a safe

Fig 14



- 2 **Comfort:** Since you are going to spend money anyway, why not to invest on sanitary ware that make your life little comfortable. If you can afford it invest in bath tub and a shower that allows temperature adjustment.
- 3 **Ease of cleaning:** It would be convenient if all of your sanitary items in bathroom have a self cleaning

feature. Always think how easy an item would be to clean before buying them. Otherwise you would end up swearing up and down while scrubbing the bath room.

- 4 **Size:** If your bathroom size is small so it would be better to off for sanitary wares which are in small size. Always plan the size of bathroom as per your requirements. Accordingly, choose the sanitary ware as per the space available.
- 5 **Resistance:** While choosing bathroom sanitaryware two major factors have to be put into consideration. These are strength and design. Toilet bowls and bathroom basins should be of good design and also be strong enough not to chip and break easily there should be no sharp edge and ensure that they are well fitted.

Factors related with choosing right sanitary wares

- 1 **Importance of choosing right toilet basin:** Ensure that the toilet basin should be in the right shape, size and style which make great difference in the bath room.
- 2 You must consider the type of tap you choose for your toilet basin because it can affect the aesthetic of your sink and bathroom.
- 3 More commonly seen the deck mount offers easier installation and future maintenance. The other option which is wall mounted tap gives luxurious appeal. It is more space efficient especially for sweller home toilets.
- 4 Material of toilet basin depends upon the individual's requirement there are many materials used for toilet basin like marble, stone toilet, ceramic.

**Table 1
Office Building**

Sanitary fittings	For male personnel	For female personnel
Water closets	1 for every 25 persons	1 for every 15 persons
Ablution taps	1 in each W.C.	1 in each W.C.
Drinking fountain	1 for every 100 persons	1 for every 100 persons
Urinals	Nil upto 6 persons 1 for 7 - 20 persons 2 for 21 - 45 persons 3 for 46 - 70 persons 4 for 71 - 100 persons From 101 to 200 persons add @ 3% For over 200 persons add & 2.5 %	same as for male personnel
Wash basins	1 for every 25 persons	
Baths	Preferably 1 on each floor	
Cleaner's sink	1 per floor	

* For requirements for other types of buildings such as cinema houses, restaurants, halls, factories etc. See I.S. 1172 - 1963, 'Code of Basic Requirements for Water Supply, Drainage and Sanitation'

- Marble/ stone toilets basins are strong and durable and easy to clean the ceramic toilet basin is economy and easy to clean.
- Before buying toilet basin you must ensure that the type of mounting to be taken into consideration.

Pipe alignment and slope in plumbing

Horizontal drainage piping shall be installed in uniform alignment at uniform slope. The slope of horizontal drainage pipe shall be not less than that indicated in table.

Slope of the horizontal drainage pipe

Size (inches)	Minimum slope (inch per foot)
2 ½ or less	¼ ^a
3 to 6	1/8 ^a
8 or larger	1/16 ^a

Pipe alignment: Generally pipe alignment clamps are available for all the following purposes. To align and reform the matting side of the weld joint. To align and reform the both side of the weld joint. To align reform pipes, tubes, elbows, tees, flanges and other fittings. to need pipe ends against a consumable welding insert.

How to check alignment of pipes: As per the code of the vertical and horizontal deviation piping flange and rotary equipment flange centre line is within 1.5mm.

Diameter of pipe in mm	80 to 250	300	400	500	600	700	900	1050-1500
Extra pressure for water hammer in kg/cm ²	8.50	7.75	7.0	6.30	5.75	5.60	4.90	4.90

Prevention of water hammer

You can take the following measures to reduce or eliminate water hammer.

- Reduce the pressure of water supply by fitting a pressure regulator.
- Reduce fluid velocity in the pipes.
- Install slow closure faucets.
- Use start up and shut down procedure on an existing installation.
- Use SCV check valves which is specifically designed to protect from water hammer.
- Always use stronger pipe.
- Use surge alleviators.
- Use pressure relief valves.

Storage tanks for water supply

Storage tanks for water can be either at ground level, below ground level or at elevated position. (Fig 15)

Water hammer: If water flowing through a tap or valve is suddenly arrested, the water will record in the pipe. Water is practically incompressible and will act like a solid rom induce stresses inside the pipe and it will produce a noise like hammering. It is known as water hammer.

This may rupture the pipe and connected fittings. Water hammer is caused due to the following:

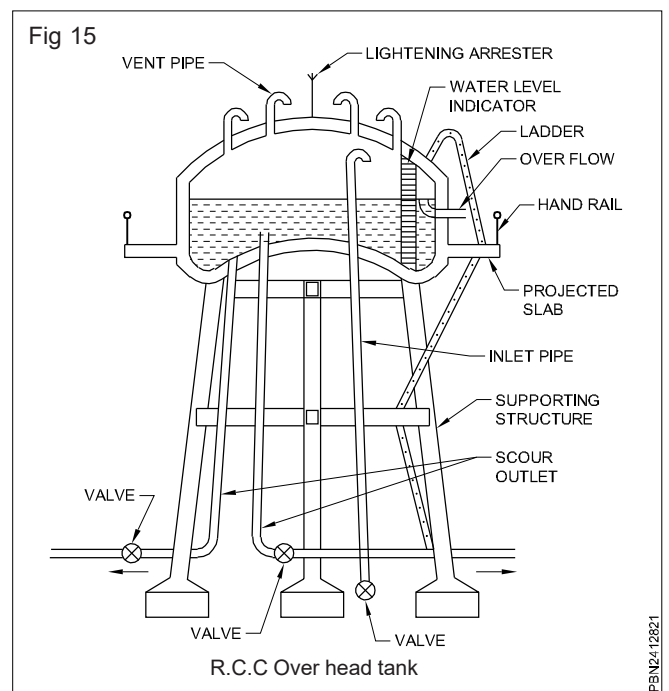
- When valve is closed, instantaneously.
- Power driving the pump fails all of a sudden.
- Pulsation in flow due to reciprocating pumps and hydraulic rams.

This effect of water hammer can be reduced by following measures:

- Provide a surge relief at or near the outlet end.
- Provide air-relief valve of considerably large size.

Safety valve: The valve consists of a disc which is controlled by a spring which can be adjusted for any pressure. When the pressure in the pipe exceeds the valve for which the valve is adjusted, the disc is lifted and the pressure is relieved through cross pipe. The disc again comes to its original position due to the spring.

For the design of pipes, extra pressure due to water hammer is assumed about 8.5 kg/cm² for pipes of 7.5 cm to 25 cm in diameter. The pressure is gradually reduced to 4.9 kg/cm² for pipes above 120 cm in diameter. Allowance for water hammer for various sizes of pipes may be taken as follows:



The parts of elevated tanks are

- foundation
- supporting super structure
- tank
- lightening arrester
- pipes and valves
- ladder
- water level indicator

Foundation: Types of foundation are decided based on the total expected load i.e self-weight and weight of water to be stored; and the bearing capacity of soil. If the bearing capacity of soil is less than 10T/sq.m we have to go for pile foundation.

Supporting structure: Considering the contour of the area of watersupply, height of structure to be served and also the length and diameter of distribution pipe the height of water tank bottom is to be decided - supporting structure are designed after taking into consideration of the total load acting upon it.

Tank: Shape of tank to be as decided by architects. Size of tank is decided considering the storage capacity and the required free board. It is preferable to have a cantilever projection like a balcony with hand rail of 90cm height to facilitate inspections-An inspection hole and cover.

Pipes and valves: 4 pipes are provided in an elevated tank for different purposes. These pipes are named based on the purpose of its use

- Inlet pipe
- Outlet pipe
- Overflow pipe
- Score pipe
- Ventilation pipe

Inlet pipe are terminating above the storage level and fitted with a control valve and non return valve. Outlet pipes are generally fixed at the opposite side of inlet and at 50mm above the tank bottom level and is fitted with a control valve. Drain pipe (scour) is fixed at the bottom level of tank and it should be taken 1m beyond the foundation area of tank and fitted with a valve. It is fitted for cleaning the tank and dewatering. Over flow pipes are fitted at the full supply level and it also to be taken away from tank area. Ventilating pipes is fixed at top of tank for fresh air inlet.

Ladder: A ladder is required for carrying out inspection and maintenance at outside and a small ladder inside. The slop of the ladder should not be flat.

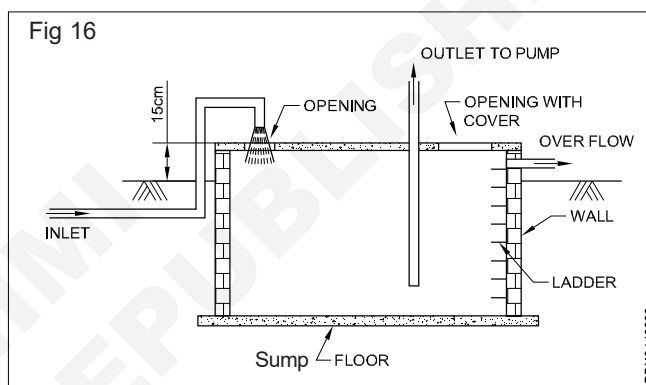
Water level indicator: In order to find out the water level at tank from ground, a water level indicator is required. It consists of a scale, float, string and indicator. When water raises float rises and indicator will lower as such the marking on scale will be the full depth at bottom and empty position at top.

Lightening arrester: It is provided to protect the structure from lightening. If the tank is constructed over airports etc. necessary red lights are to be fixed at top.

Rotational moulded polythylene water storage tanks. It shall confirm to IS12701. (Fig 16)

Installation and fittings: The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and location tanks may be suitably anchored.

For inlet, outlet and other connections fully threaded GI. HDPE or PVC connections with hexagonal checknuts and wahers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls. (Fig 17)



Manhole lid: The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

Sump: Sump is constructed below the ground to store water. It consists of bed, masonry/concrete walls, inlet, outlet, over flow pipes. Top of sump shall be 150mm above the formation ground level so that rain water should not enter. Sump also be cleaned once in six months. (Fig 33)

The storage tanks are either in P.V.C. or Brick work or R.C.C. with a capacity of 1000 to 2000 lit. These are installed on a pedestal/platform; height about 1 m from ground level. Water is filled daily in the tank from water source through pipes. Inlet, Vent pipe, manhole are provided as usual in the tank. Number of taps are provided at the foot of the tank as per the requirement of area. This system is very useful both in city & village areas. Periodical maintenance should be done once in three or four months. This system is used were the water demand is somewhat less.

Cleaning and maintenance of storage tank

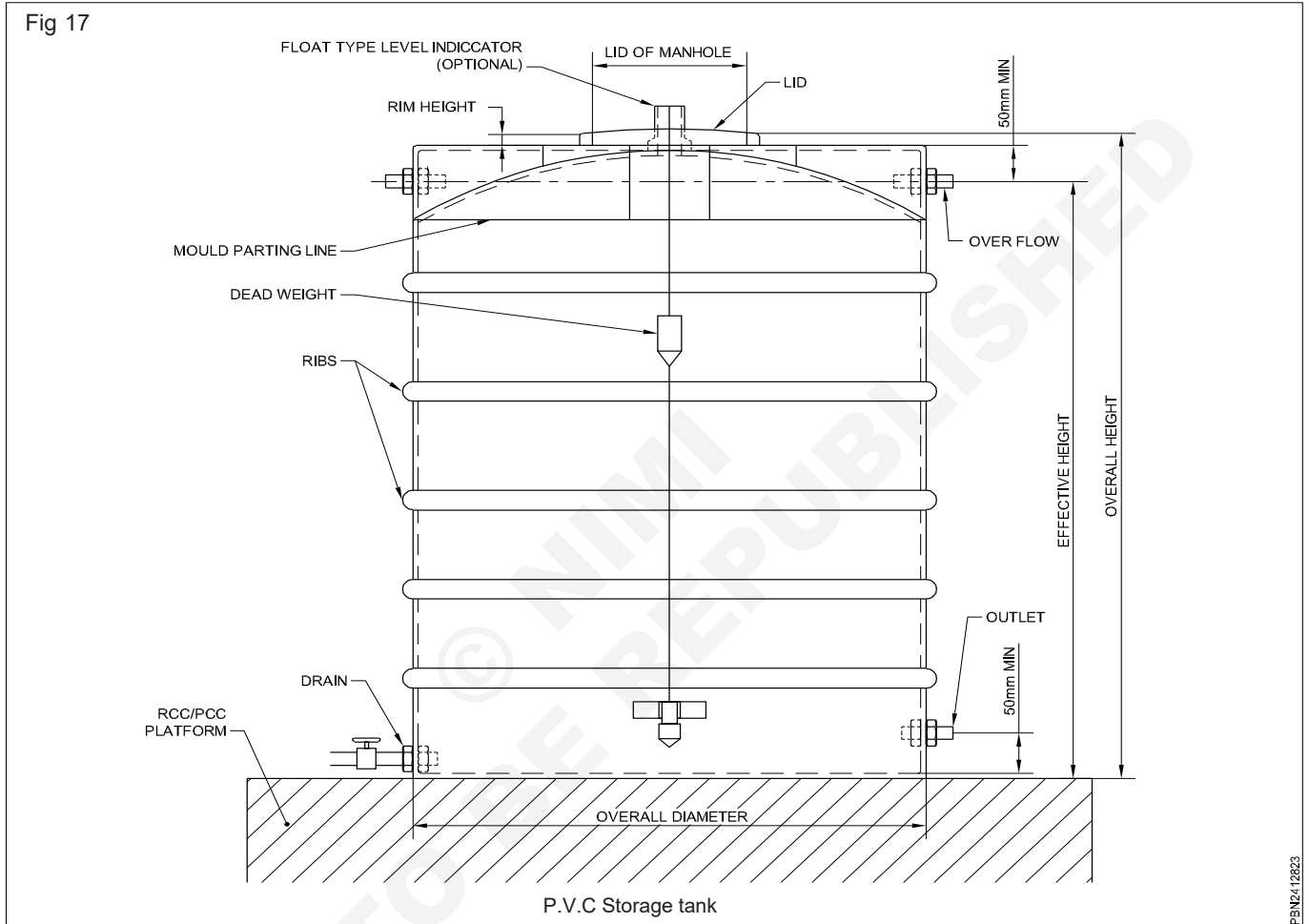
Storage tank must be clean with periodical intervals. If its not carried out, water may contained due to bacteria, fungus and sedimentation, it not advisable to usage.

Pipe line may get rust, scaling formation.

Every three months periodically check the water storage tank

- Check the water inlet and outlet pipe line's and outside wall if any damages.

- Tank must be close with sunlight
- Must be provide overflow pipe/automatic control valve.



Test for water supply pipes

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

- state the hydraulic tests
- state the soundness of pipeline system
- state the laying and jointing pipe fittings.

Hydrostatic tests of pipes

After a new pipes has been laid, jointed and back filled (or any valved section thereof) it shall be subjected to the following two tests:

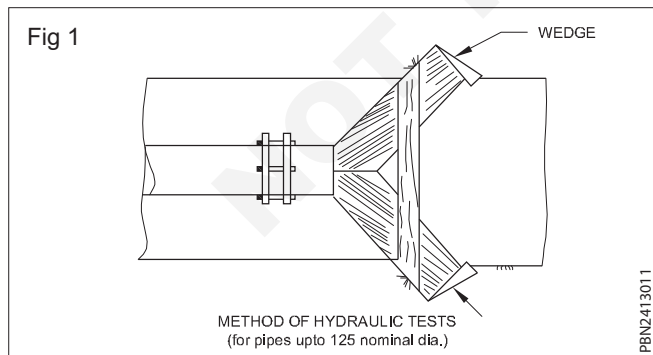
- a **Pressure test** at a pressure of at least double the maximum working pressure-pipe and joints shall be absolutely water tight under the test.
- b **Leakage test** (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for a duration of two hours.

Hydraulic Tests : The portions of the line shall be tested by subjecting to pressure test as the found immediately and can be corrected at minimum cost. Usually the length of the section to be tested shall not exceed 500m.

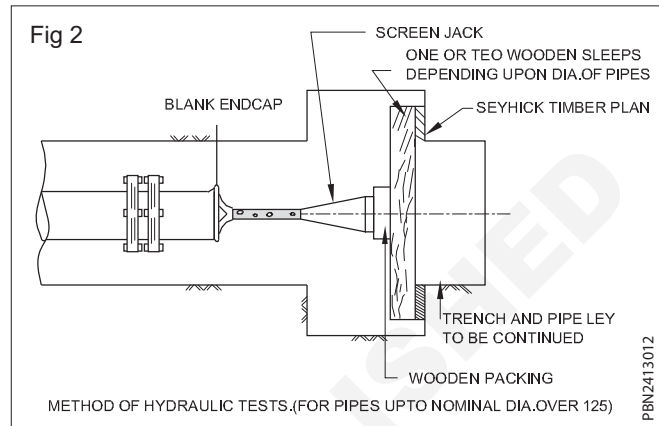
Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have lapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, the test shall not be made atleast two days have lapsed.

Prior two testing, enough back fill as described shall be places over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as relief vent or for filling the line, as may be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate as shown in Fig 1 & 2.



The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the line before making the pressure strength test because entrapped air gets compressed and causes difficulties in raising the required pressure for the pressure strength test.



The test pressure shall be gradually raised at the rate of approximately one kg/cm²/min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

The pipes shall be tested as specified in IS : 5913-1970 in the factory and hence the purpose of field testing is to check the quantity of workmanship and also to check whether the pipe have been damaged in transit. As such, the test pressure shall be kept as 1.5times the actual operating pressure unless a higher test pressure is specified. However, it may be noted that the test pressure during the field test shall not exceed the valves given in Table 1.

Table 1
Test pressure of pipes

Class of pipes	Maximum field test pressure kgf/cm
5	3.75
10	7.50
15	11.50
20	15.00
25	18.75

Asbestos cement pipes always absorb a certain amount of water. Therefore, after the line is filled, it shall be allowed to stand for 24 hours, before pressure testing and the line shall be again filled.

Specifications for laying and jointing of pipes and fittings

Pipes on slopes need be anchored only when there is a possibility of the backfill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes upto 30° good well drained soil, carefully tamped layers of 100

mm under and over the pipe, right upto the top of trench will not required anchoring. For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

Inspection and testing of water supply system

Testing of the pipe lines

After a pipe line has been laid, fitted with all appurtenances and accessories, painted both from inside as well as outside by means of protective paints, etc., the pipe line will be tested for the soundness in its construction. The soundness of the construction is examined by performing the pressure test on the pipe line. The set by step procedure adopted for performing this test is described below:

The pipe line is tested from section to section. Thus, at a time, only one particular section lying between two sluice valves is taken up for testing.

The downstream sluice valve is closed, and water is admitted into the pipe through the upstream sluice valve. The air valves will be properly operated during filling up of the pipe.

The upstream valve, through which water was admitted, is closed, so as to completely isolate the pipe section from the rest of the pipe.

Pressure gauges are then fitted along the length of the pipe section at suitable intervals (say 1 km or so) on the crown, through holes left for this purpose.

The pressure in the pipe line is low raised by means of a small hand force pump or a hydraulic pressure pump, till the test pressure (to be measured on the pressure gauge fixed on the pipe) is nearly 25-50% above the highest working pressure.

The pipe and the joints are then visualized for water tightness. The applied test pressure should also maintain itself without any appreciable loss during the observation period, which may be at least 4 hours.

When the field test pressure is less than the works test pressure, then the observation period should be increased to at least 24 hours.

The pipe is finally emptied through drain valves, and the observed defects (in the test) are rectified, so as to make the line fit for use. The pipe is again tested by repeating the test, so as to ensure proper rectification of defects already done.

After the satisfactory completion of the pressure test, a leakage test at a pressure to be specified by the authority for a duration of 2 hours may also be performed. Leakage is defined as the quantity of water that is required to be supplied for maintaining the specified leakage test pressure after the pipe has been filled with water and the air is expelled.

In a newly laid pipe line, there should generally be no leakage. Moreover, the allowable leakage during the maintenance stage of pipes carefully laid and well tested during construction, should also not exceed the value given by equation below:

$$q_L = N.D\sqrt{P} \\ 115$$

where,

q = Allow leakage in cm /hr

N = Number of joints in the length of the pipe line

D = Diameter of pipe in mm

P = The average test pressure during the leakage test in kg/cm² (i.e. 10 m of water head)

Plumbing

Plumber - Water supply systems

Related Theory for Exercise 1.10.95

Description of sanitary fitting

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

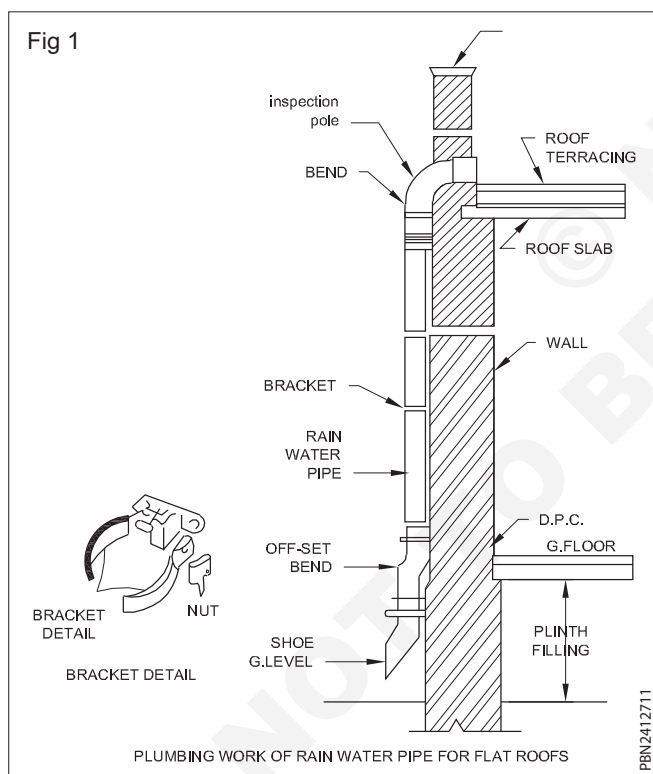
- describe sanitary fitting.
-

Refer Ex. No.1.10.89 - 1.10.93

Erecting rain water and drainage pipe system

- Objectives:** At the end of this lesson you shall be able to
- state the installation of rain water pipe from roof to ground
 - state the rain water har vesting
 - state the type of rain water har vesting
 - state the rain water gutter with rain water pipe
 - state the types of drainage pipe system.

Erecting rain water pipe: The pipe laid to collect the rain water from the roofs is known as rain water pipe. The water from the flat as well as sloppy roofs is to be connected and brought on the ground level, from where it is allowed to flow in open drains. Rain water pipes for drainage of roofs (Fig 1). The roofs of a building shall be so constructed or framed as to permit effectual drainage of the rain water there from by means of a sufficient number of rain water pipes of adequate size so arranged, jointed and fixed as to ensure that the rain water is carried away from the building without causing dampness in any part of the walls or foundations of the building or those of an adjacent building.

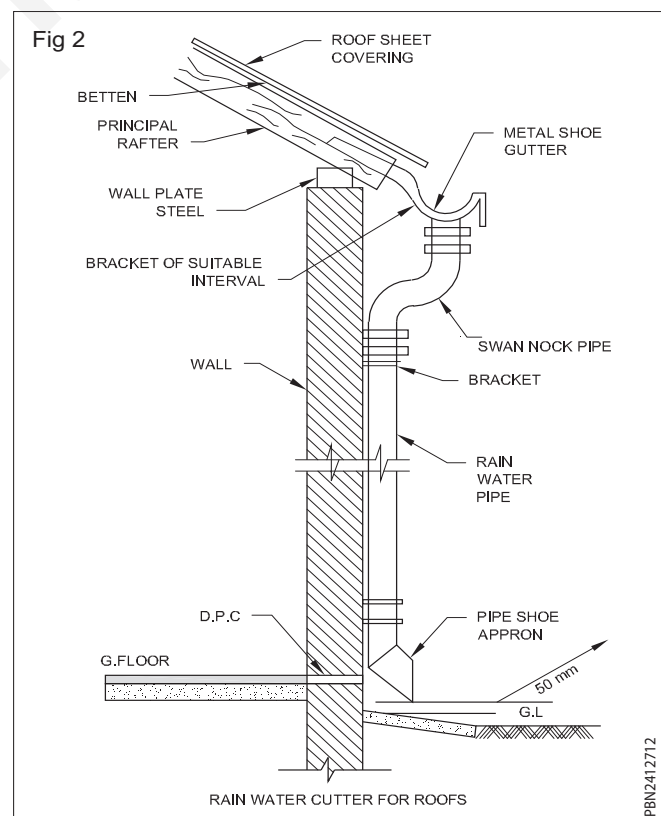


The rain water pipes shall be fixed to the outside of the external walls of the building or in recesses or chase cut or framed in such external walls or in such other manner as may be approved by the administrative authority.

(A rain water pipe conveying rain water shall discharge directly or by means of a channel into or over an inlet to a surface drain or shall discharge freely in a compound, drained to surface drain or shall discharge freely in a compound, drained to surface drain but in no case shall it discharge directly into any closed drain.)

Whenever it is not possible to discharge a rain water pipe into or over an inlet to a surface drain or in a compound, drain to surface drain or in a street drain within 30m from the boundary of the premises, such rain water pipe shall discharge into a gulley trap which shall be connected with the street drain. Such a gulley trap shall have a screen and a silt catcher incorporated in its design.

Rain water pipes shall be constructed of cast iron, asbestos cement, galvanized sheet or other equally suitable material and shall be securely fixed. The latest practice, however, is not to use the pipes made from galvanized sheets for rain water services. Cast iron rain water pipes and fittings shall conform to IS: 1230 -1979. Asbestos cement building pipes and gutters and fittings (Fig 2) (spigot and socket type) shall conform to IS: 1626 (Part 1) 1980, IS 1626 (Part 2) 1980 and IS: 1626 (Part 3) 1981. Sizing of rain water pipes for roof drainage: Rain water pipes shall be normally sized on the basis of roof areas according to Table as under. A bell mouth inlet at the roof surface is found to give better drainage effect, provided proper slopes are given to the roof surface.



The spacing of pipes depends on the position of the windows and arc openings but 6m apart is a convenient distance. The strainer fixed to the bell mouth inlet shall

have an area 1½ to 2 times the area of pipe which it connects.

Sl. No.	Dia. of pipe mm	Average rate of rainfall in mm					
		50	75	100	125	150	200
1	50	Roof area in square metres					
		13.4	8.9	6.6	5.3	4.4	3.3
2	65	24.4	16.0	12.0	9.6	8.0	6.0
3	75	40.8	27.0	20.4	16.3	13.6	10.2
4	100	85.4	57.0	42.7	34.2	28.5	21.3
5	125			80.5	64.3	53.5	40.0
6	150					83.6	62.7

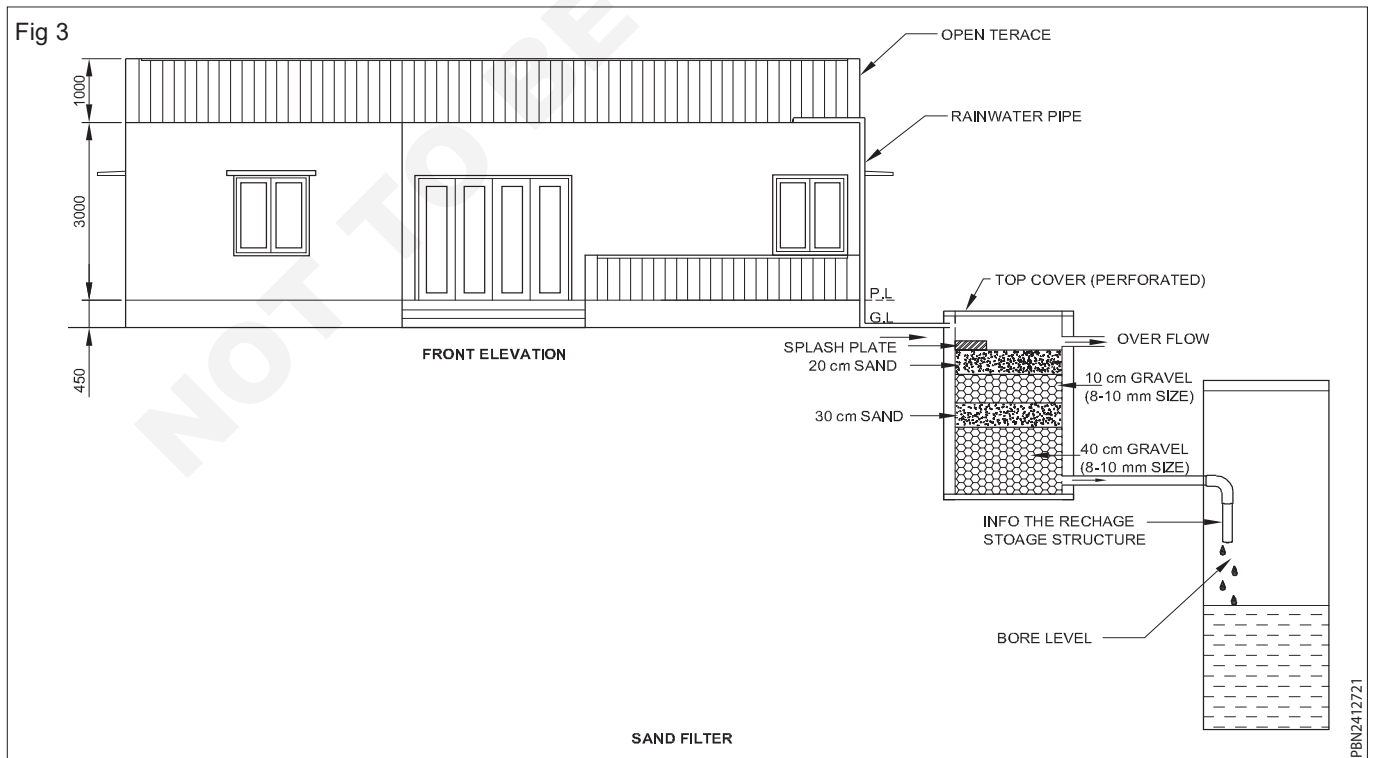
Laying of rainwater pipe

- 1 Only the required size whole should be made in the wall for fixing of pegs, brackets etc. de-shape the pipe and make it oval in section.
- 2 While bending the pipes on the bending machines, care should be taken otherwise it may also press the pipe and give more bend than desired.
- 3 The cutting of the pipes should be done properly, it should be at right angle to the axis of the pipe.
- 4 The pipes should be fixed with pipe-hooks at proper place. These hooks should be driven in the masonry joints.

- 5 In case of accidents first-aid facilities should be available.

Rain water harvesting (Fig 3)

Collection of rain water when it rains for use during non monsoon months is called rain water harvesting. When rainfall occurs in heavy during a short spell if it is not collected it floods the area or run off to sea. It is quite possible to put all the water into soil below with little effort and less expenditure so that rain water is not lost but goes to recharge ground water table.



Benefits of rain water harvesting

- Ground water table raises
- Reduce the salinity
- Avoid flooding

Method of rainwater harvesting

- Percolators/soakpit
- Percolation trenches
- Service well cum rockage well method

Percolators

Maximum plot area to be kept as unsaved so that rain water can percolate to ground.

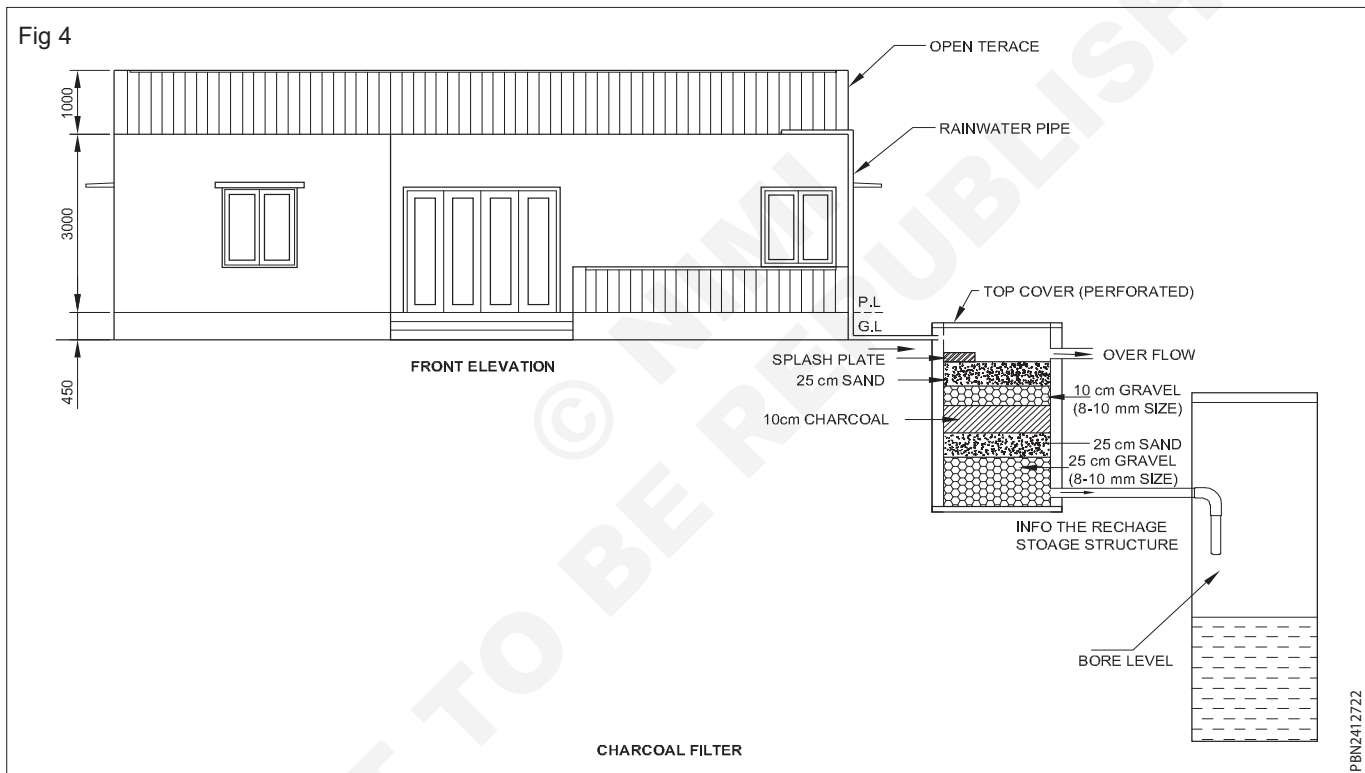
The rain water from season 1st rain should normally not be used for percolation to recharge structures. For such water suitable arrangement for bypass in pipe system should be introduced.

A suitable provision should be made if possible to allow rain water to percolate to ground water after passing it through settlement tank because such rain water contain silt which if deposited on sand bed reduces the percolation rate.

The recharge structure should be made on a plot at the places of lower levels/elevations so that rain water may flow towards it under normal gravitation flow.

On a vast and sloppy land patch, the contour bunds preferably of mud with height varying from 15cm to 30cm should be made to store run off temporarily over the katcha land area, thus allowing more time for percolation of water to the ground water and arresting the flow of run off to the drains/sewers.

For recharge of run off from roads suitable arrangements in the foot path by introducing some katcha area should be made. (Figs 4,5 & 6)

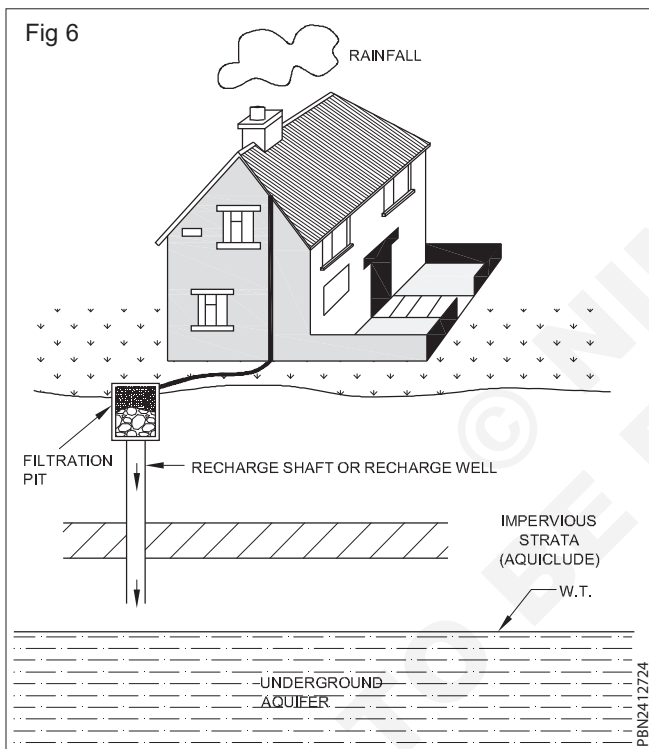
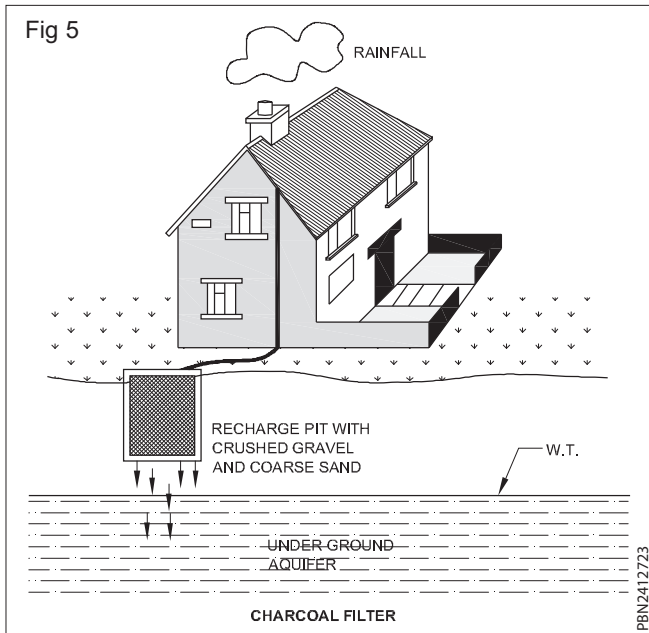


In large residential and office complexes the drive ways, pucca path and areas should had some katcha area which may facilitate rain water to percolate to ground water.

Ideal conditions for rain water harvesting and artificial recharge to ground water. Artificial recharge techniques are adopted where:

- Adequate space for surface storage is not available specially in urban areas.
- Water level is deep enough (more than 8m) and adequate sub-surface storage is available.

- Permeable strata is available at shallow/moderate depth upto 10 to 15 mtr.
- Where adequate quality of surface water is available for recharge to ground water.
- Ground water quality is bad and our aim is to improve it.
- Where there is possibility of intrusion of saline water especially in coastal area.
- Where the evaporation rate is very high from surface water bodies.



The decision whether to store or recharge rain water depends on the rain fall pattern of a particular region.

- If the rain fall period between two spells of the rain is short i.e two to four months, in such situation a small domestic size water tank for storing rain water for drinking and cooking purpose can be used.
- In other regions where total annual rain fall occurs only during 3 to 4 months of monsoon and the period between two such spells is very large i.e. 7 to 8 months, so it is feasible to use rain water to percolate to the ground water aquifers rather than for storage which means that huge volumes of storage container are required.

Rain water harvesting or roof to water harvesting

Reflection of rain water from paved or G.I. corrugated roofs and paved court yards of houses either in storage tanks or in the ground water reservoir is known as rain water harvesting. This collected water serves as a good source of water in rural and water scarce areas. This practice has been adopted since golden times, particularly in rural areas in places having high rainfall intensity, well distributed in the year. Such areas in India include : Himalayan areas, North eastern states, Andaman and Nicobar islands, Lakshadweep islands, Rajasthan and Southern parts of Kerala and Tamil Nadu. This technique is highly promising even for urban areas and places where the rainfall occurs only for a few months in a year, and where other been made compulsory in Delhi and Tamil Nadu, and Tamil Nadu, and this movement is gathering momentum. This practice is already quite prevalent in water scarce Gujarat, where even the old house of Mahatma Gandhi at Porbander can be seen to contain an arrangement for collection of rain water in a storage tank at ground level for its direct use.

In its simplest form, roof top water harvesting involves taking down a PVC or M.S. pipe of 90 - 120 mm dia from the roof's outlet to the ground floor, which can be connected to a water tank (placed either above the ground level or below the ground level) or to the underground water-table. The rain water before collection should however generally be passed through simple sand or charcoal filters (fig) for the removal of suspended particles and micro-organisms from the rain run-off being collected. The roofs or court yards should also be kept as clean as possible at the time of rains. These filters can be vertical or horizontal and can be easily constructed. Their study interface with the water, however, needs to be periodically cleaned to prevent clogging of its pores.

Rain water collection for ground water recharge

When rain water collection for direct use is difficult or costly or impracticable, there ground water recharge option can be easily practised to supplement the falling ground water-table of the area. The ground water recharging can be practised by directing the rain water to in filtrate into the ground to join the water-table either through a recharge pit. or through a recharge well; or through a recharge well with a pressure filter depending upon the available circumstances, as discussed below;

Recharge through a recharge pit

This method is suitable in areas having shallow ground water-table/aquifer and for smaller buildings with roof area of 100 - 150 sqm. A pit of 1 - 2 m deep is excavated at a suitable location in the plot, and the run-off water from the catchment area (roof, etc.) is diverted into this recharge pit. The pit is filled with crushed gravel and coarse sand to filter out the rain water, before it infiltrates through the aquifer to join the water-table.

Recharge through a recharge well

This method is suitable in areas having low ground water tables. In this method, a bore hole is dig or drilled upto or

near to the ground water level, or upto the porous strata or rock fracture for effective recharge.

The diameter of the bore hole may vary from 0.2 to 0.3 m depending upon the porosity of the receiving strata. Slotted pipes are then installed into this bore.

This is the most common type of roof top rain harvesting which can be easily adopted in almost all buildings. A perspective view of the roof-top rain water harvesting through recharge wells in a building complex.

Drainage pipe systems

Systems of sanitary plumbing

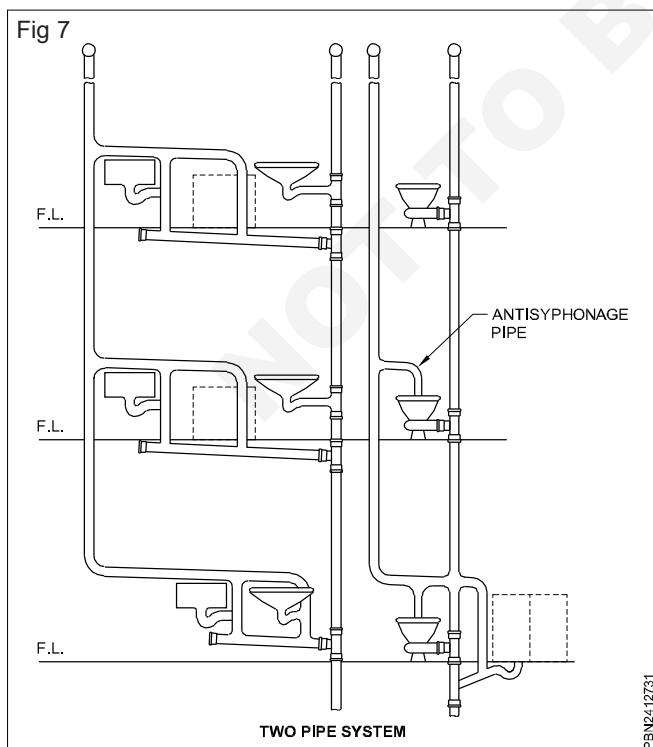
Following are the four principle systems adopted in plumbing of drainage work in a building:

- Two pipe system
- One pipe
- Single stack system
- Partially ventilated single stack system.

This systems are discussed below:

Two pipes system: This is the best and the most improved type of system of plumbing. In this system, two sets of vertical pipes are laid, i.e., one for draining night soil and the other for draining sullage. The pipes of the second set carrying sullage from baths pipes, etc., are called sullage pipes or waste pipes.

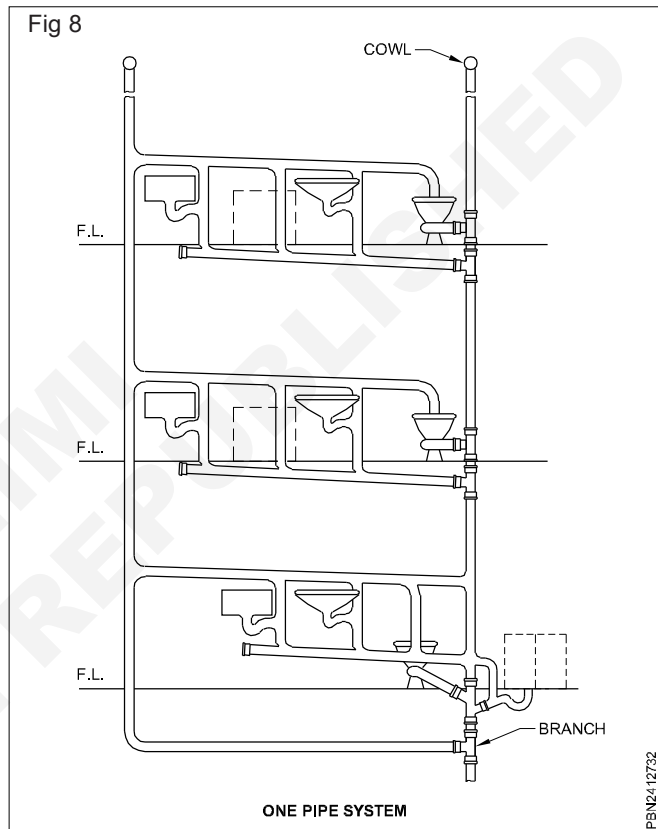
The soil fixtures, such as latrines and urinals are all connected through branch pipes (laterals) to the vertical soil pipe; whereas, the sludge fixtures such as baths, sinks, wash basins, etc. are all connected through branch pipes to the vertical waste pipe. The soil pipe as well as the waste pipe are separately ventilated by providing separate vent pipes or antisiphonage pipes. This arrangement, thus requires four pipes. (Fig 7)



This system, thus involves a large number of pipes, and is thus quite costly. In small houses, moreover, it becomes difficult to accommodate such a large number of pipes.

One pipe system

In this system, instead of using two separate pipe (for carrying sullage and night soil, as is done in the above described two pipe system) only one main vertical pipe is provided, which collects the night soil as well as the sullage water from their respective fixtures through branch pipes. The main pipe is ventilated in itself by providing cowl at its top, and in addition to this, a separate vent pipe, however, is also provided as shown in Fig 8. This system, thus, has two pipes, instead of four pipes of the two pipe system.



Single stack system

This system is a single pipe system without providing any separate ventilation pipe. Hence, it uses only one pipe, which carries the sewage as well as the sullage and is not provided with any separate vent pipe, except that it itself is extended upto about 2m higher than the roof level and provided with a cowl, for removal of foul gases as shown in Fig 9 & 10.

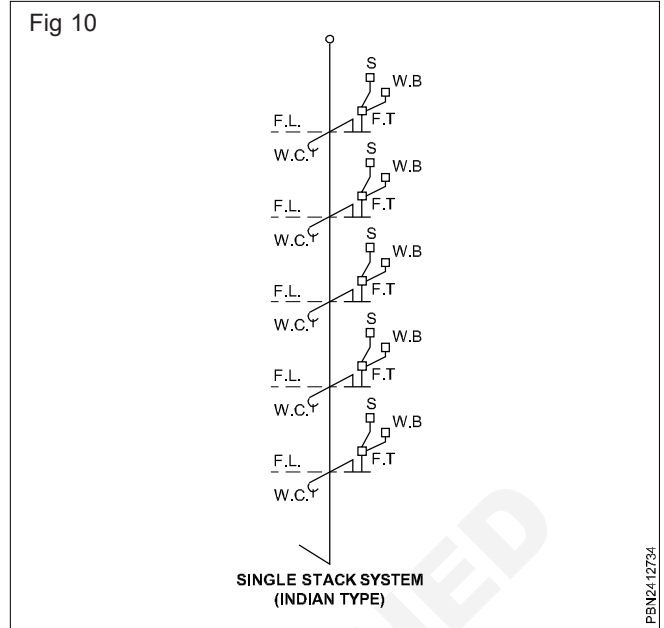
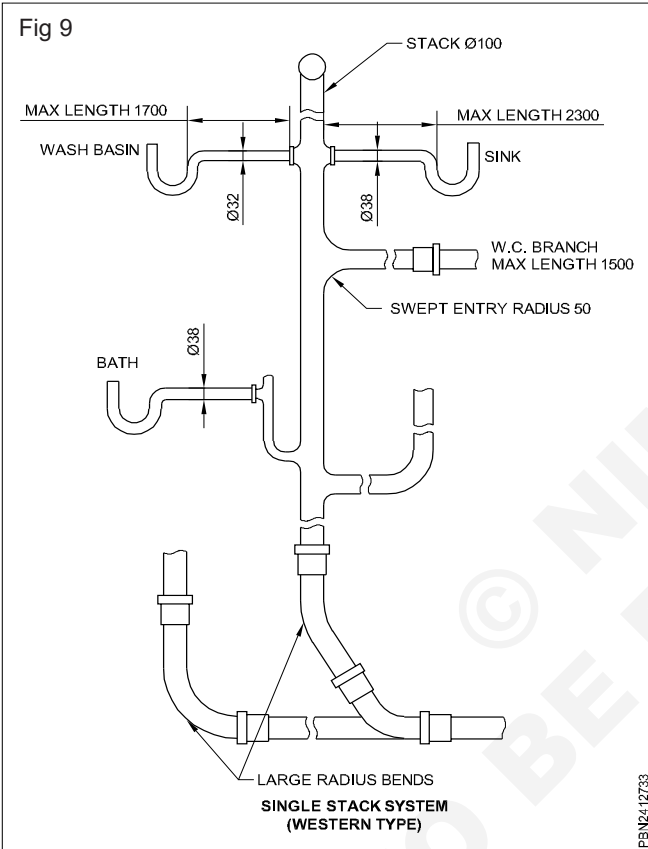
Partially ventilated single stack or single pipe system

This is an improved form of single stack system in the sense that in this system, the traps of the water closets are separately ventilated by a separate vent pipe called relief vent pipe. This system, thus, uses two pipes as in a single pipe system, but the cost of branches (laterals) is considerably reduced compared to single pipe system, because the sullage fixtures are not connected to the vent pipe. This arrangement is shown in Fig 10 Besides these systems,

other combinations and permutations are also possible and may be adopted by some people. (Fig 11)

Choice of a particular system of plumbing

As pointed out earlier, the two pipe system is the best system for efficient conveyance of sanitary house wastes with minimum use of traps and is therefore, largely favoured, particularly for large and multistored buildings. This system, however, requires a large number of pipes and their connections and is hence costly. Moreover, it is also difficult to find suitable place for accommodation so many pipes in small houses and buildings. In that case, one pipe system is more economical and easy to accommodate, but requires sufficient safe guard, to make the drainage



effective in the form of proper ventilation, adequate water seals and proper connections between the sanitary fixtures and the soil pipe. In multistoried buildings, moreover, use of one pipe system, generally makes it imperative to place the lavatory blocks of various floors one above the other.

S.L.	-	Sewer Line
W.B.	-	Wash basin
W.C.	-	Water Closet
F.L.	-	Floor Level
F.T.	-	Floor Trap

Plumbing Plumber - Water supply systems

Related Theory for Exercise 1.10.97

Description of concealed flushing cistern

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

- state the concealed flushing cistern.

Refer Ex. No.1.10.89 - 1.10.93

Plumbing Plumber - Water supply systems

Related Theory for Exercise 1.11.98 - 1.11.101

Method of bending galvanized and other heavy pipes

Refer Ex. No.1.6.34 - 1.6.35

Domestic drainage system

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

- state the method of carrying refuses
- state the conservancy systems
- state the water carriage systems
- state the advantages of conservancy systems and water carriage systems
- state the comparison between conservancy and water carriage systems.

Necessity of the solid and liquid wastes are to be properly collected and conveyed at suitable spots for treatment and disposal. The cost of collection and conveyance of refuse forms a major portion of the total cost of any sanitary project. The refuse formed in any sanitary system should be rapidly, conveniently and safely carried to its disposal site so as to maintain a clean environment.

In this chapter, the methods of carrying refuse and systems of sewage will be discussed.

Methods of carrying refuse:

Following are the two methods which are employed for the collection and disposal of refuse of a locality:

- 1 Conservancy system
- 2 Water carriage system.

We will now briefly describe each system of collection and conveyance of refuse.

1 Conservancy system:

In this system, the different types of refuse are collected separately and then each type is carried and suitably disposed off.

The garbage or dry refuse is collected from roads and streets in pans or baskets. It is then conveyed by carts, trucks, etc. to some suitable place. The garbage is separated into two categories, namely, flammable and inflammable matters. The former is burnt into incinerators and the latter is buried into low lying areas for the reclamation of soil.

The night soil is collected in pans from lavatories and the sewage is carried by labour in carts, trucks, etc. It is then buried into the ground and is thus converted into manure.

Collection and conveyance of refuse

The storm water and sullage are collected and conveyed separately by closed or open channels. They are discharged in natural rivers or streams.

The conservancy system is out of date at present for modern cities. It is however adopted for small towns, villages, undeveloped areas of big cities, etc., where there is scarcity of water for the adoption of water carriage system.

Following are the disadvantages of conservancy system.

- i **Cost :** The system seems to be cheap in the beginning. But its maintenance and establishment costs are very high.
- ii **Design of building:** In this system, the lavatories are to be constructed separate from the main building. It therefore does not permit compact design of the structure.
- iii **Insanitary conditions:** The decomposition of sewage starts about 4 to 5 hours after its production. This fact leads to the development of insanitary conditions around the residential buildings and it is practicable to remove sewage only once in 24 hours or so. It also results in fly nuisance.
- iv **Labour problem:** This system entirely depends on the mercy of labour and labour goes on strike due to any reason, the public health is put into great danger.
- v **Land for disposal:** The sewage, especially the night soil, requires considerable land for its disposal.
- vi **Night soil carts:** It is highly undesirable to allow night soil carts to pass through main roads of the city.
- vii **Open drains:** If storm water and sullage are carried in open drains, it may result in insanitary conditions.
- viii **Pollution of water:** There are chances for the liquid wastes from the lavatories to be soaked into the ground. In such a case, the underground supply of water will be polluted.
- ix **Risk of epidemic:** If sewage is not properly disposed off, there are chances for the outbreak of epidemic which may result in serious disaster.

2 Water carriage system

In this system, the water is used as medium to convey the sewage to the point of its treatment or final disposal. The quantity of water to be mixed with solid matter is quite sufficient and the dilution ratio of solid matter with water is so great that the mixture behaves more or less like water. The sewage is conveyed in suitably designed and maintained sewers.

In this system, the garbage is collected and conveyed as in case of conservancy system. The storm water may be carried separately or may be allowed to flow with the sewage.

The initial cost of the installation of water carriage system is very high and it becomes difficult to adopt it when the financial condition of the area is very poor. However the water carriage system is the modern method of conveyance of sewage and it is to be recommended wherever possible. It can even be adopted in stages as the town develops.

Following are the advantages claimed by the water carriage system of conveyance:

- i Compact design:** The system permits compact design of the building as lavatories can be accommodated in any part of the building. It is thus very helpful for modern multi-stored buildings in which the toilets or sanitary blocks can easily be constructed on each floor and connected to a single or more vertical pipes.
- ii Hygienic:** It is hygienic in nature as the night soil, foul matter, etc. are carried in this system in closed conduits. The risk of outbreak of epidemic is greatly reduced.

Land for treatment works: The area of land required for treatment plant and sewage disposal in this system is smaller than that required in case of conservancy system.

iii Methods of treatment: When this system is adopted, it becomes easier to apply modern methods of sewage treatment. The sewage from the entire area can be carried to the treatment plant and after proper treatment, it can be suitably disposed off.

iv Water requirement: It is said that the system requires more water for flushing of solid matter. But in practice, no considerable amount of water is required for the functioning of this system expect the usual water supply.

Table 1 gives the comparative idea of conservancy or dry system and water carriage or wet system.

TABLE 1

S.No	Conservancy system	Water carriage system
1	It does not permit compact design of structures.	It permits compact design of structures.
2	It is laid above ground. Hence, it is visible, but non-hygienic.	It is necessarily laid below ground. Hence, it is not visible, but hygienic.
3	It requires small quantity of water to the extent of about 30 to 40 litres per capita per day.	It requires large quantity of water to the extent of about 100 to 120 litres per capita per day.
4	There exists put refaction.	There are no chances for put refaction.
5	It has been normally considered as system for rural conditions.	It has come up basically as an urban system.
6	The labour force required is much more.	Only few labourers are required.
7	There is presence of segregation.	There is absence of segregation.
8	It is cheap in initial cost, but expensive in maintenance works.	It is expensive in initial cost, but maintenance costs are low.
9	There are chances for the outbreak of epidemic.	The risk of outbreak of epidemic is greatly reduced.
10	It does not require the help of skilled or technical personnels.	It requires the help of skilled or technical personnels for laying, maintenance and running of treatment units.
11	The city remains dirty and foul smelling.	The city appears neat and clean.
12	It is likely that underground sources of water may be polluted due to soaking of liquid wastes from the latrines.	There is practically no risk of pollution of underground sources of water as sewage is carried in closed sewers and below the water pipes.

Underground laying of sewer pipes

Objective: At the end of the lesson you shall be able to

- explain the procedure adopted while laying pipes underground. (stoneware pipe)

The following operations are required to be carried out for laying sewer pipes underground.

- Excavation for trench
- Bedding for pipes
- Laying of pipe
- Jointing of pipe
- Testing
- Protecting the pipe
- Refilling.

Excavation for trench: The trenches shall be so excavated that the pipes can be laid to the required alignment and at required width and depth specified. Covers are measured from top of pipe to the surface of ground. Excavation can be carried out manually or mechanically. The width of trench for stone ware pipe is as under.

For all diameter upto an average depth of 120cm it should be \pm of pipe plus 30cm.

If depth is above 120cm it should be of pipe plus 40cm. However the width of trench should not be less than 75cm for depth exceeding 90cm. The width of trench at top can be increased depending on depth.

The bed of the trench, if in soft or made up earth are to be well watered and rammed before laying the pipes. The depressions if any are to be properly filled with earth and consolidate in 200mm layer. If the trench bottom is extremely hard or rocky the trenches are to be excavated atleast 150cm below the required trench level. The required level is made up by filling with selected fine earth or sand and compacted to get a smooth bedding for the pipe. On completion of excavation, hollows are cut at the required position to receive the socket/collar. Roots of trees with a distance of about half metre from the pipe side are also to be removed or killed. Excavated materials are to be placed beyond 1m or half the depth of trench whichever is greater from the edge of the trench. The trenches are kept free from water. Shoring and timbering are providing whenever required. Excavation below water table are done after dewatering the trenches.

When the pipe line cross an existing road, the road crossing are to be excavated half at a time, the 2nd half to be commenced only after the pipe have been laid in the 1st half and trenches are refilled. Necessary safety measures for traffic like barricade, red flag, red light etc. are to be installed. While excavating any other service lines like water main, electric, telephone etc are to be carefully protected and supported and also to be informed to the respective authorities.

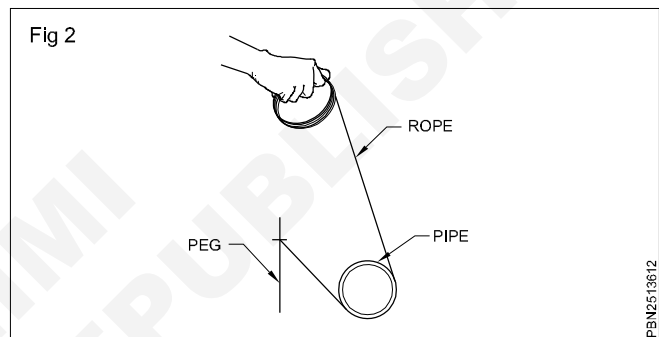
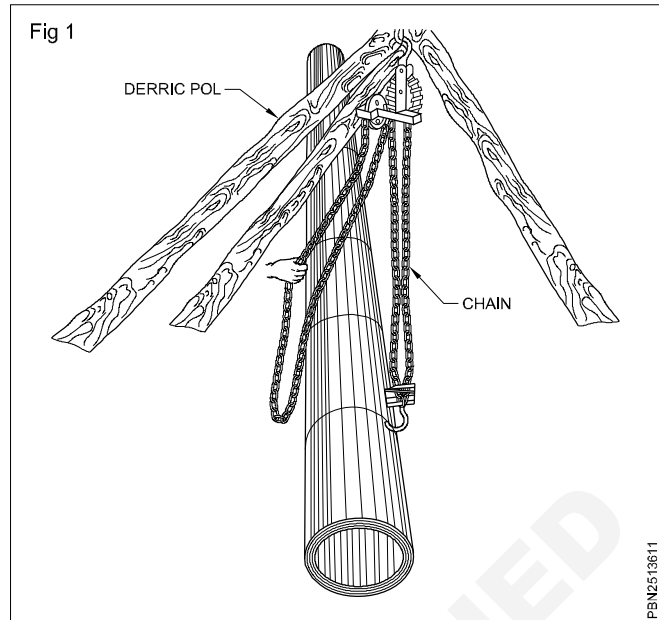
In unstable soils like soft soil and dry lumpy soils it is to be checked whether the soil can support the pipe line. Sometimes it may be required to provide suitable foundation. Expansive clay soil may damage pipes. Therefore it is necessary to give an envelope of a minimum 100mm of tamped sand around the pipe line.

Pipes are to be unloaded near the trench and kept along the trench. Keeping socket facing upstream in case of level ground and facing downstream in case of pumping up.

The pipes are lowered into the trench by means of suitable pulley block derrick pol chain ropes etc., in case of heavy pipes, it can also be lowered by using two ropes. (Fig 1)

One end of each rope may tied to a wooden or steel peg driven into ground and keep the pipe in the roper and other end held by man which when slowly released with lower the pipe into trench (Fig 2). In no case the pipes are not to be rolled and dropped into trench.

Stone ware pipes are to be laid on a bed of cement or lime concrete for the width of trench. The pipes with the crown



level at 1.2m depth and less from ground are covered with 15cm thick concrete above the crown of the pipe and sloped off to meet the outer edge of the bed concrete. But pipes laid at depth greater than 1.2m at crown are concreted at the sides upto level of the centre of the pipe and sloped off from the edge to meet the pipe tangentially. The pipes are to be carefully laid to the alignments, levels and gradients shown on the plan and sections. Care to be taken to prevent entry of foreign materials in the pipe. The pipes between two manholes are laid truly in a straight line without vertical or horizontal curves. Pipes are jointed using tarred gasket or hemp yarn socket in thick cement slurry and using cement mortar. After laying and joining, the joints are to be cured for 7 days. After the curing is over, the pipe and joints are tested. On satisfactory completion of test the earth is refilled upto ground level.

Gradient for sewers shall be as under.

Diameter mm	Gradient	
	Minimum	Maximum
100	1 in 57	1 in 5.6
150	1 in 100	1 in 9.7
200	1 in 145	1 in 14
230	1 in 175	1 in 17
250	1 in 195	1 in 19
300	1 in 250	1 in 24.5

System of house drainage

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

- explain the aim of house plumbing
- explain the principles of house drainage
- define the terms related to house plumbing
- explain the types of systems.

House plumbing

House plumbing is the collection and conveyance of liquid refuse upto the public drain and sewers. Certain part of the building are set apart for this purpose. The positions of various sanitary conveyances and other conveniences are marked on the plan of the building. The drainage lines from the places of collection, leading to the sewer are also shown on the same plan with necessary appurtenances. Sanitary conveyances include lavatory blocks comprising of water closets and urinals, and bath rooms. Other conveniences comprise kitchen sinks and washing places.

Aim of building drainage

- 1 To dispose off liquid waste as early as possible
- 2 To prevent entry of foul gases from the sewer to the building
- 3 To dispose off the storm water into open surface drain
- 4 To facilitate quick removal of foul matter
- 5 To provide health condition in the building

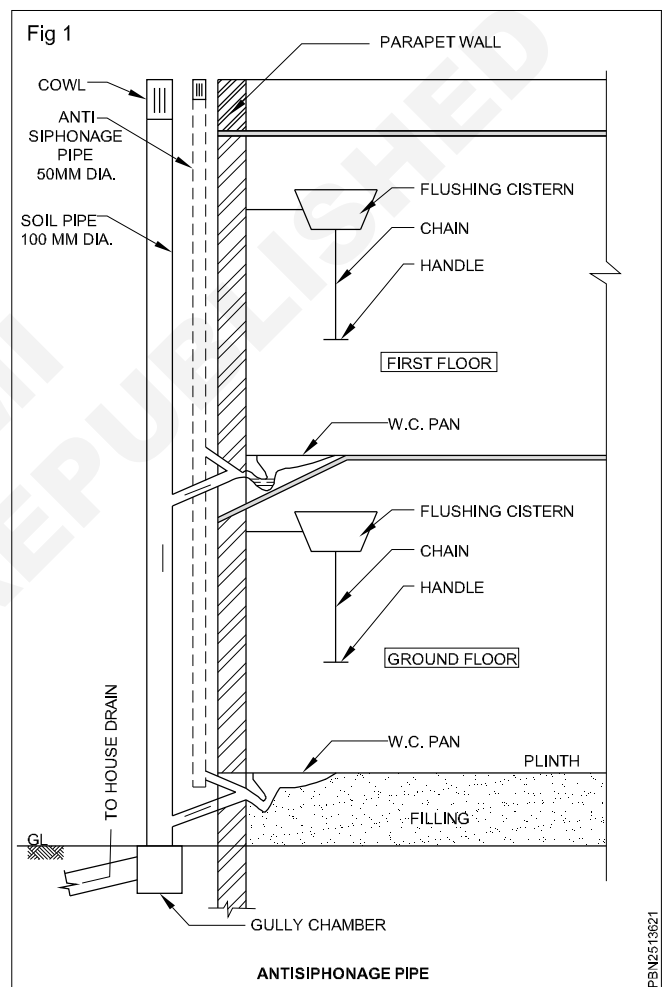
Principles of house drainage

- 1 For proper design and construction of house drainage system, the following general principles are adopted.
- 2 The entrances to drains should be outside the building.
- 3 The drainage systems should have proper ventilation.
- 4 The drains should not pass through building, but should pass by the side of the building.
- 5 The drains should not be laid close to trees.
- 6 The drain should be laid at gradients for self cleansing.
- 7 The drain should be laid straight between points of access. All changes of direction or gradient should be open for inspection.
- 8 Branch drains should be as small as possible.
- 9 All the connections should be oblique, so that the incoming drain faces the direction of flow of the sewage.
- 10 The size of drains should be just sufficient to meet the requirements.
- 11 The pipe joints should be water tight and made from non - absorbent materials.
- 12 The house drain should be connected to public sewer only when the public sewer is deeper than the house drain.
- 13 The house drain should contain sufficient number of traps at suitable points.

14 The house drain should be separated from the public sewer by a trap to prevent the entry of foul gas in to houses.

15 It is preferable to provide a separate system of drains to take the rain water.

Terms related to house drainage (Fig 1)



Anti - siphonage pipe - It is a pipe which is installed in the house drainage to preserve the water of traps. It maintains proper ventilation. It does not allow the siphonic action to take place. (Fig 1 & 2)

Cowl - It is provided at the top of vent pipe. It prevents the birds from building the nests. It is provided with slits or narrow openings. It escapes the foul gas from septic tank or the drainage line.

Fixture drain - It is the outlet pipe from the trap of a fixture to make its connection any other drainage pipe.

Fresh air inlet - This is provided at the last manhole, which connects the house drain with the public sewer for

admitting fresh air. This dilutes the sewage gases. It is kept at about 2 metres high above the ground level. It is provided with mica flap one way valve at its top. This valve opens inwards and admits fresh air.

Horizontal branch: It is a drain pipe extending laterally from a soil or waste stack or house drain. It receives the discharge from one or more fixture drains and conduct it to the soil or waste stack or house drain.

Horizontal pipe -It is any pipe or fitting which make an angle of less than 45° with the horizontal.

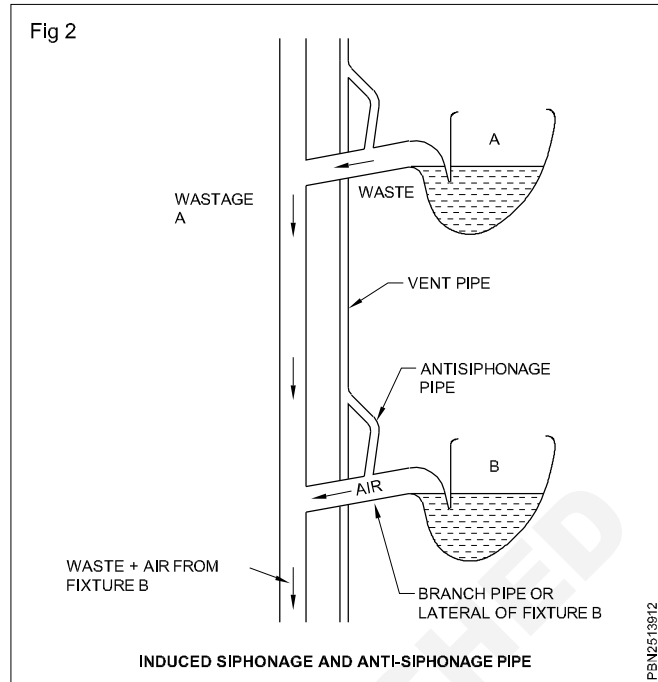
House drain or building drain: It is that part of the lowest horizontal piping of a plumbing drainage system. It receives discharge from soil, waste and other drainage pipes within the building and conveys it to the house sewer.

House sewer or building sewer: It is that part of the horizontal piping of a plumbing drainage system that extend from the end of the house drain or building drain to the public sewer or other outlet.

Siphonage: Due to siphonic action, water seal or traps may break. This is known as siphonage and it is induced when water is suddenly discharged from a fixture on the upper floor.

Soil pipe: It is any drainage pipe that carries liquid wastes containing human excreta.

Stack: A stack is any vertical line of drainage i.e., soil, waste or vent pipe.



Vent pipe: The pipe installed for ventilation of sewers is known as vent pipe. It is provided to protect the water seal of traps against siphonage and back flow.

Waste pipe: The waste pipe is any drainage pipe that carries liquid wastes that do not include human excreta.

System of plumbing

Refer to EX No. 1.10.96

Drains

Objectives: At the end of the lesson you shall be able to

- state describe the drains
- state condition of ideal drain section
- state types of drains.

Drains

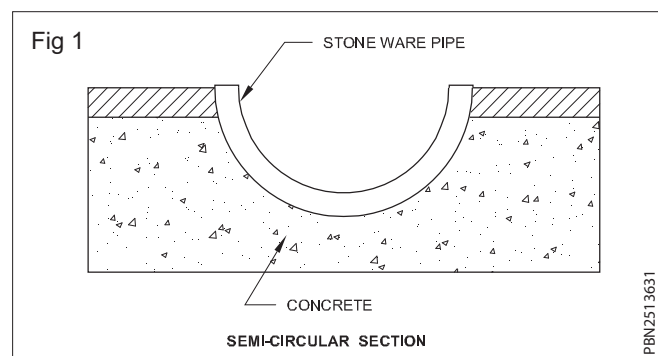
These are used for conveying less foul water from kitchens, bathrooms, washing places and rain water from courtyards, roads, roofs, open grounds etc. except foul discharge from water closets. The open drains carry away sullage and rainwater upto natural water courses or discharge it in public sewer.

The open drains are mostly laid along the either side of the streets along the boundary walls of buildings. Due to their cheapness and low maintenance cost, certain municipalities and local bodies adopted them for the conveyance of unfoul water. They require cleaning after short intervals.

Drains sections

An ideal drain should fulfil the following conditions:

- i It should develop self-cleaning velocity with minimum dry weather flow.
- ii It should have sufficient free board at its top, even during maximum discharge.



- iii It should be clean in construction and maintenance.
- iv It should be such that it can be easily cleaned.
- v It should be structurally safe and stable.
- vi It should be constructed with non-corrosive materials and should have sufficient resistance to the erosion.

In practice only four common sections of sewers are used, which have been successfully tested in experience. They are:

- a Semi-circular section
- b U-section
- c V-section, and
- d Rectangular section

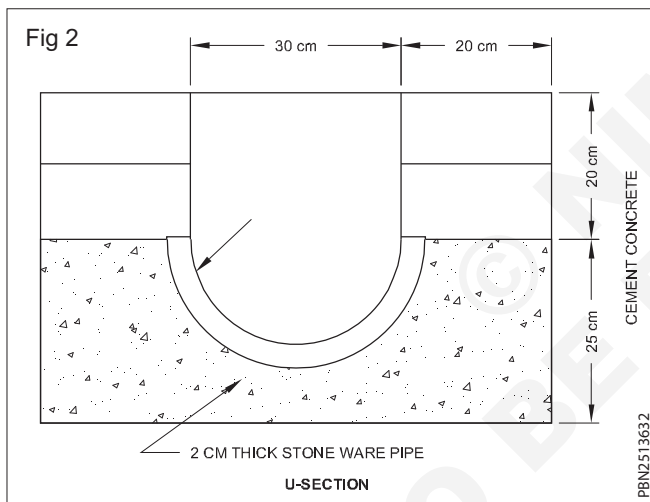
a Semi-circular section (Fig 1)

This type of drain is mostly used for small drains due to its easiness in laying, stability and cheapness. Half round glazed stone-ware pipe is used for its construction. If the discharge in this section decreases, the self-cleaning velocity will not develop and deposits will settle down in the bottom and will cause obstruction to the flow sewage.

Semi-circular drains are not suitable for large discharges, because in such cases they occupy more space. If this drain is deep, there are always chances that the wheels of the vehicles may drop in it causing damage both to the vehicle and the drain. In sandy area during high winds, these sections are filled with sand, causing of drain.

b U-Section (Fig 2)

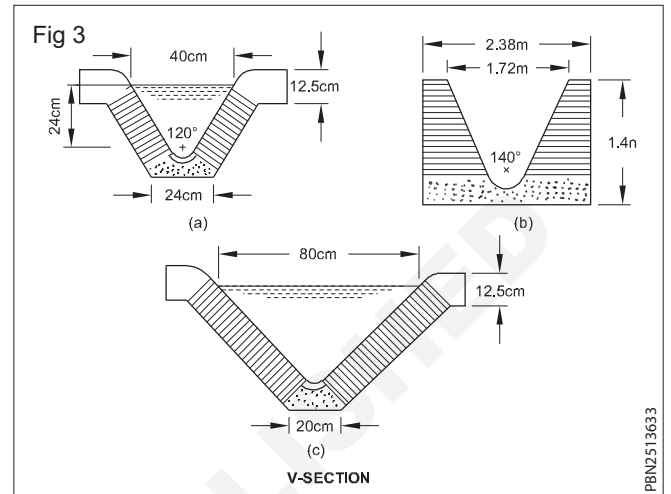
In semi-circular section if the sides are raised, it becomes U-section. It is used at such places where discharge is more and cannot be taken by a semicircular drain. Half stones are pipe is laid in the bottom and over it masonry work is done as show in Fig 2.



c V-section (Fig 3)

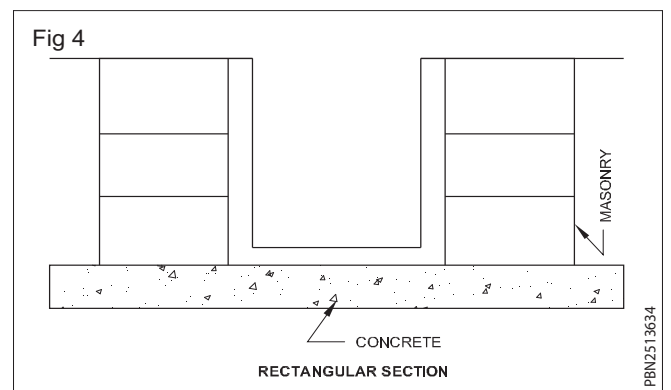
This section gives sun-cleaning velocity even for very small discharge because greater depth is available in each case. In the invert one-third to one-fourth stone ware pipe or concrete block is laid and the sides are constructed with brick or flag stones and are plastered. It is easy to clean this type of section. These sections may subtend 120° , 100° or 60° at the centre of stoneware pipe.

Figure shows three most common type V-section drains. Fig.3 shows the section used for taking small discharges. Fig. 3 shows the section used for taking DWF with small quantity of storm water. Oftenly in this section sides above the stoneware pipe are made in soil to reduce the cost. Fig. 3. shows another common section used for taking large discharges. Due to restriction of spce, the sides are provided with more slopes. In this section stoneware pipe is not required in the invert.



d Rectangular section (Fig 4)

This type of section is only for large discharges because for small discharge self-cleaning velocity will not develop causing settlement of suspended particles. This drain is constructed by laying cement bed over which sides are constructed with stone or brick masonry and finally plastered inside. Due to difficulty in cleaning, this section is not commonly used.



Method of testing leakage

Objectives: At the end of the lesson you shall be able to

- explain the smoke test.

Smoke tests (Fig 1)

The smoke test is used both for testing the soundness of the system and for tracing a suspected leak. It can be used equally well for the testing of above ground soil, waste and vent pipes.

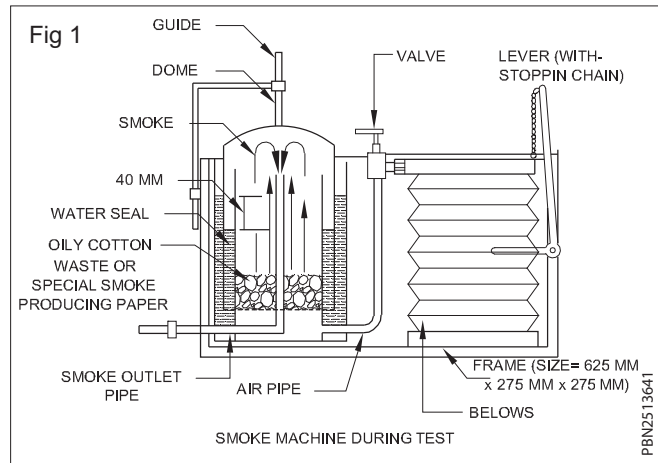
All water seals must be charged with water and all branch drains and vents must be sealed except one. Smoke is then pumped into the system through a test plug which is fitted in the lowest point of the drain or stack.

The highest vent is left open until smoke begins to escape. At this point the vent is then sealed and pumping continues until sufficient pressure is built up inside the smoke machine to raise the dome approximately 50 mm. Pumping now ceases and the system remains under test for 5 minutes. If the dome remains in the elevated position the system is sound. Should the dome fall or fail to rise a leak is indicated. Pumping is continued while the system is checked for smoke leakage.

This test should not be used on plastic system, because of the detrimental action between the smoke and some types of plastic.

To repairing of existing bath tub, wash basin and sink in drain lines

- After test any default occur in the pipeline, note the place



- If found any leaking from the accessories, fitting and pipelines make it to replace it.

Pressure testing of pipeline with pressure testing machine

Objectives: At the end of the lesson you shall be able to

- state the application of pressure testing machine
- explain the pressure testing machine.

Application

- Boilers, Pressure Vessels, C.I. Mains, Casting parts
- Gas Cylinder, Pipes & Tubes parts
- Subject to Hydro Test Pressure

Special Features

- Portable hand operated system can be easily handled by one man
- Pump unit is mounted on fabricated M.S. water tank which stores liquid for testing
- Pump done not required any foundation
- Provides self base for testing

Standard Accessories

- Pressure release cock made from brass metal.
- Discharge pressure hose with attachment of 1/2 : BSP Length 2 Mtrs.
- Stainless Steel Glycerin filled pressure gauge with 4" inch dial
- Suction & discharge valve (NRV) made form Stainless Steel material

Performance table

Discharge size BSP MM	Max. Pressure Kg/cm2 P.S.I	Output CC/Stroke	Plunger Size in mm	Water Tank Size in ltrs
1/2" 12.5	35 500	15.70	19	9

Conducting the Pressure Test

To conduct a pressure test of building services piping systems in all Station buildings, complete the ofllowing steps:

1. Identify the maximum test pressure to be used, as determined by the Project Engineer of Field Engineer.
2. Identify the type of pipe system to be tested. The maximum aggregate length of pipe to be tested at one time is 40 feet.

3. Examine all connections prior to the test t ensure proper tightness
4. Determine the pressure rating for all connected fittings and devices to ensure they are rated for the maximum test pressure.
5. Isolate any equipment that may be damaged by the test and indicate this isolation on the test form.

- 6 Secure a blind flange or cap suitable for the system's rated pressure on all openings that are not closed off by valves.
- 7 Plug all test, drain, and vent ports that are not required for the test.
- 8 If the section of pipe being tested is isolated from other sections by in-line valves, ensure the portion not being tested is open to the atmosphere.

For Pneumatic Testing follow steps 9 through 15:

- 9 Apply a preliminary test pressure of 25 psi.

This pressure should be held for a minimum of 10 minutes to allow for the location of any major leaks. If leaks are detected during this step, or at any time during the test, relieve the pressure and take appropriate action to correct the leak. If necessary, consult the Project Engineer for instruction.

- 10 Apply the test pressure in increments of 25 psi, until the maximum test pressure is reached. Hold pressure for 5 minutes at each 25 psi increment and inspect for leaks before adding more pressure.
- 11 Hold this pressure for 25 hours.
- 12 Obtain confirmation of successful by the operator after the 24 hour time period.
- 13 Remove the pressure with caution to avoid escaping air stream, debris and high decibal noise level.

After completing these steps, pressure testing is completed once the test is successfully completed, then piping system is ready for service.

Different types of traps, ventilation antisiphonage and sinks

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

- define the traps
- define the pre-requisites of traps
- state the types of traps.

Refer Ex. No. 1.9.78 & 1.11.102 & 1.11.103

Ventilation and antisiphonage

Objectives: At the end of the lesson you shall be able to

- explain ventilation
- explain antisiphonage action.

Ventilating pipes

- The building drain ventilating pipe should be not less than 75mm in diameter when, however, it is used as main soil pipe or main waste pipe (MSP or MWP). The upper portion, which does not carry discharges, should not be of lesser diameter than the remaining portion.
- The diameter of the main ventilating pipe should not be less than 50mm.
- A branch ventilating pipe on a waste pipe in both one and two pipe systems should be of not less than two-thirds, the diameters of the branch waste ventilated pipe subject to a minimum of 25mm.
- A branch ventilating pipe on a soil pipe should be not less than 32mm in diameter.

Ventilating shaft

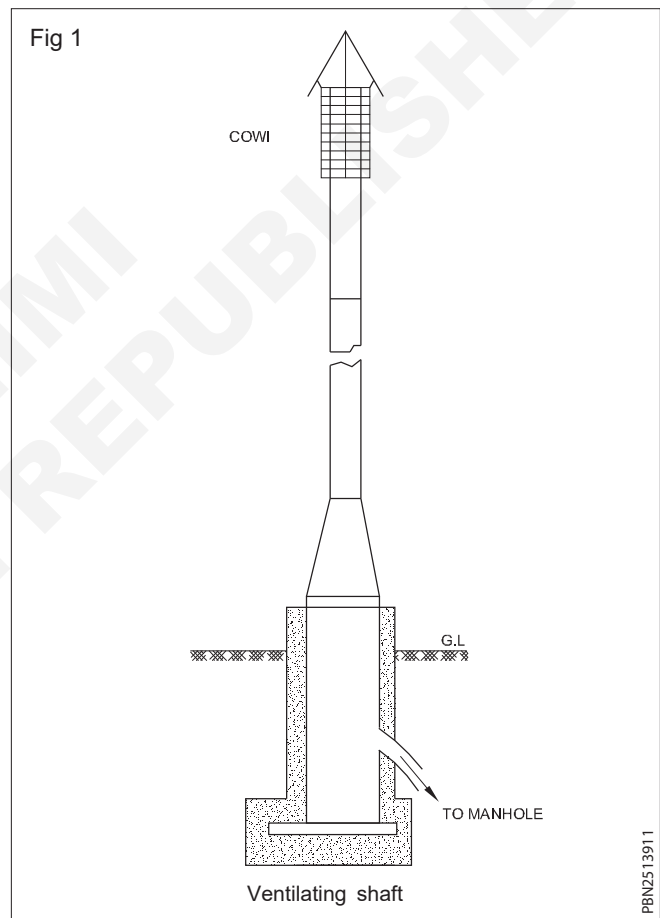
Ventilation of sewers (Fig 1)

Various gases are produced in sewers due to purification of organic materials of sewage. These gases are very foul in nature, cause harm to human health and corrode the sewers reducing their life. The gases so produced are highly explosive and in high concentration may cause fatal accidents to the maintenance people on duty due to their explosive and poisonous character. Due to the above difficulties, ventilation is provided to the sewer lines at ever 80-100 meters which will provide fresh air to the workers working in the manholes.

Ventilating pipe

A true vent is a vertical pipe attached to a drain line that travels through the roof with no water running through it. If a fixture is close to the stack and on the top floor, the upper part of the stack serves nicely as a vent. Many fixtures are not so conveniently located, however, and other solutions must be found.

A revent pipe, also called an auxiliary vent, attaches to the drain line near the fixture and runs up and over to the main vent. It may attach directly behind the fixture or to the horizontal drain line.



If two fixtures are on opposite sides of a wall, they may tie into the stack with a sanitary cross; this is called a common vent and can be found on back-to-back sinks.

When a fixture is close enough to a stack, a wet vent may be allowed by code. In the case of a tub that is close to a stack, its drain may empty into a pipe that also serves as a vent.

For a freestanding sink code may allow a loop vent. If reventing is difficult and wet venting isn't allowed, you may have to install a separate vent pipe through the roof.

An air admittance valve (AAV) opens to let air in when waste drains, then gravity closes it to keep sewer gases

from escaping back into the room. Codes in many localities allow these relatively new devices to take the place of vent lines. Depending on the size of the unit and any code restrictions, AAVs can be used to vent multiple fixtures. Check codes to make sure they permit AAVs.

Installing vent pipes: Vent pipes, often narrower than drainpipes, need not slope like drainpipes. Normally they run level or plumb, unless there is an obstacle to work around.

Vent pipes must be installed so they stay dry. This means that they should emerge from the top of the drainpipe, either straight vertically or at no less than a 45-degree angle from horizontal, so that water cannot back up into them.

The horizontal portion of a vent pipe must be at least 6 inches above the fixture's flood level – the highest point to which water can rise. (On a sink the flood level is the sink rim or overflow hole.)

The main drain: Plan drain lines to minimize the possibility of clogs. The general rule is that smaller drainpipes -- 1-1/4 inches for bathroom sinks and 1-1/2 inches for kitchen sinks, for instance -- lead to larger branch drains. These in turn lead to the main stack, which is the largest pipe of all -- typically 4 inches. Because the main stack is also vertical, it will rarely clog.

The main stack leads down into the ground, then out toward the municipal sewer. The underground horizontal pipe, or main drain, that runs toward the sewer line can sometimes get clogged, especially if it is an old drain made of clay pipe.

Typical Venting Alternatives (Fig 2): A true vent pipe must remain dry while water runs down the drain. A wet vent also serves as a drain line but is large enough that it never actually fills with water.

Precaution against air poisoning

Start with these seven tips to help keep your home and family safe from carbon monoxide.

- 1 Know the risks of carbon monoxide.
- 2 Keep your vents clear.
- 3 Do not run engines in a closed area.

Types of sinks

Objectives: At the end of the lesson you shall be able to

- explain different types of sinks.

Refer Ex.No. 1.10.89 & 1.10.93

Plumbing

Plumber - Bending and systems of water supply

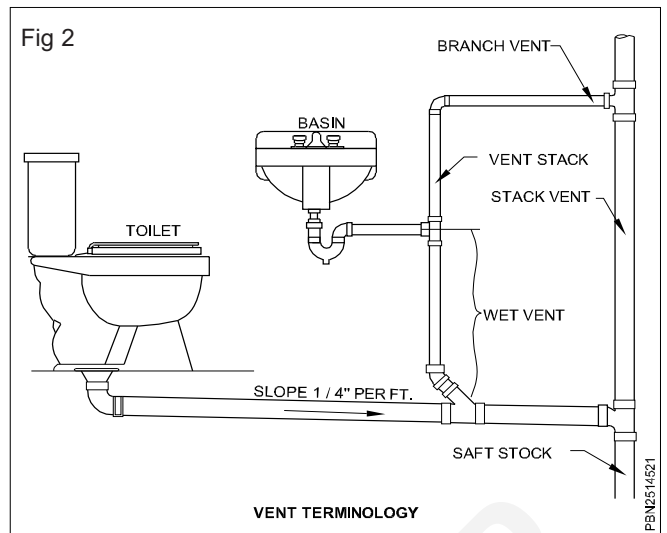
Related Theory for Exercise 1.11.106

Fire hydrants and their fittings

Objectives: At the end of the lesson you shall be able to

- describe the fire hydrants
- state the hydrants.

Refer Ex.No. 1.10.87 & 1.10.88



- 4 Schedule regular maintenance.
- 5 Keep fire places clean and well vented.
- 6 Install C.O. alarms.
- 7 Maintain your C.O. alarms

Prevention of carbon monoxide poisoning

- 1 Install carbon monoxide monitors.
- 2 Test your carbon monoxide monitor systems.
- 3 Memorise the signs and symptoms.
- 4 Clean your gas drier filter.
- 5 Limit your exposure to carbon monoxide.
- 6 Run drills and develop an emergency plan with your family.
- 7 Get your appliances serviced regularly.

Precautions in work place: Prohibit use of gasoline powered engine or tools in poorly ventilated area provide personal C.O monitors with audible alarms. If potential exposure to co exists. Test air regularly in areas where CO may be present, including confined spaces.

Elimination is the process of removing the hazard from the work place. IT is the most effective way to control a risk because the hazard is no longer present.

Concept of heat and temperature

Objectives: At the end of the lesson you shall be able to

- state the heat and unit heat
- state temperature and temperature scales.
- state the three types of heat transferring
- state the thermometer and pyrometer
- state heating system by different thermal unit
- state the types of water heater
- explain the parts of water heater.

Heat

Heat is the energy in transit from one matter of body to another matter of body due to temperature difference.

Heat is the total kinetic energy of the body, its measured by joule meter. Its unit is joule.

Temperature

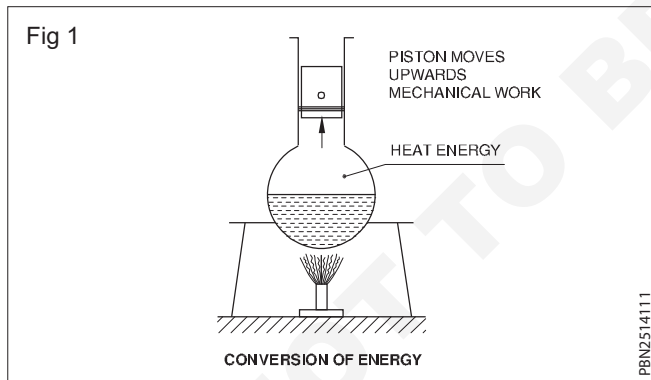
Temperature is the degree of hotness (or) coldness of the body. It's the average kinetic energy of the body.

Temperature is measured by thermometer

Units are K F and C.

Specific heat of water	= 1
of Aluminium	= 0.22
of Copper	= 0.1
of Iron	= 0.12

Heat (Fig 1)



It is a form of energy. Heat energy can be transformed into other forms of energies. Heat flows from a hotter body to a colder body.

Units of heat

Calorie: It is the quantity of heat required to raise the temperature of 1 gram of water through 1°C.

BTHU: It is the quantity of heat required to raise 1 lb of water through 1°F. (British thermal unit).

C.H.U: It is the quantity of heat required to raise 1 lb of water through 1°C.

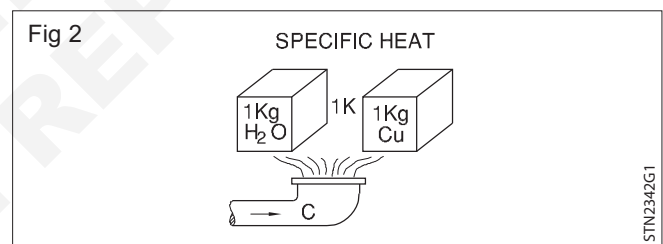
Joule: S.I. Unit (1 Calorie = 4.186 joule)

Effects of heat

- Change in temperature
- Change in size
- Change in state
- Change in structure
- Change in Physical properties

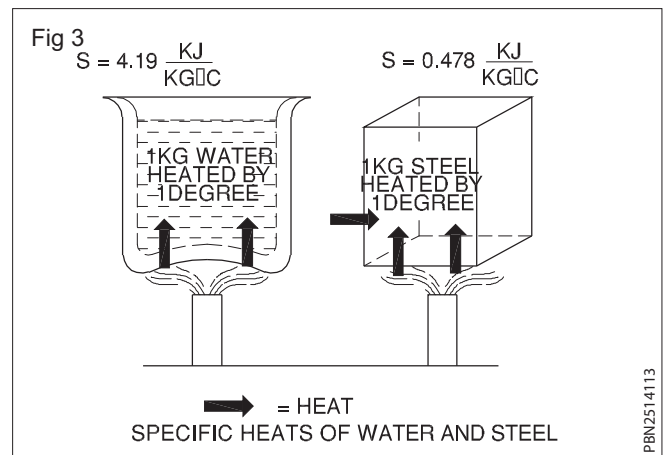
Specific heat (Fig 2)

The quantity of heat required to raise the temperature of one gm of a substance through 1°C is called specific heat. It is denoted by the letter 's'.



Water equivalent (Fig 3)

It is the mass of water which will absorb the same amount of heat as the given substance for the same temperature rise. Water equivalent = Mass of the substance x specific heat of the substance.



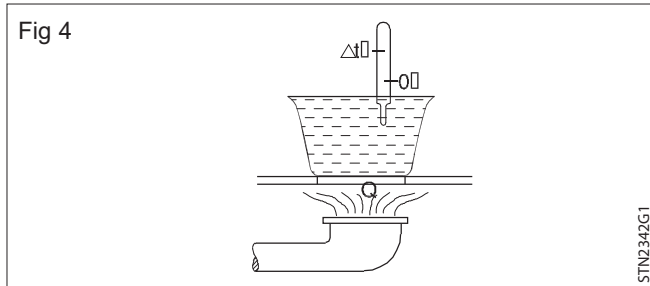
Therefore water equivalent = ms

Temperature

It is the degree of hotness or coldness of a body. The temperature is measured by thermometers.

Temperature Scales (Fig 4)

Temperatures are calibrated between two fixed reference points namely the freezing point of water, and the boiling point of water. These two fixed points on different temperature scales are:



Scale	Freezing point	Boiling point
Centigrade (°C)	0°C	100°C
Faranheit (°F)	32°F	212°F
Kelvin (K)	273°K	373°K
Reaumur (°R)	0°R	80°R

Heat is a form of energy. Temperature is the degree of hotness or coldness of a body. The relationship for conversion from one temperature scale to the others is

$$\frac{R}{80} = \frac{C}{100} = \frac{K - 273}{100} = \frac{F - 32}{180}$$

Mixing of heat

m_1 - Mass of first substance

s_1 - specific heat of first substance

m_2 - mass of 2nd substance

s_2 - specific heat of 2nd substance

t_m - temperature of mixture

m - mass

Q - Quantity of heat

$\delta t / \Delta t$ - temperature difference

t_m - temperature of the mixture.

Unit of amount of heat

The derived unit for the amount of heat is S.I. unit is 1 joule (j).

Specific heat

It is also expressed as the amount of heat required to raise the temperature of unit mass of a substance through 1°C. In S.I. unit in order to heat a mass of 1 kg of water through 1°C,

the amount of heat needed or the

mechanical equivalent of heat = 4186 joules

= 4.2 kJ/kg°C.

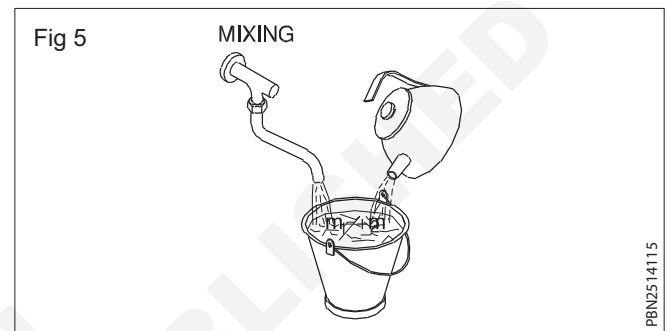
Quantity of heat needed for a substance to rise the temperature

The amount of heat needed for heating 1 kg of the substance through 1°C is equal to the specific heat of the substance 's'. For heating a mass of 'm' kg of the substance to attain a temperature difference of t,

the quantity of heat needed = $m \times s \times \Delta t$

Therefore $Q = m \times s \times \Delta t$.

Mixing (Fig 5)



When there is an exchange of temperatures, there is an exchange in the amount of heat. When hotter bodies involve with colder substances, heat transference takes place from hotter substances to the colder substances until the mixture or both the substances acquire the same temperature.

Heat lost by the bodies at higher temperature

= Heat gained by the bodies at lower temperature and hence the total amount of heat of the component substances

= amount of heat in the mixture.

Heat loss by hot substance =

Heat gained by colder substance

S of the component amounts of heat =

amount of heat in the mixture

$$m_1 \times s_1 \times t_1 + m_2 \times s_2 \times t_2 = (m_1 s_1 + m_2 s_2) t_m$$

EXAMPLE

A bath tub contains 40 litres of water at 15°C and 80 litres of water at 60°C is poured to it. What is the temperature of the mixture.

$$m_1 \times s_1 \times t_1 + m_2 \times s_2 \times t_2 = (m_1 s_1 + m_2 s_2) t_m$$

$$\therefore 40 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \times 15^\circ\text{C} + 80 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \times 60^\circ\text{C}$$

$$= \left(40 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} + 80 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \right) t_m$$

$$t_m = \frac{22680}{120 \times 42} \text{ } ^\circ\text{C} = 45^\circ\text{C}$$

Heat transmission

Transfer of Heat

There are three methods of transferring heat from one place into another

1 Conduction

Conduction is a mode of heat transfer by atomic or molecular collisions, without the movement of a bulk of a substance from one position to another, in a body. It mostly occurs in solids.

2 Convection

Convection is a mode of heat transfer by the actual movement of the bulk of the substance from one place to another through large distances. It mostly occurs in liquids and gases.

3 Radiation

Radiation is a mode of heat transfer which requires no material medium. Heat energy is carried by infrared electromagnetic waves from one place to another.

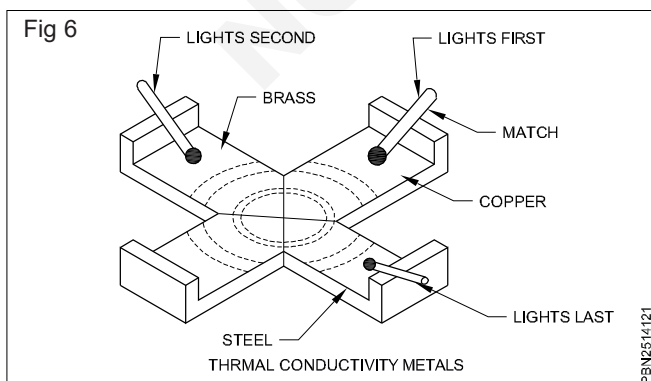
Transmission of Heat

Heat is a form of energy and is capable of doing work. Heat flows from a hot body to a cold body or from a point of high temperature to a point of low temperature. The greater is the temperature difference the more rapidly will be the heat flow. Heat is transmitted in three ways.

- By Conduction
- By Convection
- By Radiation

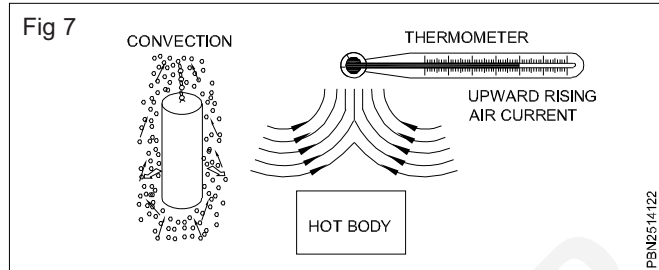
Conduction (Fig 6)

Conduction is the name given to the transmission of heat energy by contact. The heat source is in contact with the Conductor. (metal rod). The rod is in contact with a thermometer. Due to Conduction heat is transferred from the heated end to the free end. In general good electrical conductors are also good heat conductors and good electrical insulators are also good heat insulators. A good heat insulator does not necessarily withstand high temperature.



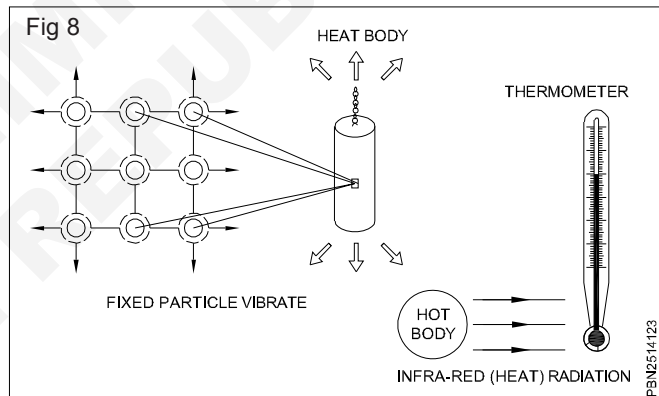
Convection (Fig 7)

Convection is the name given to the transmission of heat energy by the up-ward flow. When heated, the fluid (liquid/gas) becomes less dense and because of its mobility, is displaced upwards, by a similar but colder and more dense fluid. e.g., The domestic hot water system, The cooling system in motor cars.



Radiation (Fig 8)

Heat is radiated or transmitted from one object to the other in space without actually being in contact, by means of electro-magnetic waves. These waves are similar to light waves and radio waves. They can be refracted by lenses and reflected by mirrors. This radiation is called infrared. It requires no medium to carry the radiation. (e.g) The heat of the sun travels through the space.



**Transmission of heat takes place in three ways
Conduction, Convection and Radiation.**

Temperature and Measurement

Temperature

As stated earlier it is the degree of hotness or coldness possessed by a body.

Measurement

Temperature is generally measured in degrees Celsius. In this system the freezing point of water is defined as 0°C and the boiling point of water is defined as 100°C . The Kelvin temperature scale begins from absolute 0. i.e.— 273° . The temperature intervals are the same.

$$\therefore 273\text{K} = 0^\circ\text{C}, 20^\circ\text{C} = 273\text{K} + 20\text{K} = 293\text{K}.$$

Instruments

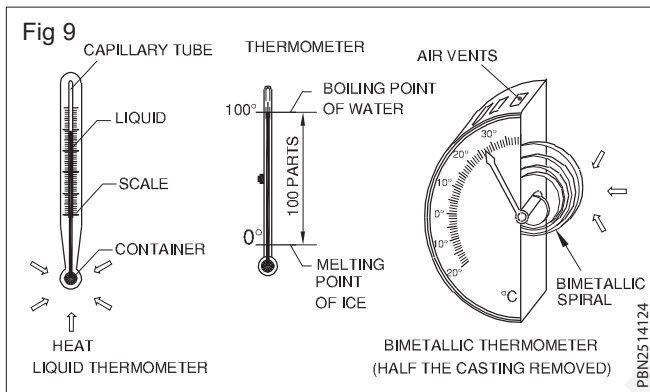
The instruments used to measure and read temperature takes into account changes in the properties of materials,

electrical phenomena incandescence, radiation and melting.

Thermometer (Fig 9)

They are based on the principle that liquids and solids expand when they are subjected to heat. Mercury and alcohol expand uniformly. When heat is applied the volume of the liquid increases and the liquid rises in the capillary tube integral with the container. Mostly mercury is used in this type of thermometers because of its properties (Shiny and will not adhere to the glass tubes and we can measure up to 300°C).

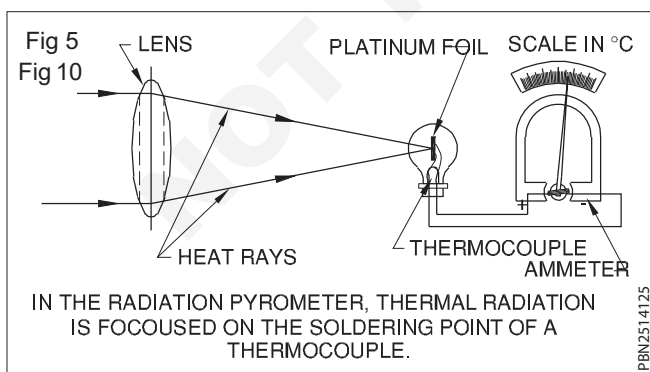
The bimetal thermometer consists of metals with different coefficient of expansion. The bimetal is twisted into a spiral which curls when the temperature rises.



Pyrometer (Fig 10)

Thermoelectric pyrometer is based on the principle that the soldering point between the wires of different metals, when heated a contact voltage is generated. The voltage depends upon the temperature difference between the hot measuring point and the cold end of the wire. Thermocouple elements are constructed of copper and Constant (up to 600°C) or of platinum and platinum-rhodium (up to 1600°C)

Radiation pyrometers are used to measure temperatures of red hot metals up to 3000°C. These concentrate thermal rays through an optical lens and focus them on to a thermos element. The scale of the ammeter is calibrated in degrees Celsius or Kelvin.



Heating system by different thermal units

The most common units for heat are

BTU (Btu) - British Thermal Unit - also known as a "heat unit" in United States

Calorie

Joule

BTU - British Thermal Unit

The unit of heat in the imperial system - the BTU - is

- 1 the amount of heat required to raise the temperature of one pound of water through 1°F (58.5°F - 59.5°F) at sea level (30 inches of mercury)
- 2 1 Btu (British thermal unit) = 1055.06 J = 107.6 kpm = 2.931 10⁻⁴ kwh = 0.252 kcal = 778.16 ft. lbf = 1.0551010 ergs = 252 cal = 0.293 watt - hours.

Calorie

A calorie is commonly defined as

- 1 The amount of heat required to raise the temperature of one gram of water 1°C.
- 2 The kilogram calorie, large calorie, food calorie, calorie (capital C) or just calorie (lower case C) is the amount of energy required to raise the temperature of one kilogram of water by one degree celsius.
- 3 1 calorie (cal) - 1/860 international watt hour (Wh)
- 4 1 kcal = 4186.8 J = 426.9 kpm = 1.163, 10⁻³ kwh = 3.088 ft lbf = 3.9683 Btu = 1000 cal.

water heater

Domestic water heater: Domestic water heaters are used to heat water for the use of houses and for smaller requirements. The instrument working with electrically 1500 watts to 3000 watts and capacity range of 2 to 100 litres are available in market.

Water heater works in two different systems i.e non pressure type and pressure type.

Non pressure type water heater (instant) There is no storage capacity in this heater. Hot water will be received from outlet as soon as the electricity is supplied to heater by switching on after opening the inlet.

The intensity of heat can be regulated by regulating the stop valve at the inlet, when more water is allowed to flow in, the temperature of water at outlet will be less while less water is let in the temperature of water at outlet will be high. There is no valve at outlet.

Pressure type water heater: It has storage capacity. After switching on the electricity, after few minutes hot water supply starts. There will be vapour pressure inside. Therefore there should be safety built in devices in the heater to prevent accidents.

Parts of water heater

Outer container: There are made up of Iron steel sheets. There will be provision for fixing on walls in the outer container.

Inner container: These are made of copper sheets and fitted away from outer container. Water is stored in inner container.

Insulation: The gap between the inner container and outer container are insulated to prevent the loss of heat. Glass wool or mineral wool is used for insulation.

Heating element: Heating element of required watts are kept in copper tube and fitted inside of inside container.

Thermostat: These are fitted along with heating elements to control the heat of water. There is a safety device which will automatically switch off the electric supply when the heat exceeds the maximum heat for which the instrument is designed.

Fuseible plug: Certain companys fix fuseible plug in pressure heater as an extra precautionary measure so that in core the system in the thermostat fails, this can prevent accident. In case the heat/pressure exceeds the heat the fuse will melt and steam will be let off.

Pressure relay valve: It is also known as safety valves. These are fitted in inlet pipe to control the pressure of inner container within 18M head.

Non return valve: These are fitted to prevent the back flow of water to inlet-presently the outlet pipe is taken inside the container above the height of heating elements. In such cases non return valve need not be provided.

Vaccum relay valve: When the heater is functioning and water supply to heater stops suddenly there is possibility of creating vacuum inside the container. This will damage the container. The vacuum relay valve will help to let air inside in case of creation of vacuum and also help to let of excess pressure inside the container. These are fitted on top of heaters.

Dead weight valve: Dead weight valves are also fitted at the top as an extra safety measures in certain brands of heater.

Vent pipe: Generally G.I of 15mmf pipes are used as vent pipe. This is a substitute for vacuum relay valve. It should be upto a height of atleast 15cm above the level of overhear tank supplying water to heater.

Control valves: Control valves are fitted at inlet and outlet to control the supply of water to and from heater.

Water heater capable of fixing horizontally and vertically are available in market. These can be chosen based on the space availability and capacity.

Precautions

- Heater to be switched ON only after allowing water in, in case of non pressure type heater, otherwise it will damage the heating elements.
- Do not provide control valve at outlet for non pressure type heater.
- It is Mandatory to fix non-return valve in case inlet pressure is more than 18M head.
- In case it is not possible to fix vent pipe it is better to have dead weight valve.
- Half yearly maintenance to be carried out to see that valves are functioning properly, no scale formation in inner containers etc.
- Scale formation can be removed by apply diluted Hydrochloric acid.
- In case the fusible plug fuses checkup for its reason and remedy is required.

General layout specification of materials required and connection of pipes to mains

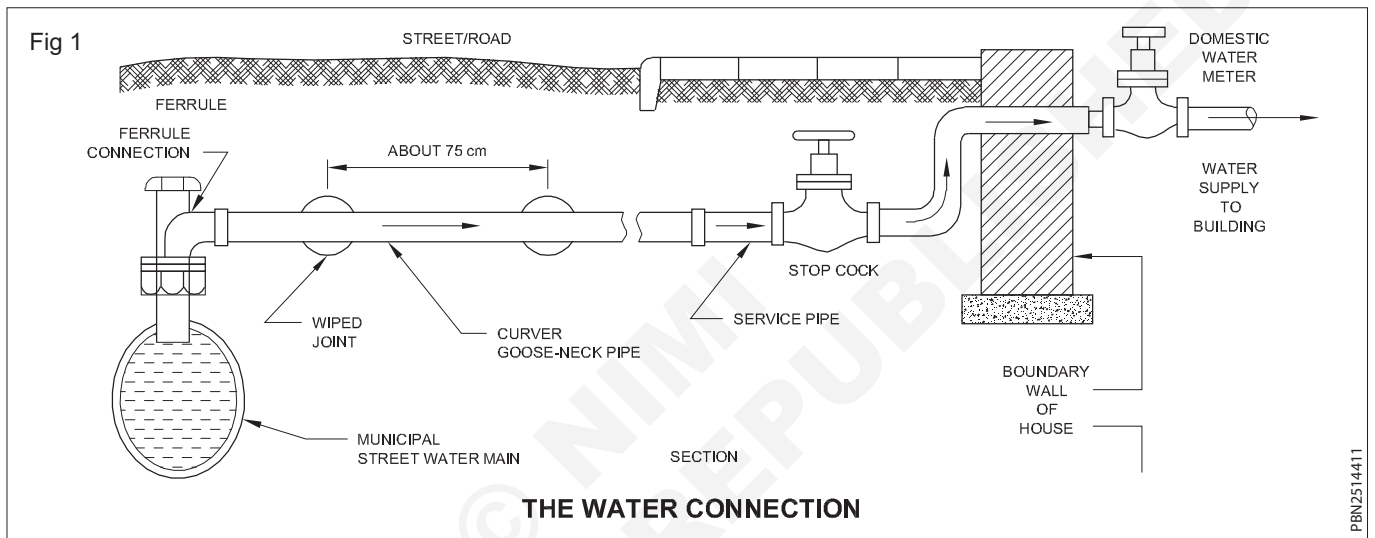
Objectives: At the end of the lesson you shall be able to

- state house water connection.
- state goose neck, service pipe, stop cock
- state water meter and stop cocks.

The house water connection

In installing a 'water supply plumbing system' in a building, the first and main step, obviously is, to obtain a 'water connection' from the municipal water main.

A typical water connection, connecting the service pipe with the municipal water main, is shown in Fig 1. As is evident, the water connection consists of: (i) a ferrule; (ii) a goose neck; (iii) a service pipe; (iv) a stop cock; and (v) a water meter, as described below:



Ferrule

A ferrule is a right angled sleeve made of brass or gun metal, and is joined to a hole drilled in the water main, to which it is screwed down with a plug. Its size usually varies between 10 to 50 mm dia. For all other connections of more than 50 mm dia, a tee branch connection, off the water main, is used.

Goose neck

Goose neck is small sized curved pipe made of a flexible material (usually lead) and is about 75cm in length forming a flexible connection between the water service pipe.

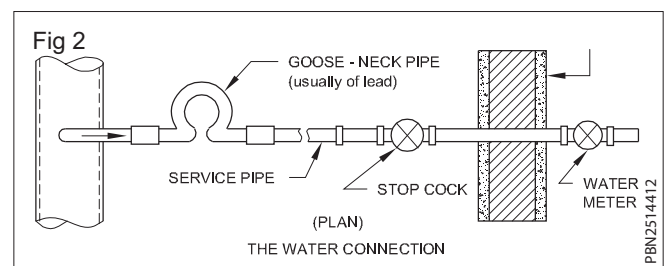
Service pipe

Service pipe is galvanized iron pipe of size less than 50 mm dia. It should be laid underground in a trench in which no sewer or drainage pipe is laid. The service pipe which supplies water to the building through the municipal main is thus connected to the main through the goose neck and ferrule.

Water meter (Fig 2)

Water meter measures and records the quantity of water consumed in the house. The domestic type water meter generally employed for houses is fitted into the service

pipe with unions, which enables the meter to be changed where necessary. The water meter is generally fixed in an iron box fitted in an opening or cavity made in the boundary wall of the house, and is covered with a movable iron cover.

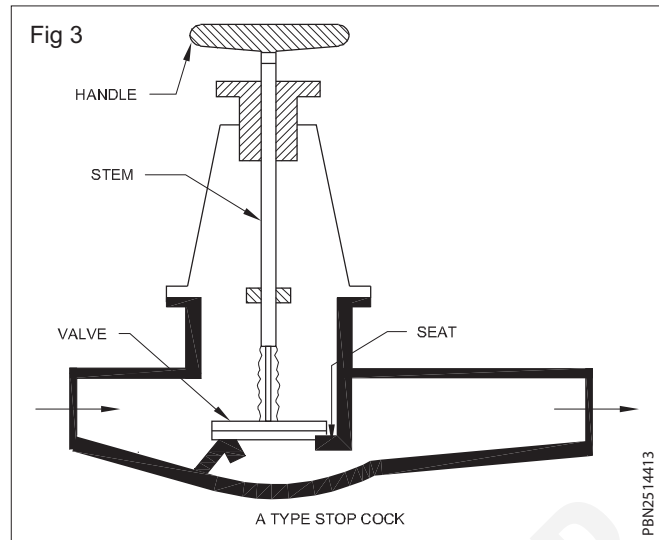


Stop cock (Fig 3)

The stop cock is provided before the water enters the water meter in the house. It is housed in a suitable masonry chamber with a removable cover, and is fixed in the street close to the boundary wall in an accessible position. Sometimes, it is provided just before the water meter inside the house, keeping both of them in one chamber. The details of stop cocks are given in the next article.

A stop cock is a screw down type of sluice valve which is used in smaller sized pipes in service connections for

stopping or opening the supply. They are generally provided at the water entrance of each building and also within the building. When provided just prior to the water meter in each house connection, they should be enclosed in a proper cast iron box having a hinged cover.



Tracing of leakage, Repair to service main

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

- state the losses from water supply system
- explain benefits of leak detection and repair
- state the types of leakages
- explain the leak deflection and repair strategies check the leakages.
- explain repair to service main.

Losses from Water Supply System

Detecting and repairing leaks is one of the main components of water conservation. This guidance document will address the strategies to reduce water loss due to leaks, and acknowledges the concepts developed by organizations such as the International Water Association

Old or poorly constructed pipelines, inadequate corrosion protection, poorly maintained valves and mechanical damage are some of the factors contributing to leakage. Leak detection has historically assumed that all, if not most, leaks rise to the surface and are visible. In fact, many leaks continue below the surface for long periods of time and remain undetected. With an aggressive leak detection program, water systems can search for and reduce previously undetected leaks. Water lost after treatment and pressurization, but before delivered for the intended use, is water, money and energy wasted. Accurate location and repair of leaking water pipes in a supply system greatly reduces these losses. Once a leak is detected, the water utility must take corrective action to minimize water losses in the water distribution system.

Benefits of Leak Detection and Repair

Minimizing leakage in water systems has many benefits for water customers (and their suppliers). These benefits include:

- Improved operational efficiency.
- Lowered water system operational costs.
- Reduced potential for contamination.
- Extended life of facilities.
- Reduced potential property damage and water system liability.

- Reduced water outage events.
- Improved public relations.

Some added benefits of leak detection and repair that are difficult to quantify include:

- increased knowledge about the distribution system, which can be used to respond more quickly to emergencies and set priorities for replacement or rehabilitation programs;
- more efficient use of existing supplies and delayed capacity expansion;
- increased firefighting capability.

Leak detection and repair programs can lead other important water system activities, such as:

- inspecting hydrants and valves in a distribution system;
- updating distribution system maps;
- using remote sensor and telemetry technologies for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns; and
- inspecting pipes, cleaning, lining, and other maintenance efforts to improve the distribution system and prevent leaks and ruptures from occurring. Systems might also consider methods for minimizing water used in routine water system maintenance.

Types of Leaks

There are different types of leaks, including service line leaks, and valve leaks, but in most cases, the largest portion of unaccounted-for water is lost through leaks in

supply lines. There are many possible causes of leaks, and often a combination of factors leads to their occurrence. The material, composition, age, and joining methods of the distribution system components can influence leak occurrence. Another related factor is the quality of the initial installation of distribution system components. Water conditions are also a factor, including temperature, velocity, and pressure. External conditions, such as stray electric current; contact with other structures; and stress from traffic vibrations, frost loads, and freezing soil around a pipe can also contribute to leaks.

Underground Leaks

The underground piping on either side of a water meter should be maintained. Leaks in underground plumbing can be caused by many different factors, including rusting through from age or from stray electric currents from other underground utilities that can prematurely rust metallic piping, driving over piping with heavy trucks or equipment, poor initial installation, freezing and thawing of a pipeline, 5 leaking joints or valves, or transient high pressure events such as opening and closing valves or starting and stopping pumps quickly.

Signs of underground leaks include:

- Unusually wet spots in landscaped areas and/or water pooling on the ground surface.
- An area that is green, moldy, soft, or mossy surrounded by drier conditions.
- A notable drop in water pressure/flow volume.
- A sudden problem with rusty water or dirt or air in the water supply (there are other causes for this besides a leak).
- A portion of an irrigated area is suddenly brown/dead/dying when it used to be thriving (water pressure is too low to enable distant heads to pop up properly).
- Heaving or cracking of paved areas. Sink holes or potholes.
- Uneven floor grade or leaning of a structure.
- Unexplained sudden increase in water use, consistently high water use, or water use that has been climbing at a fairly steady rate for several billing cycles.

Leak Detection and Repair Strategies

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground. In addition, correlator devices can listen at two points simultaneously to pinpoint the exact location of a leak.

Large leaks do not necessarily constitute the greatest volume of lost water, particularly if water reaches the surface where they are usually found quickly, isolated, and repaired. However, undetected leaks, even small ones, can lead to large quantities of lost water since these leaks

might exist for a long time. Ironically, many small leaks are easier to detect because they are noisier and easier to hear using hydrophones. The most difficult leaks to detect and repair are usually those under stream crossings. Leak detection efforts should focus on that portion of the distribution system.

Checking for Leaks

Identifying leaks can be difficult; however, at minimum the following should be performed:

- Inspect irrigation systems for obvious above ground leaks. Extremely wet areas above an underground pipe can be an indication of a broken pipe or joint.
- Examine equipment routinely and look at exposed pipes to see if you can visually see any leaking water.

If you suspect a leak at your facility, take steps to get the leak fixed.

Repairs to service main

Water mains are generally repaired and completed between four to eight hours.

Main water line leak symptoms

- 1 Puddles of water.
- 2 Hissing, whistling or bubbling sounds.
- 3 Low water pressure
- 4 Water damage on the ceiling and walls
- 5 Mold and Molden presence.
- 6 Discolored water
- 7 Unexplained spike in water bill.

Pipe used in main water line

Polyvinyl chloride (PVC) pipe is widely used for new water main applications PVC pipe material is in expensive durable and light weight further more. It is corrosion resistance for bigger dia water supply mains ductile iron pipe is used as often for water applications.

Causes of water main break

As the weather turns cold water main breaks due to the expansion and contraction of the pipe material Pipe corrosion soil conditions age and ground movement can also cause water main breaks.

Repair on PVC pipe

Repairing PVC pipe first clean and dry the damaged area. Then apply the epoxy and let it cure for ten minutes.

HDPE (High density polyethylene)

Pipes are considered the best choice for underground water lines. HDPE pipes are non-toxic, tasteless and considered a green building material.

Pipes should be buried at least 600mm (two feet) underground. At this depth the soil acts as a natural insulator and prevents then freezing.

Domestic boilers and geysers

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

- explain the function and use of boiler
- describe type of boilers.
- explain the function and use of geysers.
- state about the installation of vent pipes.

Domestic boilers and geysers

Boilers: A boiler is an enclosed vessel in which to produce steam vapourised form of a liquid. The steam or hot water is then circulated through a piping system to transfer heat for various applications such as heating power generation and other process.

There are two main categories of boilers they are:

- 1 **Fire tube boilers:** Hot gas in several tubes is used to heat the surrounding water.
- 2 **Water tube boiler:** Water in the tubes is heated by the surrounding hot gas.

Types of domestic boilers

- 1 Conventional boilers
- 2 Combination boilers
- 3 System boilers
- 4 CHP boilers
- 5 Bio mass boilers.

Conventional boilers: This is used in older heating system where the higher pressures used.

Combination boilers: This boiler supply central heating and hot water directly from the water supply without the need for a water tank or hot water cylinder. Hot water is used immediately rather than being stored.

System boilers: This boiler have a hot water cylinder but no water tank. This requires less space.

CHP boilers: Micro CHP or micro combined heat and power can be installed as direct replacement for gas fired boilers.

Bio mass boilers: The boilers run on renewable fuel such as wood pellets. This boiler occupies more space than other standard boilers.

Geysers

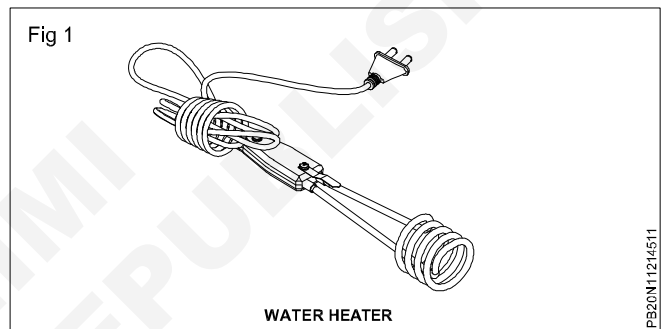
Definition

The geysers are electronic devices which are utilised primarily for water heating purpose. Geysers are widely used within bathrooms, kitchens, and showers for heating water within homes.

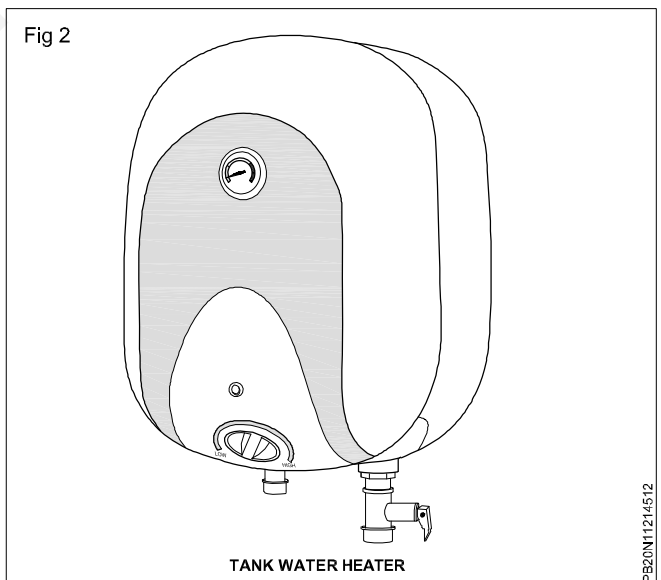
The Different Types of Water Heater?

Immersion rods (Fig 1)

Immersion rods are user-friendly and don't need any installation process. In order to heat water, you will only need to dip the device in a metal bucket full of water and put on the switch. It takes 10-15 minutes to heat a bucket of water. It contains a heating coil and a chord which resembles an electronic iron.



Water Heaters (Fig 2): Water heaters are normally used to heat the water supply of homes. They offer hot water supplies to appliances and fixtures.



Tank Type Water Heaters

Tank type water heaters are normally used in homes. They have a large, cylindrical tank standing on the end with pipes that are attached to them.

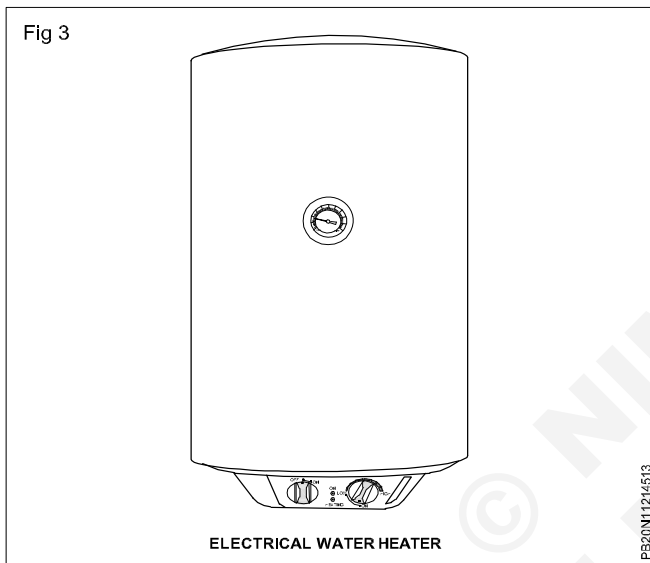
To ensure safety, all water heaters have a T & P valve (temperature and pressure relief valve). The valve opens if either the temperature or pressure of water exceeds a safety limit.

Most of the tanks are made from steel and are glass-lined in the interior to check corrosion. Corrosion is the major reason why tanks fail.

At the bottom of the tank, there is a drain cock for an emptying heater. The valve on supply pipe enables you to shut down the hot-water plumbing without affecting the home's cold-water supply.

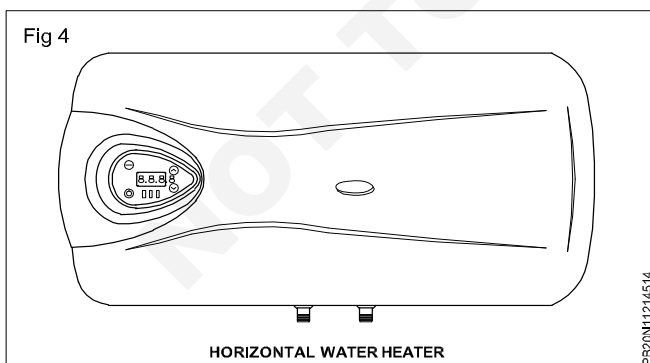
Electrical Water Heaters (Fig 3)

Electric water heaters are normally wired to a 220-volt circuit. On heating the water, the current passes through electrical resistance heating elements.



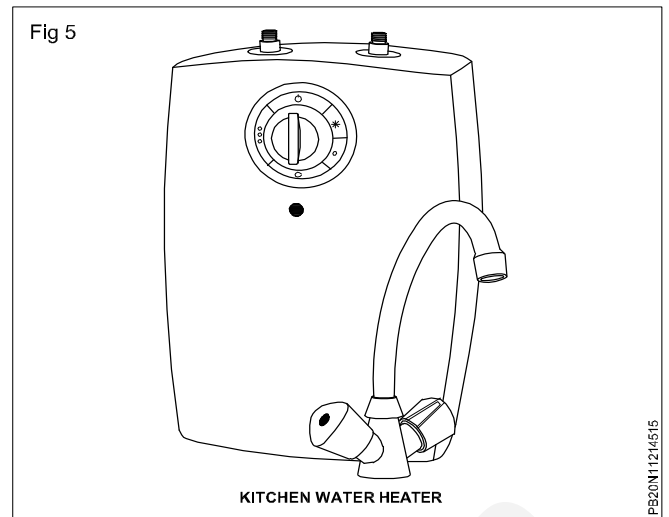
Horizontal Water Heaters (Fig 4)

Usually, geyser water heaters are vertically mounted. In case the bathroom ceiling wall is low, then you won't have sufficient vertical space on the wall for mounting the geyser vertically.



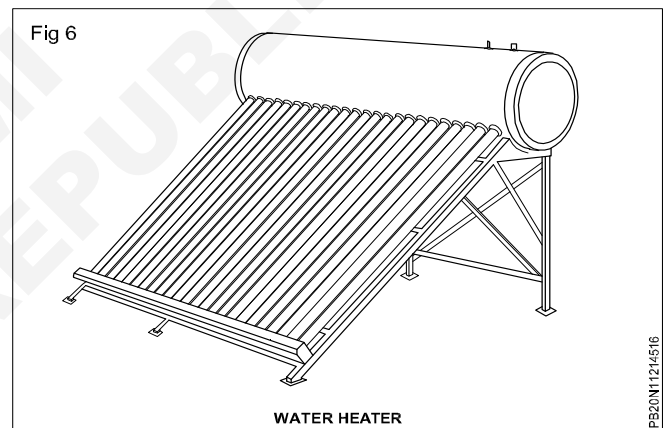
Kitchen Water Heaters (Fig 5)

Electric instant geysers with a capacity of 1 liter to 3 liters are suitable only for kitchens.

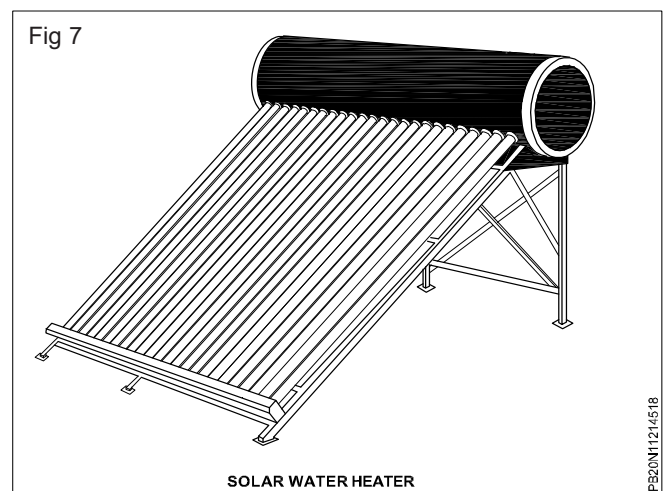


Water Heaters for High Rise Buildings (Fig 6)

Depending on the floor capacity of a building, a geyser with a strong tank is most suitable if you reside in a high-rise building. Geysers for high-rise buildings need to have a minimum pressure of more than 6 bars. Glass-lined coated inner tanks are more suitable since they will resist high pressure.



Solar Water Heaters (Fig 7)



A solar water heater is an ideal choice if you are living in an independent house with your family. Solar water heater usage will ensure that you don't need to spend heavily on electricity. It will offer hot water to the entire house. Initial investment is extremely high. They are not suitable for large apartments. These geysers are unsuitable for bigger apartments.

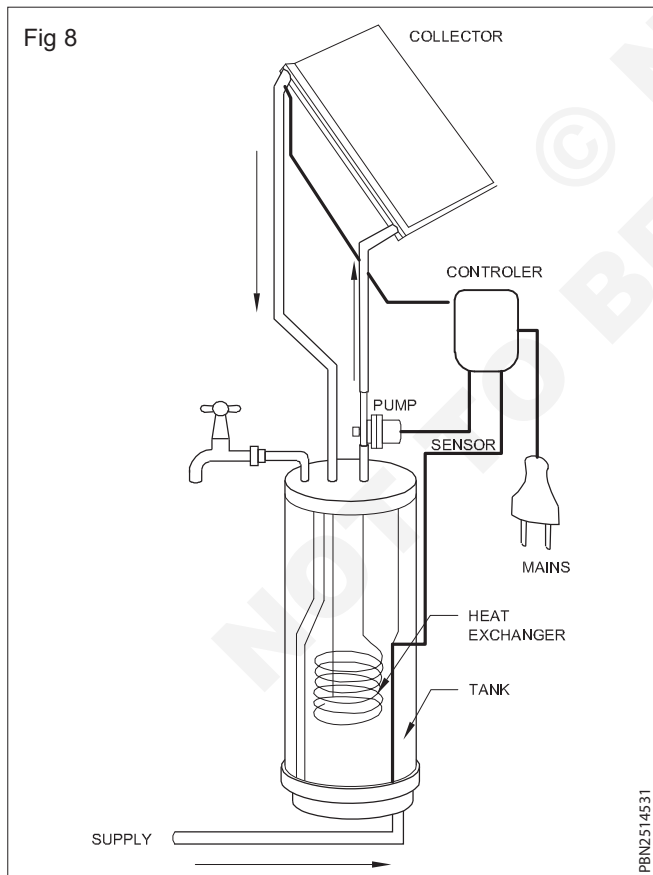
Solar water system

Solar water heating (SWH)

Solar water heating (SWH) is the conversion of sunlight into renewable energy for water heating using a solar thermal collector. Solar water heating systems comprise various technologies that are used worldwide increasingly.

In a "close-coupled" SWH system the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermosiphon flow. In a "pump-circulated" system the storage tank is ground- or floor-mounted and is below the level of the collectors; a circulating pump moves water or heat transfer fluid between the tank and the collectors.

SWH systems are designed to deliver hot water for most of the year. However, in winter there sometimes may not be sufficient solar heat gain to deliver sufficient hot water. In this case a gas or electric booster is used to heat the water. (Fig 8)

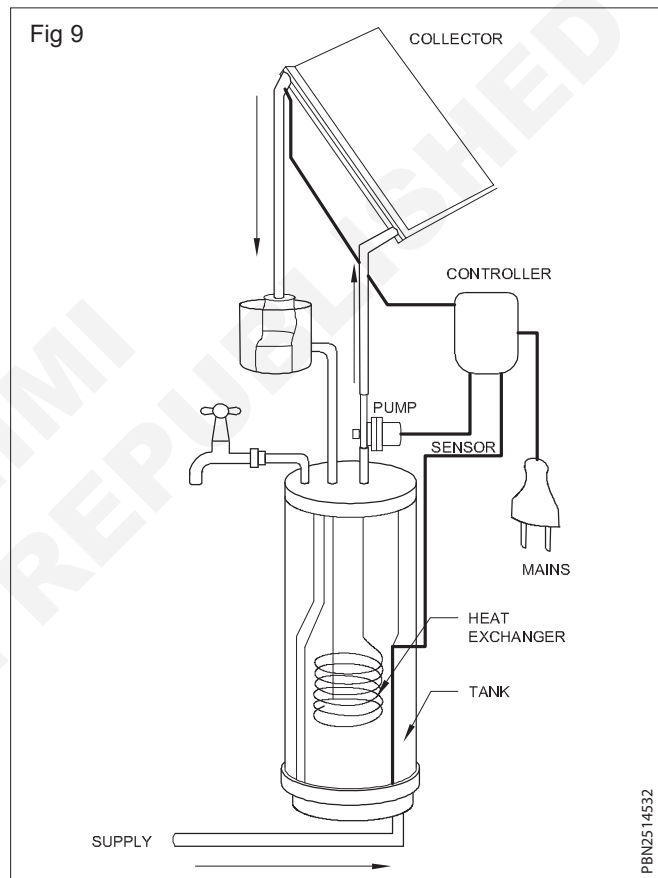


Freeze protection

Freeze protection measures prevent damage to the system due to the expansion of freezing transfer fluid. Drain back systems drain the transfer fluid from the system when the pump stops. Many indirect systems use antifreeze (e.g. Propylene glycol) in the heat transfer fluid.

Overheat protection

When no hot water has been used for a day or two, the fluid in the collectors and storage can reach very high temperatures in all systems except for those of the drain back variety. When the storage tank in a drain back system reaches its desired temperature, the pumps are shut off, putting an end to the heating process and thus preventing the storage tank from overheating. (Fig 9)



Types of solar water heating systems

Direct and indirect systems

Direct or open loop systems circulate potable water through the collectors. They are relatively cheap but can have the following drawbacks:

- They offer little or no overheat protection unless they have a heat export pump.
- They offer little or no freeze protection, unless the collectors are freeze-tolerant.
- Collectors accumulate scale in hard water areas, unless an ion-exchange softener is used.

Until the advent of freeze-tolerant solar collectors, they were not considered suitable for cold climates since, in the event of the collector being damaged by a freeze, pressurized water lines will force water to gush from the freeze-damaged collector until the problem is noticed and rectified.

Indirect or closed loop systems use a heat exchanger that separates the potable water from the fluid, known as the "heat-transfer fluid" (HTF), that circulates through the collector. The two most common HTFs are water and an antifreeze/water mix that typically uses non-toxic propylene glycol. After being heated in the panels, the HTF travels to the heat exchanger, where its heat is transferred to the potable water. Though slightly more expensive, indirect systems offer freeze protection and typically offer overheat protection as well.

Passive and active systems

Passive systems rely on heat-driven convection or heat pipes to circulate water or heating fluid in the system. Passive solar water heating systems costless and have extremely low or no maintenance, but the efficiency of a passive system is significantly lower than that of an active system. Overheating and freezing are major concerns.

Active systems use one or more pumps to circulate water and/or heating fluid in the system.

Though slightly more expensive, active systems offer several advantages:

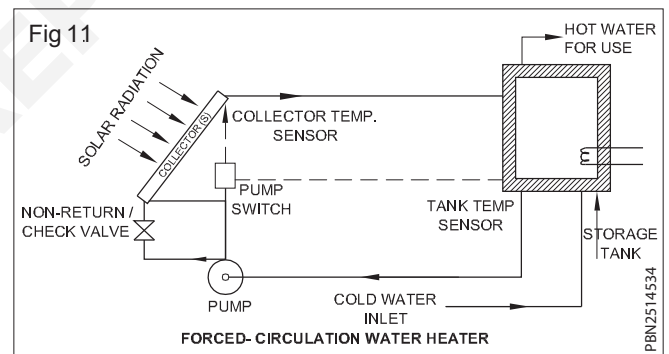
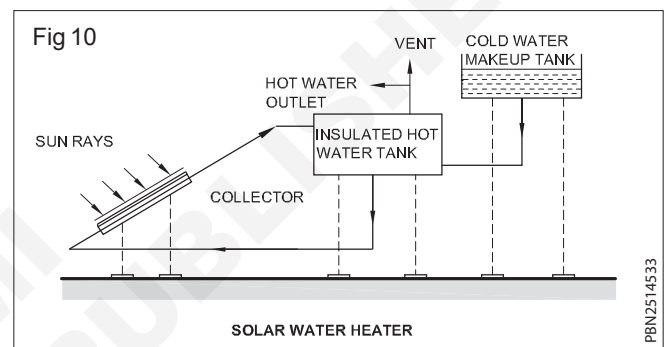
- The storage tank can be situated lower than the collectors, allowing increased freedom in system design and allowing pre-existing storage tanks to be used.
- The storage tank can be hidden from view.
- The storage tank can be placed in conditioned or semi-conditioned space, reducing heat loss.
- Drainback tanks can be used.
- Superior efficiency.
- Increased control over the system.

Modern active solar water systems have electronic controllers that offer a wide range of functionality, such as the modification of settings that control the system, interaction with a backup electric or gas-driven water heater, calculation and logging of the energy saved by a SWH system, safety functions, remote access, and informative displays, such as temperature readings.

The details of the most common type of solar water heater are shown in the fig 8 & 9. Here a tilted flat plate solar collector with water as heat transfer fluid is used. A thermally insulated hot water storage tank is mounted above the collector. The heated water of the collector rises up to the hot water tank and replaces an equal of quantity of cold water, which enters the collector. The cycle repeats, resulting in all the water of the hot water tank getting heated up.

When hot water is taken out from hot water outlet, the same quantity is replaced by cold water from the cold-water make up tank. The cold water tank is fixed above the level of the hot water tank. The scheme is known as passive heating scheme, as water is circulated in the loop naturally due to thermo syphon action.

When the collector is fixed above the level of the hot water tank, a pump is required to induce circulation of the water in the loop, and the scheme will be known as active or forced solar thermal system. Water is pumped through flat plate solar collector, where it is heated and flows back into the storage tank. Whenever hot water is withdrawn for use, cold water takes its place. When the difference in water temperature at the collector outlet and at the storage tank exceeds 7°C, the pump motor is activated by a differential thermostat. A non-return/check valve is needed to prevent reverse circulation. An auxiliary electrical immersion heater may be used as back up for use during cloudy periods. (Figs 10, 11)



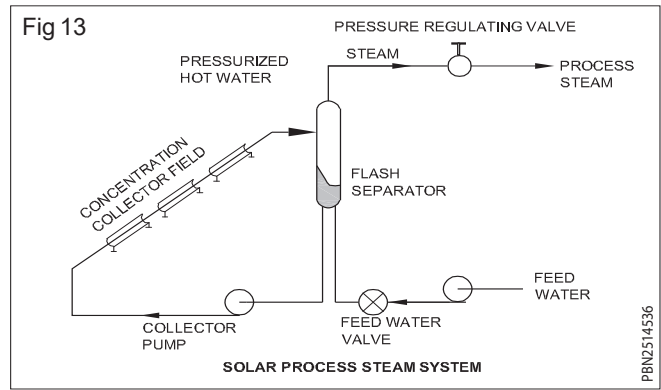
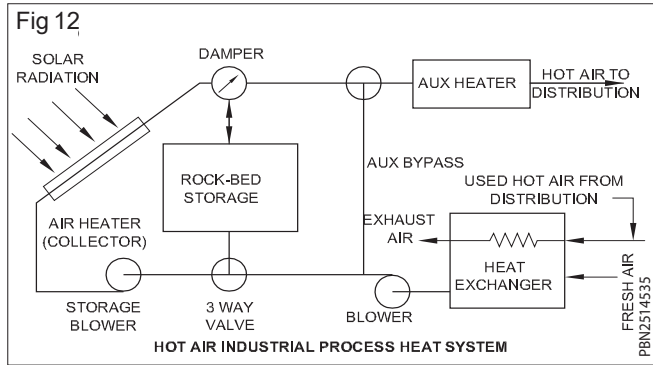
In other scheme, the hot water from the collector delivers heat to service water through a heat exchanger. In this scheme an anti-freeze solution may be used as heat transport medium to avoid freezing during cold nights.

Solar industrial heating system

Solar active heating systems are used for several industrial process heat requirements. The process heat in various industries is generally supplied in the form of (i) Process hot water, (ii) Hot air, (iii) Process steam.

An arrangement of the hot air solar heating system is shown in the (Fig 8 to 11). Thermal energy is transported from collector through hot air and utilized for process heat. The excess heat is stored in rock bed thermal storage, to be used later when solar radiation is not available. Auxiliary heating augments are used when the solar heat supplied by collector or storage is not sufficient. The used air is passed through a heat exchanger to recover the heat from the exhaust air to raise the initial temperature of the fresh entering the collector.

An arrangement of a solar process steam system is shown in the fig 11. Here the pressurized water is circulated through a concentrating collector to prevent boiling. The high pressure heated water is throttled and flash separated in a flash separator. Boiled feed water is injected into the pump section, for maintaining the necessary liquid level in the flash tank,. The saturated steam obtained from the flash separator is recirculated through the collector field and distributed for use. A pressure regulator valve is used to regulate the pressure. (Figs 12 & 13)



Plumbing and sanitary symbols and plumbing codes

Objectives: At the end of the lesson you shall be able to

- state about the plumbing (sanitary) codes and standard
- state about the symbols for sanitary installation as per IS abz: 1967.

Purpose

The purpose of this standard is to define specifications to be followed for plumbing, sanitary works and drainage.

Scope

The work covered by this specification includes supply of approved quality sanitary ware, accessories, their installation and commissioning the scheme as directed.

Codes and standards

IS:1172:1993 - Code of basic requirements for water supply drainage and sanitation

IS:1200 - Method of Measurement of building & civil Engg. Work appurtenant

Part 19:1981 - Water Supply plumbing & drains

Part 16 : 1979 - Laying of water & sewer lines including appurtenant items

IS : 1239 - Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe

Part 2 : 1992 fittings

IS : 1536 : 2001 - Centrifugally cast (Spun) iron pressure pipes for water gas & sewage.

IS : 1537 : 1976 - Vertically cast iron pressure pipe for water, gas & sewage

IS : 1742 : 1983 - Code of Practice for building drainage

IS : 5329 : 1983 - Code of Practice for sanitary pipe work above ground for buildings

IS : 2470 : 1985 - Code of Practice for installation of septic tank

IS : 3076 : 1985 - Specification for Low density polyethylene pipes for potable water supplies.

IS : 4984 : 1995 - Specification for High density polyethylene pipes for potable water supplies.

IS : 1537 : 1976 - Vertically cast iron pressure pipes for water, gas and sewage

IS : 3989 : 1984 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS : 1729 : 2002 - Cast iron / Ductile iron Drainage pipes and pipe fittings for over ground Non-pressure pipeline socket and spigot series

IS : 1626 : 1994 - Specifications for Asbestos cement building pipes, gutters and fittings

IS : 458 : 2003 - Specification for Concrete pipes (with and without reinforcement)

IS : 783 : 1985 - Code of practice for laying of concrete pipes.

IS : 784 : 2001 - Prestressed concrete pipes (including fittings)

IS : 651 : 1992 - Specification for Salt glazed stoneware pipes and fittings

IS : 4127 : 1983 - Code of Practice for laying of glazed stoneware pipes

IS : 1726 : 1991 - Specification for Cast Iron manhole covers & frames

IS : 5961 : 1970 - Specification for Cast Iron gratings for drainage purposes'

IS : 5219 - Specification for cast copper alloys traps

Part 1 : 1969 - Part 1 'P' & 'S' traps

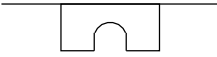
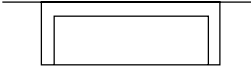


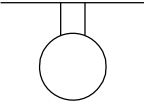

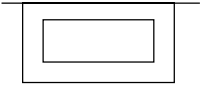
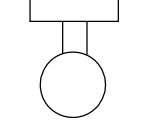
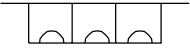
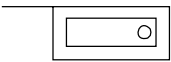
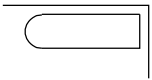

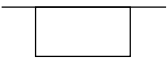
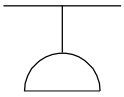

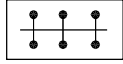
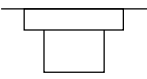
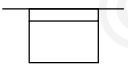


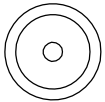
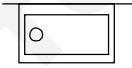
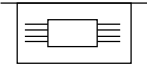
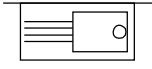
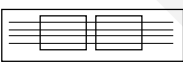

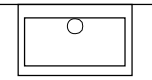
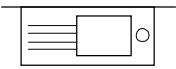
IS : 771 - Specification for Glazed fire - clay sanitary appliance


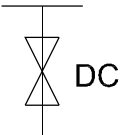

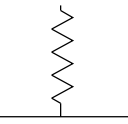
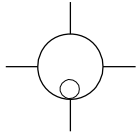
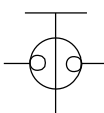


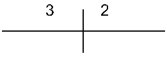


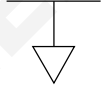
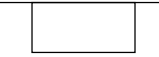

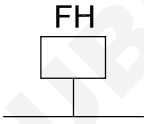



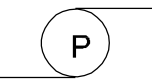

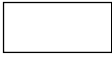
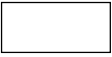
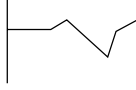
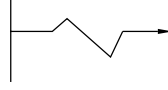



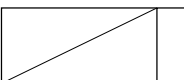
Part 1 : 1979 - Part 1 - General requirements

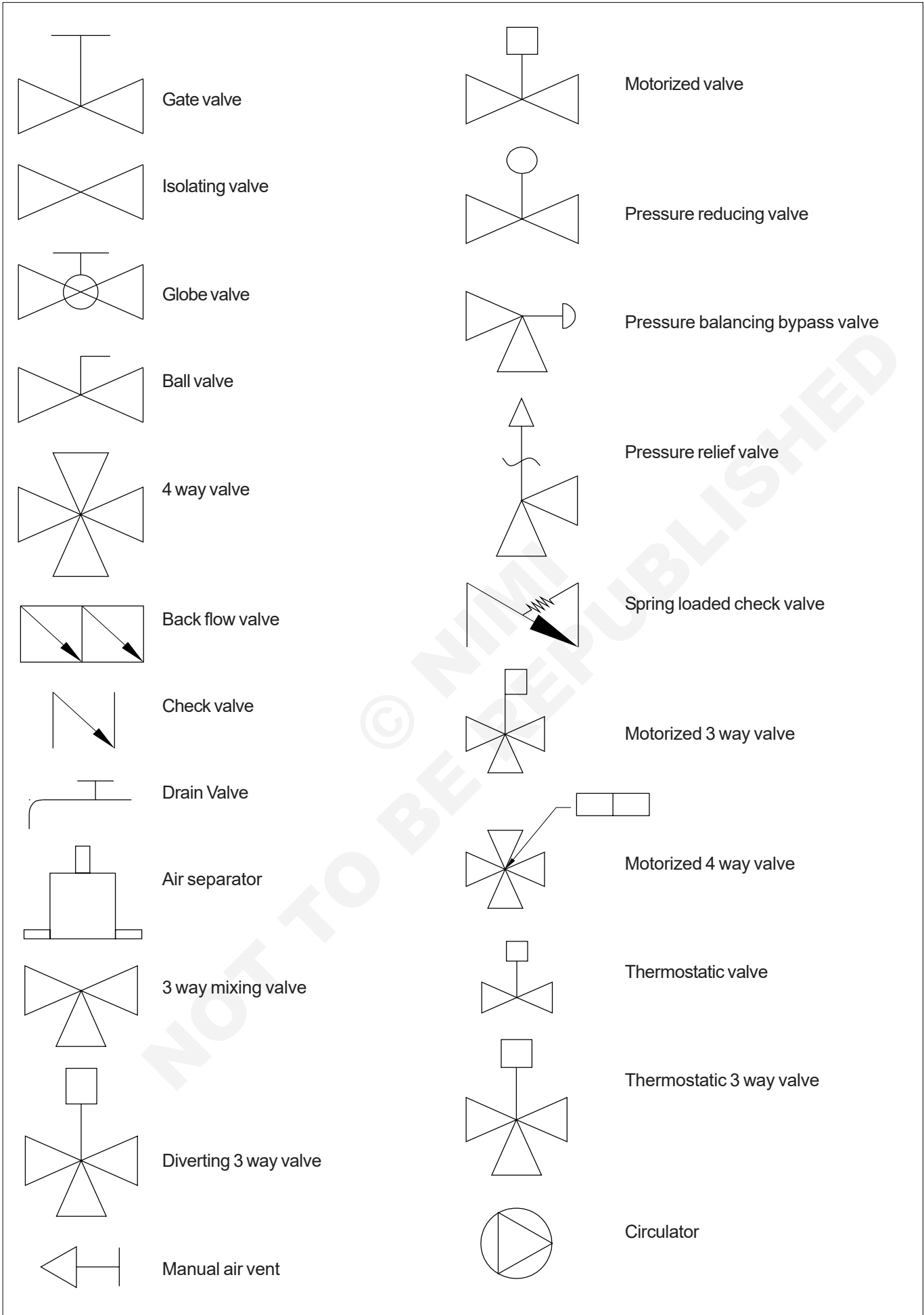
IS : 772 : 1973 - Specification for General requirements of enamelled cast iron sanitary appliances.

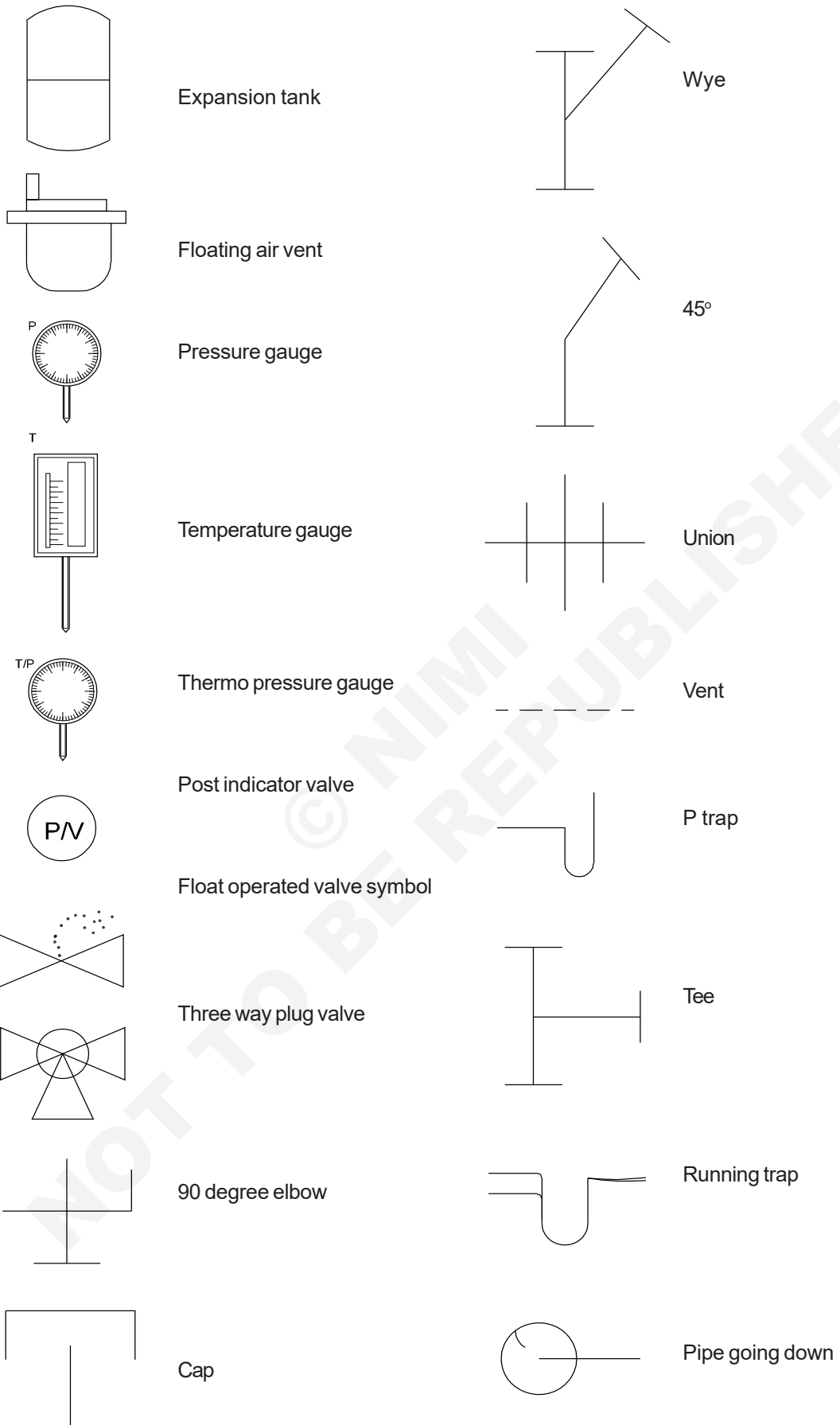
IS : 774 : 2004 - Flushing cistern for water closets & urinals (other than plastic Cistern) Specification

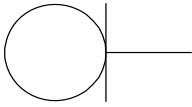
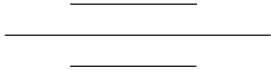
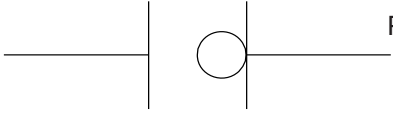
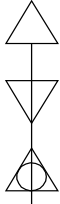
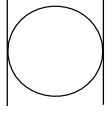

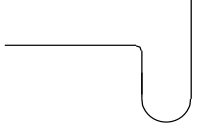
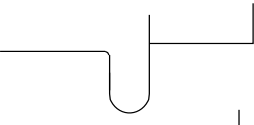
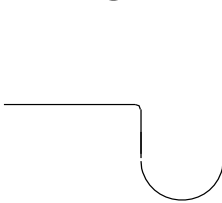
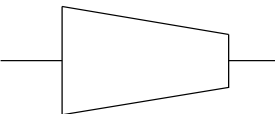
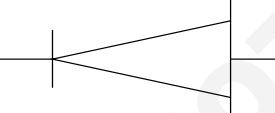
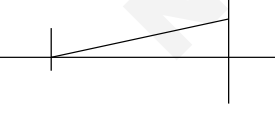
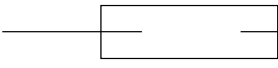
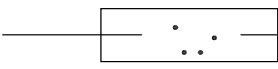
IS 2548 : 1996 - Specification for Plastic water & cover for water closet

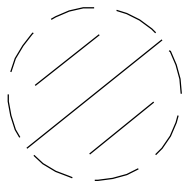
			
URINAL FLOOR	SLAB URINAL	PEDESTAL TYPE URINAL	INDIAN TYPE W.C
			
NO TANK FLUSH TYPE W.C	PEDESTAL TYPE DRINKING FOUNDATION	WALL LEVORATORY BASING	LOW TANK W.C
			
URINAL STALL	SHOWER HEAD	ROLL RIM BATH	CORNER LEVORATORY BASIN
			
SHOWER STALL	SHOWER HEAD	TROUGH LEVORATORY WALL TYPE	TROUGH LEVORATORY ISLAND TYPE
			
W.C.LOW DOWN	W.C.	WALL HUNG URINAL	CORNER HUNG URINAL
			
CIRCULAR WASHING FOUNDATION	PLAIN KITCHEN SINK	KITCHEN SINK WITH DOUBLE DRAINAGE BOARD	KITCHEN SINK WITH SINGLE DRAINAGE BOARD
			
DOUBLE SINK UNIT	SINK AND TUB SETS	SLOP SINK	COMBINATION SINK

 <p>HOT OR COLD WATER DRAIN</p>	 <p>DRAIN COCK</p>	 <p>STOP VALVE OR SLUICE VALVE</p>	 <p>SAFETY VALVE</p>
 <p>MIXING VALVE HAND CONTROL</p>	 <p>MIXING VALVE THERMOSTATIC</p>	 <p>W.M WATER METER</p>	 <p>HMC HOT WATER CYLINDER</p>
 <p>CHANGE OF PIPE SIZE</p>	 <p>HMT HOT WATER TANK</p>	 <p>HB HOSE BIB</p>	 <p>FIRE EXTINGUISHER</p>
 <p>HT HOUSE TANK</p>	 <p>WAC VACUUM PUMP</p>	 <p>FH FIRE HYDRANT</p>	 <p>G GULLY</p>
 <p>GT GREASE TRAP</p>	 <p>RWH RAIN WATER HEAD</p>	 <p>P PUMP</p>	 <p>RE RODDING EYE</p>
 <p>MH or IC MAN HOLE OR INSPECTION CHAMBER</p>	 <p>CWC COLD WATER CISTERN</p>	 <p>VENT-INLET</p>	 <p>VENT-OUTLET</p>
 <p>RWO RAIN WATER OUTLET</p>	 <p>C COOKER</p>	 <p>R REFRIGERATOR</p>	 <p>BED</p>

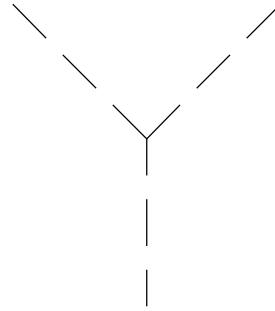




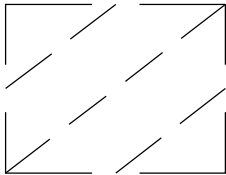
	Pipe going up	-----	Cub stop
	Pipe guide symbol		Fire hydrant and isolation valve
	P-tee up symbol		
	P-cross up down symbol	----- A -----	Comp. air line
	WC	-----	Domestic cold water hot
	Floor drain	----- HW -----	Hot water
	K. Sink	----- CW -----	Cold water
	Lavatory	-----	Hot
	Bushing symbol	----- G -----	Gas line
	Concentric reducer	----- SAN -----	Sanitary drain above ground
	Ecentric reducer	----- SAN -----	Below ground
	Expansion joint	----- D -----	Storm sewer symbol size and D of pipe
	Flexible Connector	----- W -----	Water main symbol with size and type of pipe
		----- TP -----	Trap primer symbol



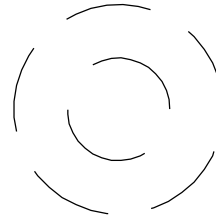
Floor drain round



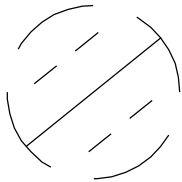
Funnel drain elevation



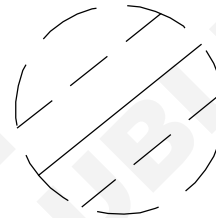
Floor drain



Hub drain



Funnel floor drain



Roof drain

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Corrosion due to electrolytic action

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

- explain corrosion caused by electrolytic action.
- explain the corrosion, causes and remedies.
- state the effect of water and frost on materials.

Electrolytic corrosion is a process of accelerated corrosion. In this process a metallic surface is continuously corroded by other metal. It is in contact with due to electrolyte and the flow of an electrical current between the two metals caused from an external source of electro motive force (EMF). The electrolytes pull out the electrons from the anode metal while flowing towards the cathode metal as the anode metal begins to oxidise and corrode away. This oxidation process is called galvanic corrosion.

Cause of electrolysis in cooling system

When the anti freeze turns bad or electrolysis occurs. It leeches off very small particles of metal rust and aluminium oxide into the coolant. Test shows these particles are like having liquid sand paper flowing through your cooling systems which in turn erodes the aluminium components even more.

Process of electrolysis

Electrolysis is the process by which ionic substances are decomposed (broken down) into simpler substances when an electric current is passed through them. Electricity is the flow of electrons or ions for electrolysis to work the compound must contain ions.

How electrolysis affect the environment

The electrolysis of water breaks it down into pure hydrogen and pure oxygen. Although this process doesn't produce any environmentally harmful by products the prominent way of producing electricity is through the burning of fossil fuels.

Meaning

Corrosion is natural process that converts a refined metal into a more chemically stable form such as oxide, hydroxide, carbonate or sulphate. In the most common use of the word this means electro chemical oxidation of metal in reaction with an oxidant such as oxygen or sulphates.

Causes of corrosion: Metal corrodes when it reacts with another substance such as oxygen hydrogen an electrical current or even dirt and bacteria. Corrosion can also happen when metals like steel are placed under too much stress causing the material to crack.

Corrosion types

- Uniform corrosion it is considered an even attack across the surface of a material and is the most common type of corrosion

- Pitting corrosion
- Crevice corrosion
- Inter granular corrosion
- Stress corrosion cracking
- Galvanic corrosion

Factors that affect atmospheric corrosion

- Moisture, dew and condensation, moisture whether in the form of dew, rain or condensation is a very significant factor when it comes to atmosphere corrosion.
- Temperature
- Relative humidity
- Aerosol particle deposition
- Presence of pollutants

Types of corrosion prevention methods

- Barrier coatings one of the easiest and cheapest ways to prevent corrosion is to use barrier coatings like paint, plastic or powder.
- Hot dip galvanisation
- Alloyed steel (Stainless)
- Cathodic protection
- Eon coat - A new way to protect assets from corrosion.

Difference between corrosion and rusting

Corrosion is the process by which certain materials, metals and non metals, deteriorate as a result of oxidation. Rusting is oxidation of iron in the presence of air and moisture. Corrosion can occur on materials such as ceramics or polymers. Rusting occurs on the surface of iron and its alloys.

Concrete corrosion

Concrete corrosion is the chemical colloidal or physico chemical detrition and disintegration of solid concrete components and structures due to attack by reactive liquids and gases.

This type of corrosion causes wide spread damage to critical sewage pipe lines bridges and other critical assets made of concrete.

Layout of pipes as per drawing

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

- state plan layout of pipes as per drawing
- state the method of layout of pipes.

Before starting plumbing work. Most essential are detailed drawings before the starting the construction of building the detailed plan should be prepared.

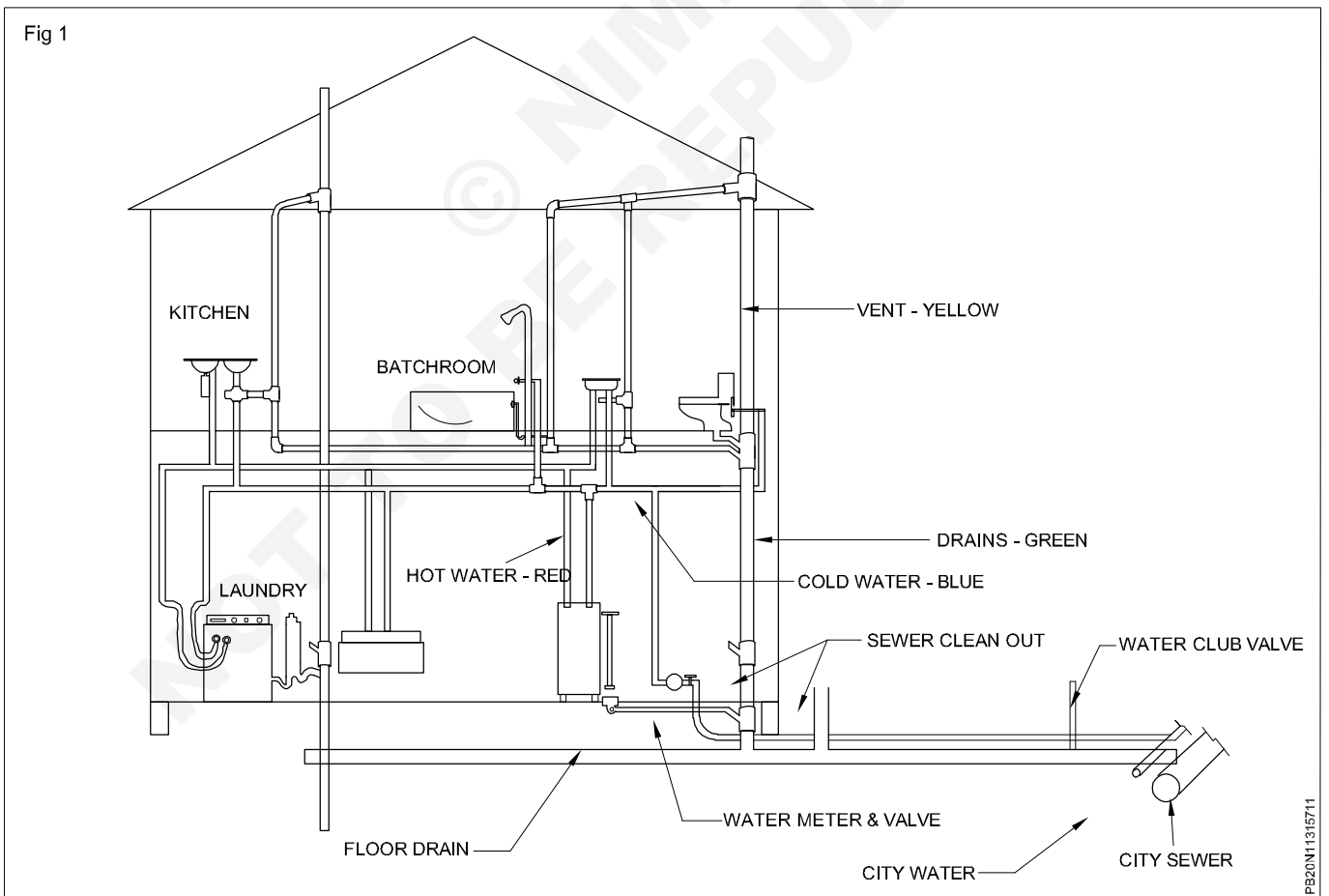
The following points should be kept in mind while preparing the layout of pipes. (Figs 1 & 2)

- 1 The plumbing pipes should be laid to remove the sewage quickly from the building.
- 2 The quick removal is governed by the falls of the pipe. The drain should be laid with a slope that self cleaning velocity should be developed in them.
- 3 All the pipes and the drainage system should be properly ventilated on the house side. The ventilation pipe should be carried sufficiently high above the building.

- 4 All the inspection chambers should be provided with fresh air inlets.
- 5 All the pipes laid to ensure their safety in future.
- 6 The plumbing pipes should be laid future extentsion.
- 7 If the quantity of sewage flowing in a small pipe. An automatic flushing tank may be provided on its top for flushing it.
- 8 All the rain water pipes sweeping from house and bath water should discharge over gully traps.

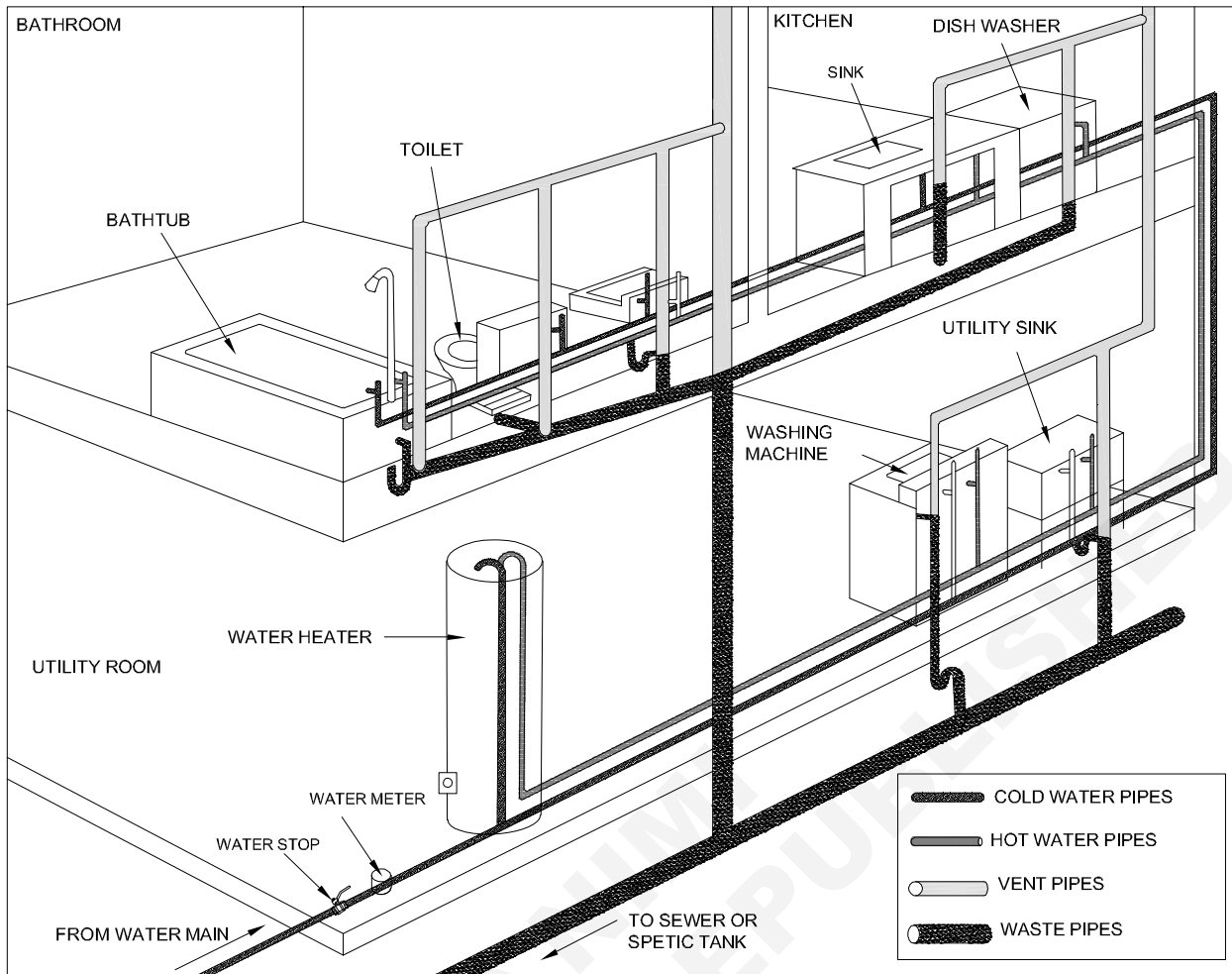
Piping layout

A piping designer does piping layout. This is the process of defining the piece of equipment, the maintenance spaces and the related electrical needs. The final location of any piece of equipment is impacted by the piping layout.



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Fig 2



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Plumbing plan - blueprint reading

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

- recognise the plumbing symbols
- interpret the abbreviations used in the drawing.

Plumbing plan - blueprint reading: Plumbing plan describes the piping systems and plumbing fixtures.

The term 'blueprint' will be used when referring to drawings. Ability to interpret drawings and specifications for a building is absolutely necessary if plumbers are to do their work correctly.

In most cases the location of the plumbing fixtures and the basic layout of the piping system will be shown on the drawing for the building. (Fig 3) It is the plumber's responsibility to interpret the drawings and install the plumbing system according to the plan.

Plumbing symbols: Plumbing symbols are used on the working drawings or sketches. The fittings are shown by symbols.

The symbols used for representing elbow, valves unions, reducer etc are shown in Fig 1 to 7.

These symbols should be recognised to locate fluid supply systems on drawings.

The plumbing abbreviations used in the plumbing plan are given in the Table.

ITEM	ABBR.	ITEM	ABBR.
CAST IRON	CL	HOT WATER	HW
CENTERLINE	CL	LAUNDRY TRAY	LT
CLEANOUT	CO	LAVATORY	LAV
COLD WATER	CW	MEDICINE CABINET	MC
COPPER	COP	PLASTIC	PLAC
DISHWASHER	DW	PLUMBING	PLAG
FLOOR DRAIN	FD	WATER CLOSET	WC
GALVANIZED IRON	GALI	WATER HEATER	WH
HOSE BIB	HB	WATER SOFTENER	WS

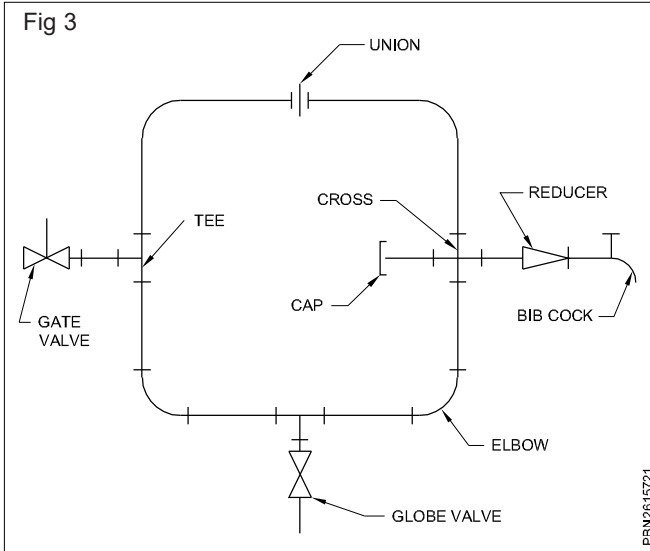


Fig 4

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
90°		45°	
Turning down/away		Turning up/towards	
Double branch		Base	
Side outlet (outlet down)		Side outlet (outlet up)	

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Fig 5

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Welded		Soldered/brazed	
	OR 	Bell and spigot	
Flanged		Flexible	
Screwed (plain coupling)			OR
			OR

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Fig 6

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Lateral		Plug screwed	
Cap		Plug bell and spigot	
Union		Reducer concentric	
		Reducer eccentric	

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Fig 7

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Straight size		Outlet up	
Outlet down		Double sweep	
Single sweep		Side outlet (outlet down)	
Side outlet (outlet up)		Cross	

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Analysis quantity measurement and abstract rate of plumbing and sanitary work

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

- explain analysis of quantity measurement
- state estimate abstract rate of plumbing of sanitary work.

Around 8% of the construction cost of a building is allotted for plumbing and sanitary work. The plumbing system comprises the whole system of pipe fitting and appliances used for water supply and drainage system. Different pipes

are used for different purposes. Plumbing and sanitary items used in building construction are as follows. Piping fixtures and appliances are used to supply water and for drainage of waste water. A plumbing system consists of water supply and distribution pipes taps storage tanks

S.No.	Description of items	Qty	Unit	Rate	Amount
1	Supplying fitting and fixing 10 Litrs PVC low down listen conforming to IS specification with PVC fitting complete C.I bracket including two coats of painting.	8 Nos	Each	1015/- each	9120
2	Supplying PVC water storage tank of approved quality with closed top with lid multi layer a 1000 litre capacity	3 Nos	Each	8000/- each	24000
3	Labour for hoisting plastic water storage tank upto 1500 liter capacity	3 Nos	Each	300/-	900
4	Wash basin vitreous china and approved make (without fittings) supplied fitted and fixed in position on 75mm x 75mm x 75mm wood blocks and CI brackets including two coats of painting of CI brockets 1 550mm x 400mm size	8 Nos	Each	400/-	11200
5	Supplying fitting and fixing approved brand 32mm dia PVC waste pipe with PVC coupling at one end fitted with necessary clamps 750mm long	8 Nos	Each	155	1320
6	Supplying fitting and fixing waste fittings complete 1 32mm	8 Nos	Each	190 each	1520
7	Supplying fitting and fixing pillar cock of approved make a CP pillar cock -15mm equivalent to code No 507 and model tropical/sum using special of essco or similar brand	3 Nos	Each	700 each	2100
8	Supply of UPVC pipe (B type) of fittings conforming to IS-13592-1992 A 1 Single socketed 3 meter length a 75mm b 110mm 2 Double socketed 3 meter length a 15mm b 110mm	25mtr 90mtr 9mtr 9mtr	mtr mtr mtr mtr	196/ mtr 292/mtr 211/mtr 315/mtr	4900 26280 1899 2835

and valves. The drainage system consists of water closets, urinals, soil pipes, vent pipes, wash basins, sinks and bath room waste water pipes.

Water pipes: used for internal and external water supply systems in building. PVC pipes provide energy saving, service cost effective, maintenance free, and safe check the required quantity and calculate abstract rate.

Analysis of quantity measurement

It usually has four units of measurement to choose from millimeter, centimeter, inch and foot. A meter stick is an instrument for measuring short distances. For short distances the metric unit meter (m) and the English unit yard (yd) are commonly used.

Bill of quantity and estimation

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

- explain quantity estimation
 - explain preparation of bill of quantity and estimation.
-

Quantity estimate: A quantity estimate includes a list of quantities for all materials needed to complete a project. Its purpose is to give the client a complete list of all the quantities required for the project and what the cost will be for each quantity. It is a key estimating method in construction.

Bill of quantity: It is a document by which it is possible to estimate the cost of a construction project (or part of it) or for its maintenance. It is a very important document prepared by the quantity surveyor on the basis of a project and used by all parties involved in the building's development.

General format of a BOQ

Like the other documents a BOQ also has a general format. This includes heads like:

- 1 Serial number
- 2 Description of work / item description
- 3 Unit / Unit of measurement
- 4 Quantity
- 5 Rate per unit (some times in figures and words, both)
- 6 Total amount
- 7 Remarks (If any)

Preparation of estimation

Meaning: It is necessary to prepare the cost estimate for the intended work from the plans and specifications. The following are types of estimates.

Unit descriptor: This unit of competency specifies the outcome required to use and interpret plans accurately with construction work and calculation to establish quantities of materials for the plumbing and service industry. The unit requires the interpretation of plan drawing and specification to interpret requirements and making measurements and calculation to determine quantities of plumbing materials.

- 1 Preliminary or rough estimate
- 2 Plan the area estimate
- 3 Service unit method
- 4 Floor area method
- 5 Carpet area method
- 6 Typical bay method
- 7 Cost comparison method
- 8 Cubic content method
- 9 Annual repair estimate
- 10 Revised estimate
- 11 Supplementary estimate
- 12 Detailed estimate

Approximate estimate: This is also known as preliminary or rough estimate. It helps to find out the approximate cost of a project in a very short time.

Uses of detailed estimate

- 1 It is required for the preparation of contract document
- 2 It serves as a guide during executions of the work
- 3 It helps in computing the quantities of materials, and labour employed for the completion of various items of constructions.
- 4 It is very useful in the efficient planning and programming of all activities required for the speedy completion of work.
- 5 It enables to prepare bar chart material schedules etc for the work.