

PLUMBER

NSQF LEVEL - 4

Volume II of II

TRADE THEORY

SECTOR: PLUMBING



Directorate General of Training

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



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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of 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 Volume II of II Trade Theory NSQF Level - 4 in Plumbing Sector under Yearly Pattern**. The NSQF Level - 4 Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 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

Director General
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New Delhi - 110 001

PREFACE

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

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

**R. P. DHINGRA
EXECUTIVE DIRECTOR**

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National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP (**Trade Theory**) for the trade of **Plumber** 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 workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Plumber** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4.

The manual is divided into Six modules. The distribution of time for the practical in the six modules are given below.

Module 1	- Piping system	50 Hrs
Module 2	- Pumps and PVC joints	125 Hrs
Module 3	- Drainage systems	50 Hrs
Module 4	- Water supply system	125 Hrs
Module 5	- Bending and systems of water supply	125 Hrs
Module 6	- Tank installation, test and maintenance	50 Hrs
Total		525 Hrs

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the course of the Plumber Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the 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 material is not the purpose of self learning and should be considered as supplementary to class room instruction.

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LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

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1	Align and lay humid asbestos pipe line of different dia. and fitting & maintenance of drainage pipe line.	2.1.93 - 100
2	Install and maintain different Electric pumps.	2.2.101 - 106
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7	Install, fix & maintain different valve & cock.	2.4.122 - 126
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11	Carry out fitting, fixing & laying installation of hot & cold water pipe line & symbolizing.	2.5.141 - 146
12	Perform repairing & reconditioning of waste pipe line.	2.6.147 - 150
13	Perform repairing& reconditioning, scraping & painting of sanitary fittings pipe line.	2.6.151 - 157

SYLLABUS FOR PLUMBER

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With indicative hour)	Professional Knowledge (Trade Theory)
Professional Skill 50Hrs; Professional Knowledge 14 Hrs	Align and lay humid asbestos pipe line of different dia. and fitting & maintenance of drainage pipe line.	93 Interpret drawing of sanitary plumbing.(05 hrs)	<ul style="list-style-type: none"> Use of hummed and asbestos pipes of different sizes. Method of laying out pipes alignment and joining. (07 hrs)
		94 Lay & align pipe. (08 hrs)	
		95 Lay & align humid and asbestos pipe. (08 hrs)	
		96 Demonstrate use of specific dia in different location. (04 hrs)	
		97 Use various sanitary fitting. (06 hrs)	<ul style="list-style-type: none"> Description of various pipe joints-straight, Branch, Taft and blow, Expansion joints. Solders and fluxes used in joints. (07 hrs)
		98 Use various fitting of different materials.(06 hrs)	
		99 Use joining materials of pipe. (07 hrs)	
		100 Join pipe as per laid down Procedure.(06 hrs)	
Professional Skill 75 Hrs; Professional Knowledge 21 Hrs	Install and maintain different Electric pumps.	101 Demonstrate use of different pump. (10 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. (21 hrs)
		102 Demonstrate installation of electric pump (20 hrs)	
		103 Demonstrate maintenance of electric pump. (10 hrs)	
		104 Demonstrate working process of centrifugal, reciprocating, submersible pump. (15 hrs)	
		105 Demonstrate delivery of water to overhead tank through pump, presser head, delivery pipe, suction pipe, etc, (15 hrs)	
		106 Contamination of water in a well. (05 hrs)	
Professional Skill 50Hrs; Professional Knowledge 14Hrs	Join fittings for different purposes on PVC pipe line.	107 Produce metric & BSP thread on pipe. (10 hrs)	<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. (14 hrs)
		108 Produce Internal and external thread on PVC pipes of different dia. (10 hrs)	
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		110 Join PVC pipe with solvent cement and heat process (10 hrs)	
		111 Join PVC pipe as per layout. (14 hrs)	

Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Construct inspection chamber, manhole, gutter, septic tank, socket etc.	112 Demonstrate inspection chamber, manhole, gully trap, septic tank, soak pit. (04 hrs) 113 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 07 Hrs	Test pipe line as per site drainage pipe line layout.	114 Demonstrate drawing layout of drainage pipe line. (06 hrs) 115 Perform testing for smoke test, water test, smell test, ball test mirror test. (10 hrs) 116 Join heavy cast iron socket pipe. (03 hrs) 117 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 (07 hrs)
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Perform removal of leakage pipe line.	118 Identify location of leakage pipe. (06 hrs) 119 Removing out leakages pipe. (10 hrs) 120 Removing of air locks (06 hrs) 121 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. (07 hrs)
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Install, fix & maintain different valve & cock.	122 Demonstrate different cocks & valves including materials.(04 hrs) 123 Employ cocks & valves at different place. (06 hrs) 124 Employ different cock & valve with sensor system. (06 hrs) 125 Demonstrate maintenance of different cocks & valves. (06 hrs) 126 Demonstrate use of packing washer gasket of different cock & valve. (03 hrs)	<ul style="list-style-type: none"> • Description of cocks & valves-their types, materials & advantages for particular work. (07 hrs)
Professional Skill 75Hrs; Professional Knowledge 21 Hrs	Install & maintain water meter and water supply for fixture.	127 Demonstrate location of meter. Fitting of water meter, bath tub, wash basin. (10 hrs) 128 Install water metre, bath tub, hand wash basin, water closet urinal, sink etc with sensor system. (25 hrs) 129 Demonstrate maintenance of water metre, bath tub, hand wash basin, water closet urinal, sink etc. (15 hrs) 130 Demonstrate testing of water metre, Bath Tub, Hand wash basin. (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 (21 hrs)

		131 Erect rain water and drainage pipe system. (15 hrs)	
Professional Skill 50Hrs; Professional Knowledge 14 Hrs	Demonstrate method of bending for different materials & different pipe joint.	132 Demonstrate bending of pipes in bending machine. (08 hrs) 133 Bend GI pipe of different diameter in different angle. (14 hrs) 134 Bend G.I. pipe as per drawing and measurement. (14 hrs) 135 Bend PVC pipe of different diameter in different angle with dry sand by heating. (14 hrs)	Method of bending galvanized mand other heavy pipes. (14 hrs)
Professional Skill 50Hrs; Professional Knowledge 14 Hrs	Perform fitting and maintenance of Fixture at different place.	136 Demonstrate process of C.I pipe cutting & joining. (12 hrs) 137 Process of C.I. pipe fitting for waste pipe line in different section. (08 hrs) 138 Employ Process of fixing of external soil pipe. (12 hrs) 139 Demonstrate process of fixing of rain water gutter outlet and ground pipe. (10 hrs) 140 Demonstrate process of measurement of waste pipe line. (08 hrs)	Domestic drainage system General layout, one pipe system, specifications of Materials required. Method of testing leakage. Different types of traps, ventilation, antisiphonage and sinks. About Fire hydrants and their fittings. (14 hrs)
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Carry out fitting, fixing & laying installation of hot & cold water pipe line & symbolizing.	141 Demonstrate working of solar water heating system. (02 hrs) 142 Analyse temperature of water (hot and cold). (02 hrs) 143 Layout pipe line for hot and cold water distribution as per drawing. (04 hrs) 144 Install pipe line for distribution of hot & cold water. (08 hrs) 145 Install hot water system & solar water heating system. (08 hrs) 146 Symbolise distribution of hot & cold water pipe line. (01 hr)	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. Method of ventilating pipe. Precaution against air Poisoning. Fixing of solar water system. (07 hrs)
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Perform repairing & reconditioning of waste pipe line.	147 Perform fitting of different trap, valve, cistern etc. (03 hrs) 148 Demonstrate construction of over head tank as per measurement. (08 hrs) 149 Maintenance and recondition pipe line. (10 hrs)	Plumbing and sanitary symbols and plumbing codes for all tools and materials (07 hrs)

		150 Perform pressure test by hydraulic test machine. (04 hrs)	
Professional Skill 25Hrs; Professional Knowledge 07 Hrs	Perform repairing & reconditioning, scraping & painting of sanitary fittings pipe line.	<p>151 Demonstrate cleaning of sanitary pipeline (02 hrs)</p> <p>152 Perform cleaning of sanitary pipe line. (04 hrs)</p> <p>153 Remove corrosion from pipe line. (03 hrs)</p> <p>154 Demonstrate scraping & painting. (02 hrs)</p> <p>155 Perform scraping & painting of pipe line. (04 hrs)</p> <p>156 Maintenance of broken or cracked sanitary fitting. (05 hrs)</p> <p>157 Estimate and work out abstract cost of plumbing work as per drawing/ layout. (05 hrs)</p>	<p>Sensor system for urinals and was basin, etc.</p> <p>Corrosion - causes and remedies, prevention.</p> <p>Corrosion due to electrolytic action.</p> <p>Effect of water and frost on materials.</p> <p>Layout of pipes as per drawing.</p> <p>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 (07 hrs)

Use of hummed and asbestos pipes of different sizes

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

- **necessity of pipes**
- **describe the hummed pipes**
- **manufacturing method of hummed pipes**
- **classification of hummed pipes**
- **merit & demerit of hummed pipes**
- **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 depending upon whether the necessary energy is to be provided by gravity or by pumping. The various types of conduits used are: Open channels, tunnels and pipe lines. Open channels and tunnels are generally used to convey raw water from the source to the water treatment plants. However, the transported water must be safeguarded against pollution by interior water sources. This is a special problem when open channels or conduits operating at low pressures are used. Due to this, pipe lines are invariably used for conveyance of water. Another 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 Pipes having steel bar and mesh reinforcement, and by pouring concrete by usual methods, tamping and curing.
- 2 Pipes having fabricated reinforcement and cast by centrifugal methods and curing in tanks.
- 3 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. The concrete is placed around the reinforcement by centrifugal process. Sometimes mesh reinforcement are more water-tight and strong. 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.

In difficult areas pipes can be constructed at the site by using local materials. These are not corroded by the water, therefore have long life, above 75 years. The surface of these pipes is not affected with the time, therefore, the carrying capacity does not reduce. 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.

- 4 Normally R.C.C. pipes are made from 1:2:2 cement, sand and aggregate. The maximum size of the aggregates is kept as 6 mm. For carrying tension they are provided with circumferential reinforcement. 0.25% longitudinal reinforcement is provided in the pipes. Thickness of the pipes varies from 25 mm to 65 mm for pipe diameters varying from 10 cm to 120 cm.

Now-a-days prestressed concrete pipes are also available in the market, but these are not common. Various available standard sizes of the concrete pipes 80, 100, 150, 250, 300, 350, 400, 500, 600, 700, 800, 900, 1000 and 1200 mm. These diameters are internal diameters of the pipes.

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

The ends of the concrete pipes are so manufactured that they are suitable for butt end joint for all classes of pipes. NP 1 class of pipe may have spigot and socket ends.

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 of advantages and disadvantages of using A.C.pipes
- list usage of A.C.pipes
- classification of A.C.pipes.

AC pipes

General: AC pipes are manufactured from pure asbestos fibre, 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). Their tensile and compressive strengths used in the design. Homogenous mixture are used 200 and 600 kg/cm² respectively. The joints used in the asbestos cement pipe are of simple type consisting of a sleeve which fits over the plain ends of the lengths, water-tightness being obtained by two rubber rings compressed between the sleeve and the pipe barrels as shown in Fig 2. They can be classified in four categories,

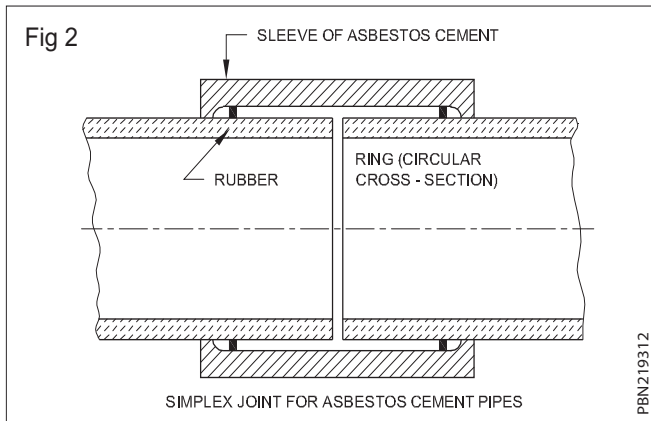
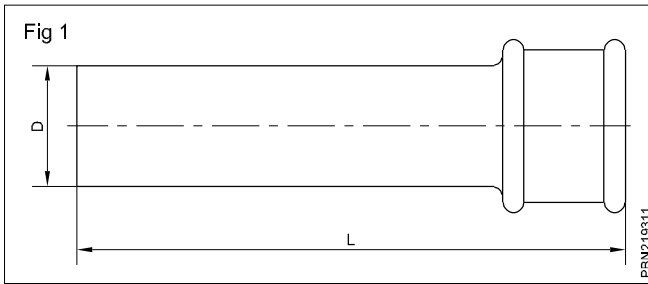
namely 3.5 kg/cm², 7 kg/cm², 10.5 kg/cm² and 14 kg/cm² depending upon the pressures they 10m with stand.

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.

Sewer pipe may have to be laid under the following conditions

- a Culvert condition :** When the pipe is laid under embankment and it projects wholly or partly above the original surface or sub-grade.
- b Trench condition :** When the pipe is laid in a trench excavated for the purpose.
- c Negative projecting conditions :** When the pipe is laid in a relatively narrow and shallow trench in such a manner that the two of the pipes is at an elevation below the natural ground surface.
- d Open condition :** In this condition the pipe is laid such that it projects wholly or partly above the ground surface.

When a sewer has to be laid in a soft underground strata or in a reclaimed land, the trench shall be excavated deeper than what is ordinarily required. The trench bottom shall

be stabilized by the addition of coarse gravel or rock; in case of very bad soil the trench bottom shall be filled in with cement concrete of appropriate grade.

In areas subject subsidence, pipe sewer shall be laid on a timber platform or concrete cradle supported on piles.

In the case of cast-in-situ sewer, an R.C.C. section with both transverse and longitudinal steel reinforcement shall be provided when intermittent variations in soil bearing capacity are encountered. In case of long stretches of very soft trench bottom, soil stabilization shall be done either by rubble, concrete or wooden crib.

The sewer pipes are not usually laid directly on the soil in the trenches. Before actual laying the bottom of the trench is prepared to receive the pipe such that the load is distributed uniformly. It is always preferred to provide concrete bedding in the trench below the pipes. Various types of pipe bedding usually provided below sewer pipes under various conditions.

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 fixed over the 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 at the position of centre line.
- iv The top of the nail or sight rails is fixed at some fixed distance from the invert level of the sewer at that spot. The line joining the top of nails fixed on the sight rails also confirms to the grade of the sewer.
- v Sight rails are usually fixed at 7.5m centre to centre spacing and also at all junctions and change of gradient or alignment.
- 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 and also lies in the vertical plane passing through the centre line 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 by hand only, but heavier and larger size pipes are lowering in the trenches by passing ropes around them and supporting through a hook.

It is the common practice to lay the pipes with their socket end up grade for easiness in jointing. After lowering the pipes, these are brought near and the 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. The joints are carefully cured for sufficient time.

Classification of A.C. pressure pipes

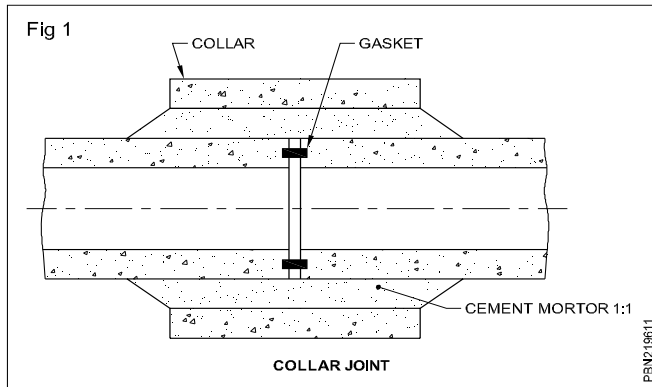
Class of pipes	Class 1	Class 2	Class 3	Class 4	Class 5
Test pressure	5 kg/cm ² (50 m head)	10 kg/cm ² (100 m head)	15 kg/cm ² (150 m head)	20 kg/cm ² (200 m head)	25 kg/cm ² (250 m head)

Method of laying out pipes alignment and joining

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

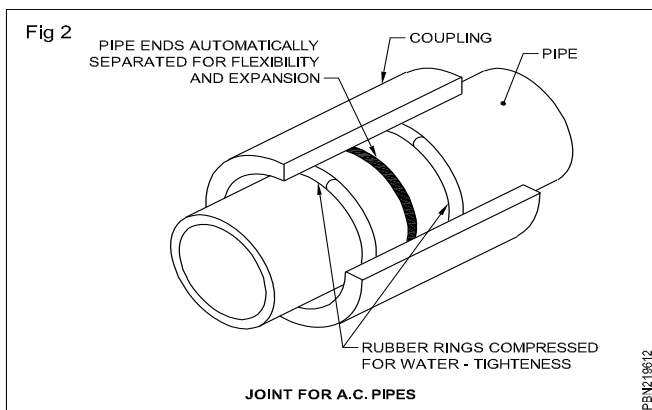
- state collar joint and A.C. pipe joint
- state various types of pipe bedding.

Collar- Joint (Fig 1)



The collars shall be placed symmetrically over the end of two pipes and the annular space between the inside of the collar and the outside of the pipe shall be filled with hemp yarn soaked in tar or cement slurry tamped with just sufficient quantity of water to have a consistency of semi-dry condition, well packed and thoroughly rammed with caulking tools and then filled with cement mortar 1:2. The joints shall be finished off with a fillet sloping at 45° to the surface of the pipe. The finished joints shall be protected and cured for at least 24 hours. Any plastic solution or cement mortar that may have squeezed in the pipe shall be removed to leave the inside of the pipe perfectly clean.

Joint for A.C.Pipes (Fig 2)

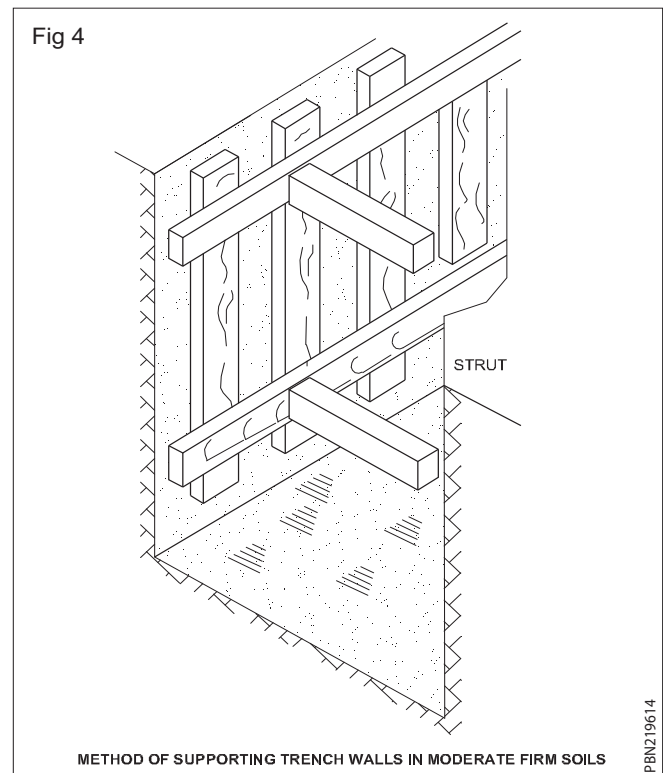
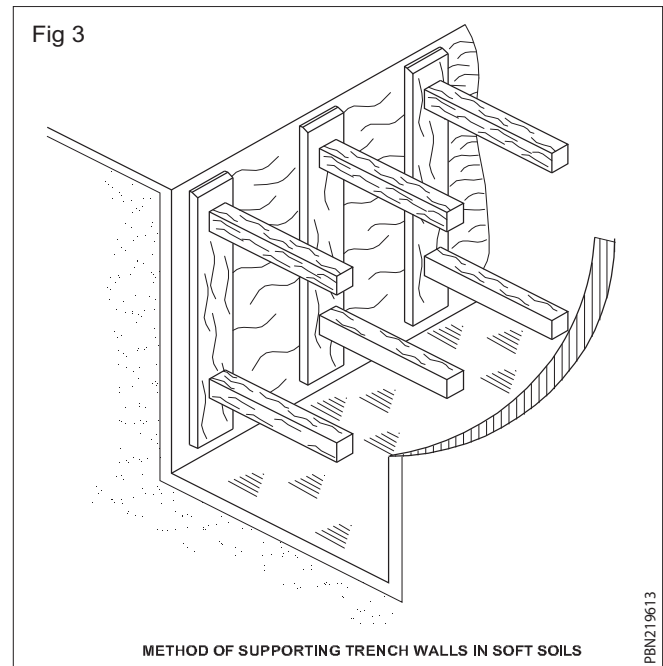


For joining small diameter A.C. pipes, the two ends of pipes are butted against each other, then two rubber rings will be supplied over the pipes and the coupling will be pushed over the ring as shown in Fig 2. The rubber rings make the joint waterproof. (Figs 3 - 5)

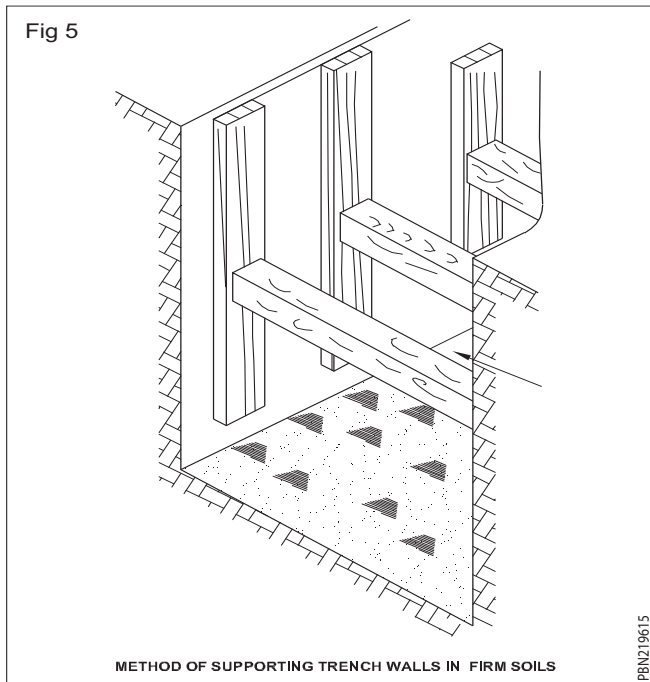
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b Trench condition : When the pipe is laid in a trench excavated for the purpose. According to trench condition is vary firm soil, moderate firm soil and soft soil.



c Negative projecting conditions : When the pipe is laid in a relatively narrow and shallow trench in such a manner that the two of the pipes is at an elevation below the natural ground surface.



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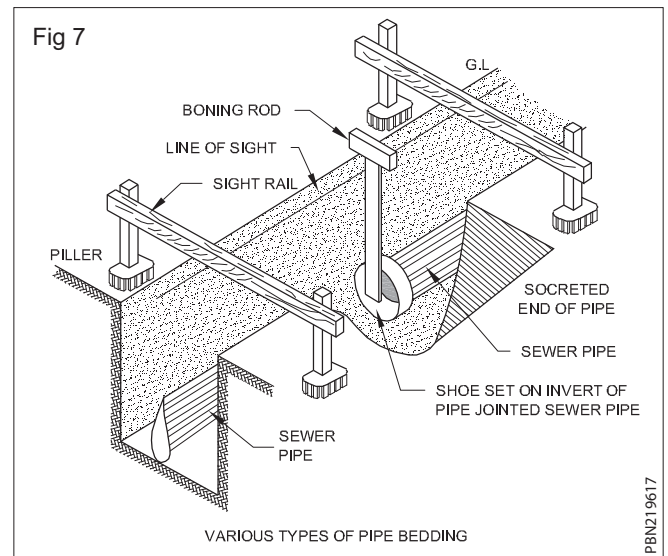
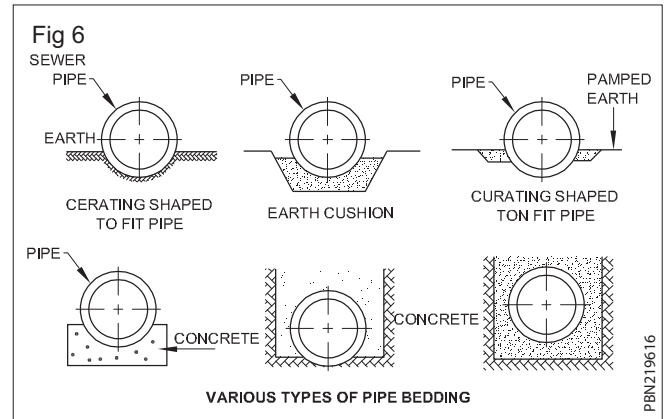
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The sewer pipes are not usually laid directly on the soil in the trenches. Before actual laying the bottom of the trench is prepared to receive the pipe such that the load is distributed uniformly. It is always preferred to provide concrete bedding in the trench below the pipes. Fig 6 shows various types of pipe bedding usually provided below sewer pipes under various conditions.

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It is the common practice to lay the pipes with their socket end up grade for easiness in jointing. After lowering the pipes, these are brought near and the spigot end of one pipe is placed in the socketed end of the other. After properly placing and arranging the pipes they are suitable joined. The joints are carefully cured for sufficient time.

Description of various pipe joints and solders

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

- describe the pipe joints
- classification of pipe joints
- explain the pipe joints.

Describe

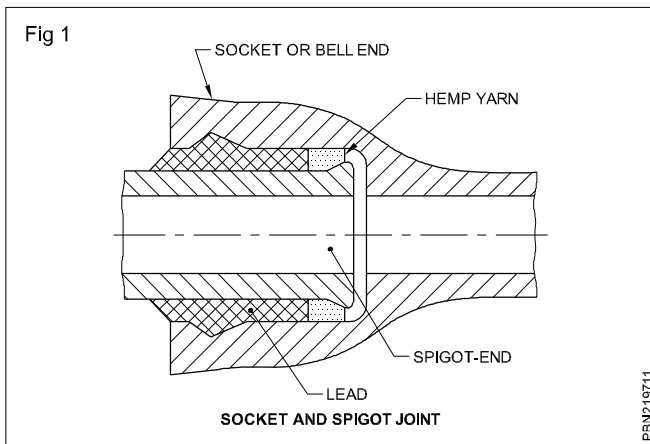
Mainly pipes are used for handling & transporting the water in position.

Pipes are manufacturing in small length of 2 to 6 metres. 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 Flexible joint
- 8 Solvent cement joint

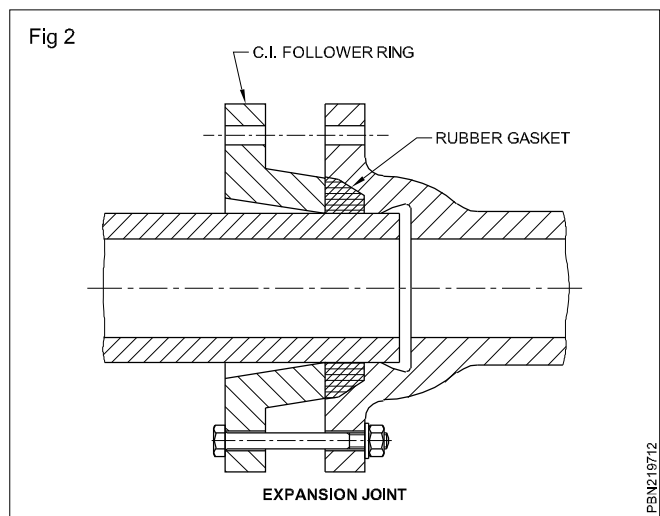
1 Socket and spigot joint (Fig 1)



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. (Fig 1)

2 Expansion joint (Fig 2)



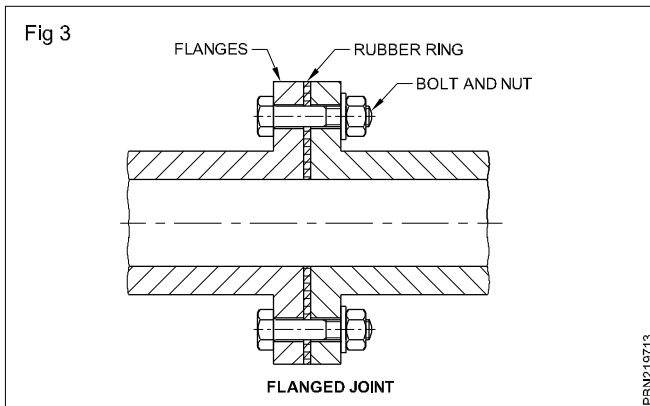
This joint is used at such places where pipes contract due to change in atmospheric temperature and thus checks the setting of thermal stresses in the pipe. In this joint the socket end is flanged with cast iron follower ring, which can freely slide on the spigot end or plane and of other pipe. An elastic 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)

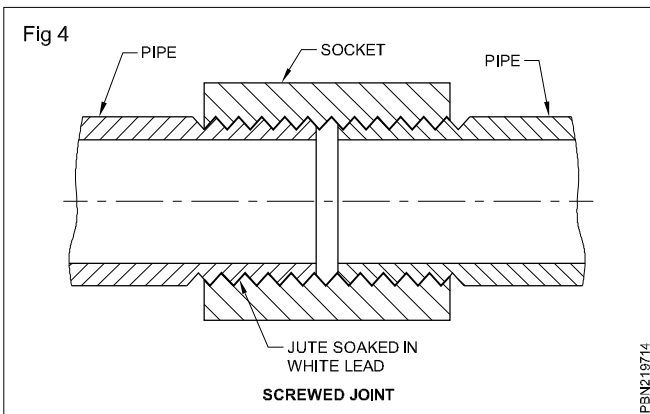
This joint is mostly used for temporary pipe lines, because the pipe line can be dismantled and again assembled at other place. The pipe in this case has flanges on its both end welded or screwed with pipe. The two end of the pipes which are to be joined together are brought in perfect level near one 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 joined 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.

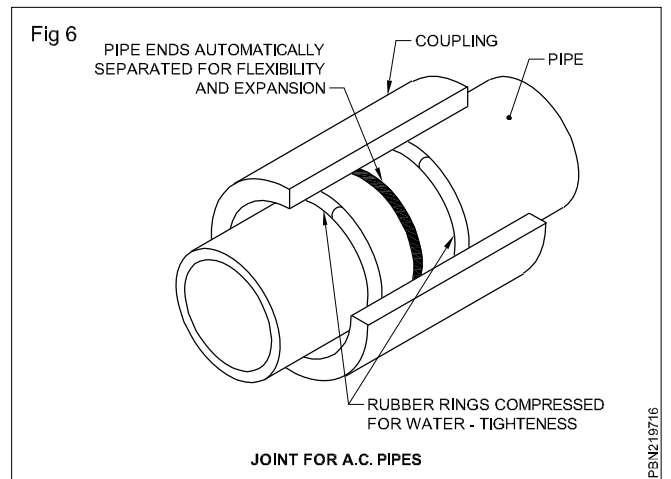
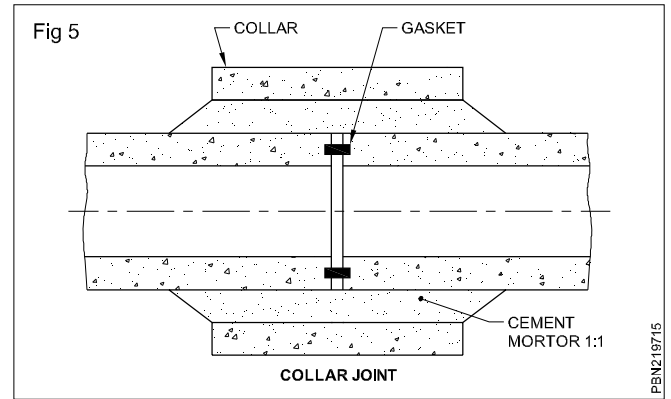
5 Collar joint (Fig 5)

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.

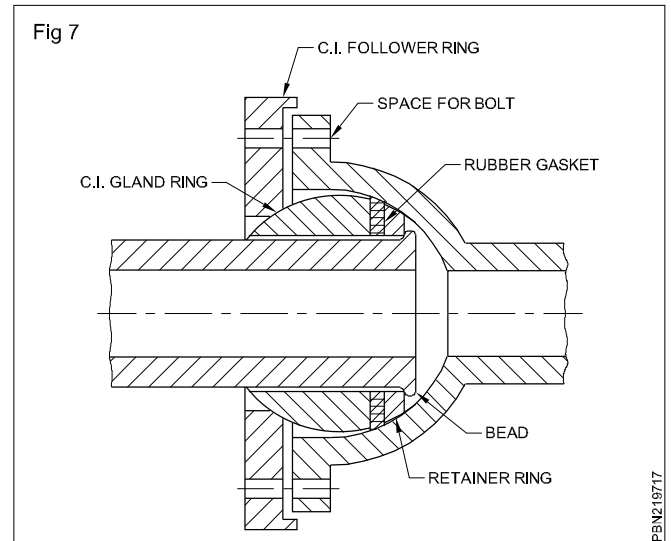
6 AC pipe Joint (Fig 6)

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 (Fig 7)



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- Abrace 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 Æ 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 Æ 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.

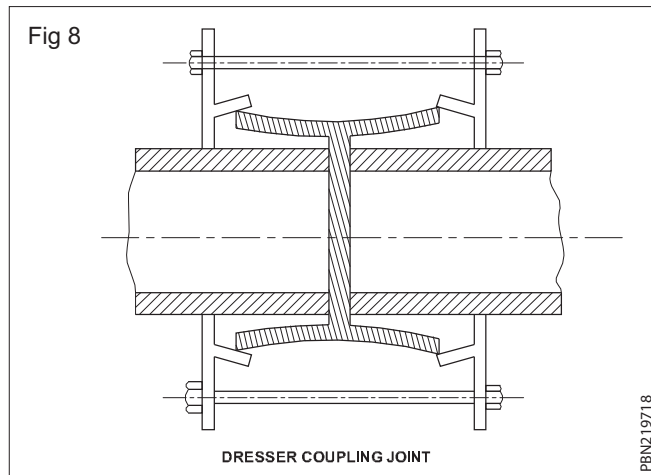
9 Mechanical Joints

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.

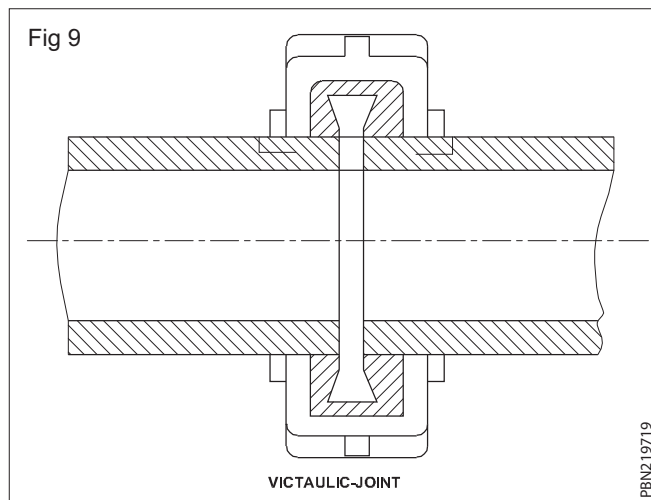
a Dresser-coupling: It essentially consists of one middle ring, two follower rings and two rubber gaskets. The two follower rings are connected together by bolts, and

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 3 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)



Various pipe fitting joints

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

- necessity of pipe fitting joints for pipe line
- types of pipe fittings joints
- state the pipe fittings joints.

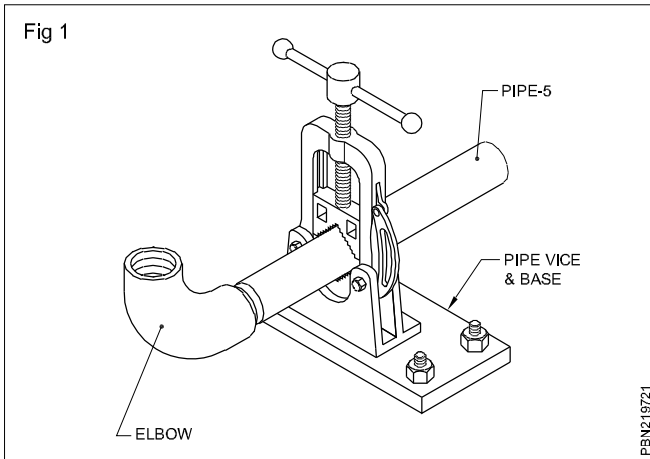
Standard pipe fitting

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

1 Change the direction flow in the pipe.

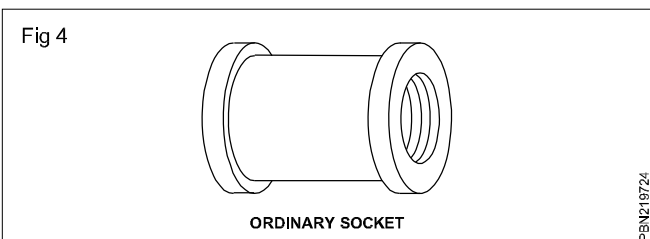
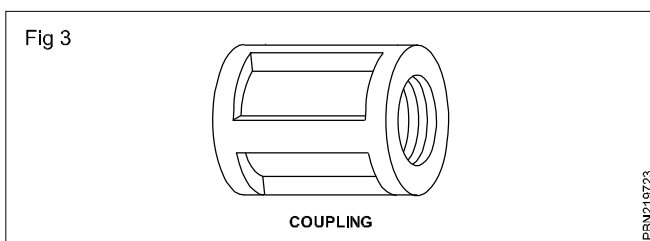
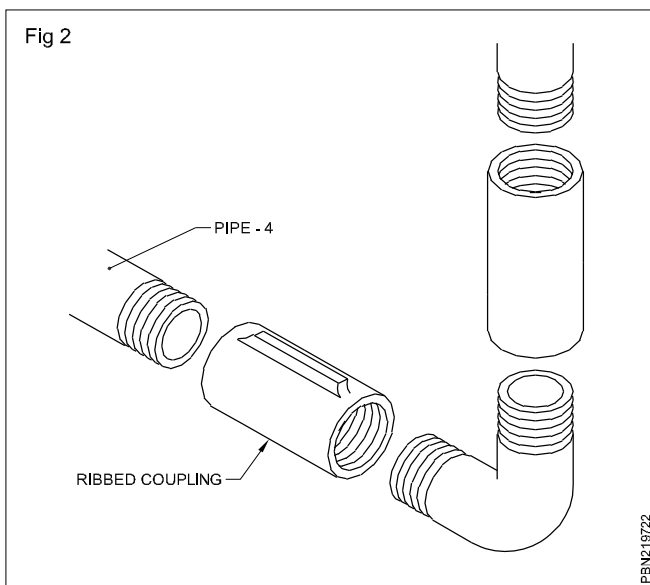
- 2 Connect a branch with a main water supply pipe.
- 3 Connect two or more pipes of different sizes.
- 4 Close the pipe ends.

Elbows (Fig 1)



Elbows and bends provide deviations of 90° and 45° in pipe work systems.

Coupling (Fig 2 to 4)



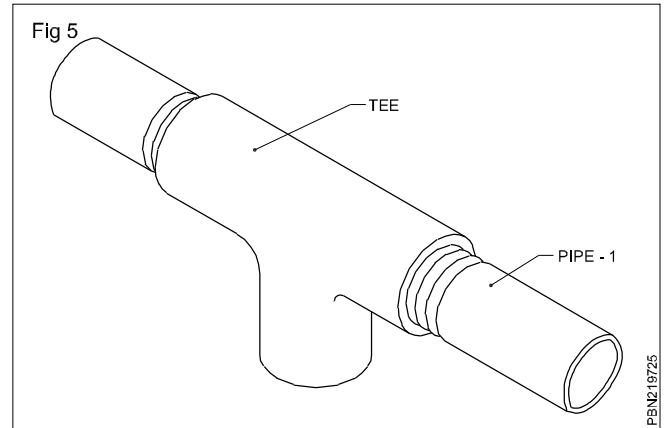
An ordinary coupling shown in Fig 2 usually comes with the pipe, one coupling to each length. The couplings are made of wrought iron or cast iron metal or of brass. They are regularly threaded with right hand threads R and L coupling have projecting bars or rings to distinguish them from standard coupling. Another form of coupling called an

extension piece. 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.

Types

Elbows, bends, coupling, Tee branch crosses union, Reducer, End plug & cap.

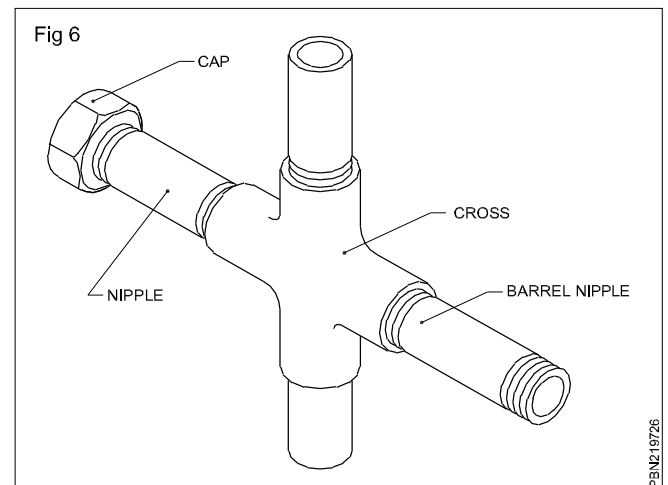
Tee (Fig 5)



Tees are most important and widely used of the branching fittings. Tees like elbows, are made in a multiplicity of sizes and pattern. They are used for making a branch of 90° into the main pipe and always have the branch at right angles. When three outlets are of the same size the fitting is specified by the size of the pipe.(Fig 5)

Crosses

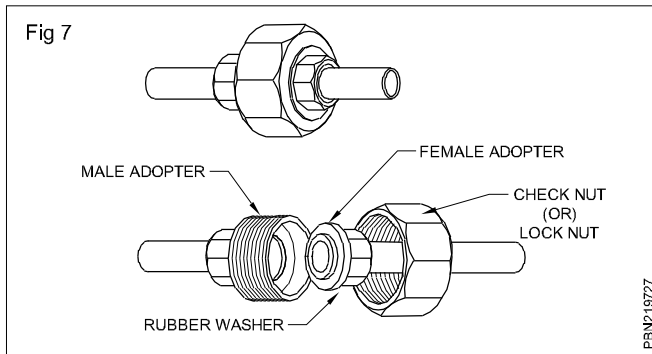
A cross is simply an ordinary tee having a back outlet opposite the branch outlet. The axis of the four outlet are in the same plane and at right angle to each other. Crosses like tees are made in the number of sizes. Regarding a cross as a tee with a back outlet, the tee part is made in various combination of size as the opposite side outlet of the tee part. (Fig 6)



Union

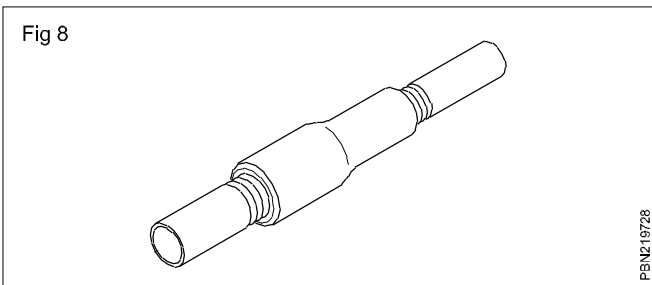
A device used to connect pipes. Unions are inserted in a pipe-line to permit connections with little change to the position of the pipe.

When unions are used in pipe lines, it is easy to dismantle and repair. (Fig 7)



Reducer

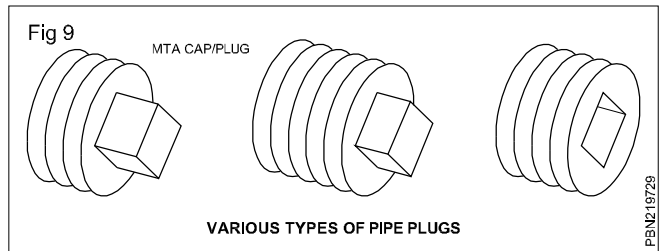
A reducer coupling is used to connect two pipes with different diameters. (Fig 8)



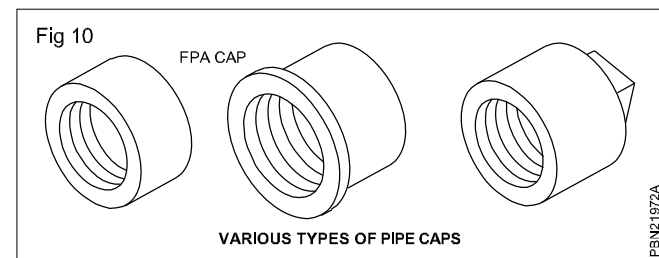
Types of pipe plugs

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 9) the various pattern usually a square head

or four side counter sink head is used 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. Plain and flat band or beaded caps are regularly made in size from 6mm to 150mm. (Fig. 10)



Solders and fluxes used in different pipe joint

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

- describe the solder, and flux
- application of solders and flux in different joints.

Solder

Two more metallic element consists lead and tin when alloyed together in various proportions from the soft solder. The more percentage of lead increases the melting point of solder whereas tin increases the flow ability of solder.

Types of solders

There are two types of solders.

- Soft solder
- Hard solder

One distinguishes between soft solders whose melting points are below 450° C and hard solders whose 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.

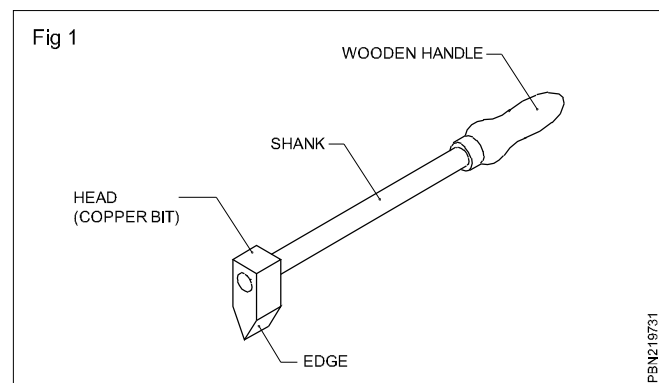
There are different methods of joining metallic sheets. Soldering is one of them.

Soldering is the process by which metallic materials are joined with the help of another liquified metal (solder).

The melting point of the solder is lower than that of the materials being joined.

The solder wets the base material without melting it.

Soldering iron (Fig 1)



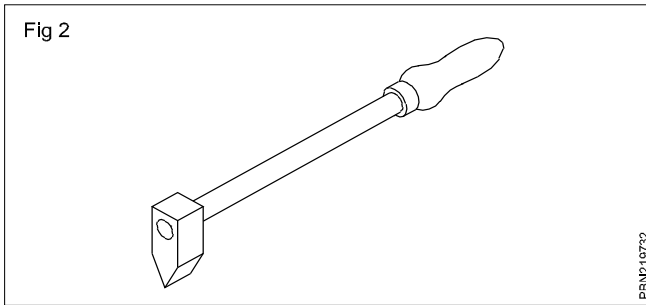
The soldering iron is used to melt the solder and heat the metal that are to be joined together.

A soldering iron has the following parts.

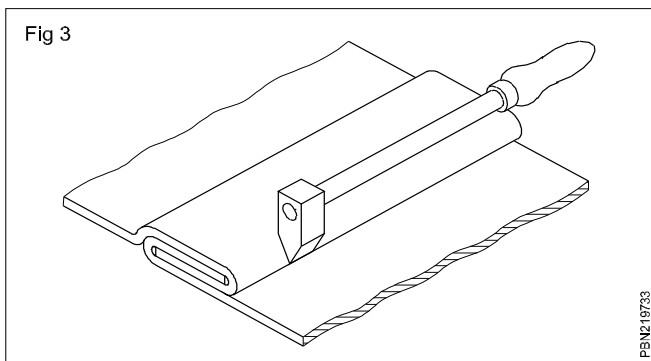
- Head (copper bit)
- Shank
- Wooden handle
- Edge

Shape of head: The head of the iron is made of forged copper. This is because copper has a good heat conductivity and has a strong affinity for the solder so that the solder melts easily and sticks to the bit.

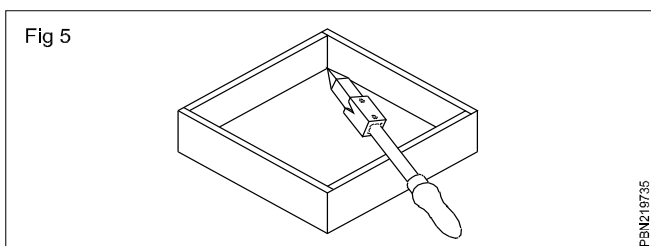
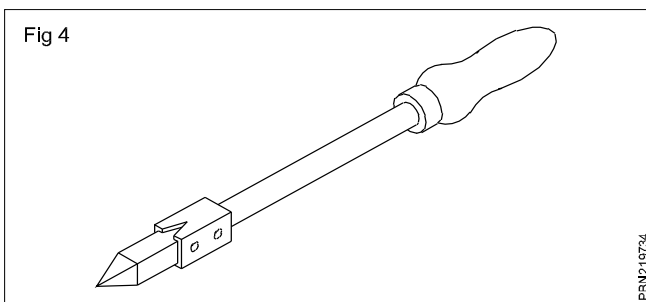
A Hatchet type soldering as in (Fig 2) has shank fitted at 90° to the head. The soldering edge is 'V' shaped.(Fig 2)



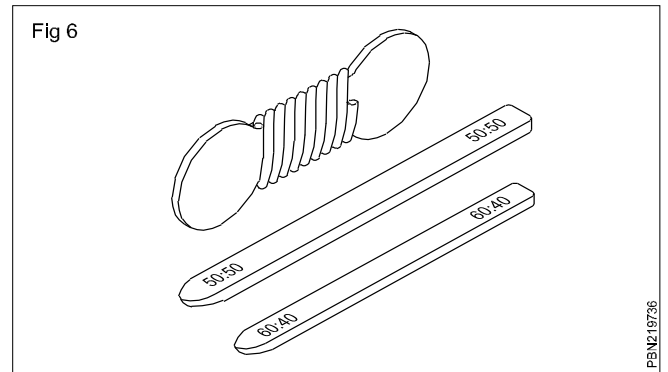
This type is used for straight soldering joints.(Fig 3)



The other type is the square pointed soldering iron or a standard workshop pattern soldering iron. (Figs 4, 5) For this type the edge is shaped to an angle on four sides to form a pyramid shape.



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 is corrosive and should be washed immediately after the soldering operation is completed.

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. So it cannot be used as a flux for sheet metals other than zinc, iron or galvanised sheets.

Zinc chloride: It is mainly used for soldering copper sheets, brass sheets and tin plates.

Fluxes are non-metallic materials which are used at the time of soldering.

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: As resin is not very effective for removing oxidation coating, and, as 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, glycerine and others and is available as a paste.

As it is effective for removing oxidation coating, it is used for soldering small handworks and radio wiring.

As it is extremely corrosive, the flux must be perfectly washed off after soldering.

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.

A solution of a mixture of hydrogen chloride, zinc chloride and ammonium chloride is used as a flux for stainless steel sheets.

Joints

There are two main types of joints which are used for connecting copper pipes, namely:

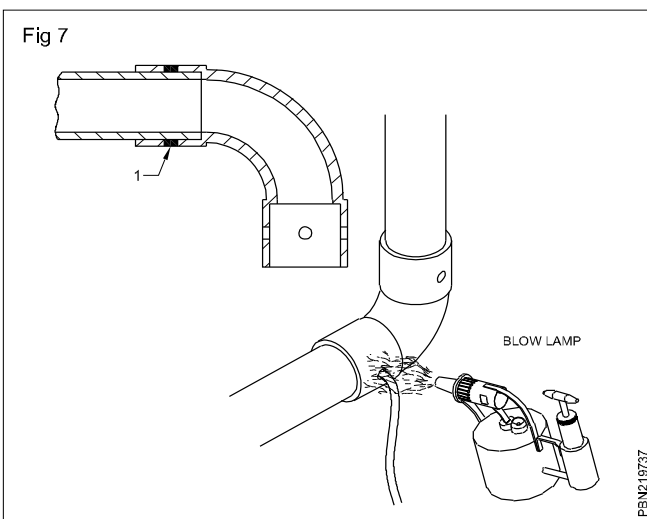
- soft solder capillary joints
- compression joints/flaring joints

Solder wire is applied through the touch holes in the fitting.

Soft solder capillary joints are a recent development. It is a method of jointing pipe and fitting together by soft soldering.

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 reservoir of solder is already in the fitting. (Fig 9)

All three soft solder capillary joints are constructed upon the basic principles of capillary attraction by which molten solder is drawn into the narrow space between the two close metal surfaces of the copper fitting and copper pipe.

The joint shown in the illustration relies for its soundness upon compressing the tail ends of the fitting on the wall of the copper pipe and the joint is made water-tight by compressing the soft copper rings into the conical annular recess of the fitting.

Capillary fittings are so designed that the pipe slides into the fitting forming a double wall of additional strength at the joint.

They are carefully machined and held to such close tolerances that the distance between the inner wall of the fitting and the outer wall of the pipe remains constantly at capillary distance.

This capillary distance is such that the solder can be inserted at the bottom or any other point of the fitting.

There are two different joints for which only brass or bronze fittings should be used:

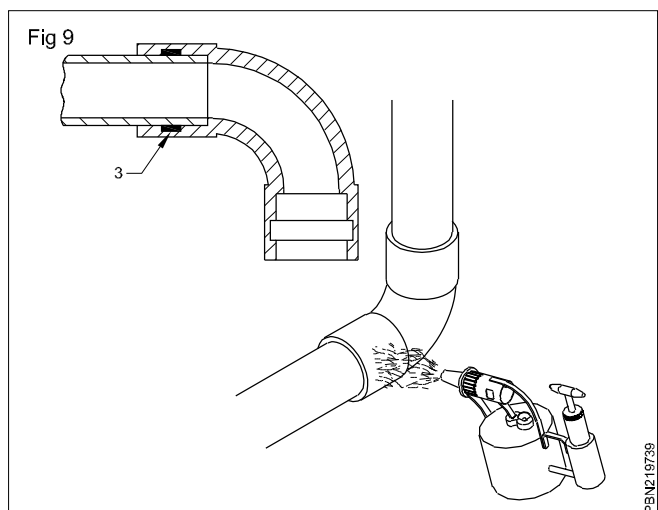
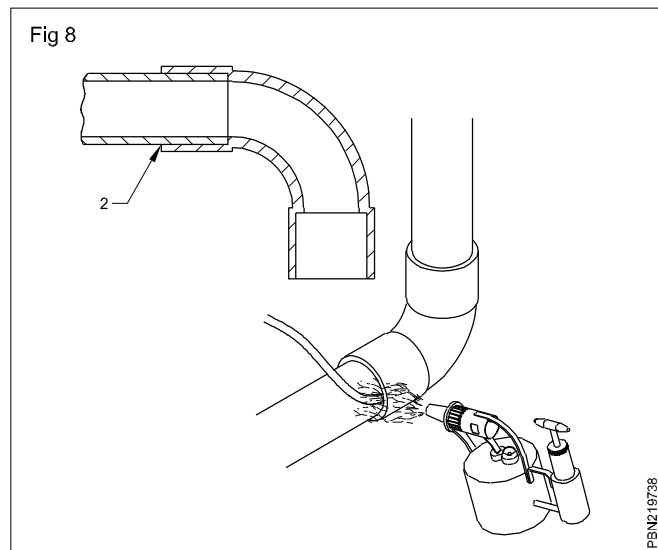
- Flaring joints
- Compression joints

The flared joints require that the ends of the pipe be enlarged and either cuped, flared or flanged.

Another joint is the friction compression joint which is prepared by cutting the pipe ends off square. To make the friction joint water-tight, a ring or sleeve is inserted either between the pipes or fitted onto the pipes.

Friction compression joints are suitable only when no strain is placed upon the joint. (Fig 7)

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 portable water systems, lead-free solid core solder must be used. It is typically 95/5 (95 % tin and 5% antimony), or an alloy of tin and a small amount of copper and / or silver, commonly sold in one pound rolls of 1/8" diameter wire. Solder with lead must not be used for portable water systems.

Solder flux

This is typically a jelly with a zinc chloride or resin cleaning component used to cover the cleaned surfaces of the copper to be soldered before assembly and heating. It is the function of the flux, upon heating, to facilitate further cleaning, exclude atmospheric oxygen, prevent re-oxidation, and to aid in wetting out the solder.

Plumber soldering material

Portable water systems, lead-free solid core solder must be used (95% tin and 5% antimony) or an alloy of tin and a small amount of copper, commonly sold in one pound rolls of 1/8".

Description of Plumber's materials (Non ferrous metals) and their uses

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

- state the non ferrous metals its uses
- state the properties of metals
- state the alloy of metals and its uses.

Copper symbol (cu): Copper generally occurs in ores important ores are chalcocite (Cu₂S) and copper pyrites. The copper companion sulphur is removed in a roasting furnace. Its combines with oxygen to form sulphurdioxide. The oxygen also oxidies the copper to copper oxide. 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. These are classified into forging and casting alloys. The components are specified when designation copper alloys.

Brass: These alloys contains copper and zinc. These characteristics properties are good castability, workability corrosion resistance and cold harden ability. The hardness of the alloy increases with rising zinc content. This metals are used for making water tap, valve etc.

Tin: symbol 'Sn' (Latin Stannum): The most important mineral is tin-stone (SnO₂) melting point 2320C the casting alloys varying percentage of tin+copper+lead. (Sn+Cu+pb) i.e. 12 to 18% Sn (antimony) upto 4.5 Cu and vary quantities of pb.

Lead: The commonly used metals and the softest of the heavy metal. When it is cast or cut it is a silvery colour to begin with. After standing for a time, however the surface turns a dull bluish grey due to oxidation. Lead is poisonous and should not be brought in to contact with food. The metal ores are galena and mixed ores. Melting point of this metal 3270C. Pure lead is used for roof coating acid holders, lead cables sealing points in bullet rartition protection in fuels, lead plumbing and 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, gulanized, roofing sheet etc. Zinc is obtained from the ore-calamnric or blende its melting point is 420°C.

Aluminium: Aluminium is a non-ferrous metal which is extracted from "BAUXITE". Aluminium is white or whitish grey in colour. Its melting point is 6600C. Aluminium has high electrical and thermal conductivity. It is soft and ductile and has low tensile strength. Aluminium is very widely used in aircraft industry and fabrication work because of its lightness. It's application in the electrical industry is also on the increase. It is also very much in use in household heating appliances.

Metals	Melting point
Copper	10830C
Brass	9830C
Bronze	10050C
Lead	3270C
Zinc	4200C
Tin	2310C
Aluminium	6600C

Corrosion on metals

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

- define the corrosion of metallic materials
- state the causes of corrosion.

Chemical effects on metals

Corrosion is the chemical, electrochemical or metal-physical reaction of a metallic material with its environment, leading to a change in its properties.

Materials are affected above all by the air round them. The air contains oxygen, water vapour, smoke gases with sulphur and phosphorus compounts, combustion products such as carbon dioxide, sulphur dioxide, dilute acids such as carbonic acid, sulphurous acid and hydrochloric acid.

Most metals have combined chemically with oxygen, water, sulphur, phosphorus or carbon to form ores. Even after these compounds have been analysed with the expenditure of a great deal of energy in smelting, they strive to returnto their original states as ores. This is the nature of most forms of damage to metals (corrosion).

The inert (noble) a metal is, the more resistant it is to corrosion

Rusting: Rust forms when iron comes in contact with atmospheri oxygen and water, the more acidic the water

is, the more rapid the process. The lower the carbon content of the steel, the more resistant it is to rust.

Types of corrosion

Electrochemical effects on metals

If two metals are connected through an electrolyte, electrolytic decay occurs due to the formation of a galvanic cell. Some electrolytes are : atmospheric moisture and acidulated or saline water.

Types of corrosion not involving mechanical stress

Uniform surface corrosion results in the uniform decay of the outer surface as a whole. Eg. Rusting

Localised corrosion involves decay concentrated in small regions. Eg. pitting

Crack corrosion in moisture results from variable oxygen concentration in the water

Contact corrosion occurs when an electrolyte acts as a connecting medium between two metals which are widely separated in the electrochemical series. This leads to the decay of the baser metal.

Intercrystalline corrosion takes place along the grain boundaries and leads to a reduction in strength.

Transcrystalline corrosion occurs mostly under high tensile load and procedds parallel to the direction of deformation within the grain.

Types of corrosion involving mechanical stress

Stress crack corrosion results from tensile stressing and the penetration of corrosive agents. Crack formation follows along intercrystalline or transcrystalline lines.

Vibration crack corrosion is a form of corrosion fatigue caused by alternating stress.

Corrosion proofing

Non-metallic coatings

One method of corrosion proofing is to protect the metallic material from the corroding influence by means of protective coats or deposits which prevent or reduce corrosion to acceptable levels.

Oiling and greasing are carried out when the part must remain bright (vernier calipers). Grease and oil must be acid free.

Spraying or coating with paint. Red lead forms an impervious protective coat when used as a primer. Top paints (oil bound paints or lacquers) chosen according to the purpose they have to fulfill.

Enamelling is carried out by sprinkling or spraying enamel powder on the surface and baking at 800°C to 1000°C. These coating is chemically resistant and heat resistant. The enamel consists of glass powder, a mixture of quartz, feldspar, alumina and dyes.

Plastic coatings are applied by immersion in molten plastic or by varnishing. The common oil paints are being increasingly replaced by synthetic resin paints, cellulose paints and chlorinated rubber paints. In addition, there are

stove enamels which dry at 120-150°C and provide good protection against corrosion.

Metallic coatings

Molten metal bath: The cleaned work piece is immersed in a bath of molten metal e.g. steel plate in zinc. Subsequently, the excess metal drops oil, leaving behind a thin layer. One such process is pot galvanisation.

Protective function of tin and zinc

Tin being electrochemically less active than iron, iron ions will go into solution from a tinned steel plate. If the surface is damaged. Corrosion advances under the coating metal and the rust formed breaks through the tin coating because of volumetric expansion (subsurface corrosion).

Because zinc is more active than iron, it acts as a cathode when the surface of a galvanised steel plate is damaged. Zinc dissolves and an electron flow takes place from the zinc to the iron.

Processes of electroplating (nickel plating, chrome plating, copper plating). The cleaned workpiece is immersed in a solution of a metal salt and connected to the negative pole of a direct voltage source. The plating metal is bound to the positive pole. Under the effect of electric current, the positively charged metal ions migrate out of the salt solution to the workpiece, take up electrons here and turn into neutral metal atoms which are deposited on the workpiece.

A quantity of the plating metal equal to that deposited on the work piece, enters into the solution from the cathode in the form of ions.

Cladding: This consists of rolling thin layer of metal onto a base metal (e.g. for coins). More expensive metals can be saved in this way.

Spraying: Liquefied metals are applied to the workpiece with compressed air. e.g. lead, zinc and even steel.

Chemical coating

Browning: Steel parts are given a blackish surface coating by repeatedly burning off oil at 400°C. Th process does not yield a lasting protective coat.

Phosphatisation: An aqueous solution of manganes and zinc phosphate is applied to the metal surface by spraying or immersion after it has been freed of grease and rust. This results in the formation of protective layer of iron phosphate. This generally serves as the basis for further protective coatings.

Electrolytic surface treatment consists of artificial oxidation to strengthen the natural oxide layers in aluminium alloys. Roughness, grooves and scratches remain visible after the treatment. The proofing layer is strong and does not crack.

Eloxal process-electrolytically oxidised aluminium

A lead plate as negative pole and the aluminium workpiece as positive pole are introduced into a bath containing sulphuric acid as electrolyte. When a direct current flows

between them, the oxygen liberated forms an oxide layer - the elozal layer on the workpiece.

Cathodic corrosion proofing

If the manganese rod is connected to the steel body to be protected by means of a conductor, the magnesium releases ions (galvanic cell). The electrons thus freed in the magnesium flow to the steel and generate an electron pressure there, which prevents ions from being released and protects the metal from corrosion.

Effect of alkalies on metals

Some metal oxides combines with water to form bases (hydroxides); the aqueous solutions of these compounds are called alkalies common alkalies are caustic soda solution, aqueous (spirits of) ammonia, caustic potash solution. These are used to clean soiled workpieces or equipment by etching e.g. etching aluminium.

Alkalies may be detected by red litmus paper which turns blue in contact with them.

Alkalies are corrosive. they often destroy animal and plant products, paints and varnish and remove dirt. Metals too are corroded by alkalies.

Reaction of metals to acids

The important inorganic acids are hydrochloride acid, sulphuric acid, nitric acid and carbonic acid. Common properties of these acids are a) they taste sour b) they corrode the skin, destroying cellular tissue c) they react with active metals, d) they destroy or bleach dyes e) they remove the oxide layer from metals.

Acids are generally formed from non metal oxides and water.

Water supply systems of towns

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.

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. This is estimated based on past population records available from the Municipalities by various methods.

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

Drawl 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

Hydrochloric Acid: This is one of the strongest acids. It consists of hydrogen (H) and chlorine (Cl). HCl is a pungent smelling gas which dissolves in water to form hydrochloride acid. HCl dissolves most base metals and their oxides.

Sulphuric Acid: Sulphuric acid is an oily liquid. The chemical components are hydrogen, sulphur and oxygen (H_2SO_4). It is highly corrosive and chars organic materials. Dilute sulphuric acid is used to remove oxide layers.

When diluting sulphuric acid, always pour the acid into water. Never pour water into the acid.

Carbonic acid

Carbon dioxide is generated when carbon compounds are burnt. When passed through water, carbon dioxide combines with it to some extent to form carbonic acid H_2CO_3 . Salts of metals and carbonic acid are called carbonates. When lead is exposed to carbonic acid, it forms a layer of lead carbonate, which is insoluble in water. Iron reacts with carbonic acid to form iron carbonate, copper to form basic copper carbonate.

Handling acids and alkalies

Acids and alkalies corrode the skin. The more concentrated they are, worse their effect. HCl fumes when inhaled will corrode the mucous membranes of the mouth, the nose, the lungs and the stomach. For acid burns immediately bathe the eyes and skin continuously and liberally with water for at least 15 minutes.

Use protective gloves and goggles when handling acids and alkalies. Bottles containing acids and alkalies must be labelled.

- 2 Spring
- 3 Infiltration gallery

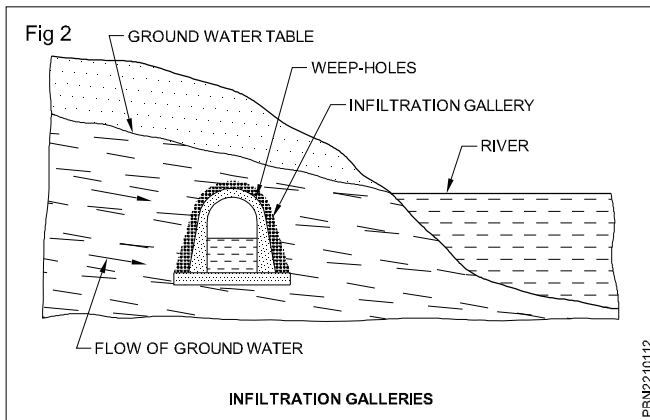
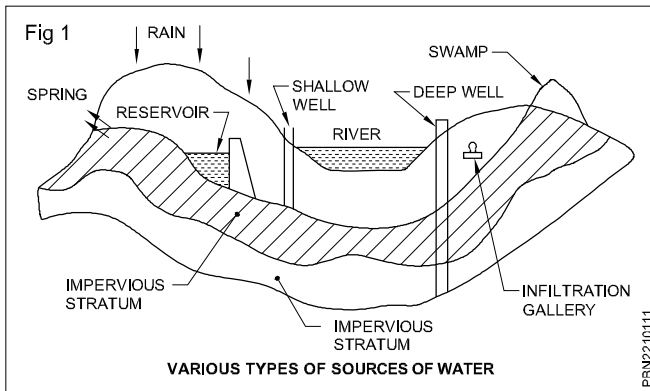
The surface sources are river, streams, ponds, lake, reservoirs.

Water can be drawn from river bed from the following ways.

- 1 Intake wall
- 2 Weir intake
- 3 Intake well with approach channel
- 4 Pipe intakes
- 5 Canel 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 under ground 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.



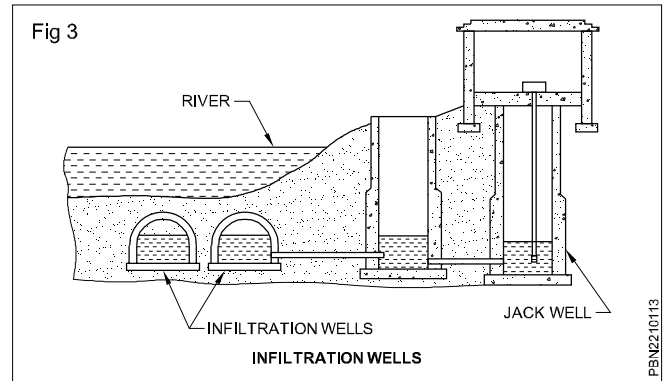
The infiltration galleries are constructed with masonry or concrete weep holes of size 5 x 10 cm are provided in the well. Gravel or pebble stones are provided on the sides and top of the galleries to increase their intake capacity. Longitudinal slope is given to the galleries and at the end a sump well 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 porous material to a depth of 3 metre 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)

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.

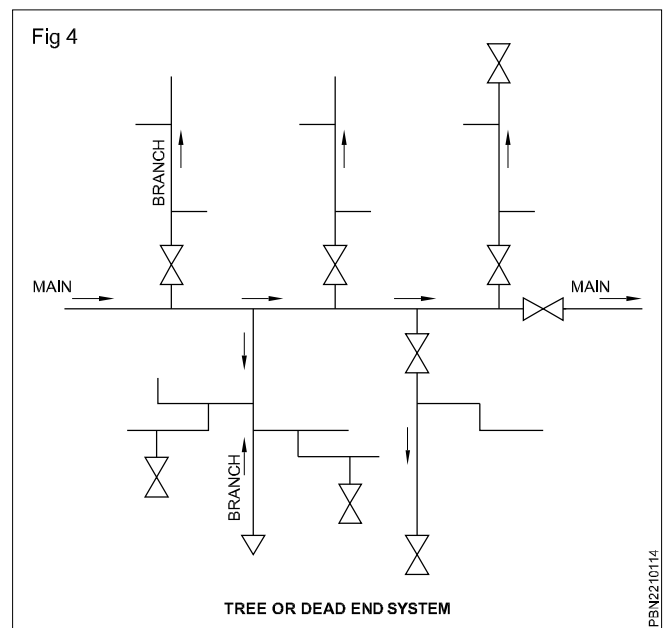
The only advantage is that water can be supplied to high level areas also with adequate pressure as different areas of the town may be supplied with water in different hours.

However, in India generally intermitedd 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

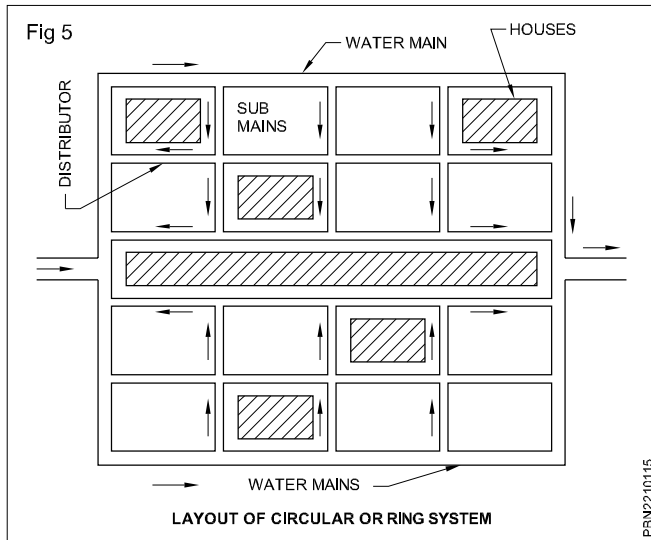
Tree or dead end system: In this system the main line is laid along the main road and goes on diminishing in size. Branch lines are taken in many places along the road and there are many dead ends in the system. (Fig 4)



This system is suitable for towns growing irregularly. The dead ends cause stagnation of water. Also in case of any

repair, the area beyond that point will not get water. However this system requires less number of valves and design of pipe sizes is easy.

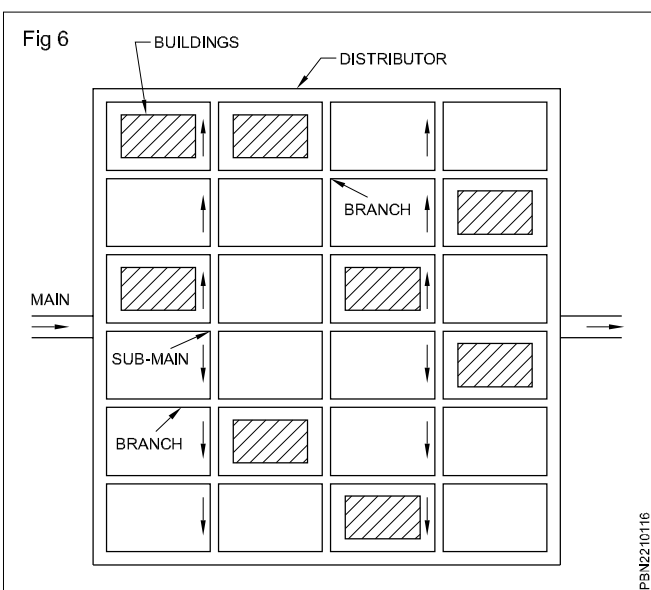
Circle or ring system: In this system each locality of a town is divided into square or circular blocks and water lines are laid around the circumference of the square or circle. The branches, sub mains are laid along the inner roads. (Fig 5)



At the sub main and branches are interconnected end cross point gets supply from two direction.

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.

Grind iron system: In this system water mains and branches are laid in rectangles (Fig 6). 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 of the each zone boundary of the area to be served (Fig 7). It gives quick service. This system is suitable for towns with a radial layout. The design of pipe sizes is also easy.

The water may contains 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.

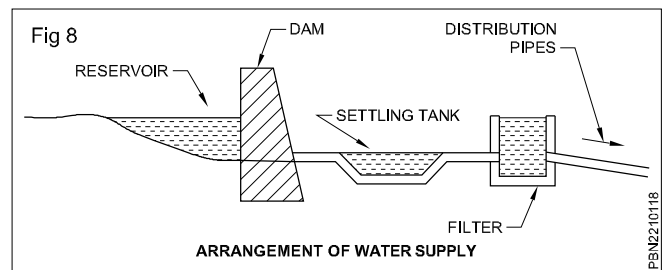
- 1 Screening
- 2 Plain sedimentation
- 3 Sedimentation with coagulation
- 4 Filtration
- 5 Aeration and chemical treatment
- 6 Disinfection

All the above steps may not be necessary and different treatments are given depending upon quality of water taken from different sources.

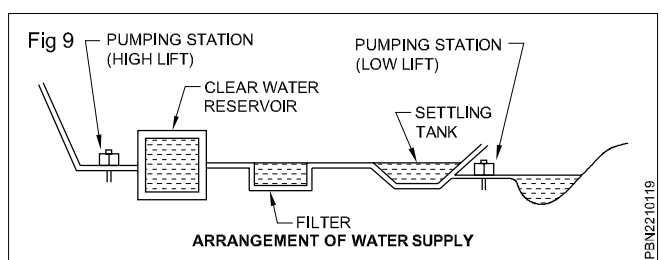
Then the treated water is supplied to the consumers using the following system of distribution.

- 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 8). In this method no pumping is required.

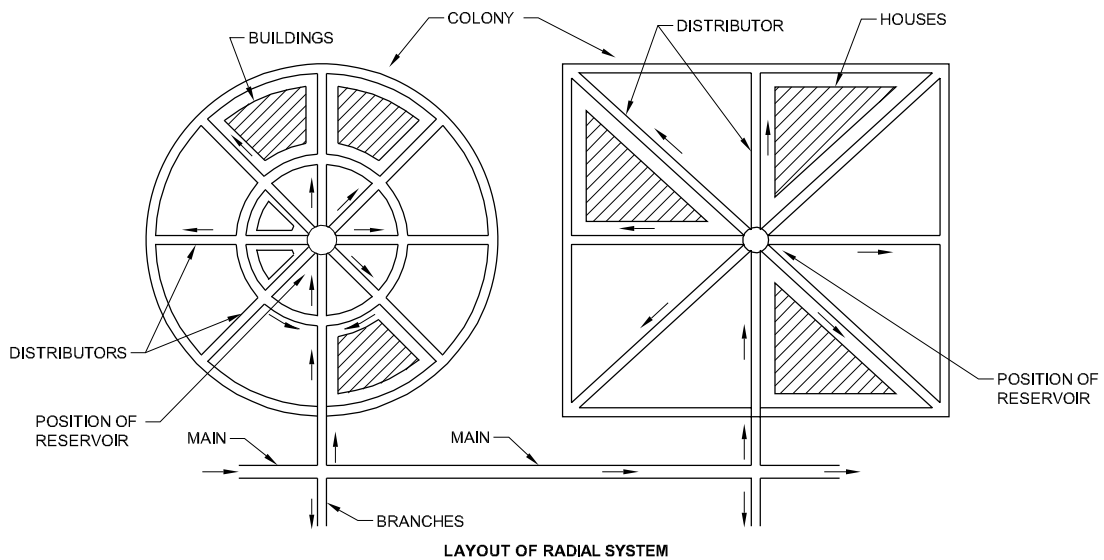


Pumping system: In this system, the water is pumped direct to mains from the treatment plant. Because of direct pumping, required pressure is maintained in this system. (Fig 9).



Dual system: This system is also known as combined gravity and pumping system. In this system, the pump is

Fig 7



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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/galvanised 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.

The above objectives are achieved by establishing minimum standards of quality for public water supply.

Physical and Chemical standards

Sl.No.	Characteristics	Accetable	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 dissovled solids (mg/1)	500	1500 _l
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	0.5
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	0.2 ug/l	0.2ug/l
Radio Activity			
28	Gross Alpha activity	3 PCI/l	3 PCI/l
29	Gross Beta activity	30 PCi/l	30PCi/l

Bacteriological quality

SI.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 occasional sample but not 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 silit, clay, sand etc.	Plain sedimentation
3	Fine suspended matter	Sedimentation with coagulation
4	Micro organisms and colloidal matters	Fileteration
5	Dissolved gases tastes and odours	Areation 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 good layout of a treatment plant shall be:
- Located in the order of sequence
- Select elevations of plants properly so that water should flow from plant to plant by gravity
- Plan with in minimum area
- Keep provision for future expansion

- Keep the plant area neat
- 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 include 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 nowadays. 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. Coagulants like aluminium sulphate, sodium aluminate, ferric chloride, ferric sulphate, ferrous sulphate are mixed in the water to produce the required precipitate, then the water is sent in sedimentation basins. Earlier separate unit for feeding, mixing, flocculation and clarifier were used. Certain firms are manufacturing combined unit where all the functions are in operations.

Filteration: 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 1)
- Rapid sand filters (Fig 1)
- Pressure filters

Slow sand filter: 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: 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: 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.

Description and types of pumps

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

- **necessary of pumps**
- **types of pumps**
- **classification of pumps.**

A device is used for pumping

It is also necessary when its require to increase the pressure in pipe lines, its called as pump.

Purpose of pumps

The pumping is therefore resorted to for the following purposes

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

- Mechanical principle of operation,
- Type of power required, and
- 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

- Displacement pumps
 - Centrifugal pumps
 - Air lift pumps
 - Miscellaneous pumps.
- b Classification based on type of power required:
- Steam engine pumps
 - Diesel engine pumps
 - Electricity driven pumps
- c Classification based on the type of service called for:
- Low lift pumps
 - High lift pumps

iii Deep well pumps

iv Booster pumps

The selection of a particular type of pump depends upon the following factors:

- Capacity of the pump.
- Number of pump units required.
- Suction conditions.
- Lift (Total head)
- Discharge conditions, and variations in the load.
- Floor space requirement.
- Flexibility of operation.
- Starting and priming characteristics.
- Type of drive required.
- 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.

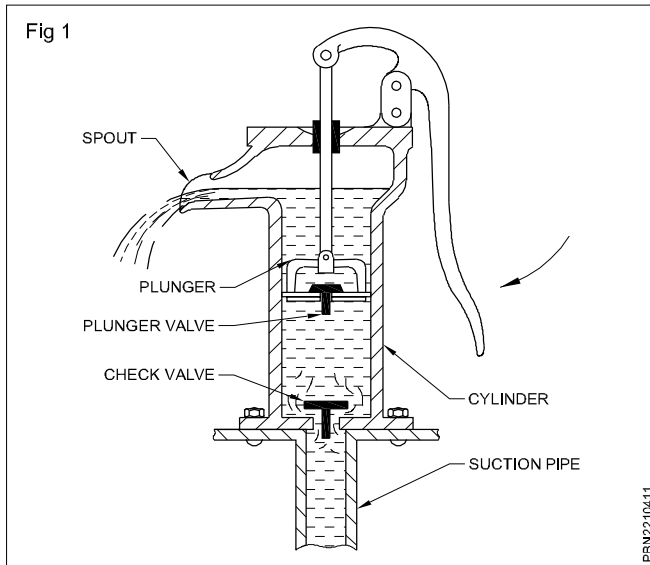
Reciprocating pumps are of the following types.

- 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 and the pump thus gives continuous supply of water which is sucked from the ground.



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)

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).

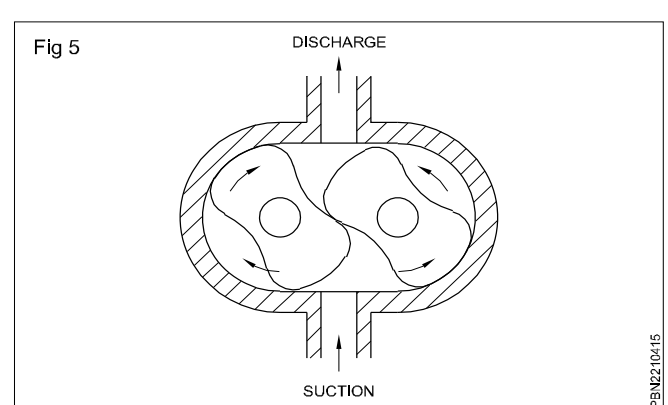
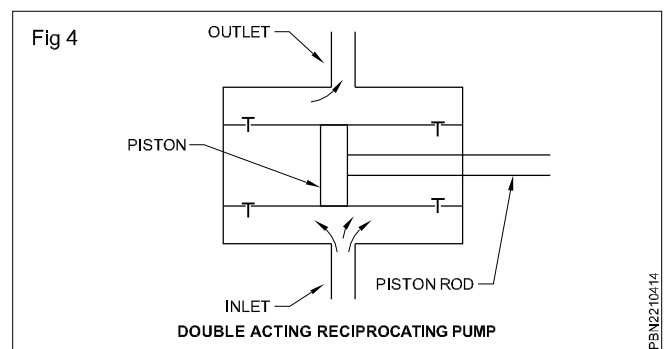
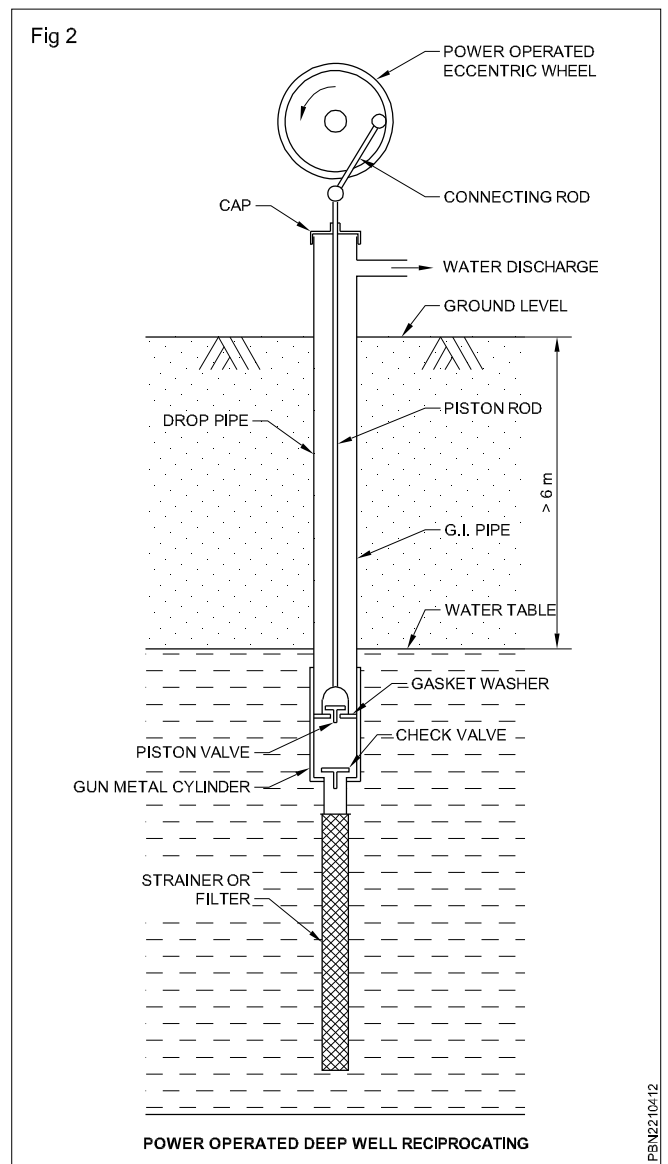
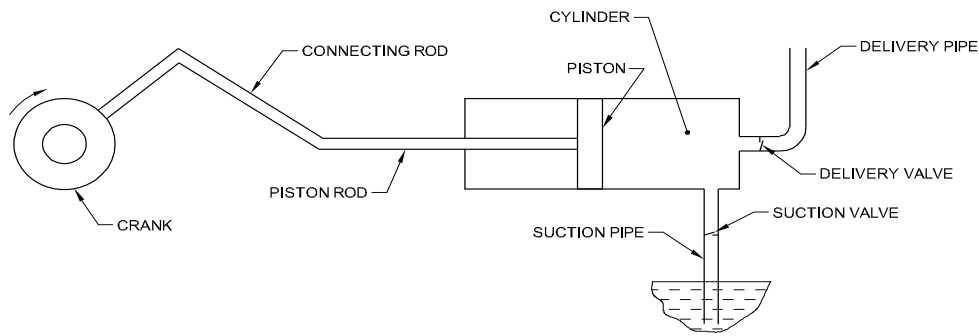
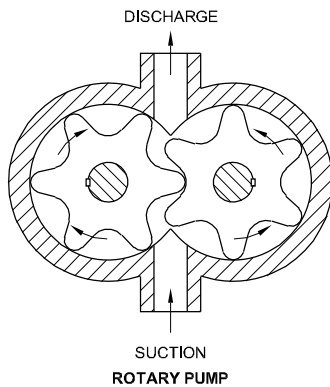


Fig 3



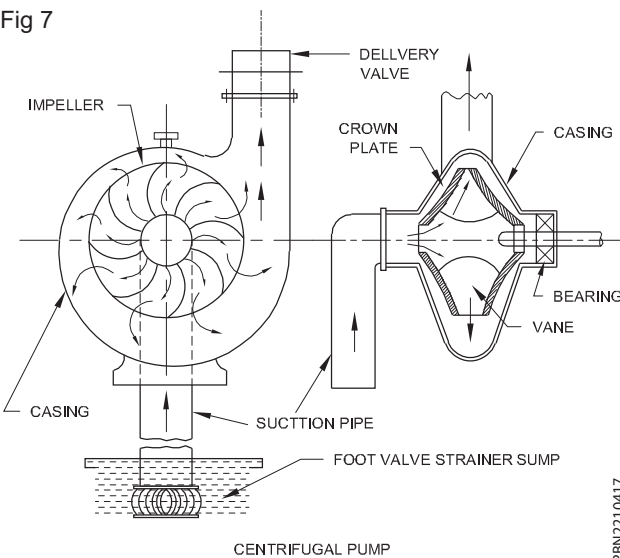
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Fig 6



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Fig 7



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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, casing and a portion of delivery valve. 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. The delivery valve is kept closed during priming.

After priming, the impeller is rotated by a prime mover keeping the delivery valve still closed. The rotating vanes give a centrifugal head to the pump. When the pump attains a constant speed, the delivery valve is gradually opened. The water flows in a radially outward direction. Then, it leaves the vanes at the outer circumference with a high velocity and pressure. As the liquid flows along the spiral casing, its kinetic energy is gradually converted into pressure energy. The high pressure water is discharged through the delivery pipe to the required height.

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.

Classifications of centrifugal pumps

Centrifugal pumps may be classified according to

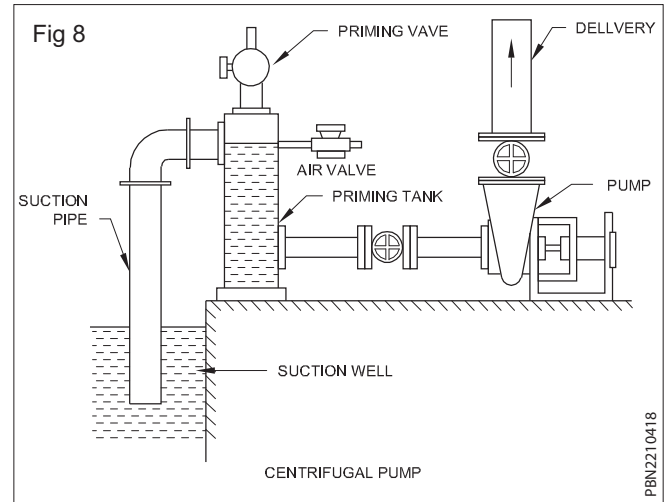
- a Working head or lift
 - 1 Low lift or low head pump.
 - 2 Medium lift or medium head pump.
 - 3 High lift or high head pump.
- b Type of casing
 - 1 Volute pump
 - 2 Vortex pump and
 - 3 Turbine or diffuser pump.
- c Number of impellers per shaft (stages)
 - 1 Single stage pump and
 - 2 Multistage pump
- d Type of impellers (or liquid handled)
 - 1 Closed impeller
 - 2 Semi-open impeller and
 - 3 Open impeller
- e Duration of flow
 - 1 Radial flow pumps
 - 2 Axial flow pumps and
 - 3 Mixed flow pumps
- f Number of entrances to the impeller:
 - 1 Single suction (entry) pump and
 - 2 Double suction pump
- g Position of shaft
 - 1 Horizontal pump and
 - 2 Vertical pump

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.
- 7 The pump will run backward, if it is stopped with the discharge valve open.

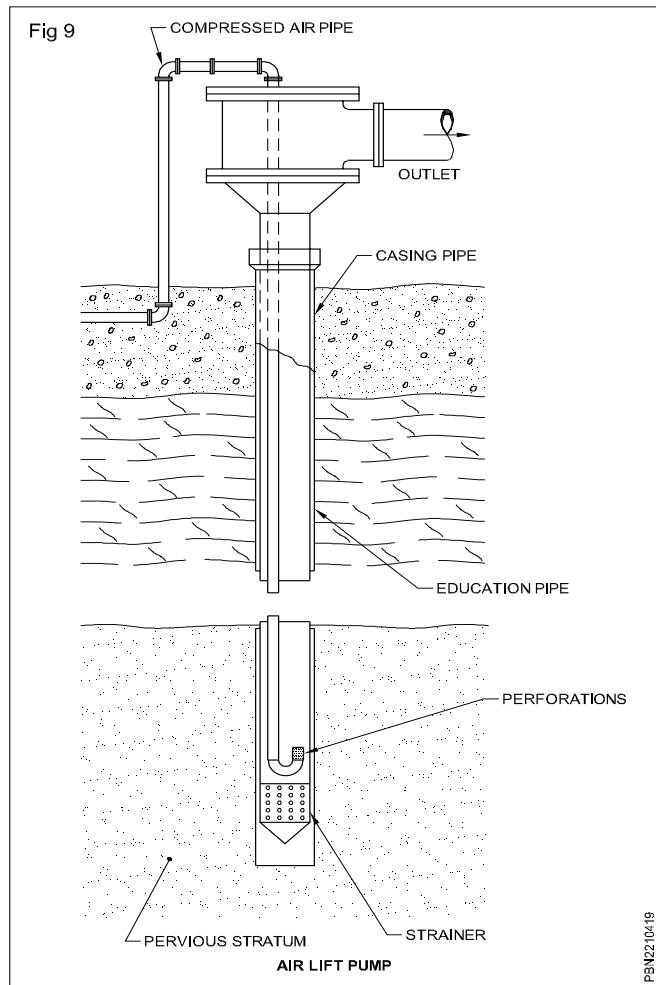
Air lift pump (Fig 9)

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 pump 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, a foot valve and strainer is provided at the suction pipe. (Fig 9)



Characteristics Reciprocating pumps

	Centrifugal pumps	Reciprocating pumps
1 Discharge	<ol style="list-style-type: none"> i Flow pulsating ii Constant discharge even if head on delivery side varies. iii Large amount of losses due to leakage through valves etc. 	<ol style="list-style-type: none"> i Continuous flow. ii Does not give constant discharge under variable head. iii No such trouble.
2 Speed	Run at low speeds; piston speed less than 30 m/min. If coupled to driving machines, speed reducing devices necessary.	Run at high speed (500 to 1000 r.p.m.). Direct connection with driving machines possible
3 Efficiency	Long stroke engines have 85% efficiency while smaller pumps have only 40% efficiency.	Efficiency between 40 and 85%; more efficiency if the head and discharge are maintained within narrow limits.
4 Head	Can work against high heads.	Better suited to low heads.
5 Size	Large size, bulky and heavy. Requires large space.	Small, compact and light.
6 Initial and	High initial cost; maintenance cost is also high. cost low.	Low initial cost. Maintenance
7 Running	Starting is difficult; more power required; complicated mechanism required; operation difficult.	Starting is easy; less power required; simple mechanism; operation easier.

Installation of india mark III pump

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

- state the installation of Indian mark III pump.

Basic features

The India Mark III (VLOM) hand pump can be used in deepwell conditions upto 50 mtrs. The India Mark III (VLOM) hand pump (IS : 13056) is identical in design to the India Mark II deepwell handpump (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 (VLOM) handpump 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.

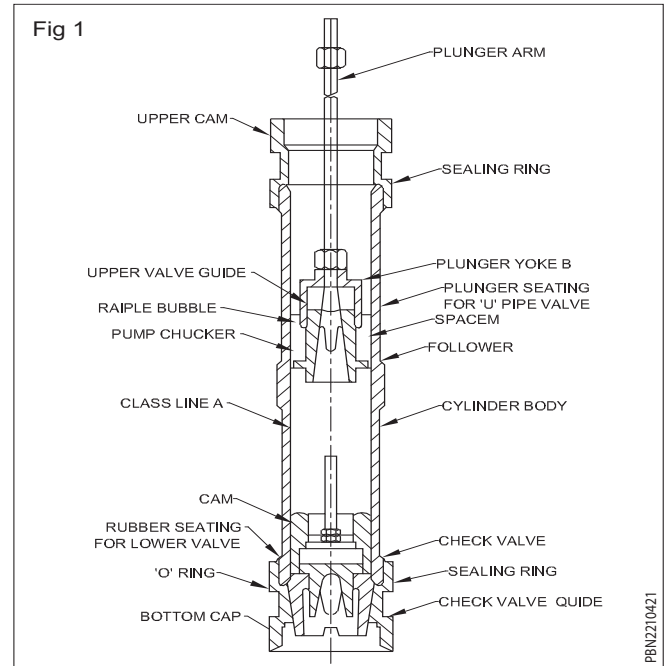
Cylinder

- 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 handpump.
- 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.

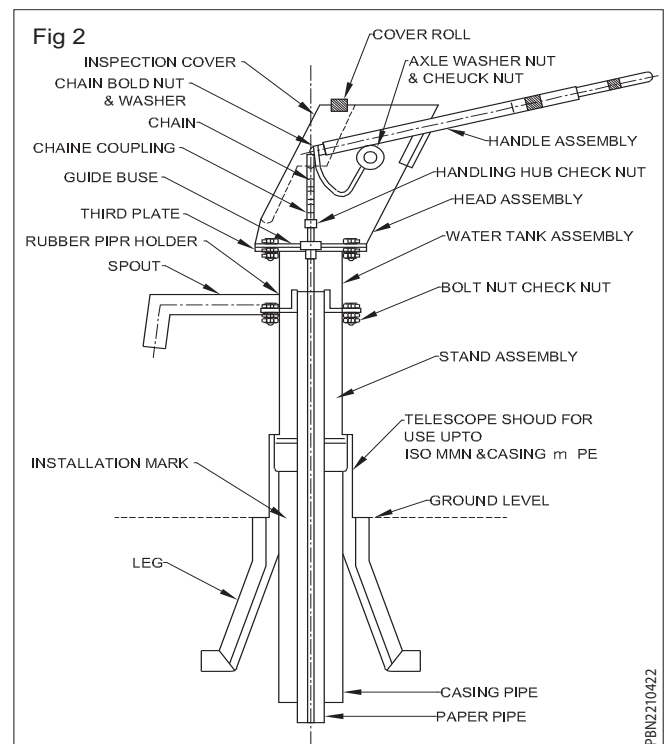
By providing an open cylinder, the connecting rods and plunger assembly with cup washers can be pulled out without removing the riser pipes. This enables easy repair

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)



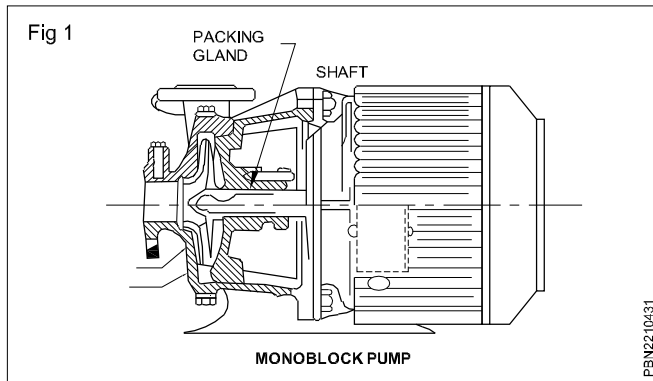
Installation of mono block pump

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

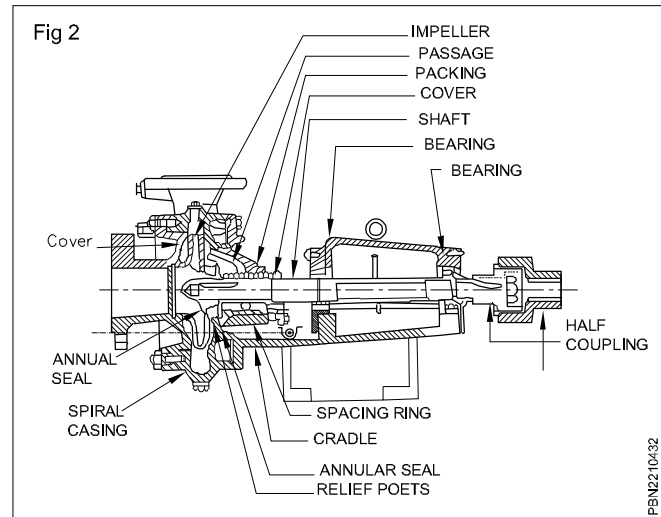
- state mono-block pump.

Mono-block pump (Fig 1 & 2)

These pumps 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 unbalanced, because there are no ports in the hub or second sealing ring. Therefore simple packing gland without a water seal are used in these pumps.



The spiral casing is cast integral with inlet 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 is located at ground level. The motor drives

a vertical shaft extending down to the pump. The vertical spindle turbine pump is invariably adopted nowadays. The bowls of the bore-hole pumps should be kept at sufficiently low level so that they remain submerged below water under working conditions. If that is not possible, the foot valve should remain submerged. 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

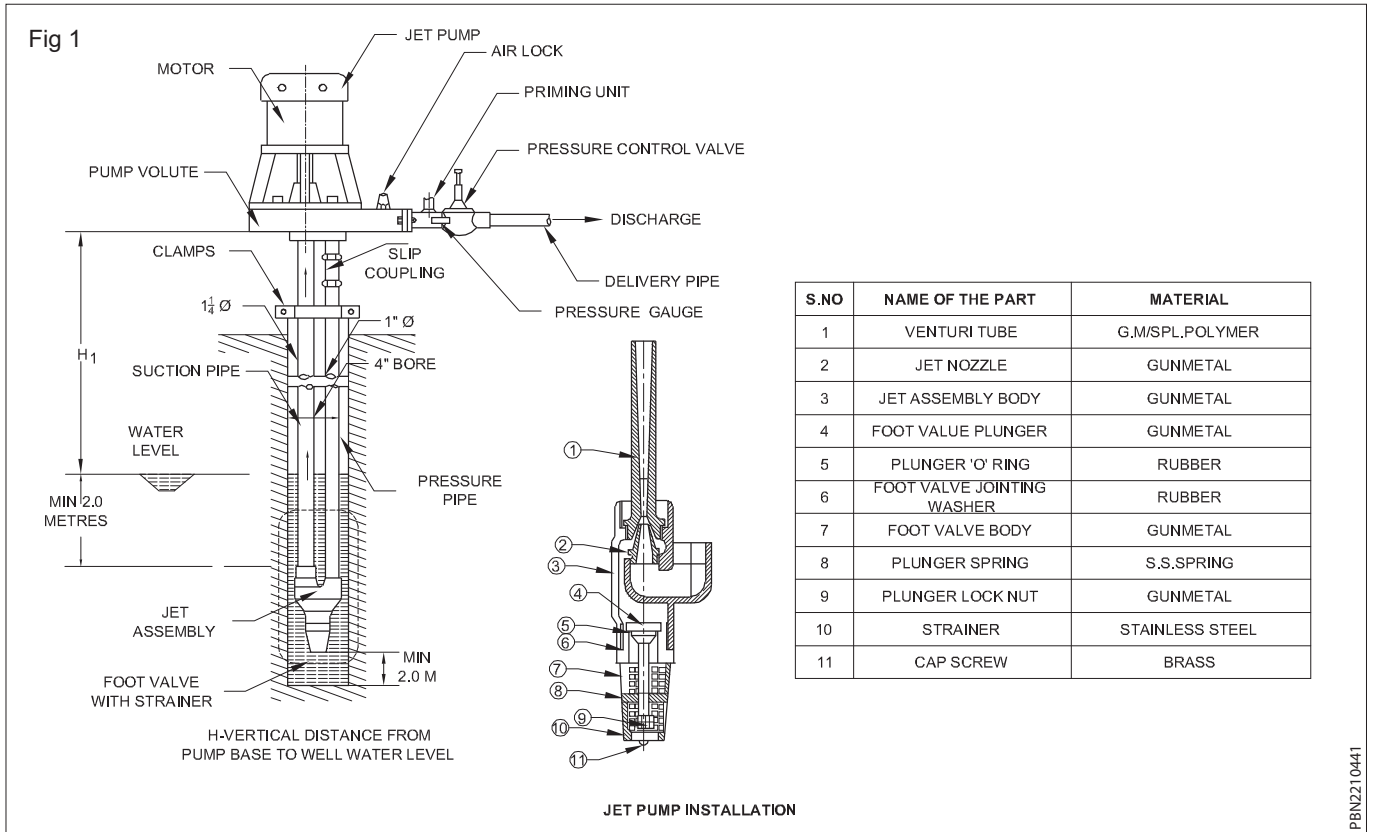
- state the jet pumps.

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 storied 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 36 m ; 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.

The specifications of different types of jet pumps being manufactured by Crompton Greaves in India.



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, or 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.

Grounding & 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.

***See table on Page 3 for maximum incoming pressure.**

Pump Boost	Amps	Voltage	Power	*Maximum incoming pressure
35 psi	5.5	120 - 60 Hz	1/2 HP	45 psi
52 psi	7.0	120 - 60 Hz	3/4 HP	28 psi
70 psi	4.0	230 - 60 Hz	1 HP	10 psi (For use with holding tank)

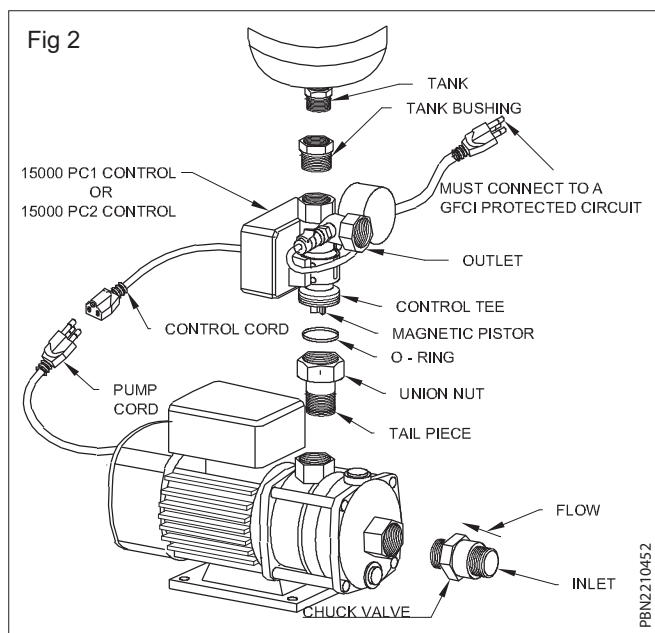
Do not spray water on or near the electric motor or control.

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.

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.

- 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.

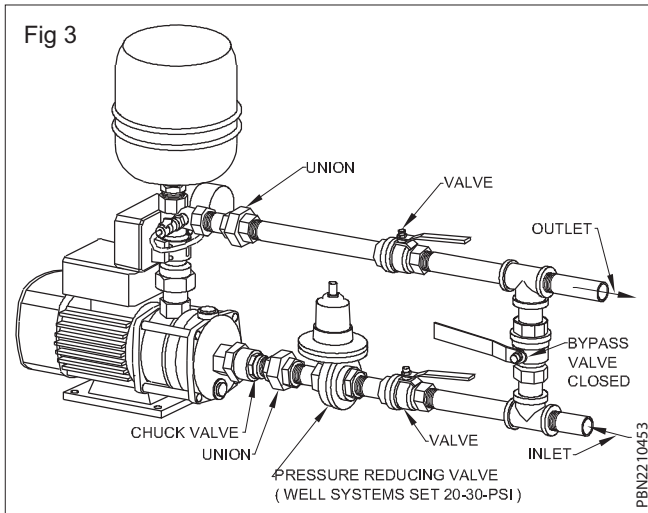
Piping

Pressurized - City Supply or flooded suction

It is recommended that you install a gate valve or ball valve with a union before and after the pump. This will enable you to easily disconnect the system to allow for service if required.

Well Tank System (Fig 3)

The booster pump should be installed after the well tank and before the water softener. Water treatment equipment to increase pH (potential of hydrogen), must be done before the pump. If debris is present in the water, a strainer of 40-50 mesh should be installed before the pump and cleaned regularly.



When installing on a well system, it is recommended that you install a gate valve or ball valve with a union before and after the pump. This will enable you to easily disconnect the system to allow for service if required.

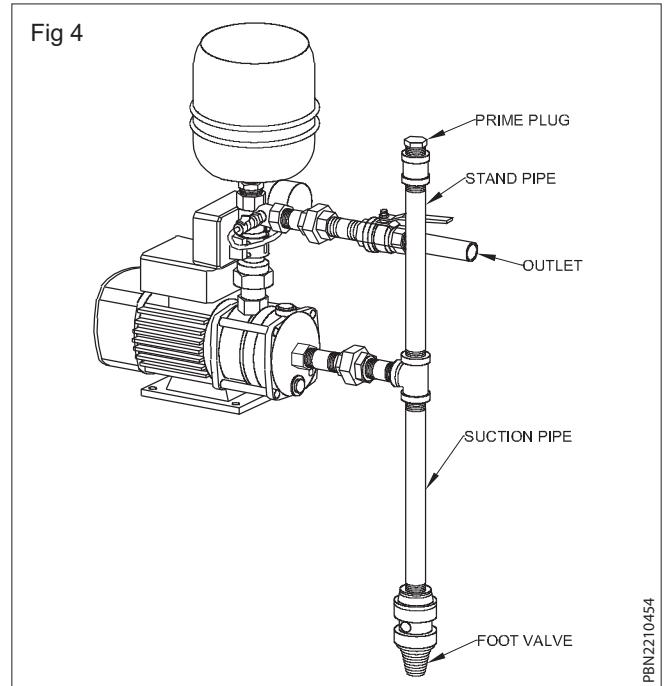
A pressure reducing valve is required and must be installed before the pump to ensure proper operation. Set the pressure reducing valve to the cut in pressure of your well pressure switch. For example if your well pressure switch is set between 30-50 psi, then set your pressure reducing valve to 30 psi. This will eliminate the pressure fluctuations from your well tank, and give you a constant boost.

Suction Lift - Cisterns or Holding tanks (Fig 4)

Install the pump as close to the water source as possible to minimize the length of your suction pipe. The diameter of the suction pipe should be the same or larger than the suction inlet of the pump.

Make sure the piping is free of all air leaks, and that it slopes continuously upward from the water source to the pump. The pipeline should be free of high spots which can trap air. Avoid bends such as elbows and fittings when possible. A stand pipe at least 12" high with a plug will help with priming the system.

A foot valve on the end of the suction pipe is required, as shown below. Maximum suction lift is 20 feet. This is not a self priming pump.



In this application the pump will need to be primed with water. Leaks in the inlet piping of these pumps may cause the pump to not build pressure and cause the pump to lose prime. Prime the pump by pouring clean water into the stand pipe until the pipe is full. Start the pump for a few seconds by pushing reset, and then repeat. This will need to be done a few times to purge all the air out of the system.

Make sure that all pipe joints do not leak - use thread sealant on the threads.

It may be necessary to push the reset button on the control a few times to fully prime the pump. Repeat the priming instructions above if the pump does not build pressure quickly.

When fully primed the pressure gauge should be the same as the value in the table on page 3 in the Pump Boost column, or slightly less depending on the length of the suction pipe.

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 <ul 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 	<ul 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 <ul 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 	<ul 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 <ul 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 	<ul 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 <ul 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. 	<ul 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 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

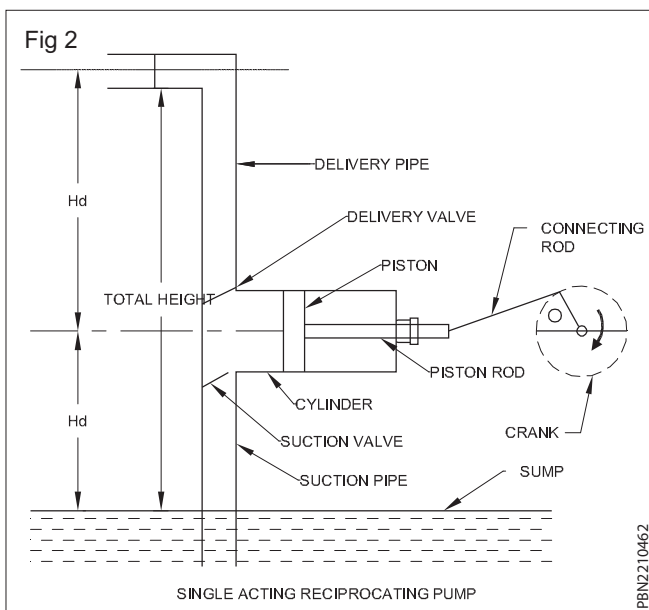
Reciprocating pumps (Fig 1)



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 remains 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 remains 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 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/ wornout 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 harbour 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**
• **classified 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 lean 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

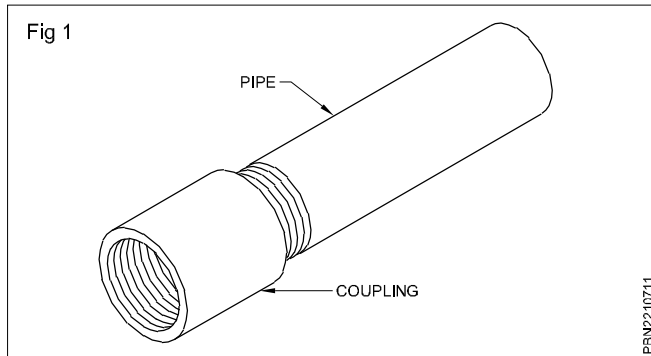
Algae Protozoa, silt, clay etc.- Produce turbidity, odour, and colour.

Describe of pipes dies their uses care and precaution

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

- necessity of pipe thread
- state the pipe dies taps & tap wrenches.

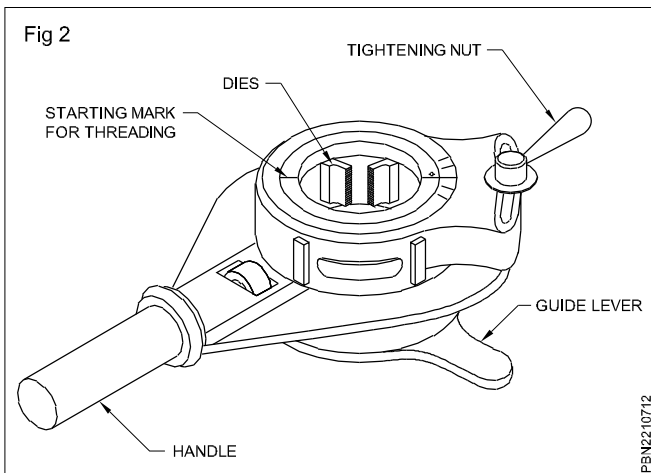
Pipe dies: Most of the G.I. pipes that plumbers install are threaded at both ends. The pipes are available in lengths of 6 metres and it will be necessary to cut the pipe to the required length and thread it. (Fig 1)



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 1/4" to 4".

The dies must be sharp so that they will cut metal rather than push it around. Dies which push the metal around instead of cutting freely cause threads to break.

Pipe threading dies (Fig 2)

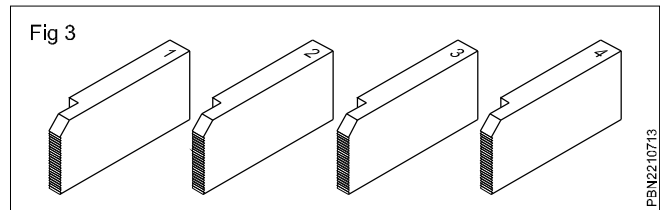


Pipe threading dies are called stocks and dies. There are two types of stocks and dies, solid and adjustable. The solid type consists of steel die stock or frame with a handle at each end. The dies are fitted into the centre of the frame. Dies are held in position by a block which is adjustable by means of a tommy bar. This stock cuts parallel threads and is not much employed as its use is a laborious process. There is another draw back in this stock that whenever the dies are removed from the pipe, it must run back the full length of the threads and sometimes it spoils

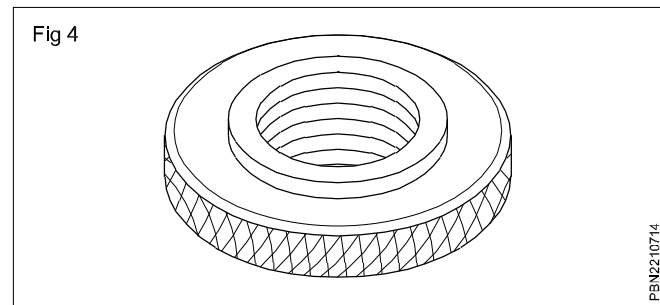
the threads. In this type a separate set of dies is required for each pipe size.

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. At the front side of the stock are adjustable self-centering guides to enable a square thread to be cut. The die stock can be obtained with ratchet lever handles for use in a confined space. A catch or bolt is provided for quick release to enable the dies stock to be withdrawn from the pipe without running back. Pressure may be kept on the lever and the bolt half released to clear any burr from the thread.

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)



Taps

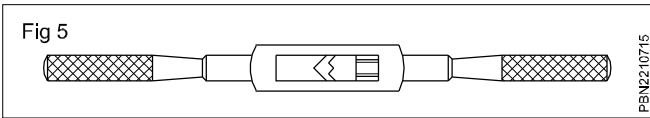
Taps are used for cutting internal threads on a pipe or fitting. A pipe tap is shown in figure. It is made of high carbon steel, hardened and tempered. Its shank is made square to fit into a tap handle for turning. To cut threads, three types of tap are necessary. It consists a set of three shows a set of tap. Taper tap is used first and cuts light thread, then plug tap is used and finally bottoming tap is used which cuts the threads to the required depth.

Tap wrenches

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

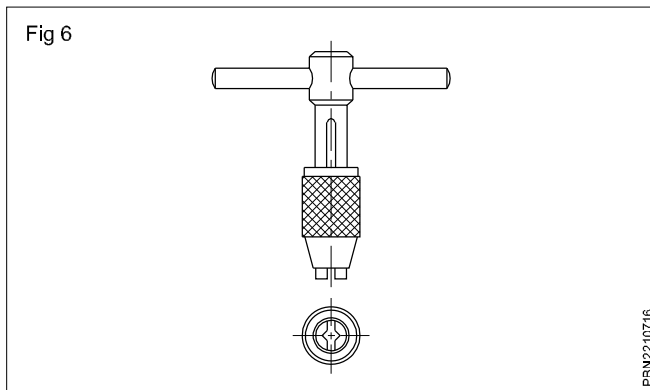
Tap wrenches are of different types, such as double-ended adjustable wrench, T-handle tap wrench, solid type tap wrench etc.

Double-ended adjustable tap wrench or bar type tap wrench (Fig 5)



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 6)

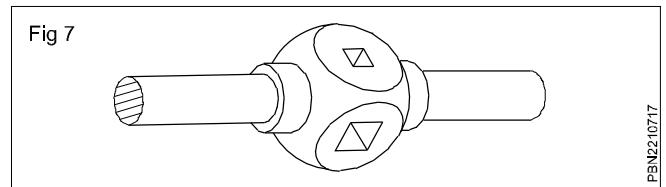


These are small, adjustable chucks with two jaws and a handle to turn the wrench.

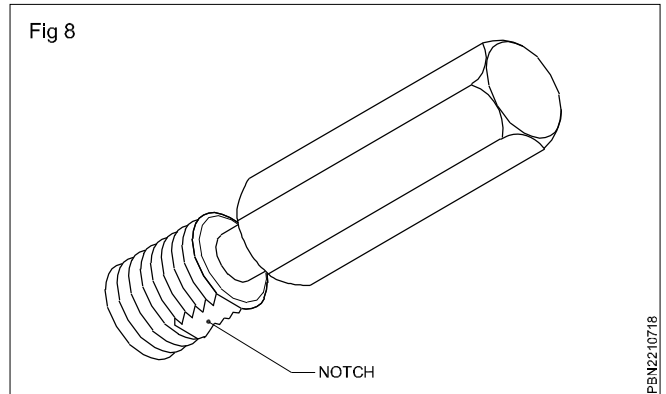
This tap wrench is useful to work in restricted places, and is turned with one hand only. Most suitable for smaller sizes of taps.

Solid type tap wrench (Fig 7): 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.



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 8)



Care and precautions

- 1 Secure the pipe finally in a vise.
- 2 Put on work gloves while threading.
- 3 Use a cutting fluid while cutting thread to minimise friction and heat.
- 4 Clean the die frequently with brush to prevent the chips from clogging.
- 5 Check the fit of thread with a matching nut.
- 6 Too much of depth of cut at one time will spoil the thread and the die.

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 two inch pipe does not measure two inches on the outside diameter. But rather measures 60.3mm on the outside diameter.

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 nominal 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.

Calculation of area of pipe

Plug in L and D into the following equation to calculate the surface area of the pipe $3.14 \times L \times D$

For example if you had a pipe with a length of 20 feet and a diameter of 2 feet. You would get $3.14 \times 20 \times 2$ and find that the surface area of the pipe equals 125.6 square feet.

Volume of pipe

For a pipe use its length instead of height pipe volume = $\pi \times \text{radius}^2 \times \text{length}$ where radius = inner diameter/2. The volume of pipe is equal to the volume of a liquid inside (if pipe is fully filled with it).

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. There are two basic types of copper tubing soft copper and rigid copper.

PVC and CPVC pipes - schedule 40

Nominal pipe size (inches)	Outside diameter (inches)	Minimum thickness wall (inches)
½	0.840	0.109
¾	1.050	0.113
1	1.315	0.133

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

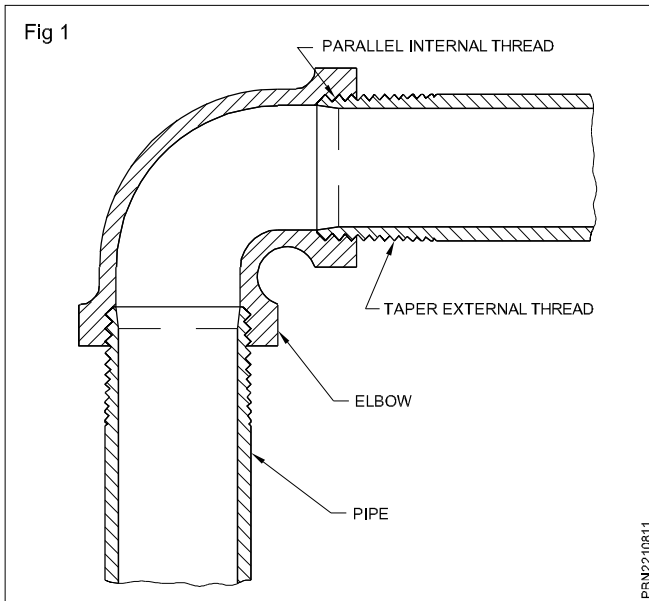
It is used to transport natural and propane gas in residential applications black steel pipe is manufactured as seamless which makes it a better type for gas transportation and fire sprinkler systems since it can prevent fire better than galvanized pipe.

Standard pipe threads

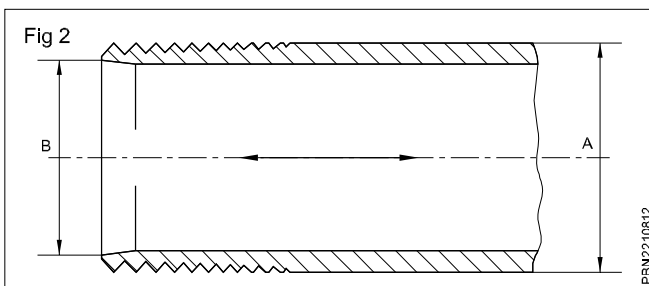
Objectives: At the end of the lesson you shall be able to

- describe pipe threads
- state the B.S.P threads
- 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)

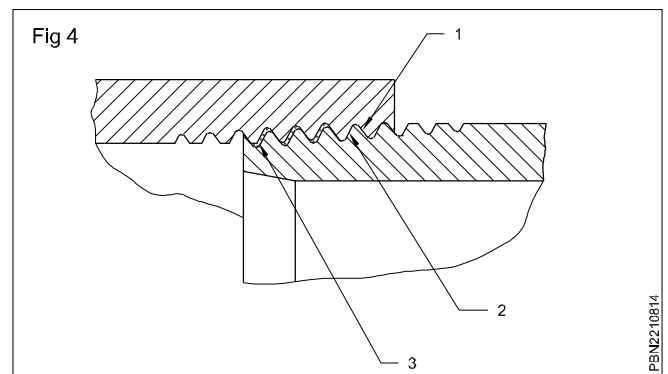
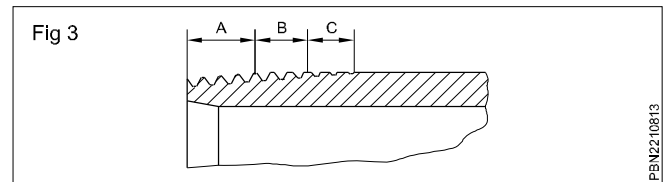
The last four threads have flat tops and bottoms. (C)

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)



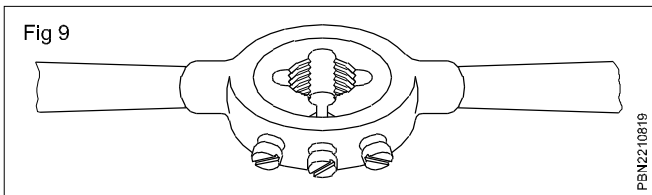
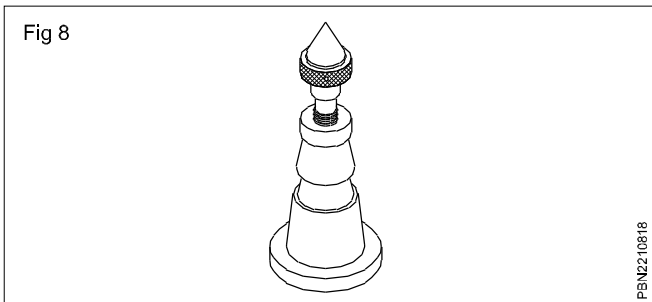
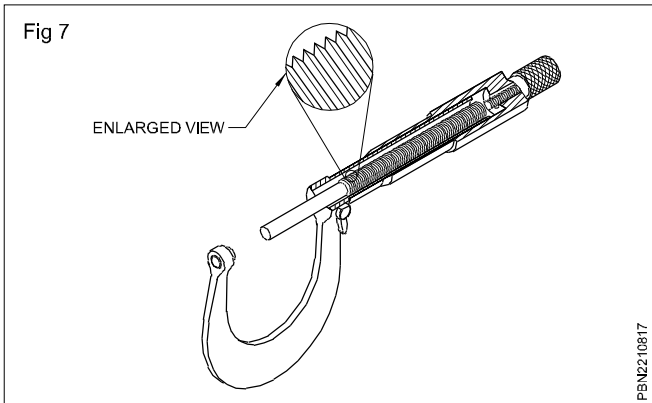
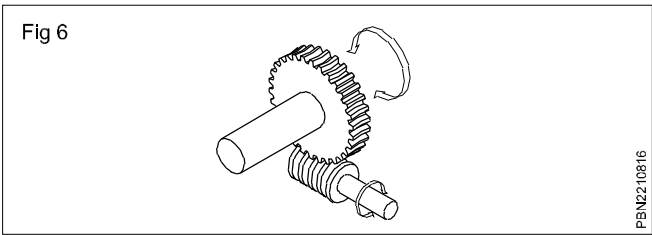
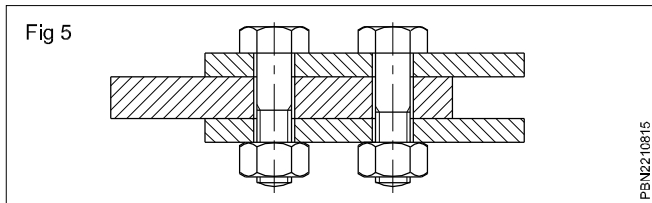
BS 21 - 1973 and IS 2643 - 1964

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

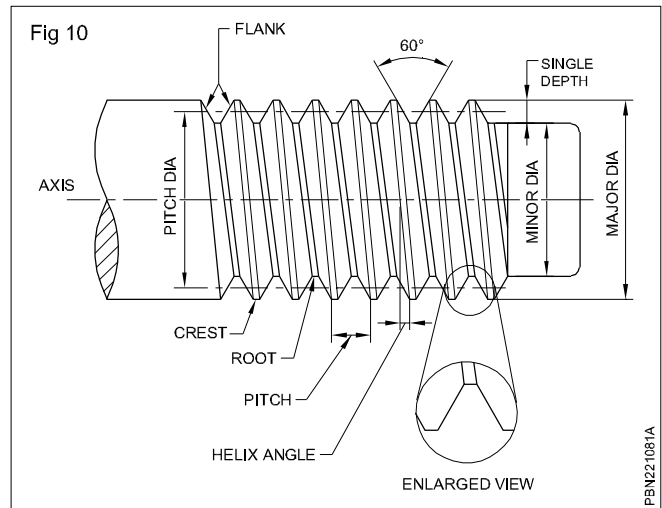
Uses of threads

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)
- to apply pressure (Fig 8)
- to make adjustments. (Fig 9)



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

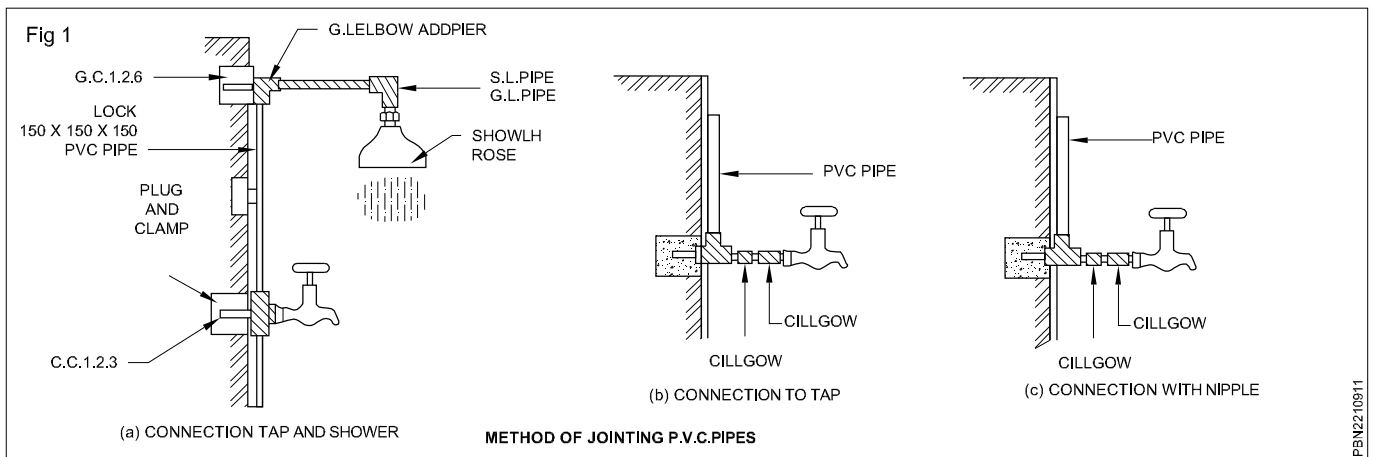
- Objectives:** At the end of this lesson you shall be able to
- state the laying and jointing pvc pipes
 - state the inspection and testing of pvc pipes
 - state the pvc pipe repairs.

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

these to prevent damages. On no account the pipes shall be dragged along the ground. Pipes shall be given adequate support at all times. They shall not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in pipe alignment and jointing.



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.

For satisfactory service performance of plastic pipes under conditions of use, the following points must be kept in view while undertaking installation of plastics piping systems :

that the plastics materials are 'thermoplastic' in nature, and must not be used in contact with hot surface (or hot water);

that 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.

Rigid P.V.C. pipes upto 600 mm dia have been produced, however in India these are available from 16 mm to 315 mm.

In these specifications only the use of rigid (unplasticised) P.V.C. pipes for cold water supplies is covered.

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 shall be bedded in sand or soft soil free from rock and gravel. Back fill 15 cm above the pipe

shall also be of fine sand or soft soil. 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 (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. Pipe ends have to be bevelled slightly with a bevelling tool (reamer) at an angle of about 30°. The total length of insertion socket (injection moulded socket or couplet) 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.

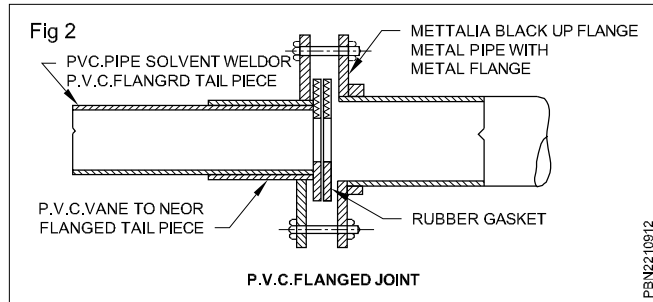
Dust oil, water, grease etc. shall be wiped cut with a dry cloth from the surcace. Further the grease should be thoroughly removed with a suitable solvent, such as methylene chloride or as an alternative the outside surface of the pipe and the inside of the fitting may be roughed with emery paper.

Generous coatings of solvent cement shall be evenly applied on the inside of the fitting around the circumference for the full length of insertion and on the outside of the pipe end upto the marked line with non synthetic brush of suitable dimension. The pipe shall be pushed into the fitting socket and held for 1 or 2 minutes as otherwise the

pipe may be out of the fitting due to the slippery quality of cement and the tapering inside bore of the fitting. The surplus cement on the pipe surfaces shall be jointing will not be proper and pipe will come out of the fitting.

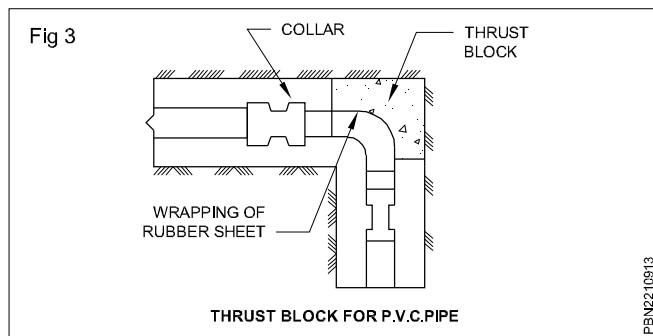
In summer months joints shall be made preferably early in the morning or in the evening when it is cooler. This will prevent joint from pulling apart when the pipe cools off at night.

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)



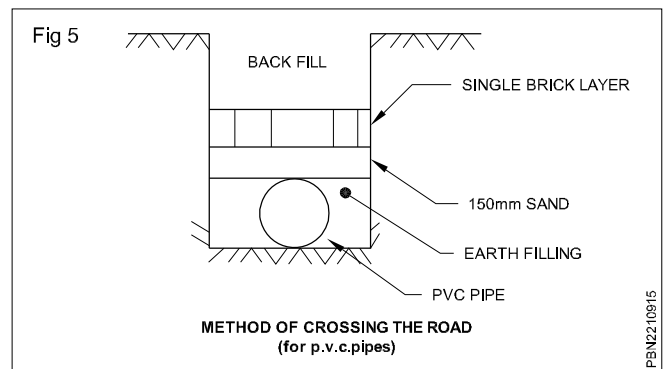
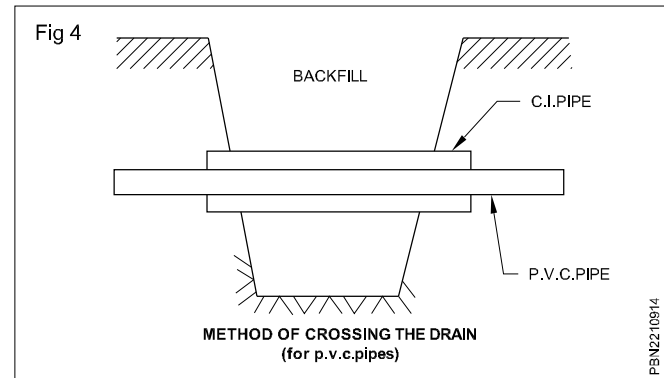
Rubber ring joints can provide a water tight seal but do not resist pull. As such these may be used only as repairs collar and for jointing pipes larger than 110 mm. Such joints may be provided on pipes which are buried in the ground and supported throughout on a bedding so that they are not subject to movement and longitudinal pull. The material of rubber ring shall conform to I.S. : 5382 - 1969 where aggressive soil are met with, synthetic rubbers perform better for jointing. 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 the ring vary considerably in different types of joints. Most joints often require the application of lubricating paste which shall be procured from the manufacturer of P.V.C. pipes. Rubber rings shall be supplied by the manufacturers.

The rubber ring joints can be either of :

- 1 With spigot and socket, or

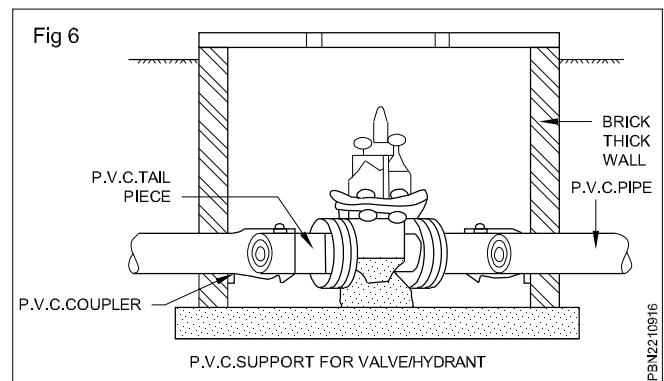
- 2 With separate collar pieces having two rubber rings, one at either end.

e Crossing Road or Drain (Fig 4, 5)



Where the pipe line crossed a road or a drain, it shall be through C.I. or R.C.C. pipe.

f Supports for Valve and Hydrant (Fig 6)



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.

g Inspection and Testing of P.V. C. pipes

Solvent welded pipe shall not be pressure tested until atleast 24 hours after the last solvent cemented 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 posi-

tioned and closely observed to ensure that no time are the test pressure exceeded. 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 one hour 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. Alternatively plastic clamps of suitable designs, wherever manufactured, shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or distorting the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated longitudinal temperature movement to take place without abrasion. 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 spacings 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
20	700
25	750
32	825
40	975
50	975

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 as shown in the 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 -

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

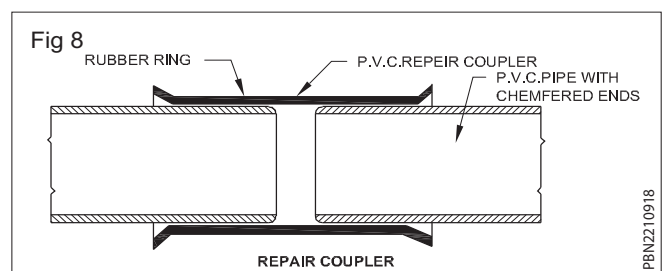
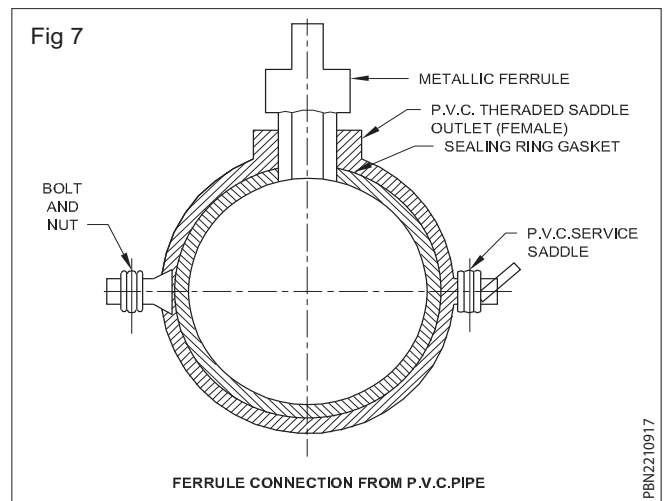
Either metal or P.V.C. saddles, as specified, shall be used for the off take of service connections from larger bore pipes (50 mm diameter and above). The saddle consists of two half round sections of metal or P.V.C. which are bolted together or held round the pipe by wedge grips. A seal is formed between 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 trapaning 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 ...

P.V.C. Pipe - Repairs (Fig 7)

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs should be made by replacement of the damaged section. In case of damage by external blows, the extent of the damage may be greater on the inner-surface.

Sometimes, pipes are damaged accidentally due to trenching operation in street repairs. Shall split or chipout occur in the wall of the pipe, 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 8)



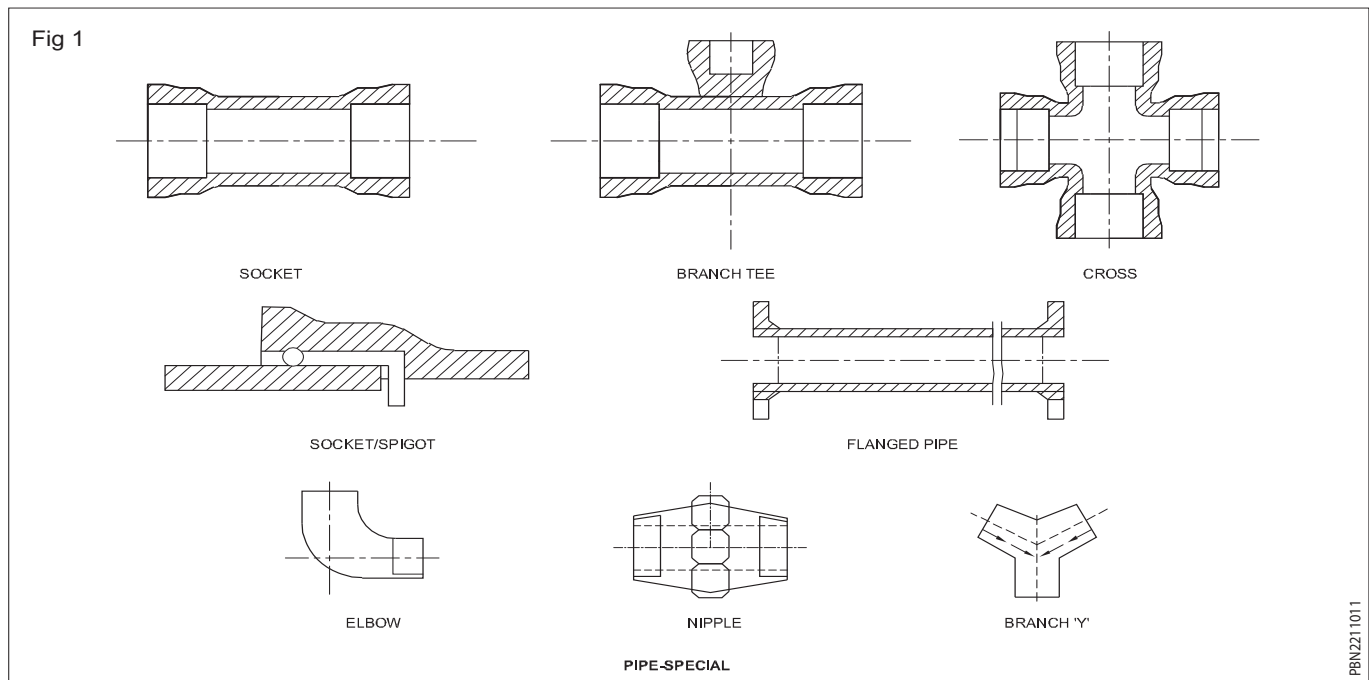
Joining material for water and gas pipes

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,

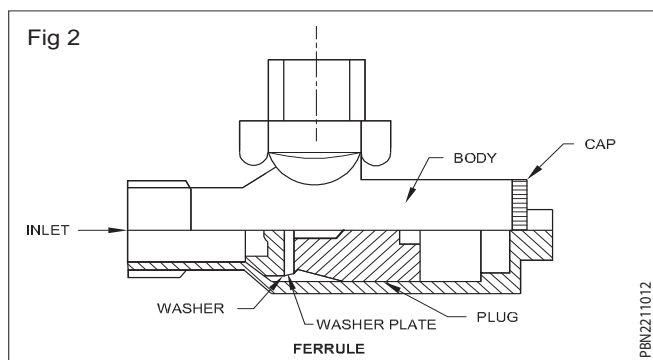
flanges, nipples, crosses tees, elbows, bends etc. are used during laying of distribution pipes.



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 supply, measurement control, distribution, utilisation or disposal of water

Flange : A projecting flat rim on the end of a valve, pipe etc.

Flanged pipe : A pipe provided with flanges so that the ends can be joined together a float to control the flow into a tank.

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.

Supply pipe : The pipe which extends from the stop cock upto the ball cock of the storage tank, if any, and any consumers pipe subject to water pressure from the water main.

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 or which makes an angle of not more than 45° with the vertical.

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

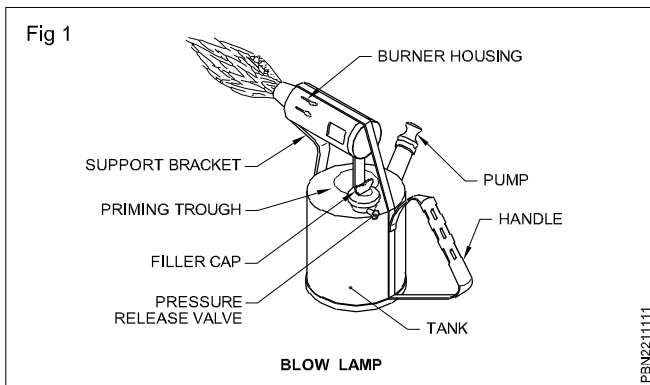
Objectives: At the end of this lesson you shall be able to

- explain the uses of blow lamp
- working of 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.

Priming trough is provided for filling methylated spirit for lighting the blow lamp. Set of nozzle is provided to direct the kerosene vapour to produce forceful flame. Burned housing is mounted on support brackets on which soldering iron is placed for heating as shown in figure.

Pump is provided to pressurise the kerosene in the tank.

There are four forms of blow lamp they are

- 1 Standard
- 2 Gardening
- 3 Swivel
- 4 Heavy buty

Standard blow lamp commonly used for soft soldering, light brazing and moulding plastic pipes.

Steps to use blow lamp

- 1 Attach gas canister
- 2 Check the leak
- 3 Adjust the flame
- 4 Use blow lamp
- 5 Turn off blow lamp

Working of blow lamp

Gas enter the burner through a small hole or jet. The gas is then ignited by a spark caused when the user presses an ignition button on the blow lamp or by a match or lighter. When the gas and air mix in the burner the gas becomes oxygenated which results in a hotter flame.

Difference between blow lamp and blow torch

Blow torch is a tool which projects a controlled stream of a highly flammable gas over a spark, in order to produce a controlled flame. While blow lamp is a burner that burns a fuel in air to produce a hot flame a blow torch.

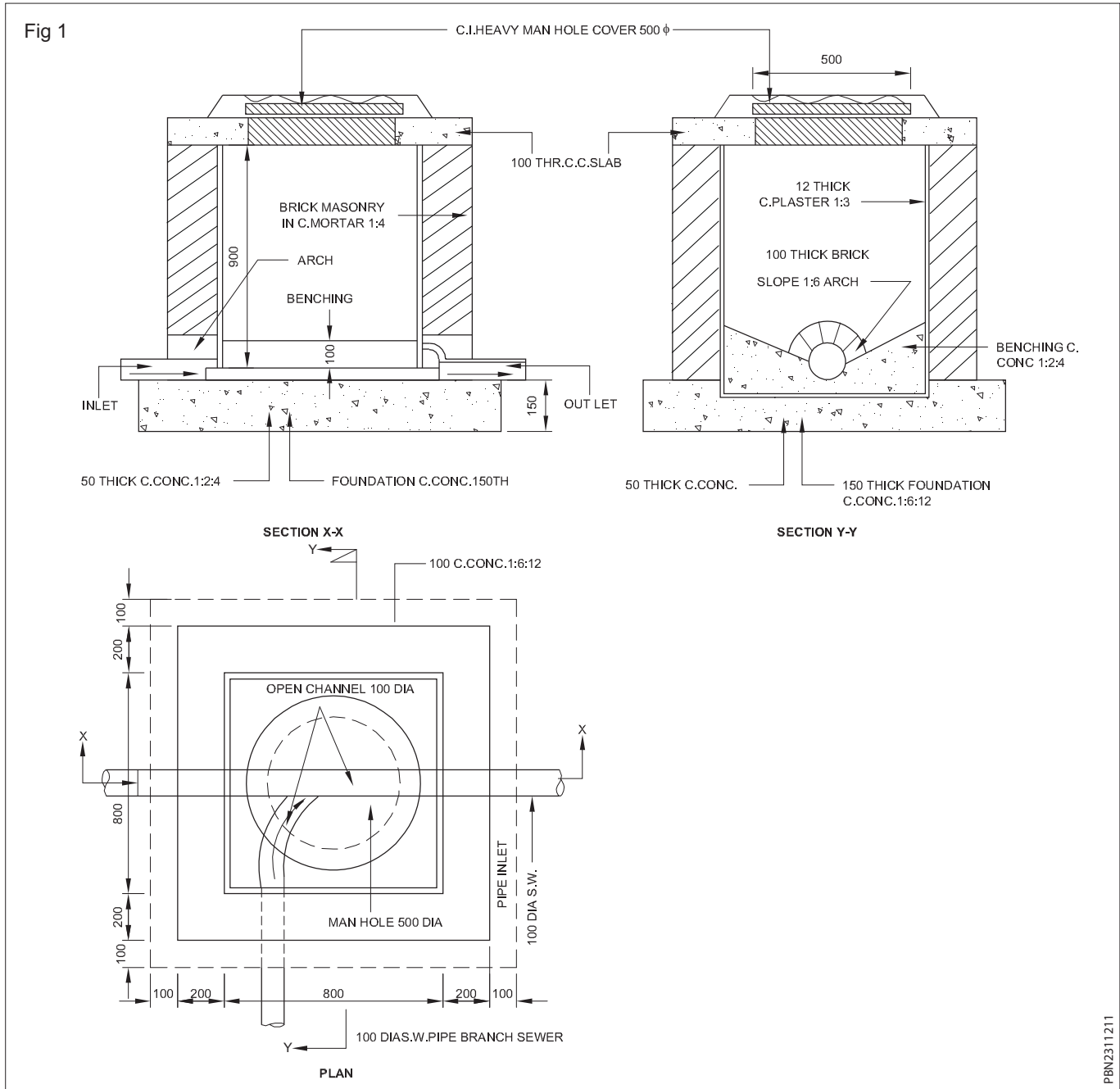
Inspection chamber, septic tank, drains, cesspools, soak pits

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

- describe inspection chamber, septic tank, drains, cesspools soakpits.

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)



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Septic tank

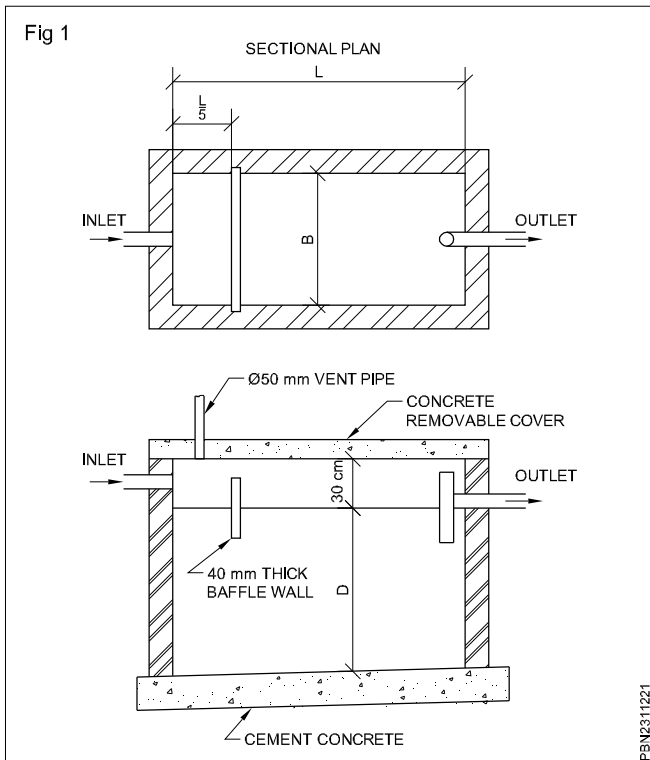
Objectives: At the end of the lesson you shall be able to

- describe the septic tank
- state points to be considered to form the septic tank
- state the construction about the septic tank
- specification about the septic tank.

Septic tank: Septic tanks are provided where there is no municipal sewerage 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 1)



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

Objectives: 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 more than 7.5cm, size. In the case of large pits the top

- 4 A vent pipe (CI/AC/PVC) should be provided on the covering slab (minimum - 100 mm).

The sewerage 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 larger 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.

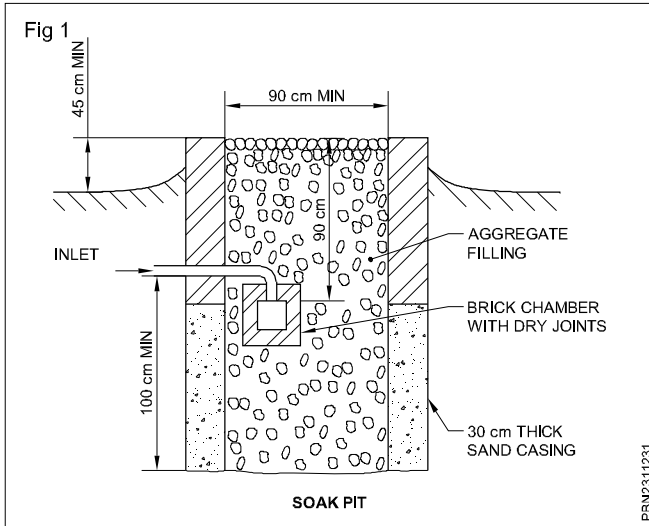
Ventilation pipe of usually 10 cm diameter of A.C. or C.I., is used for taking out the foul smells. Their tops are provided with cowls.

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.

portion is reduced in size for the reduction in the size of the R.C.C. cover. Fig.1 shows the section through a soak pit.

Sizing of soak pit are classified into

- 1 Chamber soak pit.
- 2 Square rock soak pit



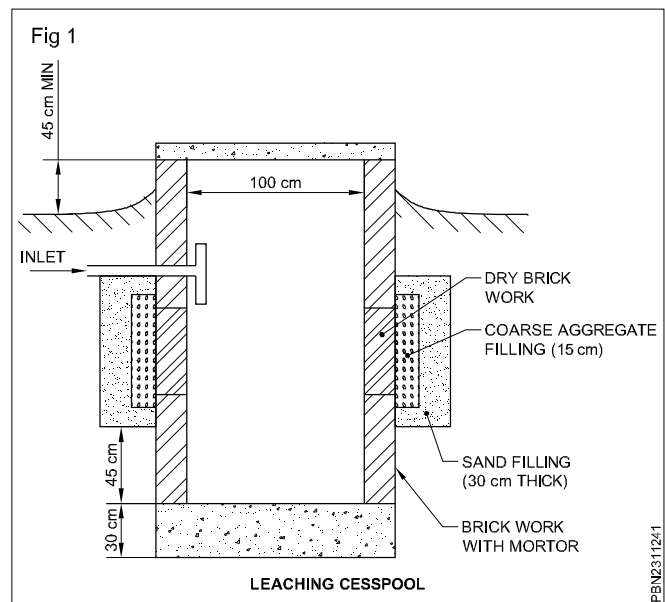
Leaching cess pools

Objectives: 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 get 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 1 shows the section through a Leaching cesspool.



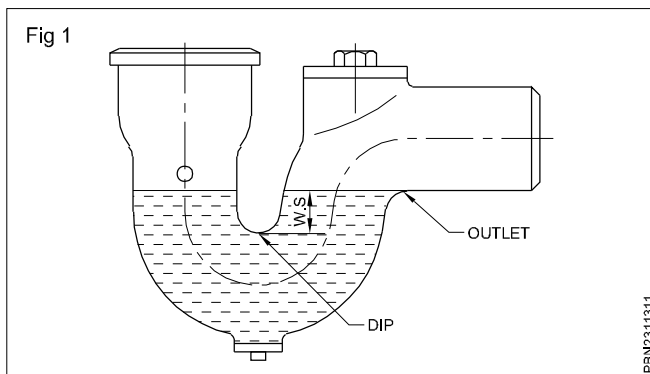
Types of traps

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

- define the traps
- pre-requisites of traps
- 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 self cleansing
- It should be provided with an access door for cleaning and
- It should be made of some non absorbent material.

Foul gases produced in the sewers, drains, waste-pipes may cause nuisance by entering in houses through house-connecting pipes, if their passage is not checked by some suitable devices. The devices which are used to stop the escape of foul gases inside or outside the houses are known as traps. The traps generally consist of a bend tube which provides a water seal between the atmosphere and the sewer gas. The efficiency of the traps depends on the depth of water seal, deeper the seal more efficient will be the trap

The following are the requirements of a good trap:

- i It should be made of non-absorbent material.

- ii It should provide sufficient depth of water seal all times (about 50 mm) having large surface area.
- iii It should be self-cleaning and should not obstruct the flow of sewage.
- iv It should be provided with access door for cleaning.

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.

A trap essentially consists of a U tube, which retains water, acting as a seal, between the foul gases (inside the pipe) and the outside atmosphere. They are largely used for baths, sinks and lavatories. In all such needs, they are made with enlarged mouth, so that the waste pipe may be thoroughly flushed out.

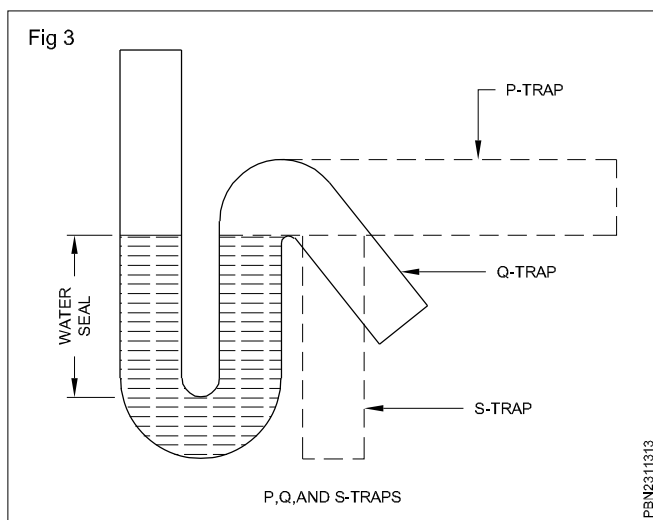
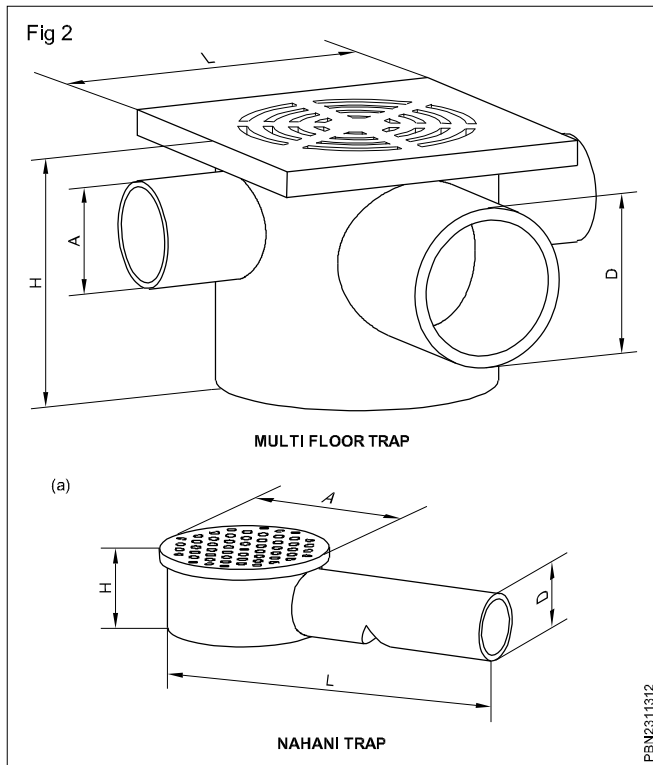
Depending upon their use, the traps may again be of three types i.e Floor trap, Gully trap and Intercepting trap.

These three different types of traps are briefly described below:

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 patented name of such a trap is Nahani trap. (Fig.2a)

The following types of traps are most commonly used in practice:

- a **P, Q and S - Traps :** These traps are classified according to their shape. They essentially consist of a U-tube which retains water acting as a seal between the foul gas and atmosphere. (Fig 3)



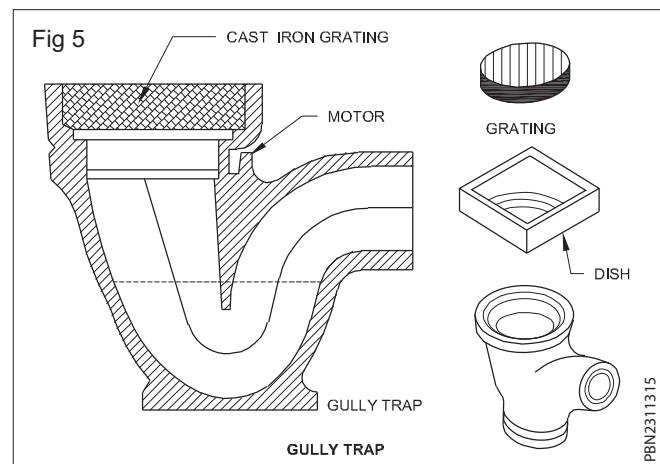
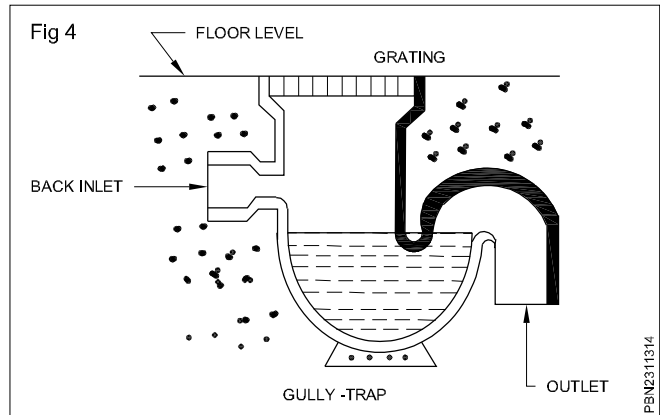
b Gully-traps : This trap is provided at a different places in the drain pipes. Waste water from sinks, bath etc., enters in through back inlet and unfoul water from the sweeping of rooms, courtyards etc. enters from the top, where a coarser screen grating is fitted to check the soil matter (Fig 4 & 5).

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.

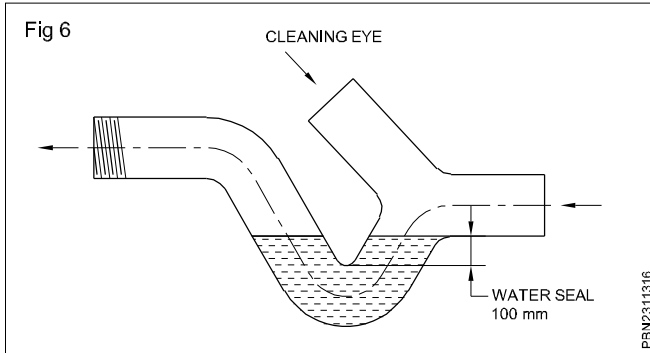


Construction of Gully Trap Chambers shall consist of the following :

- Excavation and refilling after construction of chamber.
- 1:3:6 RCC bed concrete required for embedding the Trap.
- 230 mm thick Brick Masonry in C.M. 1 : 6.
- 20 mm thick W.P. plaster from inside and smooth from outside in C.M. 1 : 6 trowell smooth by cement floating on all surfaces.
- RCC 1:3:6 coping 100 mm thick for having cast iron cover frame. (Dimensions shall suit the brick work)
- Cast iron frame and cover size fixed in coping & painted in 3 coats of anti-corrosive bitumastic paint.
- All the work necessary for satisfactory working of the same.

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. This trap at such a junction is often provided in a small man-hole constructed just near the house, 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. It is interesting to note the merits and demerits of an interceptor, which are given below.



Merits of interceptors

Foul gases of public sewer cannot pass through the interceptor, and hence prevented from entering the house drainage system. If the interceptor is 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.

Properly designed and constructed interceptors can quickly remove the foul matter of the house drains into the public sewer.

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. The basic purpose of interceptors of preventing foul gases, will then no longer be served.

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.

Omission of interceptors from house drains is found not to present too serious a difficulty or a problem.

Presence of interceptors installed by house owners, is found to seriously affect the ventilation of public sewers, as in such cases, the foul gases of public sewers will find an outlet only through the ventilating columns, which are provided at the head of every branch sewer and at other key points in the city sewerage system. Hence, if interceptors are allowed, then public sewers will need greater ventilation arrangement, and hence involving more expenditure, consequently leading to greater tax on the public.

In view of the difficulty, the city municipality itself decides whether to allow the house owners to install or not to install interceptors.

Traps which are fittings or parts of appliances that retain water so as to prevent the passage of foul air into the building should be properly sited. A trap may be formed as an integral trap with the appliance during manufacture or may be a separate fitting called an attached trap which may be connected to the waste outlet of the appliance.

Traps should always be of a self-cleaning pattern. A trap which is not an integral part of an appliance, should be directly attached to its outlet and the pipe bore should be uniform throughout and have a smooth surface.

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.

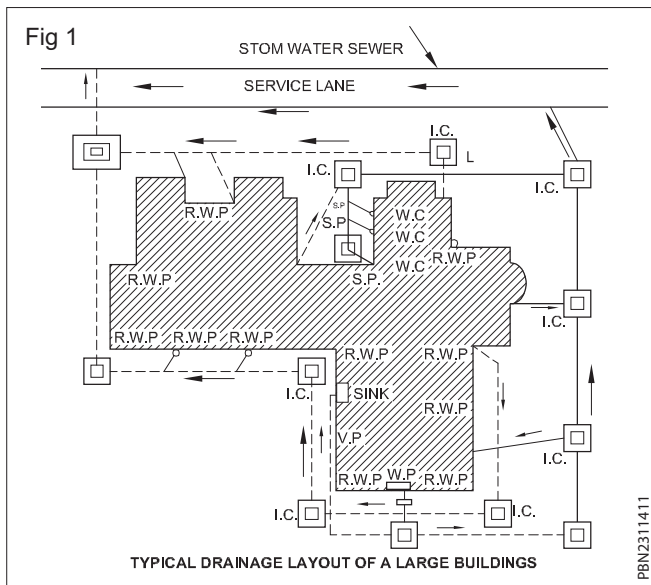
Layout of drainage system

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

- necessity & pre-planning of drainage system
- 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. The following slopes as usually sufficient.
- 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 If the quantity of sewage flowing in a pipe is small, an automatic flushing tank may be provided on its top for flushing it.
- 6 All the rain water pipes, sweeping from house and bath water should discharge over gully traps and should be disconnected from the drain.
- 7 All soil pipes should be carried direct to the manholes without gully traps.

Factors related with layout of drainage system

- Check the drainage system as per layout.
- Ensure that the pipe laid with the depth of 0.7 meters where vehicle may ride and the depth 6.5 meter for out door drainage system.
- Always use out door pipe lines and fittings with minimum dia of 100mm.
- The angle between discharge pipe and affiliable pipe. It must be atleast 90°.
- Always install out door drainage system below the depth of soil freezing.
- Install slotted or perforated pipe laid below ground.
- Use only HDPE pipe with wall thickness of 5mm.
- Construct creek bed to direct water away from low spot in your yard.

Testing of drainage lines

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

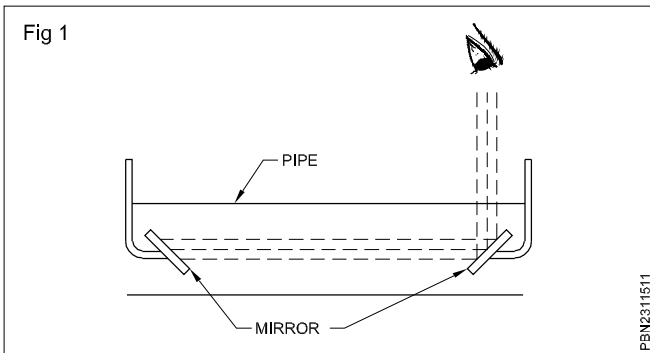
- state the testing of drainage lines
- explain various types of testing in drainage lines.

A wide ranges of testing equipments 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 test
- Smoke test
- Pneumatic or air test
- Chemical smell test
- Coloured water test

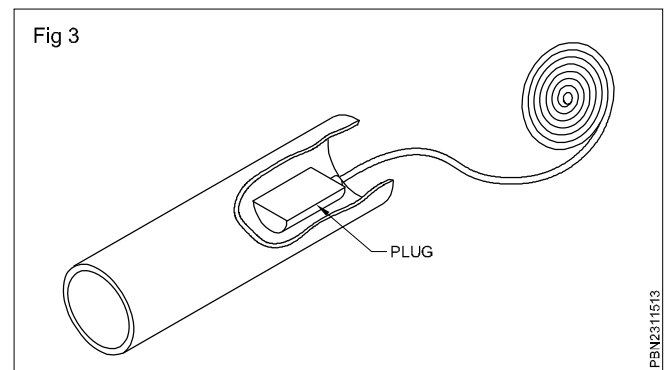
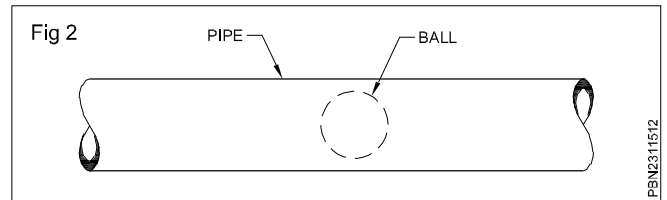
Mirror test : This test is applied to check the alignment and condition of the inside of the pipes. Two mirrors are used for the test. They are placed in position through across points and by looking at one of the mirror the condition of the bore of the pipe can be seen as the light is reflected along 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. The problem can be remedied by either. (Fig 2)

- realignment the pipe to the correct fall or
- removing the obstruction.

Alead slide or plug: Alead slide or plug can also be used to test for obstruction. Alead 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 markes and plug withdrawn. This will show exactly where the obstruction is (Fig 3).

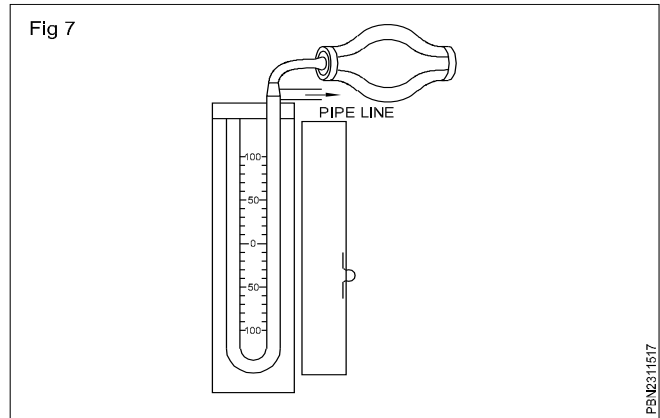
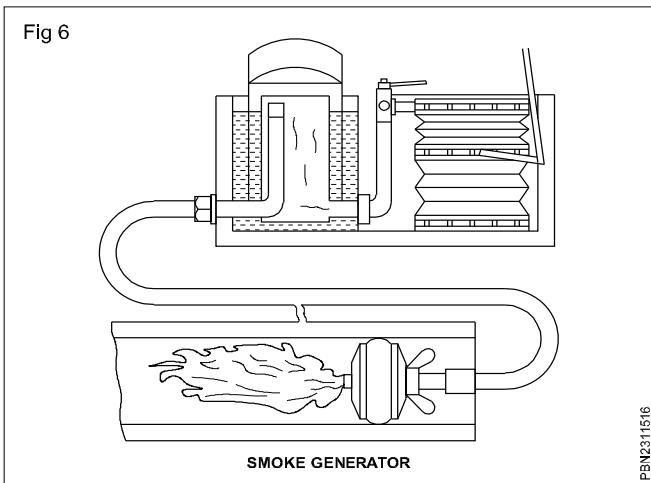
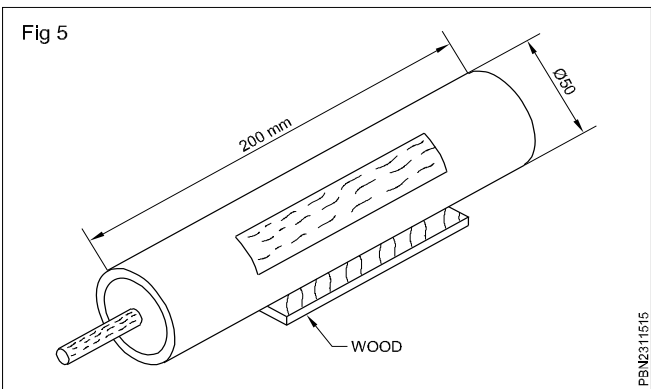
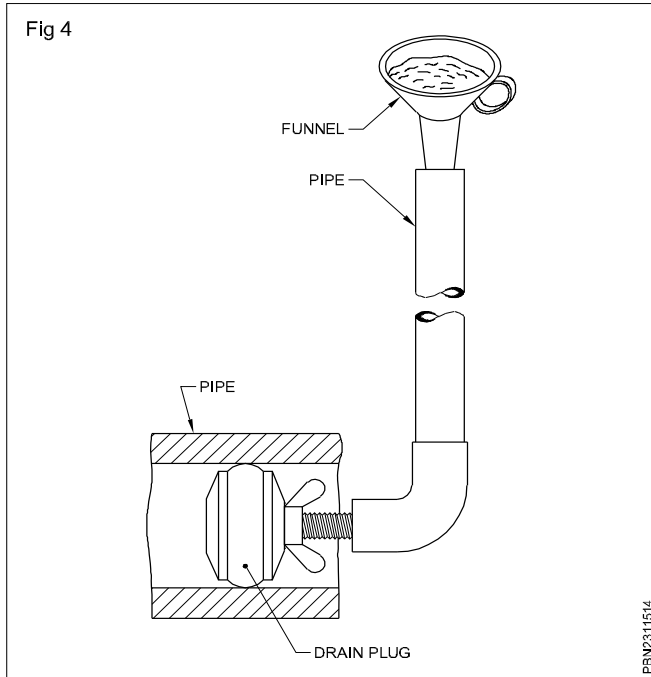


Hydrostatic or water test: The equipment required to conduct this test is drain plug/air bag stopper extrusion tubes, funnel and sight gauge.

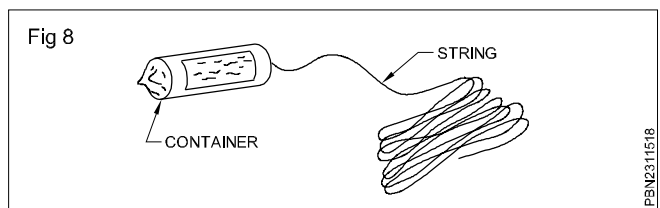
Find out from bylaw the minimum head of water required and duration of test which must be applied to the pipe work. Vertical pipes are temporarily installed on the top end of the installation to provide pressure or head on horizontal pipe and to record level of water. Coloured water test is similar to 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 for the testing of oider installation or 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 lit 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 till the required displacement reading according to local byways 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 7).



Chemical smell test: A small container filled with strong pungent chemical such as crude oil or paper 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)



Smoke-test: The test is performed for soil pipes, waste pipes and vent pipes laid above ground. The test is conducted under a pressure of 2.5m head of water and maintained for 15 minutes after all the trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper in the combustion chamber smoke machine.

Water-test: This test is performed for underground sewer pipes before back filling is done. Glazed ware and cement concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under test. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of ten minutes. The test should be carried out by suitably plugging the lower end of the drain and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Alternatively, the top end may be plugged with a connection to hose ending in a funnel which could be raised or lowered till the required head is obtained.

Testing of existing connection bath tub, wash basin and sink

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

- 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 concrete or granular material round the pipes, it should be tested.

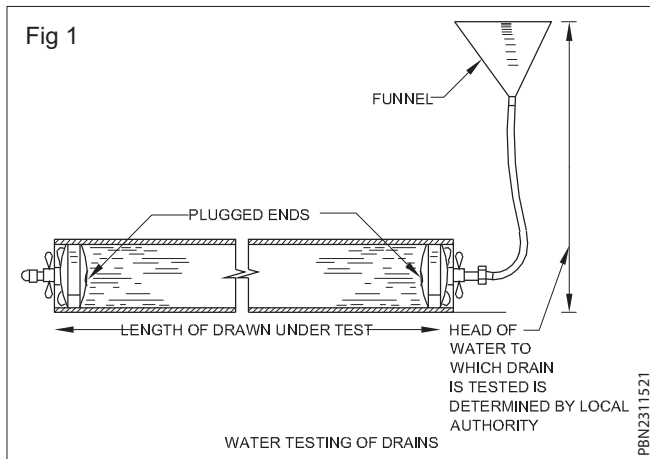
The three main methods of testing underground drains for soundness are :

- 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. Long branch drains and manholes should be tested separately. The test before backfilling should be carried out as soon as is practicable and the pipe should be supported to prevent any movement of the drain during the test.

Water Tests (Fig 1)



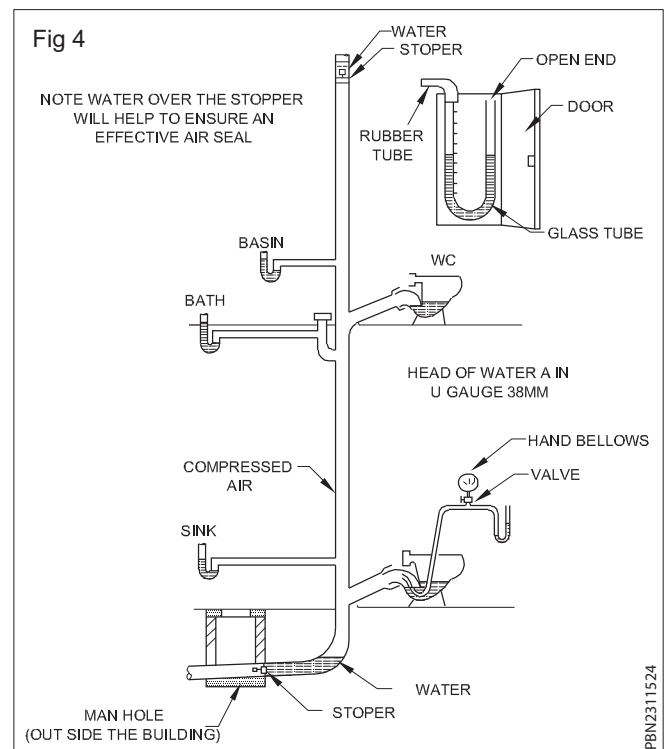
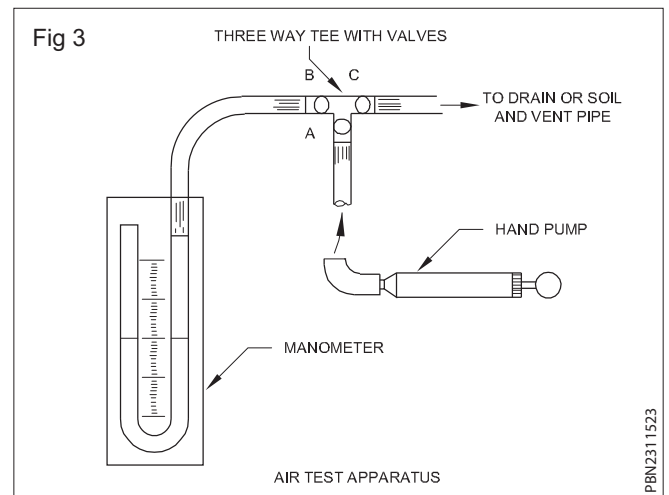
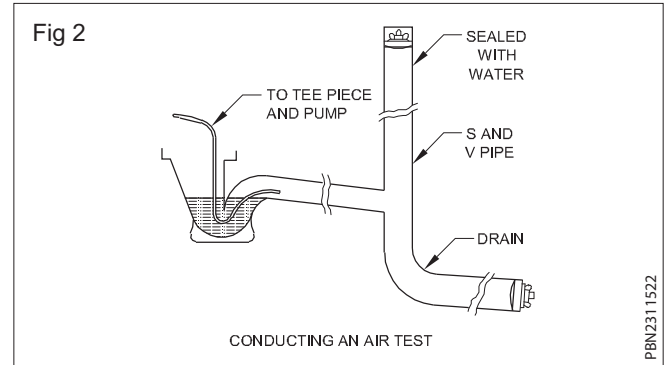
- 1 The drain should be filled with water, to give a test pressure equal to 1.5 m of water above the soffit of the drain at the high end, but not more than 4 m head of water above the soffit of the drain at the low end. Steeply grade drains should be tested in stages, so that the head of water at the 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. The fall of water needed in the vessel or stand pipe may be due to one or more of the following :
 - 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 per metre diameter, per metre run of pipe. For various pipe sizes the rate of loss per metre run during the 30 minute period is 0.05 litre for 100 mm pipe, 0.08 litre for 1.50 mm pipe, and 0.12 litre for a 225 mm pipe.

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

pressurised to 100 mm (as shown on a U-gauge) for 10 to 15 minutes, during which time 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, unlike water testing where the lower end is at a higher pressure than the inlet.

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.

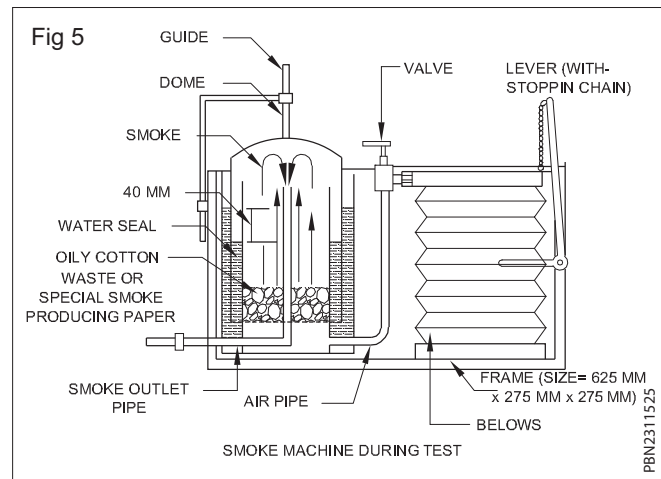
Air test on Soil and waste disposal systems

- 1 The building regulations require that soil and waste disposal systems shall be capable of withstanding an air or smoke test for a minimum of three minutes at a pressure equal to a head of water of 38 mm.
- 2 Before testing, insert stoppers at top and bottom of the stack. Pour water over the top stopper and flush one of WCs so that the bottom stopper is also sealed with water. Pour water in each sanitary appliance to ensure that the traps are sealed.
- 3 To carry out the test, pass the tube connected to the U gauge through the water seal in one of the WCs. Pump air into the pipework until the U gauge shows 38 mm water gauge. Allow a few minutes for the air temperature to stabilize. During the next three minutes the water level in the U gauge must remain stationary.

Smoke tests (Fig 5)

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.

Pipe bending

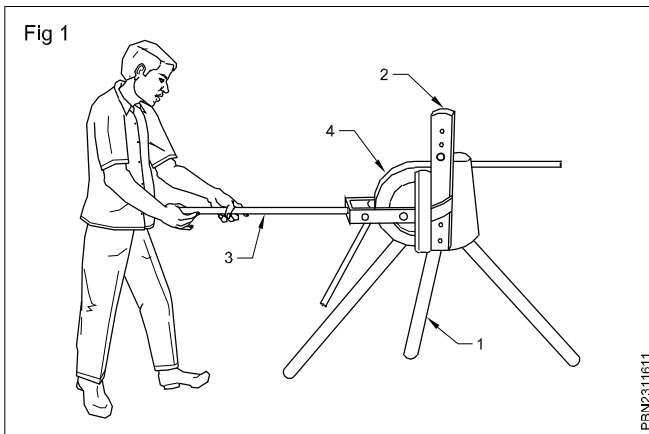
Objectives: At the end of this lesson you shall be able to

- identify the three most common pipe benders
- differentiate their constructional features
- name the parts of bending machines
- state the uses of bending machines.

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.

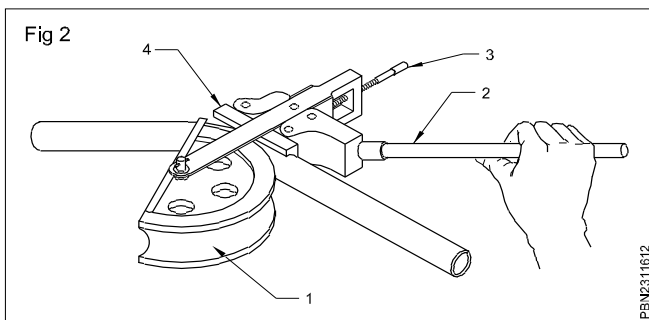
Portable hand operated pipe bender (Fig 1)



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

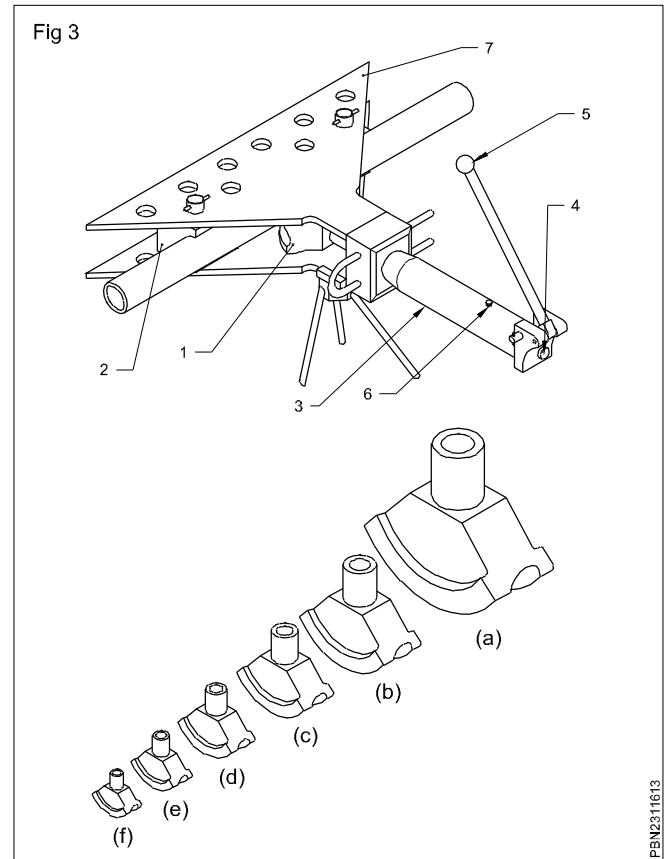
Bench type hand operated pipe bender (Fig 2)



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 former
- 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 75 mm 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 process
- state the bending of pipes by 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 : It is done by using various tooling. 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 and around which the pipe bend.

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. For small-diameter tubes, plugs of clay, rubber or hand wool may be used. Metal plugs are used for large size pipes. For removal the ends of plugs should extend from the pipe.

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.

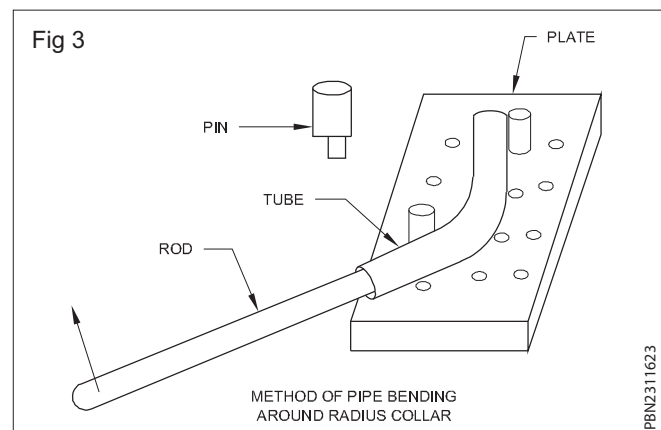
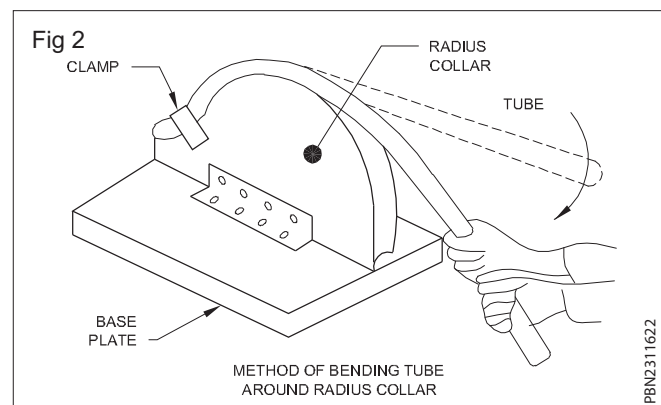
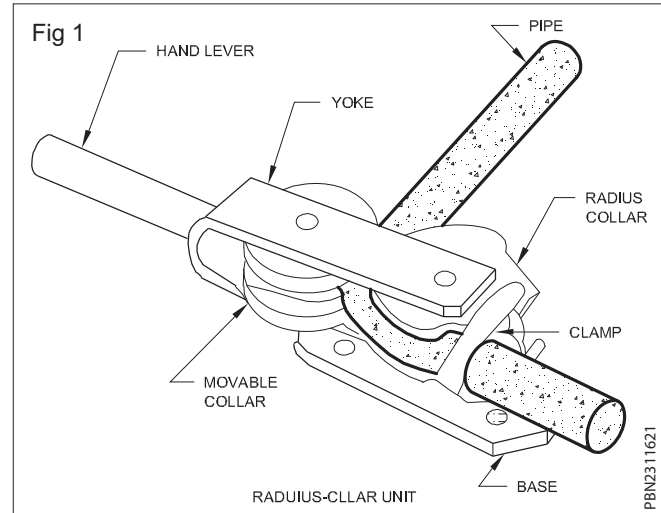
After bending the plugs are extracted or burnt out and the sand is removed. Poor compaction of sand and inadequate or non-uniform heating may cause the formation of folds or even cracking of the pipe.

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, 2 & 3)

The portable hand-operated pipe bender consists of the following parts.



Method of dismantling and renewal of the valves and pipes

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

- **remedy of spindle thread in urinal pipe**
- **remedy of the float has broken**
- **remedy of the wornout detective washer.**

Dismantling

The term dismantling implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified or according to the usage.

The demolition shall always be well planned before handling and shall generally be done in reverse order of the one in which it was constructed-it shall be

done in a systematic manner. Electric supply to be switched off before starting dismantling.

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.

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.	Stuffing box packing is dry. Spindle is bent.	Tighten the gland nut. Replace the spindle.
Spindle rotates continuously and the gate valve does not close.	Spindle thread is worn out badly.	Replace the worn-out part.

Repair of water supply fittings - Bibcock

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

- **state the common faults encountered in the functioning of bibcocks, their causes and remedies.**

Bibcock is commonly referred as tap and it is the most frequently used water supply fitting.

The defects commonly encountered during the functioning of taps, their causes and remedial measures to be taken are listed below.

There are taps of many designs available in the market. It is advisable to read the manufacturers' instructions also while repairing the taps.

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 tune off the tap.	Stuffing box packing is dry. Spindle bent.	Renew packing with greased hemp of some oil. Replace tap.
Spindle continuously slipping when the tap is turned and tap does not shut off	Spindle thread worn out	Replace tap
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.

Repair of water supply fitting-Flushing cistern and float valve

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

- list the common faults encountered in the functioning of flushing cistern, their causes and remedies
- list the common faults encountered in the functioning of flush-valves, their causes and remedies.

The commonly encountered defects during the operation of flushing cisterns and flush-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	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 valve junction	Checknut is loose, Checknut washer defective	Tighten the checknut. Replace washer
Flush 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

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

- identify the gate-valve
- state the constructional features of a gate-valve
- state the common defects in gate-valves, their causes and remedies.

Gate-valve

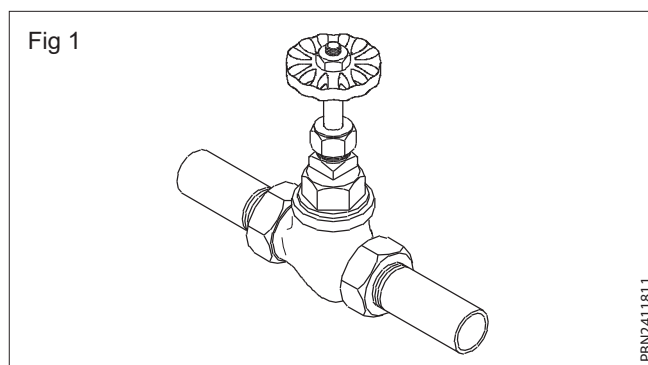
The gate-valve gets its name from the gate-like disc that slides across the path of the flow. This valve provides an unobstructed waterway when fully open. This feature makes the gate-valve useful in large piping installations. It is best suited for main supply lines and pump-lines. It should not be used to regulate flow. It should either be fully opened or completely closed.

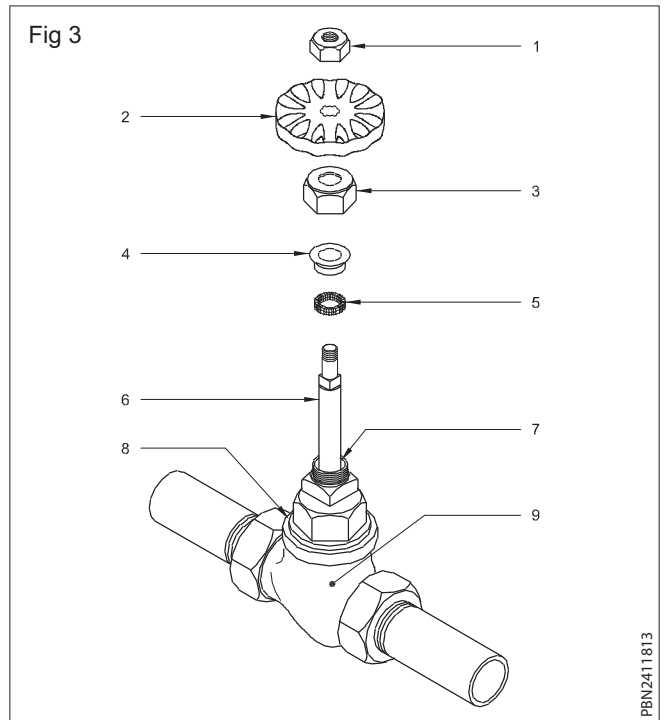
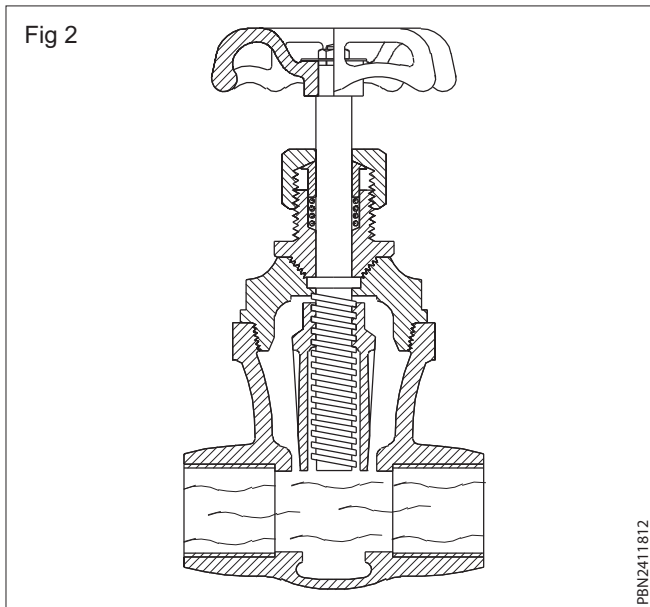
It is one of the most common valves found in a water distribution system. (Figs 1 & 2)

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



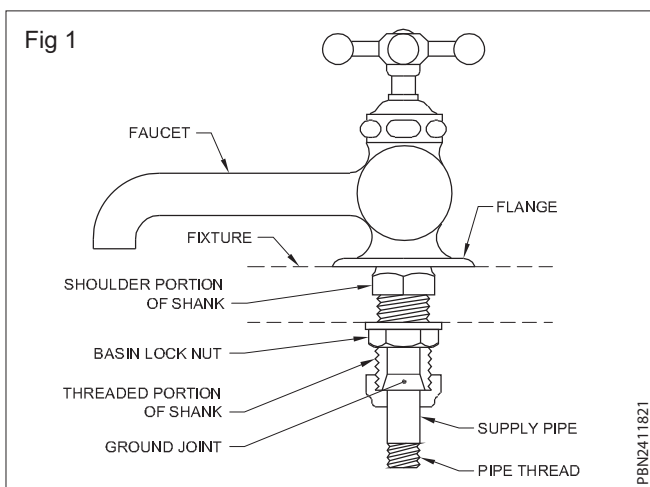


Repairing practice of pillar cocks

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

- state the pillar taps.

Pillar taps (Fig 1)



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.

Fixing of stop cocks

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

- identify the stop cocks.

Stop cocks

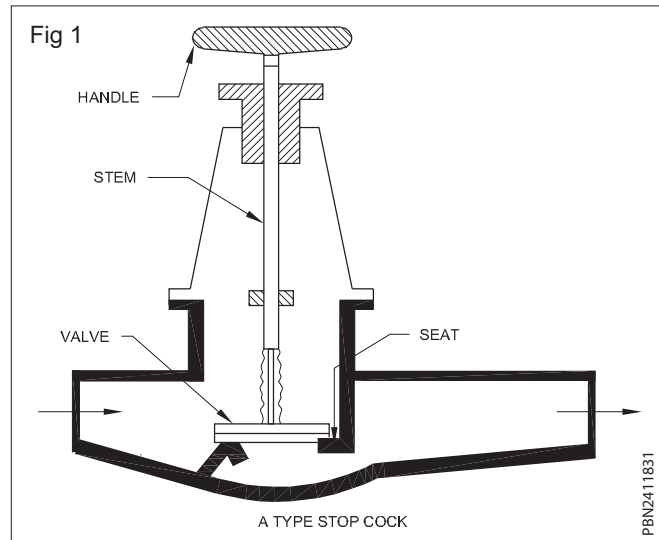
The stop cock is provided before the water enters the water meter in the house. It is housed in a suitable masonry chamber with a removable cover, and is fixed in the street close to the boundary wall in an accessible position. Sometimes, it is provided just before the water meter inside the house, keeping 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.

A typical stop cock is shown in Fig 1. The body of the valve is so cast that the water passes through an orifice when the

valve stem is raised. When the valve is closed, it rests against the seat, and thereby closing the orifice. They are extensively used in pipes upto 50 mm sizes.

Stop cocks are placed on water pipe leading to flushing tank wash basin, water tank etc.



Repair of water supply fitting-Stopcock

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

- state the common faults encountered in the functioning of stopcocks, their causes and remedies.

Stopcock is similar in construction to a bibcock except that it is placed in the pipeline instead of the outlet.

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 from the tap 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 Gland nut is loose The packing in the stuffing box is defective	Reseat tap Tighten the gland nut. Replace the packing.
It is difficult to turn on or tune off the cock	Stuffing box packing is dry Spindle bent	Renew packing. Replace cock
Spindle slips down continuously when the cock is turned and tap does not close.	Spindle thread worn out badly	Replace the stopcock

Leaks in pipes and noises in plumbing

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

- factors affection leaks in pipes and waste 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 check up 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.

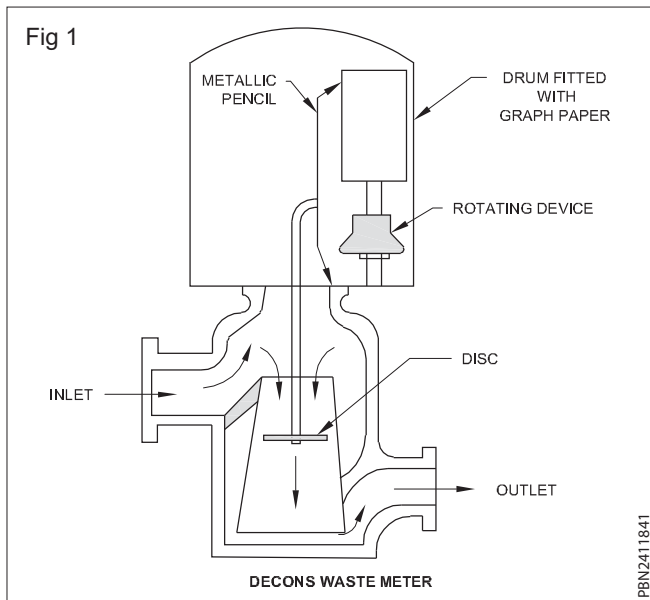
Metering: The wastage can be reduced by metering, because when the people will have to pay the cost of water on meter, they will leave their habit of wastage.

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 it can be immediately repaired with G.I pipe clamp and rubber padding. For more permanent repair it will need to 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 pipe 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 C.I collar and C.I cut pipe.

Leaking taps: It happens due to defective handle preventing washer from being pressed against a seat or washer has deteriorated or broken or seat is broken or pitted. 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.

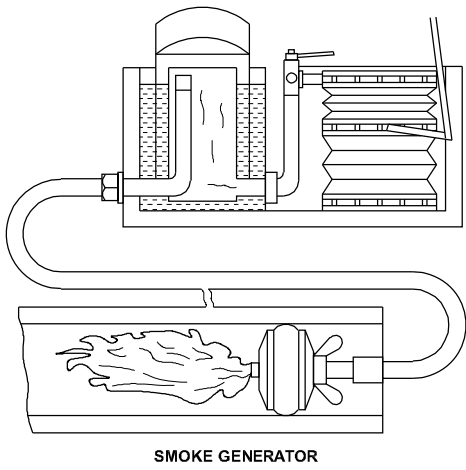
The valve consists of one or two floats inside the flow chambers. The air openings are provided at the top and the valve is connected to the main. Normally the float chamber remains full of water: but if the air fills it, the float falls due to decrease of water level above which opens the air opening 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 ballon 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).

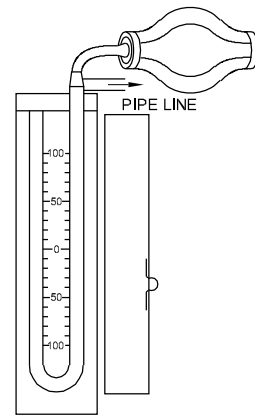
Chemical smell test: A small container filled with strong pungent chemical such as crude oil of paper mint is attached to a long length of string and flushed through a trap into the pipe work pulling on the string opens the container - leak is detected by smell (Fig 4).

Fig 2



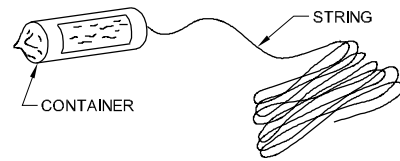
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Fig 3



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Fig 4



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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.

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.

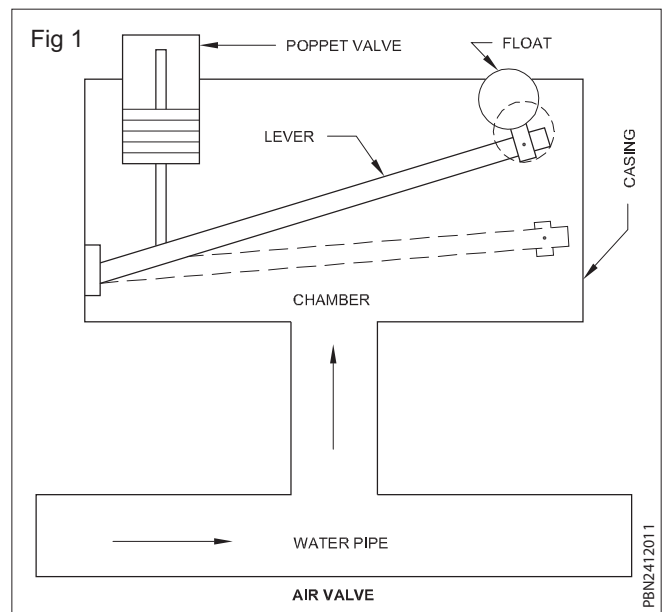
The provision of air valves along water pipe also helps in admitting air quickly when vacuum occurs in water pipe due to sudden breakdown of water pipe at low points.

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
• state water meter
• state venturi meter.

Watermeter

To determine the quantity of water flowing through pipes some devices are required which are called meter.

Meters can be classified as follows.

Positive displacement type

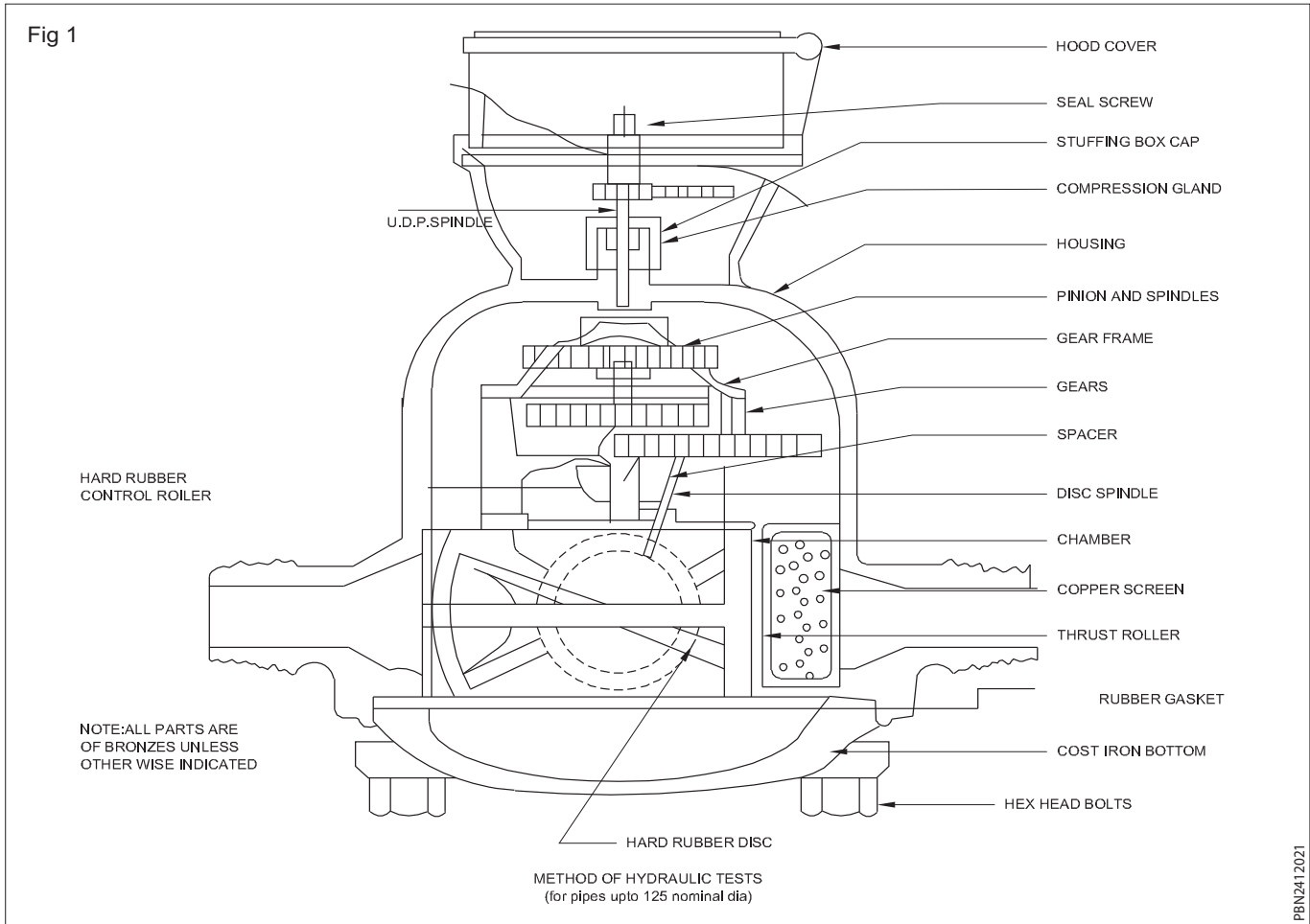
These are used for measuring small flow of water. These are designed on displacement principle and record the number of times a vessel of known volume filled and emptied. From this the rate of flow is calculated automatically. These types of meter includes rotary, reciprocating, oscillating and nutating 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 turbin 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. Two vertical piezometer tubs are provided one at the big end of short reducer and second at the junction of the small end. 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 size is based on the flow to be measured and not on the size of the main. The maximum flow should not be greater than the nominal capacity of the meter.

As the meter is not suitable for water containing sand, a filter or a dirt box is fitted on the upstream side of the meter is not a filter and does not prevent sand from entering.

The meter shall be installed in such a way that it is always full of water. If the meter body or adjustment pipes become partially drained of water, accumulated air passing through the meter will give inaccurate reading. It is desirable to have the meter kept below the level of the communication pipe. Where backward flows are anticipated, non-return or reflux valves are to be provided. A stop valve on the upstream side is to be provided to isolate the meter when needed. The meter is to be placed horizontally with the dial facing upwards. To avoid turbulent flow which affects the accuracy of the meter, straight length of pipes are used upstream and downstream of meter for an equivalent length of 10 times the nominal diameter of the pipes. 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)

Water meter boxes of the domestic type are covered by IS : 2104-1981. They are of two sizes, Size 1 and Size 2. 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. The boxes shall be of oval or rectangular shape. The boxes shall be made of any suitable material, such as cast iron, mild steel or reinforced concrete.

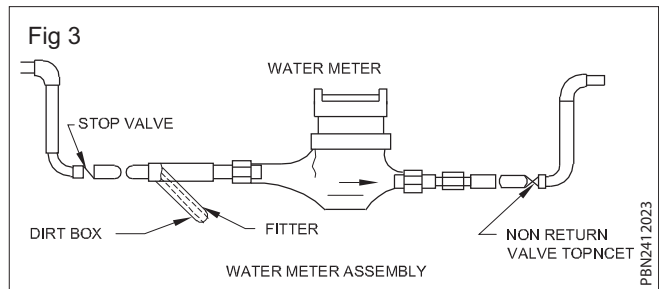
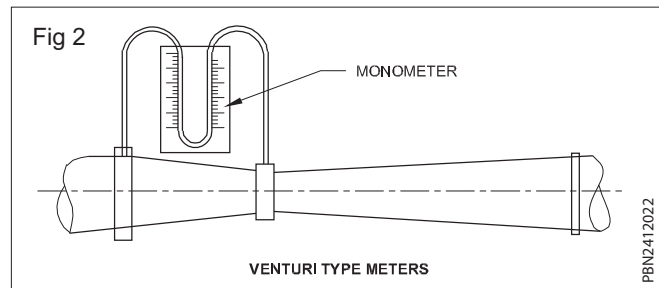


TABLE 1
Overall dimensions of Water meters

Nominal size of meter 1	Overall length including nipples 2	(All dimensions in millimeters)	
		Overall width (Max.) 3	Overall height (Max.) 4
15.....	250	130	180
20.....	290	130	180
25.....	380	140	200
40.....	430	230	250
50.....	470	250	300

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

Types of valves and cocks, materials and advantages

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

- state the sluice valve and check valve
- state the air relief valve, drain valve, gate valve, globe valve and mud 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 so many other purposes valves are required. Similarly in every house various types of fittings such as taps, bends, tees, sockets etc. are required for the distribution and forming network of pipes inside the houses. For each purpose some types of valve is best suited. Standard specification for the most commonly used valves are published by Indian Standard Institution.

General

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 doms covers 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 area of the water way of the fittings shall not be less than the area of the nominal bore of the pipe. 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)

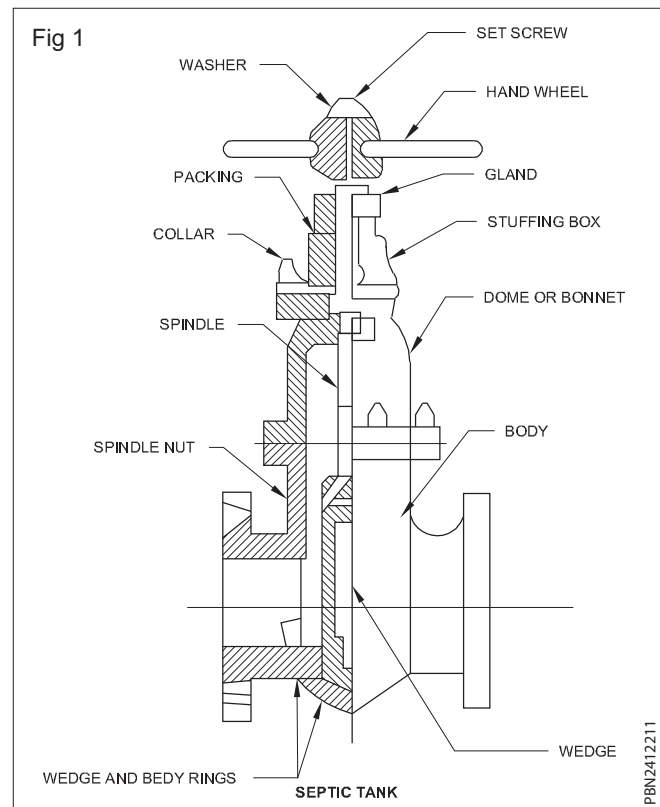
The fixing of the valve should be done by means of bolts, nuts and 3mm rubber insertions or chemically treated compressed fiber board 1.5mm thickness.

They are generally placed at a distance of about 150 to 250 m interval and at all junctions. Latest water supply and treatment manual recommends location of sluice valve at an interval of one kilometer on long straight mains.

Check-Valves

These are also called reflux valves or non-return valves and are automatic devices which allow water to flow only in one direction and prevent it from flowing in reverse direction. One such type of valve consists of a metallic disc hinged from the crown which fits tightly against the annular valve seat. The arrow indicates the direction of flow of water. When water flows, the disc rotates sound the hinge and remains in horizontal plane. The water therefore, passes off without any obstruction. Now if the

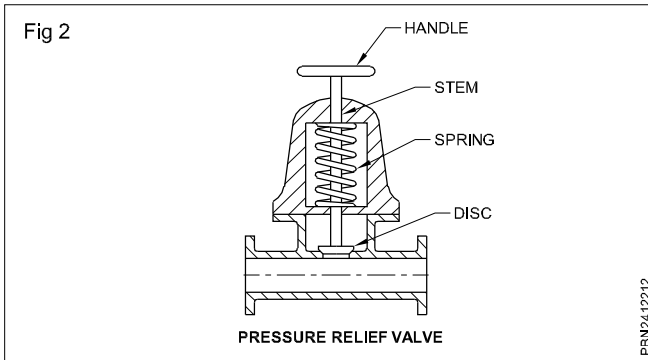
flow reverses, the disc automatically falls down by rotating round the hinge and remains tightly pressed against the valve seat by the pressure of water itself, in this way it does not allow the water to flow in reverse direction. Figure illustrates such type of check valve.



Air-Relief valves

When water enters in pipe lines, it also carries some air with it which tends to accumulate at high points of the pipe. When the quantity of air increases, it causes serious blockage to the flow of water. Therefore, it is most essential to remove the accumulated air from the pipe line. Air-relief valves are used for this purpose.

These valves consist of a cast iron chamber bolted on the pipe over the opening in the crown. A weighted float and a lever in it are so adjusted that when the chamber is filled with water under pressure from the pipe line below, the float and the lever remains raised up preventing the flow of water through the valve. But when air goes on accumulating at the top and builds up some pressure the water level gets depressed and the float sinks down with the lever and opens the valve. The accumulated air escapes out through the opening. Thus these valves are automatic in action. Fig 2 shows two types of air-relief valves.



Scour valve or drain valve

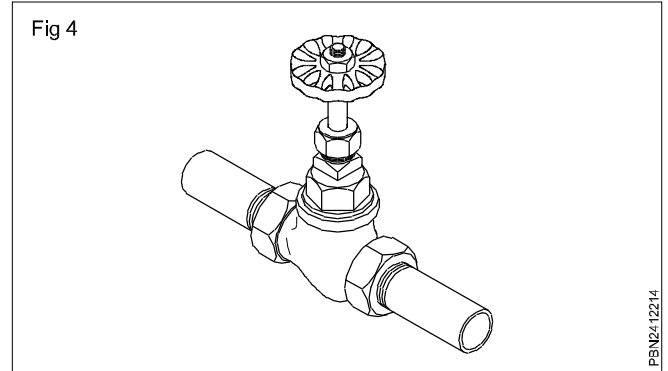
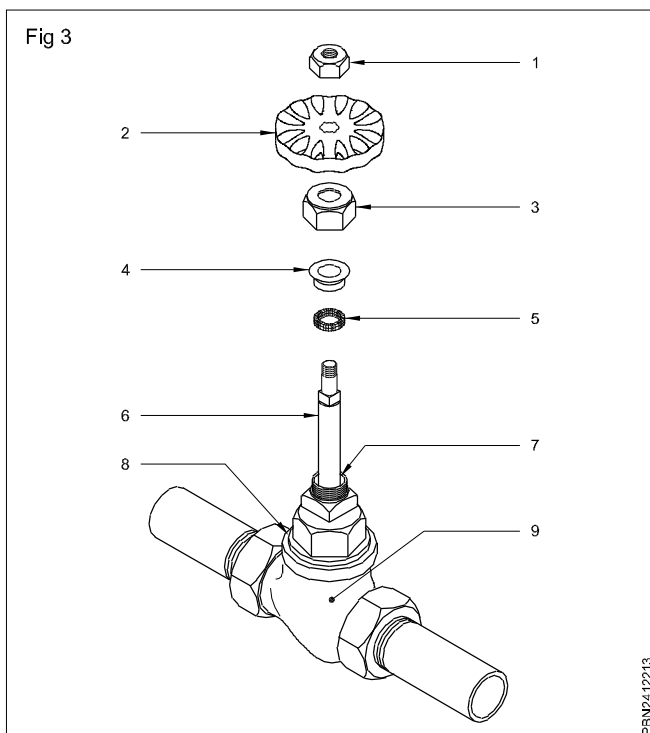
In the summits of main it is possible that some suspended impurities may settled down and cause obstruction of the flow of water. In the distribution system at dead ends, if water is not taken out it will stagnate and bacteria will be born it. To avoid the above difficulties drain valve (sluice valve) are provided at all such points. These are also called blow off valves. At the summit of main pipes a branch is taken off from the lowest point, in which drain valve is fixed. When sluice valve is opened the water rushes out thus removing all the salt, clay etc. from the main line.

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 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.

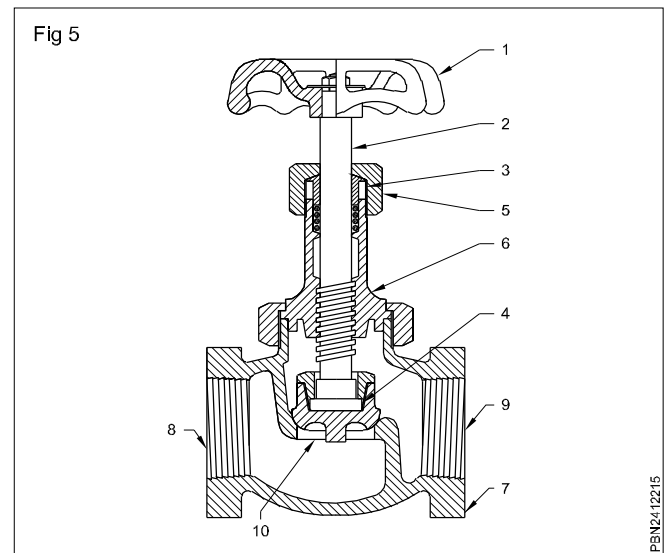
Globe valve (Fig 3 & 4)



This valve is used in distribution system. They are usually made of brass. Globe valve is the most common type of valve. It is used on pipes 10 cm in diameter or small. The wash basin, kitchen sink, showers and bath tub, etc. are all supplied with water, whose flow is controlled by globe valve. In its simplest form it is shown in Fig 3. It consists of a disc which is forced down by a screw against a circular seat. The disc and the screw, form a single moving part in the smaller valves, but in some modified forms, the disc is free to pivot on the end of the stem. Globe valve is economical, versatile, durable and simple. Heat operated globe valves are less expensive than gate valves of the same size. Its greatest disadvantage is the loss of head due to tortuous passage of the valve.

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.



Other types of valves

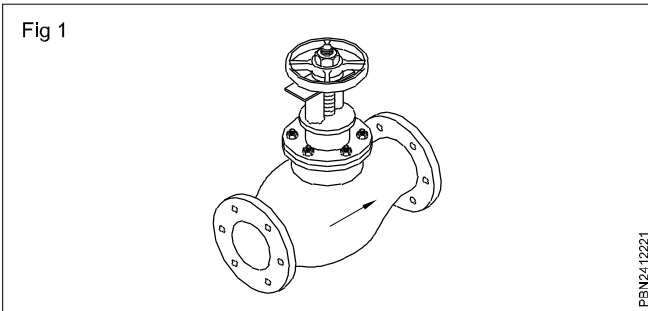
Butterfly valve, shear gate valve, scour valve and so many other types of valves come under this head. These valves are used only under special circumstances. Operation of these valves is simple and can be understood from the figure itself.

Globe valve - parts - advantages

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

- name the parts of a globe valve
- state the advantages of a globe valve
- state the constructional features of a reseating tool.

Globe valve (Fig 1): 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 2)



The upper side of the opening is ground smooth.

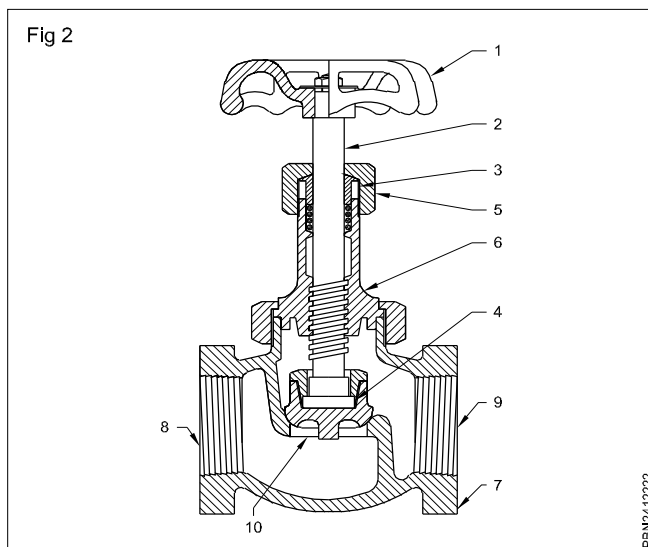
A rubber disc or metallic disc is attached to the end of the stem which presses down against the smooth opening when the handle is turned clockwise. This closes the valve and stops the flow.

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.

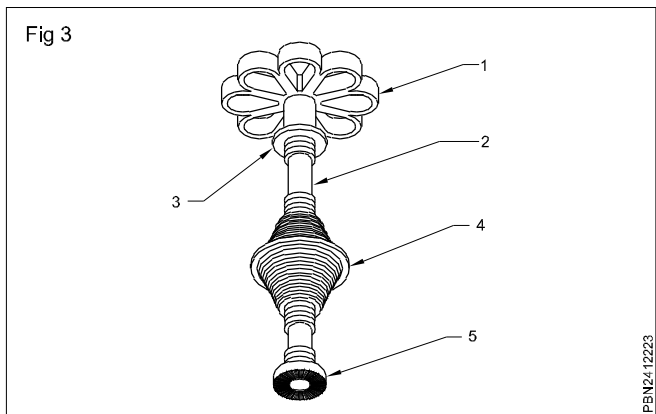
- The critical parts such as washer, seat and packing can be replaced.
- The valve permits accurate control of the flow of water.
- The valve can be used repeatedly, because it can be repaired easily.

The globe valve consists of the following parts. (Fig 2)



- 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 3): The parts of a reseating tool are as follows.

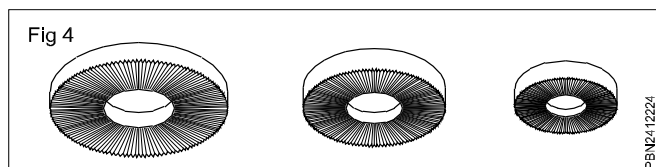


- 1 Hand wheel
- 2 Shaft or stem cone
- 3 Feed screw or collar
- 4 Tapered adapter
- 5 Cutters (inter-changeable)

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 4)



Non-return valve/check valve

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

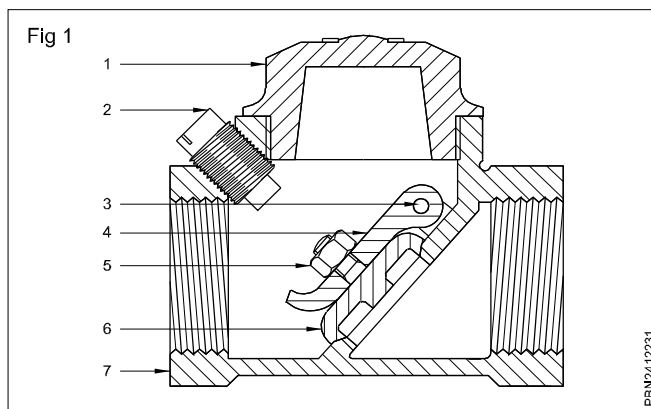
- name the parts of a non-return valve
- state the working principle of a non-return valve
- differentiate between swing and ball type check valves.

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.

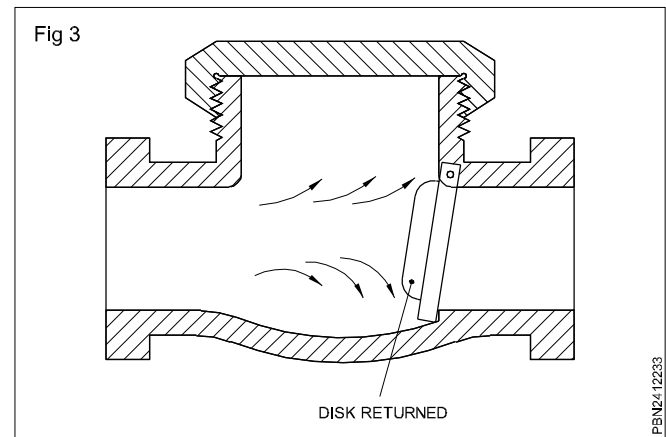
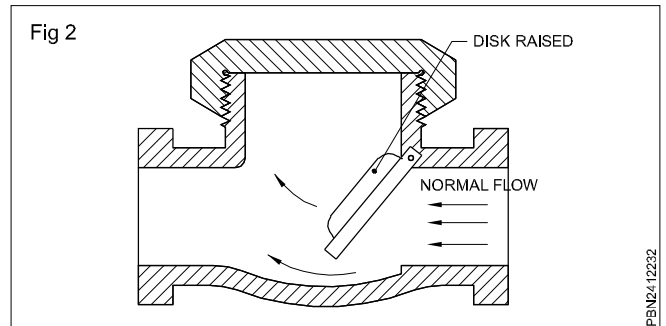
Sometimes two or more different kinds of materials are used on a single valve. There are many types of check valves available in the market.

The swing check valve consists of the following parts. (Fig 1)



- 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 2 & 3)



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.

Valves and flange joints

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

- state the use of a flange joint
- identify the different types of valves
- compare the constructional features of different valves
- state the uses of valves
- differentiate between a plug-cock and a stop cock.

Flange joints: These may be used to connect two lengths of pipes together. The flanges may be fitted by screwing, welding or bonding to the pipe (Fig 1)

Flanges are used to connect pipes and control valves or they may be used to connect two lengths of piping together. (Fig 2)

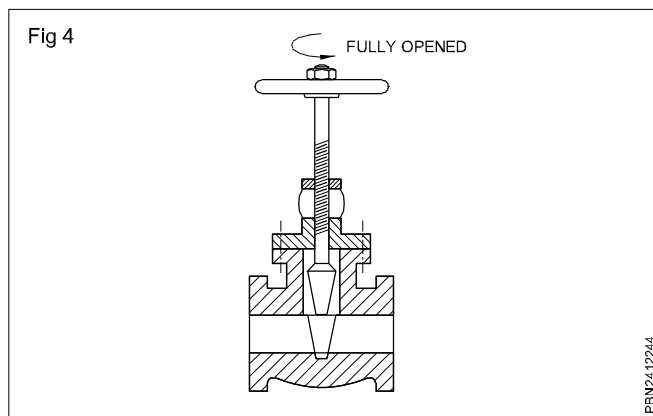
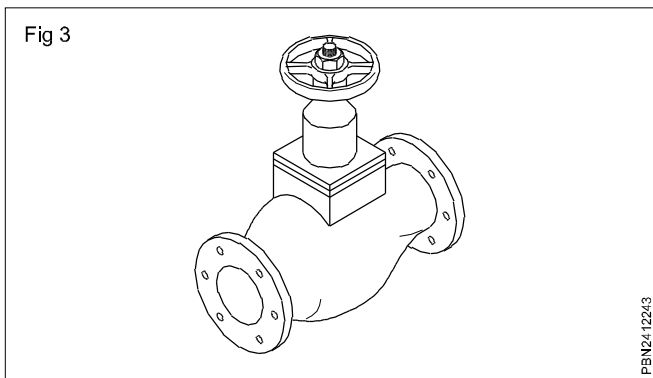
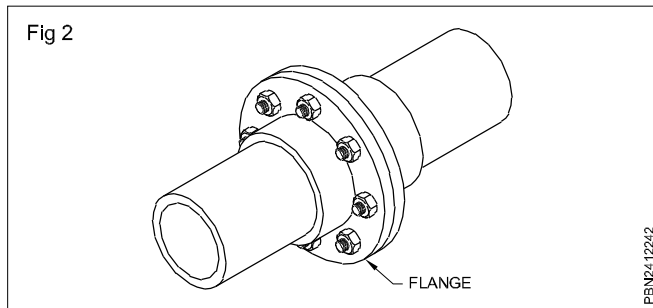
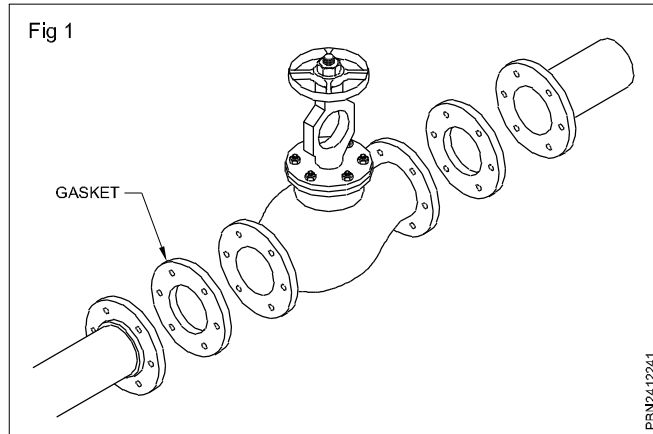
Valves (Fig 3): The function of the valve is to stop or regulate the flow in a pipeline.

Valves are made from cast steel, cast iron, stainless steel, brass or plastic depending on their applications.

Gate-valve: It is the most common type of valve. It is not used to control flow. It is kept in either a fully open or a fully closed position. (Figs 4 & 5)

Globe valve (Fig 6): It is so called because of the shape of its body. This valve is suitable for flow control. The flat disc travels only a short distance from the fully opened to

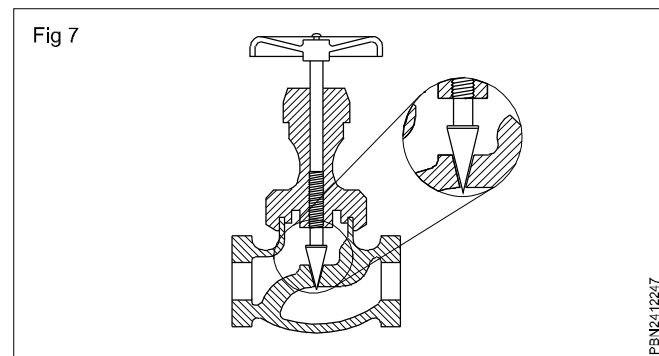
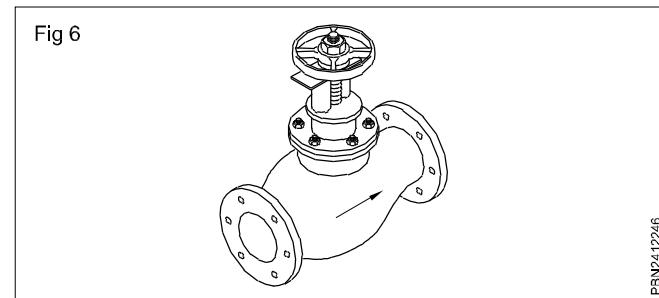
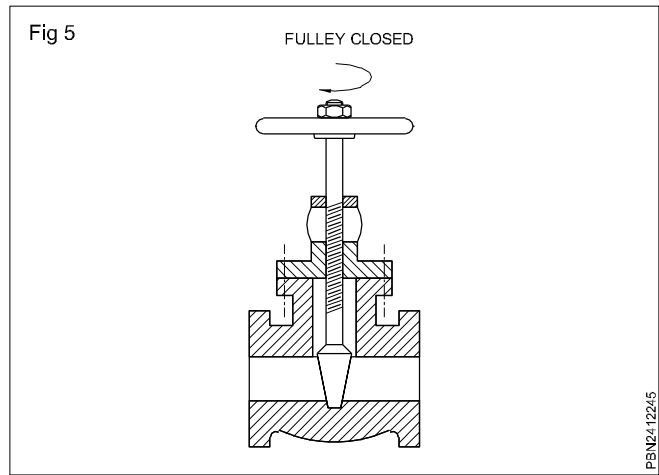
the fully closed position. The incoming pressure of water is usually under the seat.



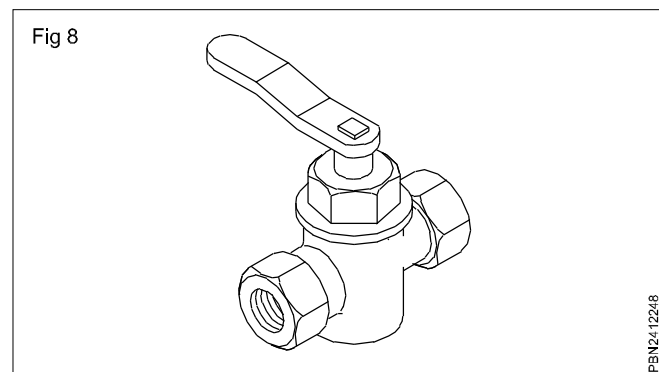
The direction of flow is always indicated by an arrow on the side of the valve.

Needle valve (Fig 7): The needle valve resembles the globe valve in outward appearance and is used to obtain a fine degree of control over the flow in the pipe.

The fine control is achieved by means of a tapered needle.

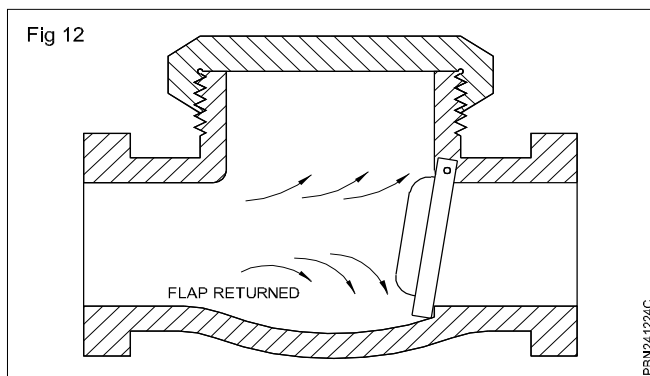
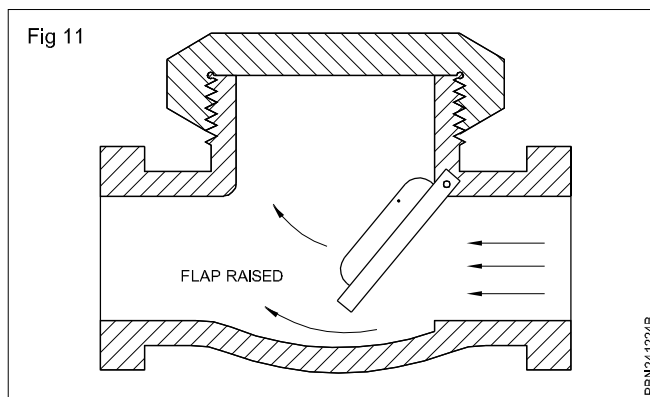
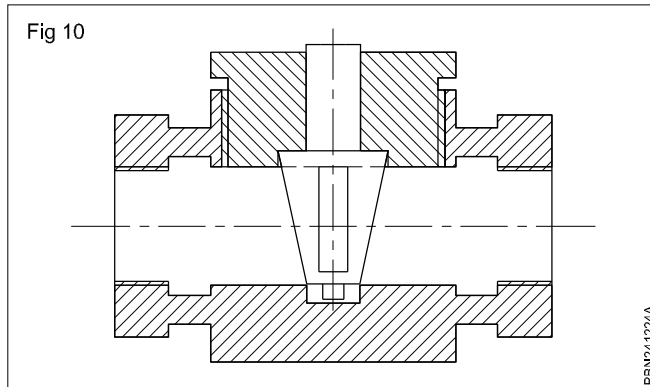
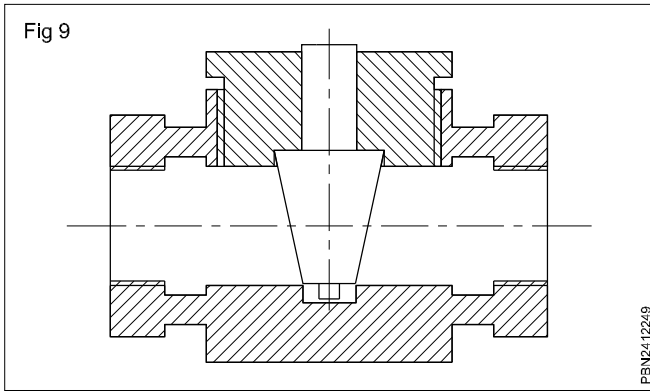


Plug-cocks: Plug-cocks are suitable for high pressure applications. A parallel, tapered or spherical plug, pierced with a hole equal in area to the bore of the pipe, is turned in the body to permit or prevent flow from one side of the plug to the other. (Figs 8,9 & 10)



Non-return valve: The non-return valves are sometimes called check-valves. They are used to prevent the build up of back pressure in a pipe line.

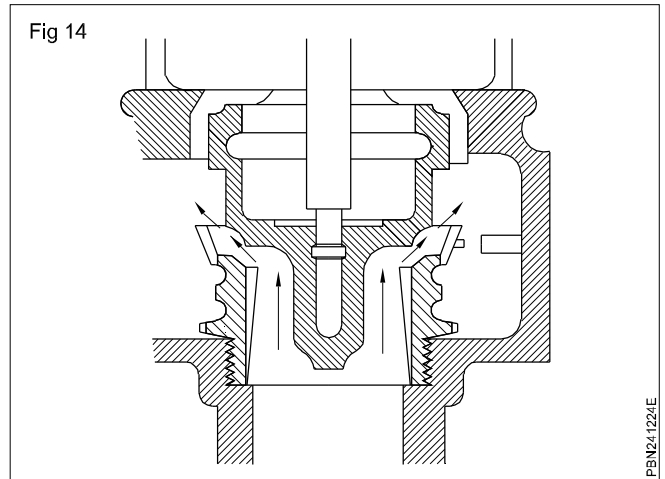
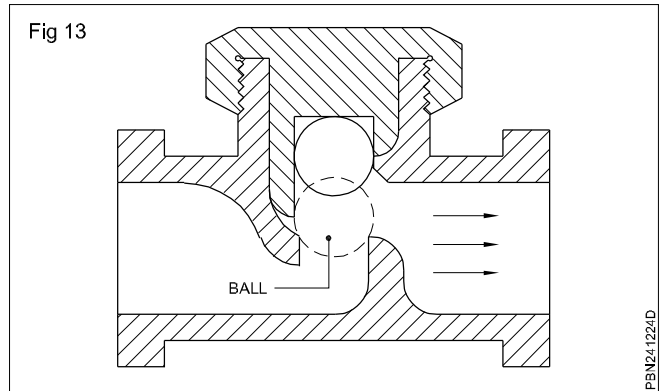
The flow in one direction opens the flap. The return of the flap to its seating prevents flow in the reverse direction. (Figs 11 & 12)



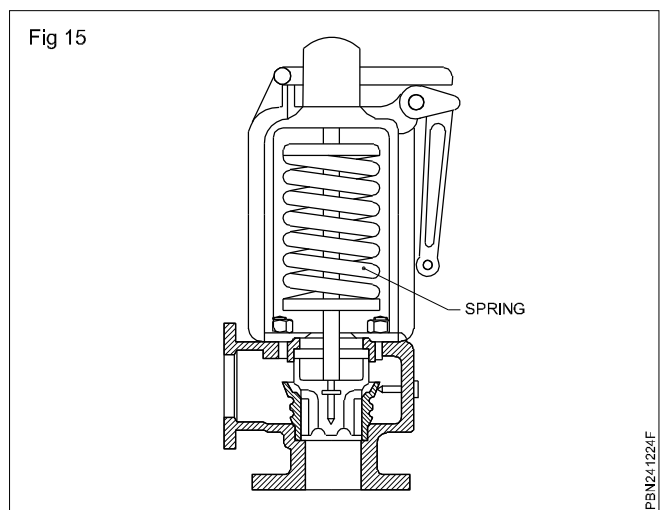
Ball check-valves: It serves the same purpose as non-return valves but balls are used instead of flaps.

The flow in one direction lifts the ball. When the pressure is released the ball falls against its seating, resisting the reverse flow. (Fig 13)

Relief valves: Relief valves are safety devices. This valve is held closed by a spring until a preset pressure is reached. At this pressure the valve opens, allowing the gas or fluid to escape and reduce the pressure in the line. (Fig 14)

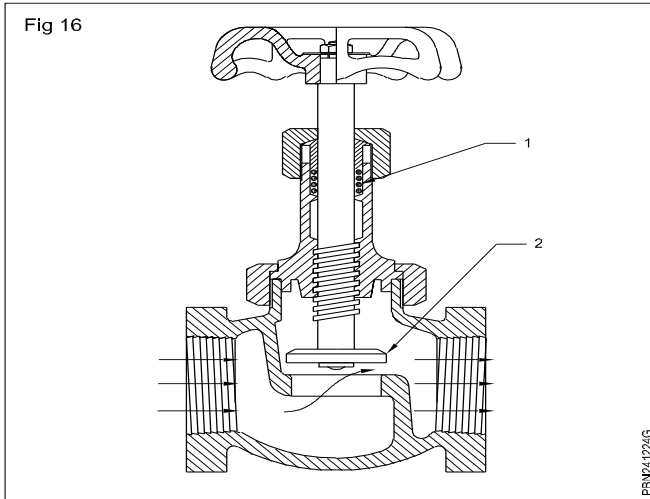


When the pressure has dropped enough, the spring will automatically close the valve again. (Fig 15)



Stop cock (Fig 16): It is a compression type valve. It controls the flow of water by means of a circular metal disk-holder. This disk-holder has a rubber washer which is forced on to or withdrawn from, an annular ring, known as seat. This seat surrounds the opening through which the water flows.

The packing for the shaft and the rubber washer on the metal disk-holder are to be properly maintained to get a leak-proof assembly.



Types of valves and fittings

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

- explain the types of valve
- explain the function of the valve
- know the parts of valve.

General: 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.

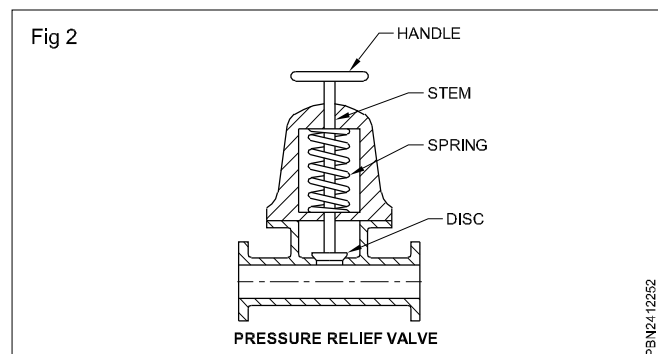
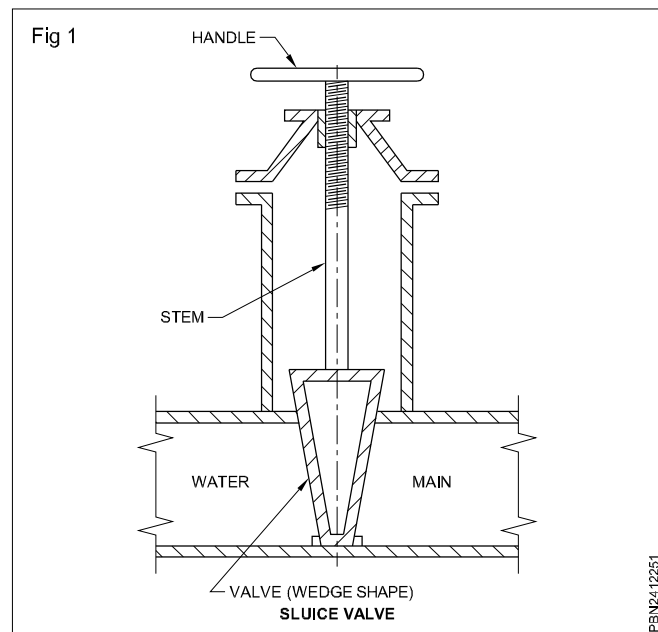
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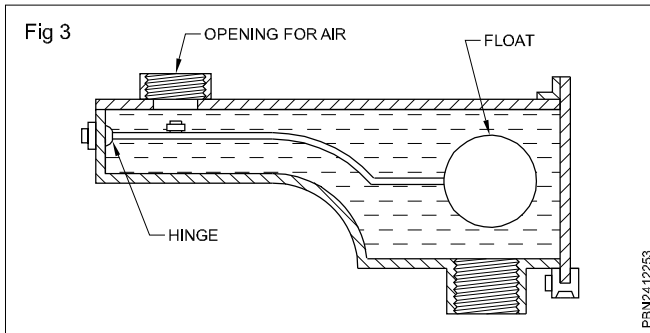
The fixing of the valve should be done by means of bolts, nuts and 3mm rubber insertions or chemically treated compressed fiber board 1.5mm thickness.

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 consist 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 relived through cross pipe after the disc comes down automatically due to force of spring these are also called flux valve or non return valve and are automatic devices which allow water to flow only in one direction and prevent it from flowing in reverse direction.

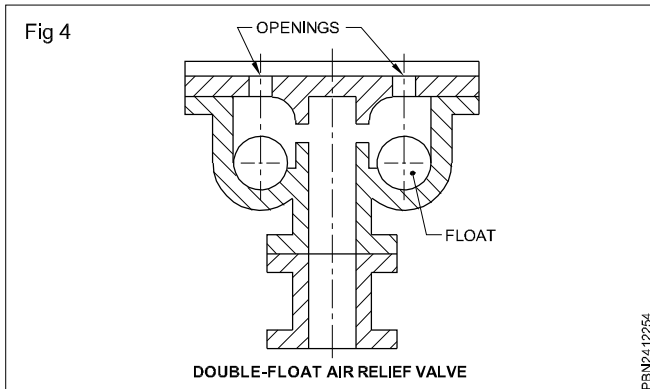
Air relief valve: When water enters in pipe lines, it also carries some air with it which tends to accumulate at high

points of the pipe. When the quantity of air increase it causes serious blockage to the flow of water. Therefore it is most essential to remove the accumulated air from the pipe line. Air relief valve are used for this purpose. (Fig 3)



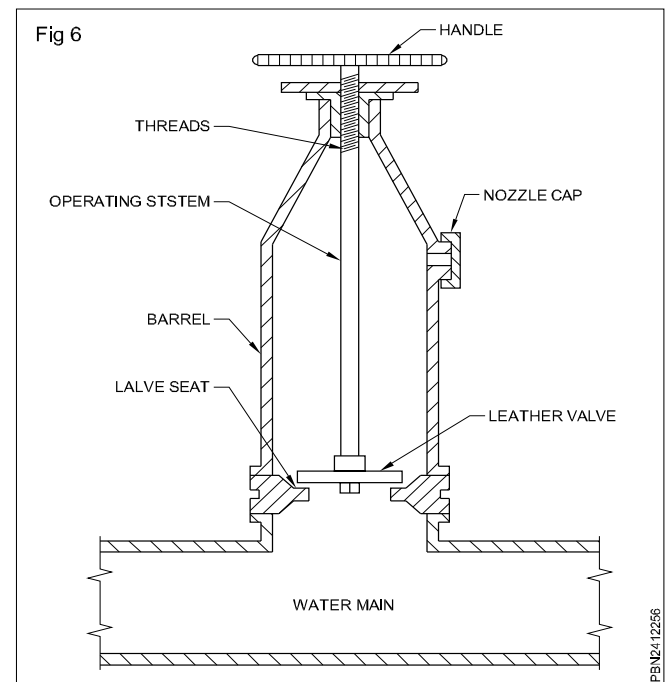
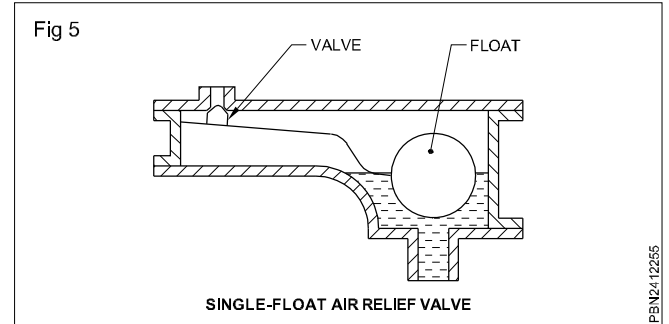


These valve consists of cast iron chamber bolted on the pipe over the opening in the crown. A weight float and a lever in it are also adjusted that when the chamber is fitted with water under pressure from the pipe line below, the float and the lever remains raised up preventing the flow of water through the valve. But when air goes on accumulating at the top and builds up some pressure the water level gets depressed and the float sinks down with the lever and open the valve. The accumulated air escapes out through the opening. The water level with in chamber again rises, rising, the float with it and the valve gets closed. Thus these valve are automatic in action. (Fig 4)



Scour valve or drain valve: In the summits of main it is possible that some suspended impurities may settle down and cause obstruction of the flow of water. In the distribution

system at dead ends, if water is not taken out it will stagnate and bacteria will be born it it. To avoid the above difficulties drain valve (sluice valve) are provided at all such points. These are also called blow off valves. At the summit of main pipes a branch is taken off from the lowest point, in which drain valve is fixed. When sluice valve is opened the water rushes out thus removing all the silt, clay etc. from the main line. (Figs 5 & 6).



Valves

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

- define the water hammer and air lock
- list out the types of valves, uses and their function.

Valves are provided in the pumping systems for efficient running and maintaining and controlling the discharge.

They are made of brass, gunmetal or other corrosion resistant alloy.

Foot valve: Foot valve is provided at the bottom of suction pipe for holding the water in the suction pipe.

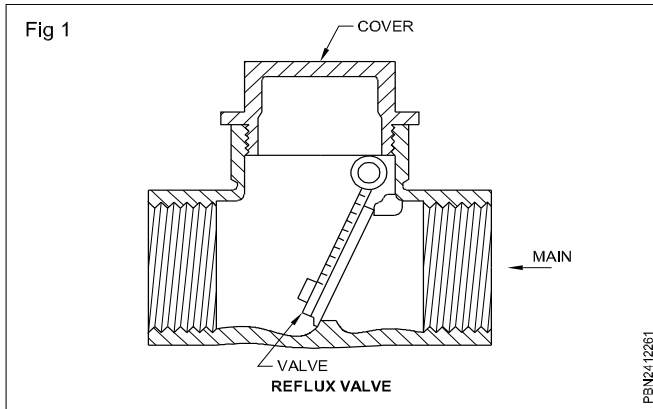
Reflux or non-return valve: This valve is provided at intervals in long mains to prevent back pressure on the pump and in rising mains to prevent back flow. (Fig 1)

The reflux valve consists of a flat disc within the pipeline, pivoted in such a manner that it opens in one direction and shuts automatically against a gunmetal seating to check back flow. It operates by pressure alone.

Gate valve: It is provided to close the pipe during repair of the pump. It should be always provided together with a union or long thread nipple.

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 inside the flow chambers. 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.

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.

Flush and float valve

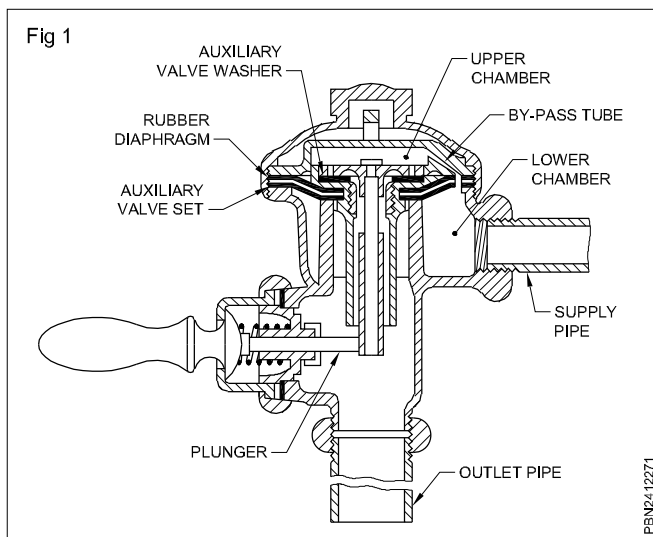
Objectives: At the end of this lesson you shall be able to

- specify flush valve and float valve
- explain the functioning of a flush valve and float valve.

Flush valve: Flush valve is non-automatic type of valve. It is widely used in the water supply system for flushing Bowls.

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 1)



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.

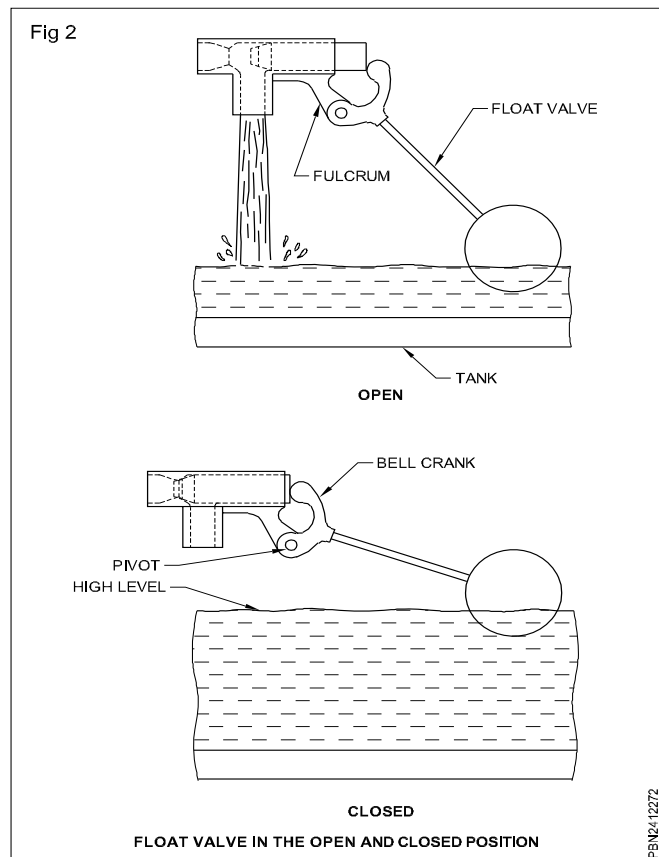
The pressure on the lower side of the diaphragm than overcomes the reduced pressure in the upper chamber and raise the entire assembly of working parts (auxiliary valve, disc, diaphragm and guide). This allows the water in the lower chamber to spill over into the outer pipe and flushes the closet bowl. 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.

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 2)



The rising level of the water causes the automatic action during the filling of the cistern/tank. The water carries with it a float made of copper/PVC etc. and tied to a rod and valve.

The valve closes the water supply when the water level reaches the pre-determined height. When the water is discharged from the cistern/tank, the float comes down by gravity and the valve opens by the pressure of water (Fig 2).

Cocks

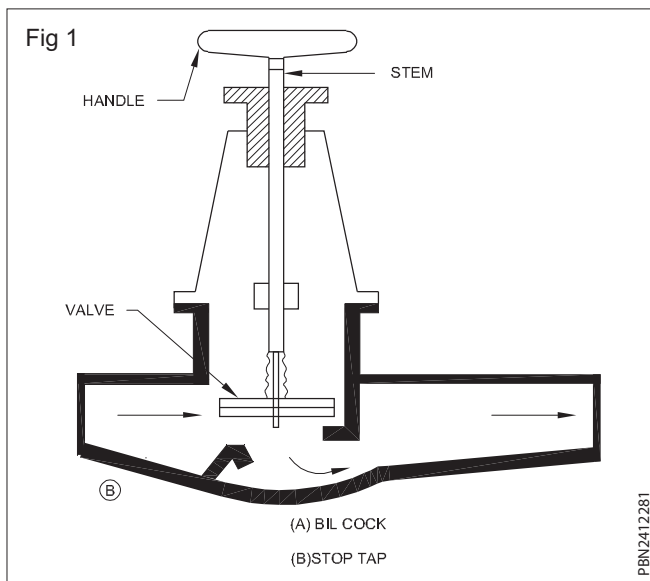
Objective: At the end of the lesson you shall be able to

- state stop cock and water tap.

A stop tap is a valve with suitable means of connection, for insertion in a pipe line for controlling or stopping the flow. The standard size of a bib tap or stop tap should be designated by the nominal bore of the pipe outlet to which the tap is to be fitted. Bib taps and stop taps shall be of following sizes. 8mm, 10mm, 15mm, 20mm, 25mm, 32mm, 40mm and 50mm. Washers for cold water taps shall be specially selected leather, rubber-asbestos composition or other equally suitable material.

The Bib cock may also be of push type. They operate automatically. They open out when a slight push is given and close as soon as the push is removed. The bib cocks should be water-tight. Leaky bib cocks are the source of waste water.

Stop cock (Fig 1)

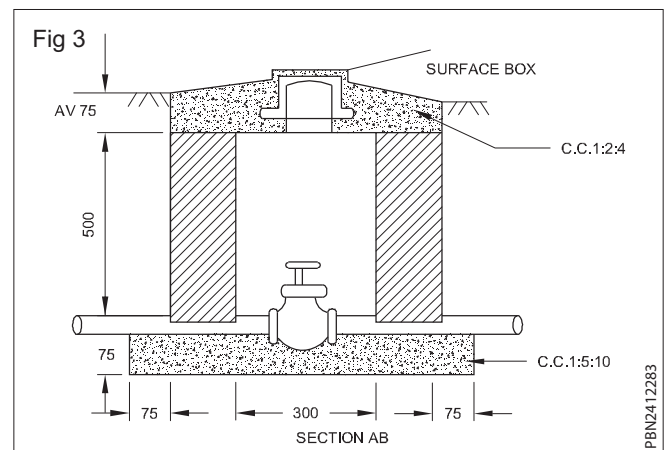
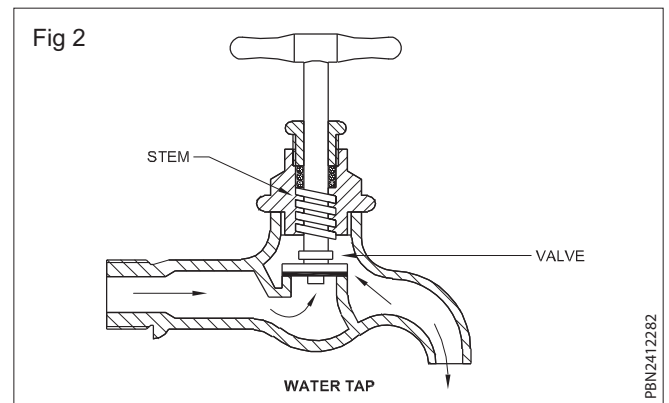


It is generally of chromium plated brass. Pillar taps of other materials are also available in market. The size is designate by the nominal bore of pipe outlet to which the twp is to be fitted. The weight of CP brass pillar tap of 15mm and 20mm are 650gm and 1175gm respectively. Pillar tap should withstand an internally applied hydraulic pressure of 20 Kg/sq.cm.

Towel rail : Different types of towel rails are available like CP brass, aluminium, acralic etc. There are to be fixed with CP brass screws using ravel plug embedded in wall. It is fixed at 1100mm from floor level.

Shelf : Glass shelves (60x12cm and 5.5cm thick) with CP bracket, PVC shelves are available. These shall be fixed with CP brass screws to rawel plugs embedded in the wall. It is fixed at 300mm above wash basin top level.

Mirror : General size of mirror is 60x45 with 5.5 mm thickness. Backing of mirror to be chosen from environmentally friendly material other than asbestos cement sheet and it shall be non water absorbant materials. Edges of mirror is to be sealed to prevent entry of water/vapour. Mirror taps are fixed at a height of 1700-1750 from floor level.



Stop-Cock and Water tap (Figs 2 & 3)

These are generally provided inside the buildings and in streets for taking water. Large number of firms manufacture varieties of stop-cocks and water-taps. The most common types of stop-cocks and water-taps are shown in figure Street stand posts should be provided with self-closing tap to prevent under wastage of water.

Merit of cocks and valves

Objective : At the end of the lesson you shall be able to

- **explain the merit of cocks & valves.**
-

Globe valves

Precise regulation qualities, characteristics can be tailored to application, safe and reliable handling of high differential pressures, Multi-stage pressure relief possible, low noise internals easy to equip, pressure relieved closure elements for low actuating forces possible, low leakage or even complete tightness easy to achieve, No problems with high switching cycle frequency.

Low valve flow rates, large space requirements

Cocks

Small dimensions, extremely large flow, free flow passage possible, tight closing.

Precise control carefully possible, high rate of wear, replace of wear parts relatively difficult.

Butterfly valves

Simple in design, low space requirements, low in weight, high flow rate, largely free of dead pockets, large nominal diameters possible.

Only relatively small differential, pressures possible, High possible leakage rate, non-modifiable flow characteristics, high actuation forces.

Gate valves

Low pressure loss, robust, accessible to cleaning/inspection "Pigs", tight sealing large stroke, high actuation forces, large height, large dead pockets, control possible only to a limited extent.

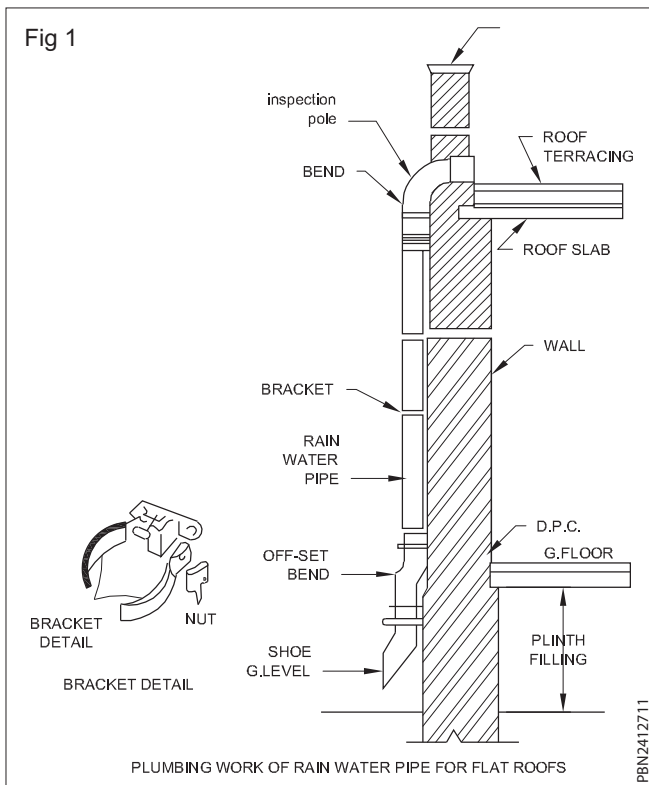
Erecting rain water and drainage pipe system

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

- state the installation of rain water pipe from roof to ground
- fix the rain water gutter with 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.



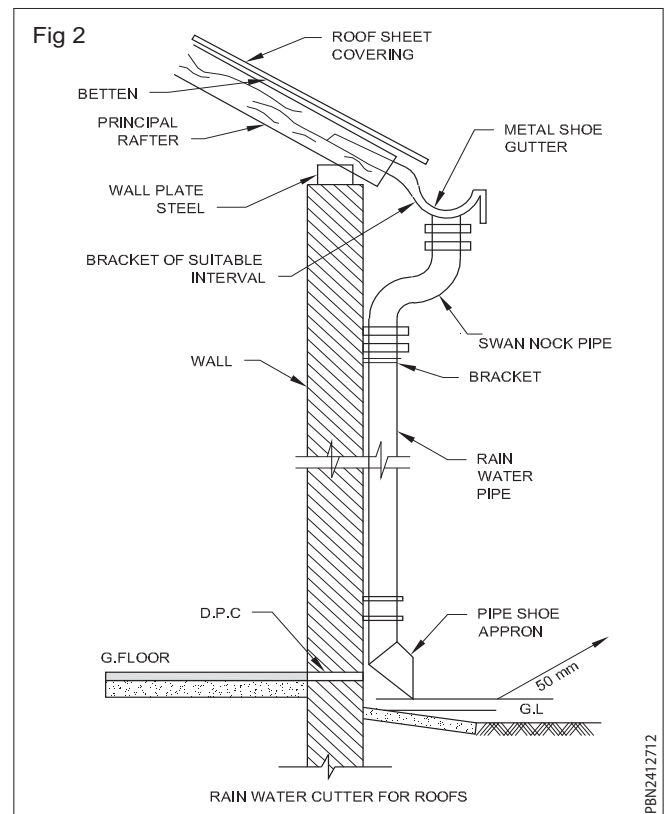
The rain water pipes shall be fixed to the outside of the external walls of the building or in recesses or chase cut or framed in such external walls or in such other manner as may be approved by the administrative authority.

(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
		Roof area in square metres					
1	50	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 Correct threading, the same which is on the specials should be done on the pipes.
- 2 All the joints should be made water-tight by wrapping jute thread and white lead paint in the threads, while screwing.
- 3 Over-screwing should not be done in any case, otherwise it may split or crack the parts of the fittings, socket, elbow, tee or cross etc.
- 4 While measuring the length of pipes for cutting, due to allowance for the space of fittings should be made, otherwise the length of the pipes may be more or less.
- 5 All the pegs should be fixed with their broader end inside the wall and smaller size in face of the wall.

- 6 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.
- 7 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.
- 8 The cutting of the pipes should be done properly, it should be at right angle to the axis of the pipe.
- 9 The pipes should be fixed with pipe-hooks at proper place. These hooks should be driven in the masonry joints.
- 10 In case of accidents first-aid facilities should be available.

Rain water harvesting

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

- state rain water harvesting
- explain water collection for ground water recharge.

Rain water harvesting (Fig 1)

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

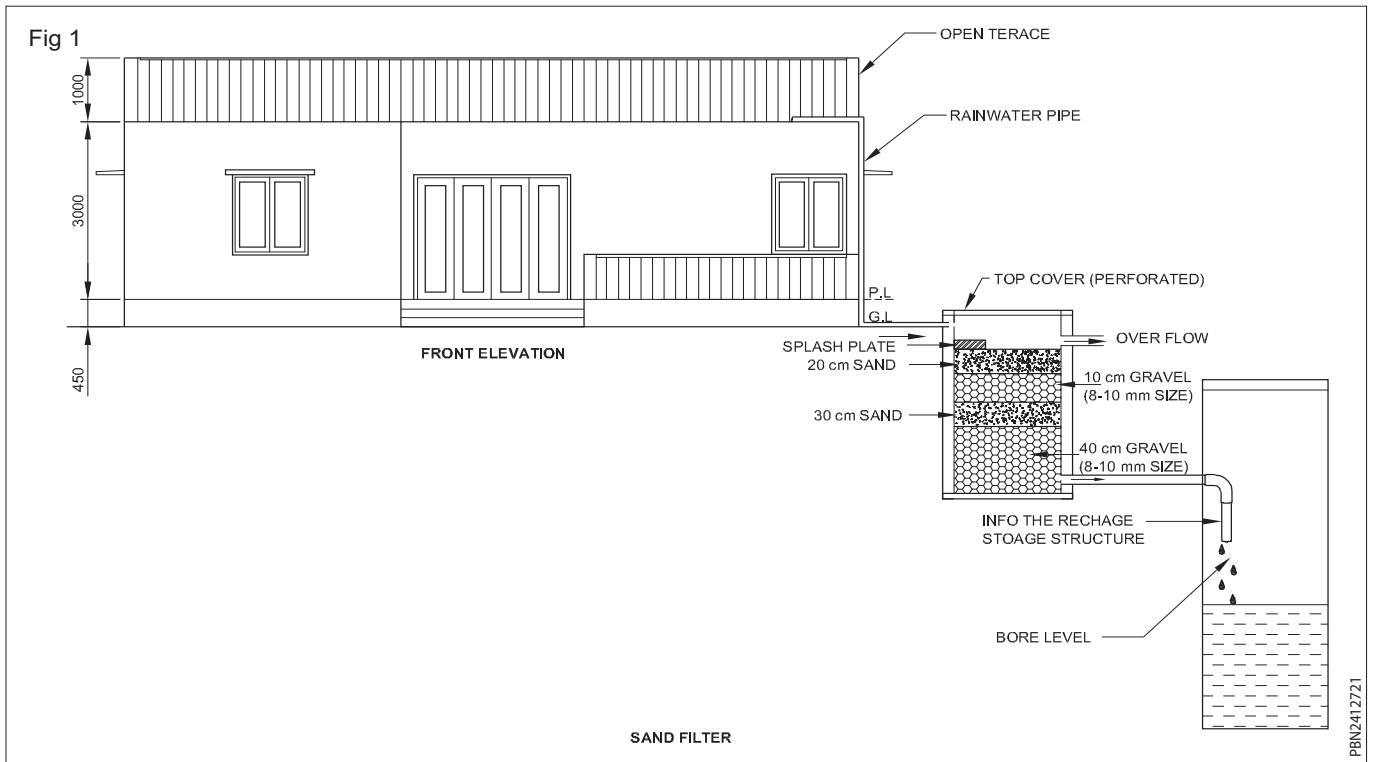
Maximum plot area to be kept as unsaved so that rain water can percolate to ground.

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.

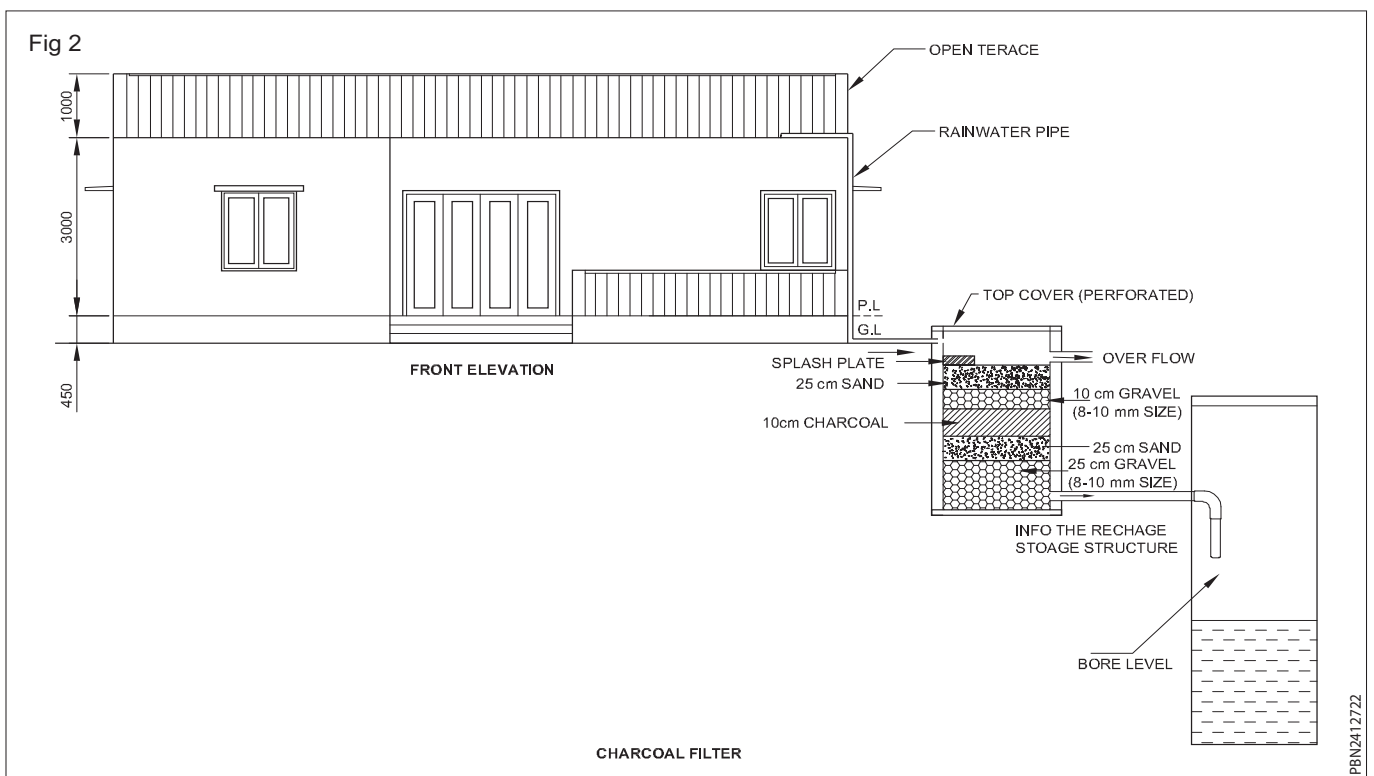
The recharge structure should be made on a plot at the places of lower levels/elevations so that rain water may flow towards it under normal gravitation flow.

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.



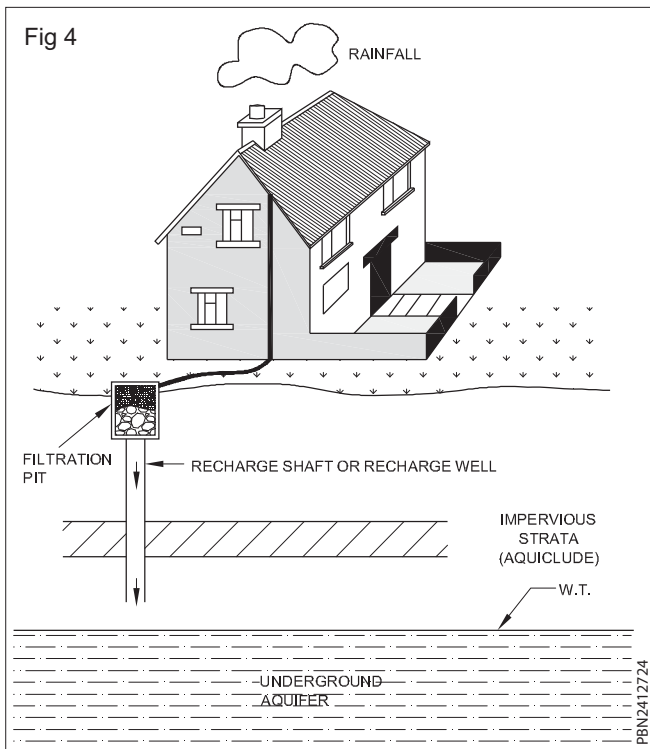
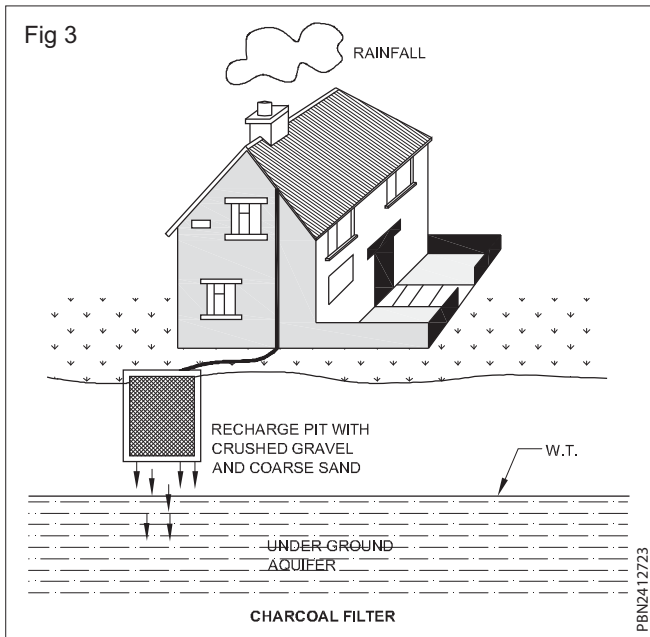
For recharge of run off from roads suitable arrangements in the foot path by introducing some katcha area should be made. (Figs 2,3 & 4)

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 infiltrate 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 dug 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.

Drainage pipe system

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

- state about the drainage pipe systems
- explain various 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 1)

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 2. 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

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.

extended upto about 2m higher than the roof level and provided with a cowl, for removal of foul gases as shown in Fig 3 & 4.

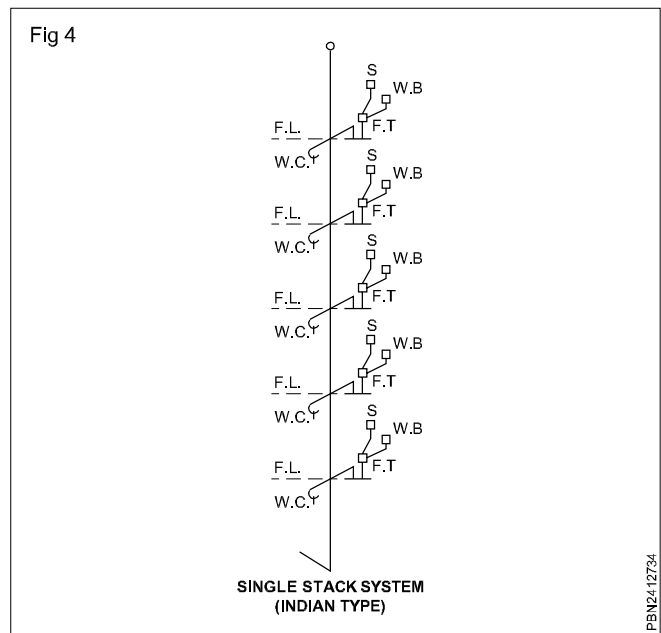
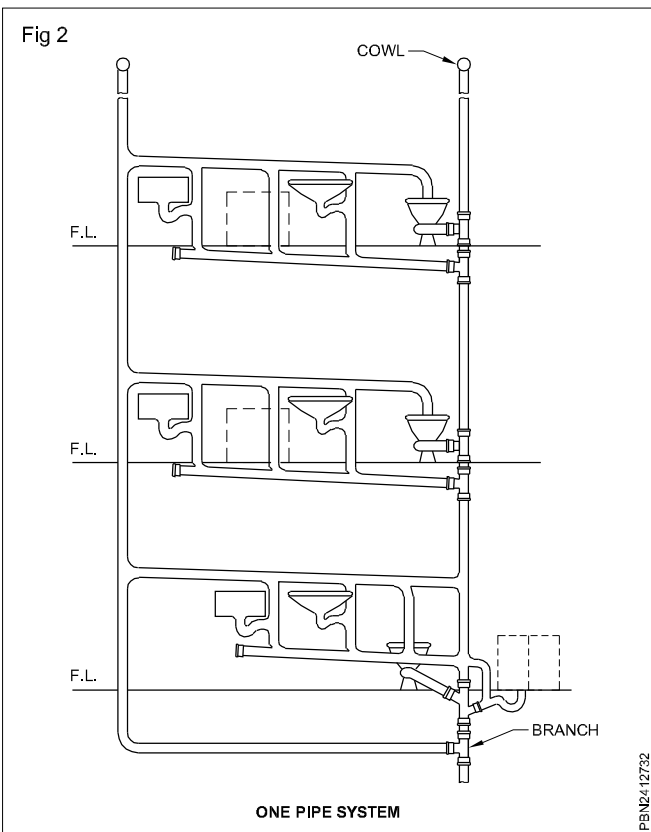
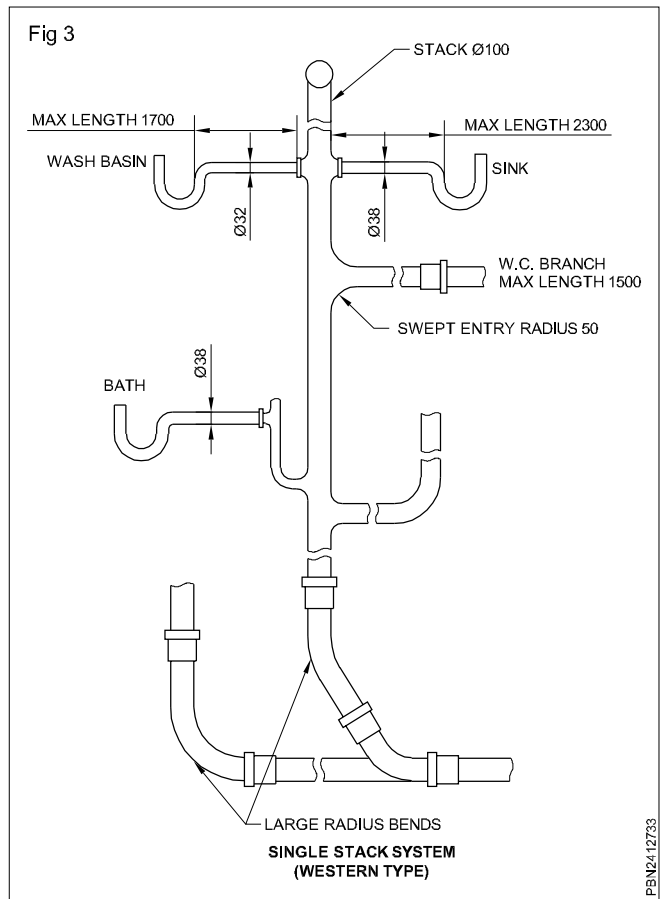
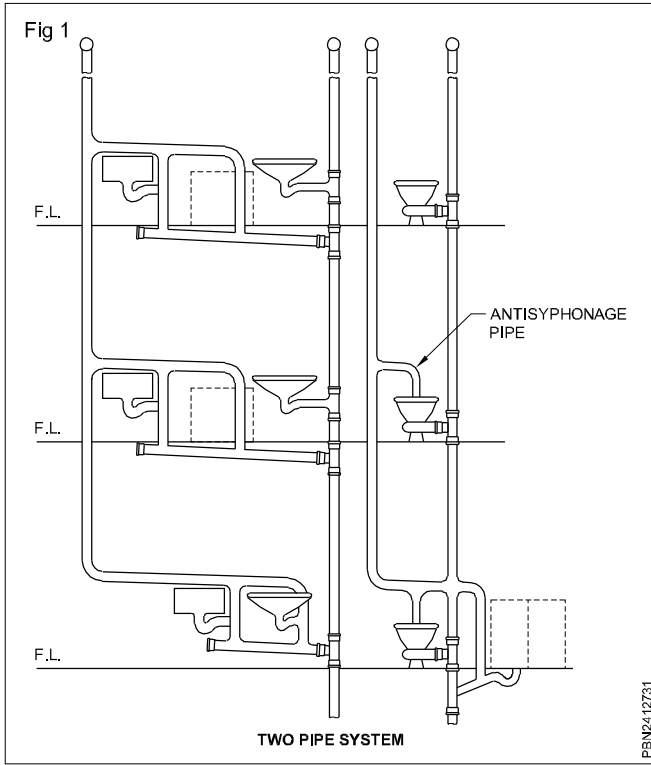
Partially ventilated single stack or single pipe system

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.4. Besides these systems, other combinations and permutations are also possible and may be adopted by some people.

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	-	Sewer Line
W.B.	-	Wash basin
W.C.	-	Water Closet
F.L.	-	Floor
F.T.	-	Floor Trap



Description and installation of sanitary appliances

Objectives: At the end of this lesson you shall be able to
 • state the specification of various sanitary appliances

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

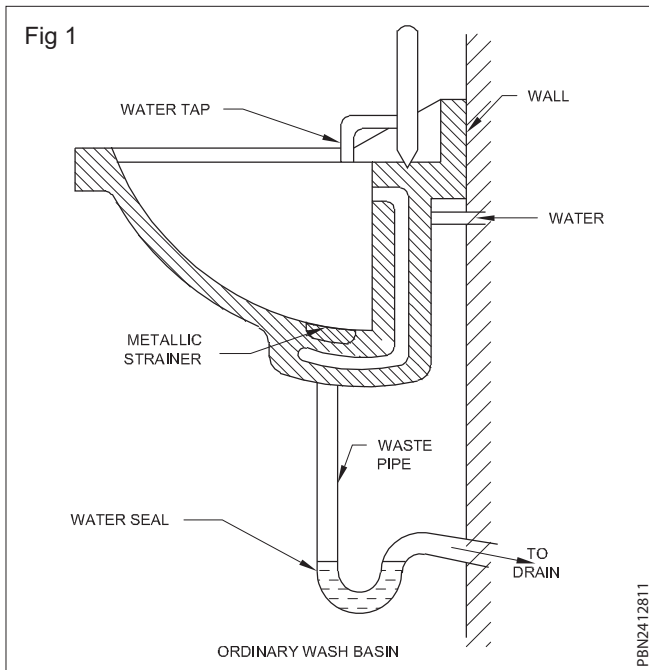
- a Wash basins
- b Sinks
- c Bath tubes
- d Flushing cisterns

2 Soil Fittings

- a Water closets
- b Urinals

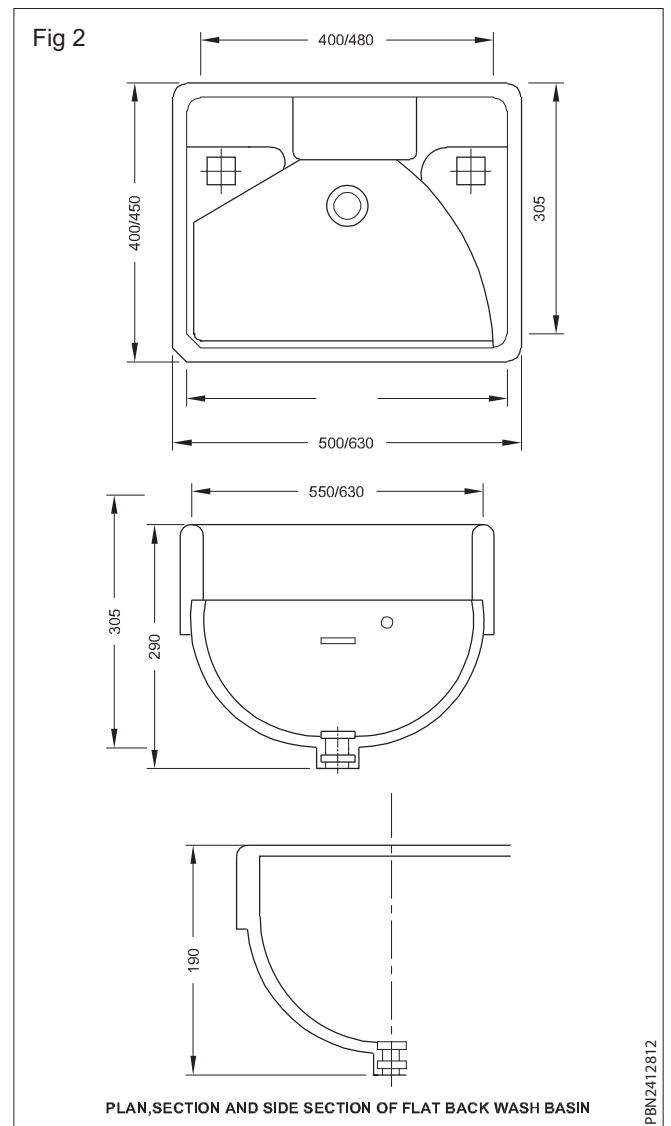
All types of sanitary fittings should be fixed as far as possible against an external walls, so that the apartment in which they are placed can be provided with natural light and air, and also their wastes can be easily collected in drain. The floors of the rooms in which sanitary fittings are fixed should be of a non-absorbent material with curved angles at the junction with walls from sanitary points of view.

Wash Basin (Fig 1)



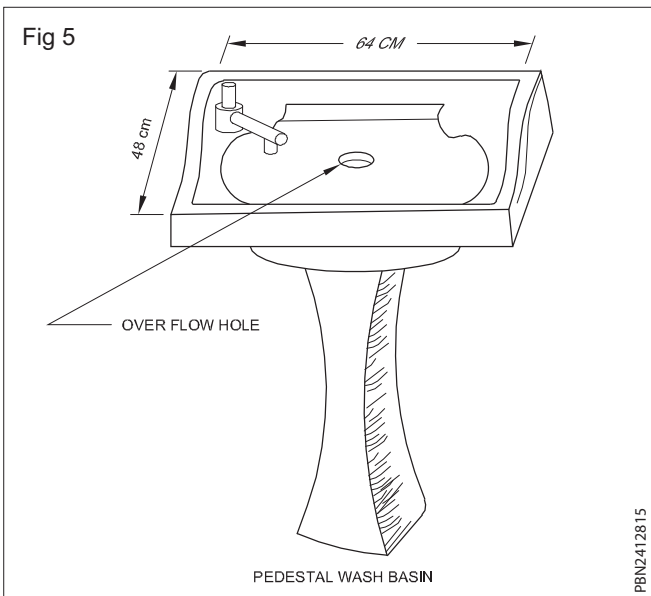
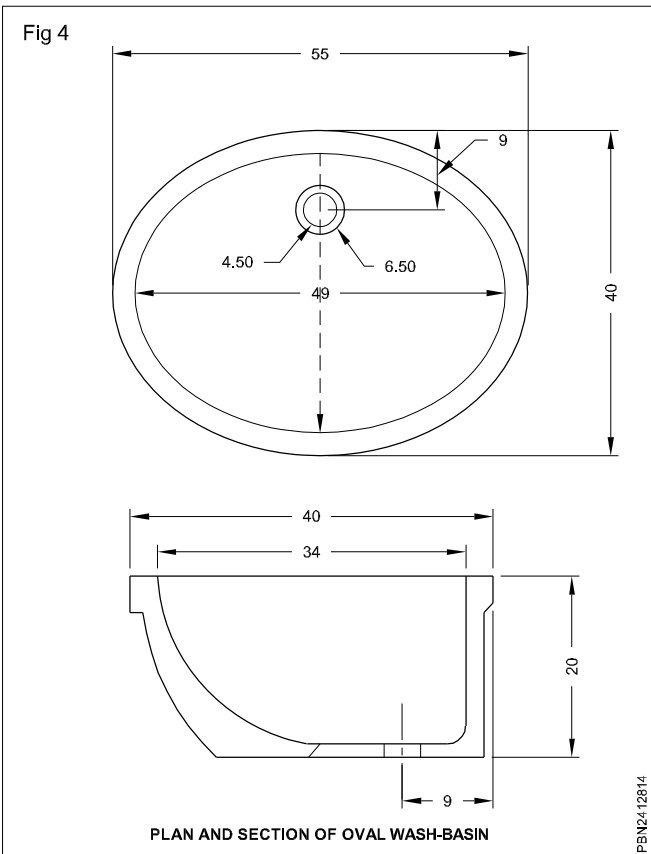
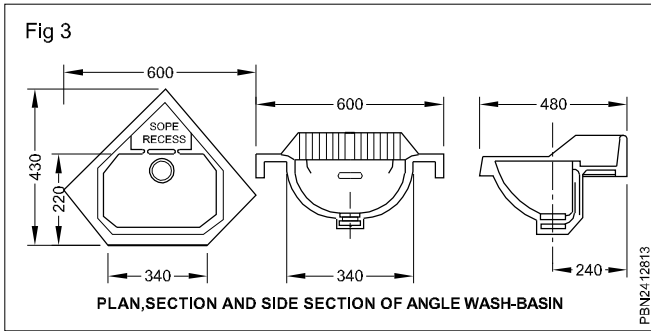
The wash basins are available in various patterns and size in the market. There are mostly three patterns : (a) Flat back for mounting on walls, (b) Angle back for fixing at the junction of two walls, and (c) Circular or oval for fixing in tables or rocks. Flat back basins are provided with double or 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 desined 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. Wash basins shall be of one pipe construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim on all sides, except sides in contact with the walls and shall have a skirting at the back. 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.

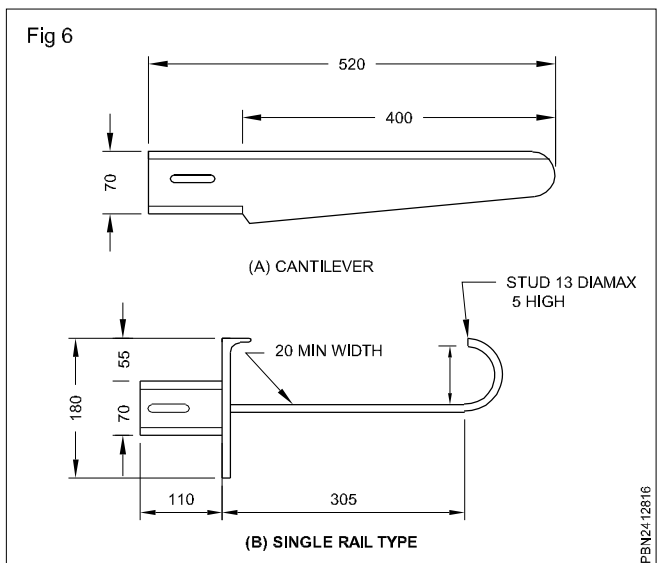
A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 66 mm at top. Each basin shall be provided with a non-ferrous 32 mm waste fitting. Stud slots to receive the brackets on the underside of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the Pedestal wash basin (Fig 5) White glazed pedestals for wash basin (Fig 2), where specified, shall be provided. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm.

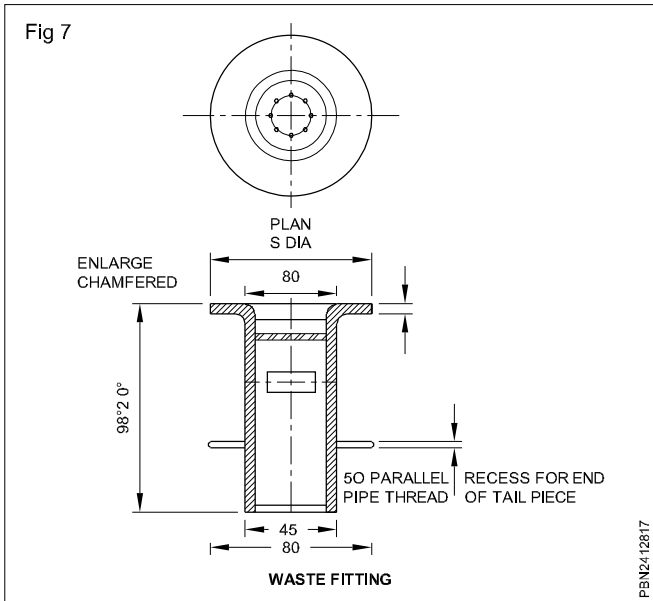
All the waste fittings shall be brass chromium plated or as specified

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 and shall be sound, free from laps, blow-holes and pitting and other manufacturing defect. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and if cast, they shall not be burnt, plugged, stopped or patched. The body and nut shall be truly machined so that the nut smoothly moves on the body.

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 tape, 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.

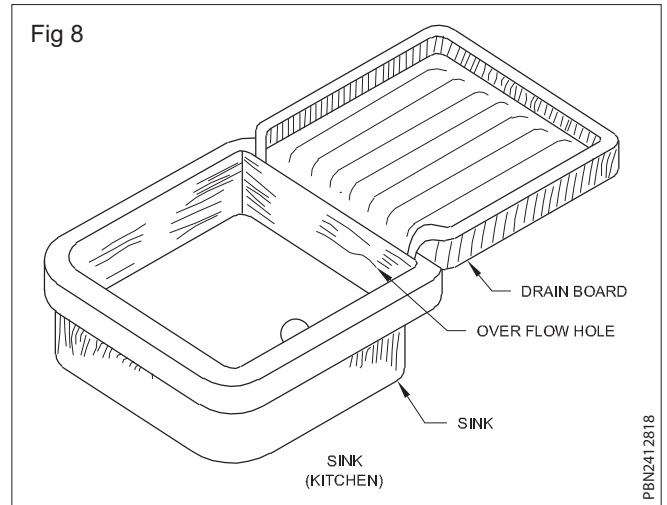
Fixing

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. (Fig 6a) Bracket shall be fixed in position before dado work is done. The brackets have been shown in fig .. The wall plaster on the rear shall be out to rest over the top edge of the basin. After fixing the basin, plaster shall be made good and surface finished to match with the existing one.

The union shall be connected to 32 mm dia waste pipe (Fig 7) which shall be suitably bent towards the wall and which shall discharge into an open drain leading to gully trap or direct into the gully trap on the ground floor and shall be connected to a waste pipe stack through a floor trap on upper floors. The C.P. brass trap and union shall be provided only when the waste pipe is to be embedded in the wall. The C.P. brass trap and union shall not be provided when the waste is discharged through floor trap or a surface drain leading to a floor trap. C.P. brass trap and union shall be paid for separately where so specified.

Where so specified a 20 mm G.I. puff pipe terminating with a perforated brass cap screwed on it on the outside of the wall or connected to the antisiphon stack will be provided. Fig 8 shows the typical types of brackets for fixing wash basins. Fig 9 shows the waste fixing for wash-basin.

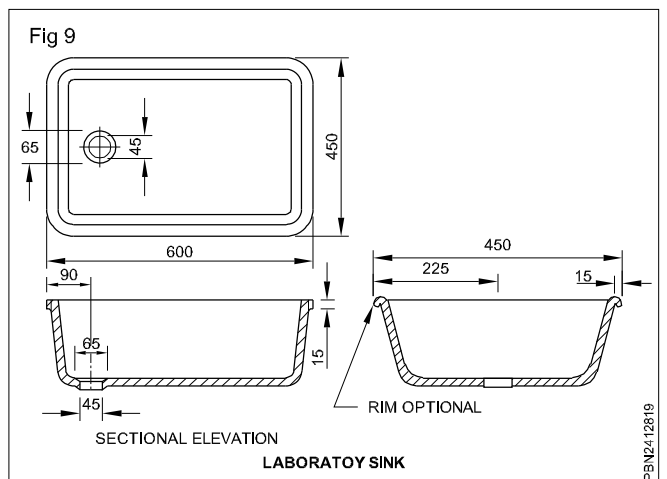
Sinks (Fig 8)

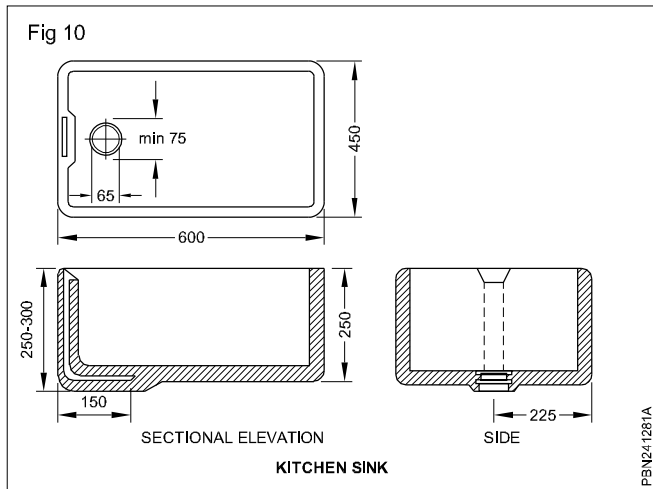


There are rectangular shallow receptacles suitable for kitchens or laboratory. Fig 8 shows a kitchen sink which is mostly used. It is on one piece construction, provided with or without rim.

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. Wir type overflow slots are also provided in some sinks

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 90 cm.

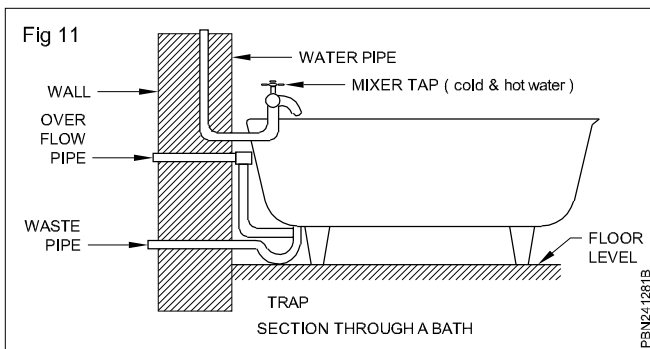
Method of Installation of sink

The installation shall consist of an assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

Fixing

The sink shall be 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. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or P.V.C. waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste pipe shall be separately paid. The height of front edge of sink from the floor level shall be 80 cm.

Bath tub (Fig 11)



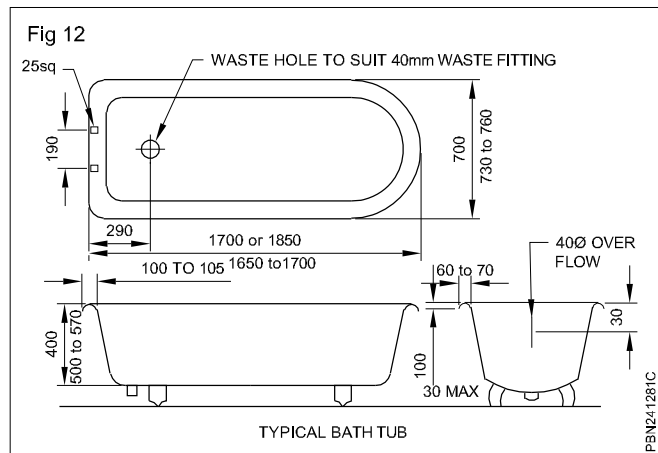
Bath tubs may be made of various materials, such as enamelled iron, plastic, cast iron porcelain enamelled, marble or fire clay etc. For high class residential buildings marble, plastic or enamelled iron or fibre glass baths are used. For public places glazed fire-clay or porcelain enamelled cast iron baths are used. Vitreous enamelled pressed steel baths are also available in the market. Previously copper baths were used but now-a-days they have become obsolete. In future aluminium alloy and fibre glass baths are coming which will replace old baths.

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 necessary surface shall be free from undulations, drawing lines and other defects deleterious to the provision of a satisfactory enamel coating.

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. External surface of the bath tub shall be given one ground or primer enamel coating. Gloss, colour and opacity shall be uniform and visually satisfactory.

A bath tub shall be liable to rejection if the finish shows any of the following defects

- Crazing (not to be confused with mechanical scratching, which will exhibit an irregular edge under a magnifying glass)
- Dimples, Rundown, Sagging - Unless not readily attracting attention when viewed from normal eye level under natural light.
- Blisters - Not more than two in number on the interior surface shall be permitted provided they cannot be broken by a pressure of a finger nail.
- Pinholes - Pinholes not more than two in number for coloured bath tubs and not more than four for white enamelled bath tubs shall be permissible. There shall be no grouping of pinholes and they shall not penetrate to the metal.
- Specks - Specks shall be less than one millimeter in size and maximum five in number and there shall be

no grouping. Specks less than 0.25 mm in size shall not be treated as defect unless in sufficient number to form discolouration.

Warpage of edges set against wall or floor and edges of roll rims shall not exceed 5 mm/m. Warpage of all other edges shall not exceed 7.5 mm/m.

In forming the roll the outer edges shall be flanged or rolled back underneath sufficiently to prevent exposure of sharp edges. The vertical height of the flanged or rolled edges shall be not more than 30 mm. At the tap end of the roll, there shall be a level area within a radius of atleast 25 mm from the centre of each tap hole.

For safety of users, bath tubs shall be as flat bottomed as practicable. The fall along the bottom head end to outlet shall be adequate for complete emptying. The waste hole shall be so formed as to be suitable for receiving a 40 mm waste fitting. The bath tubs shall be provided at the tap end, with effective means of attaching an earth continuity conductor. With each bath tub, two spacing washers of suitable thickness to take up the difference between the thickness of the metal of the bath tub and the depth of the seating on pillar taps shall be supplied. In addition, two fibre or lead washers for each tap shall be supplied for fitting above and below the tap roll to prevent the enamel from crazing when the taps are tightened in position.

The maximum permissible variation from the dimensions specified in (Fig 12) shall be ± 4 percent in all cases except overall width and overall length, where the variation shall not exceed ± 1 percent.

Supports made of cast iron, mild steel or any other suitable material as specified shall be provided.

The support shall be non adjustable type, as indicated in chain dotted lines in for use on bath tubs without panels. This shall include two sizes :

- i For bath tubs to which a trap with 35 mm min seal is to be fitted.
- ii For bath tubs to which a trap with a 70 mm min seal is to be fitted.

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.

Following two types of cisterns are most common now-a-days :

- i Bell type without valve. (Fig 13)
- ii Flat bottom type fitted with valve (Fig 14)

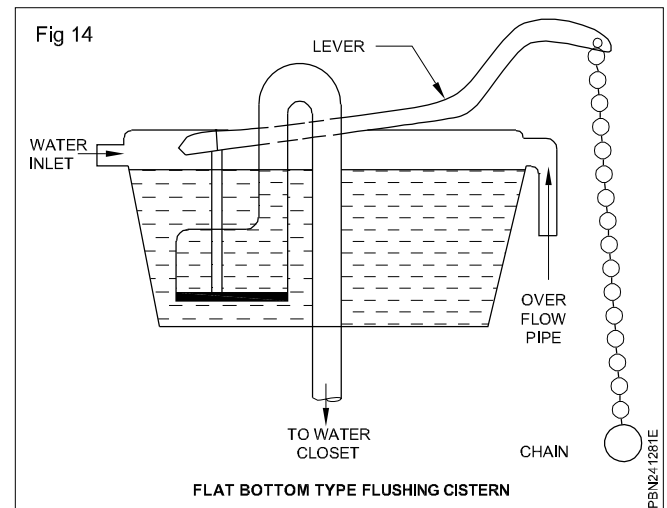
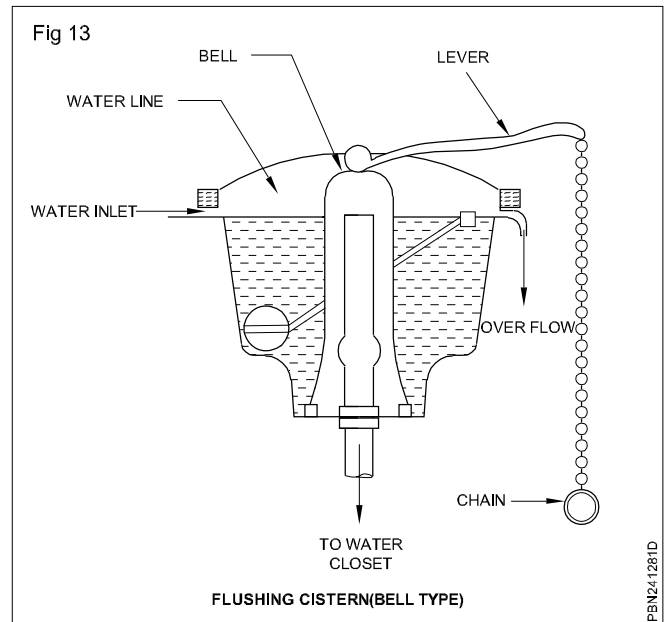


Fig 13 shows the bell type flushing cistern. The bell is kept over the outlet pipe, the inlet end of which is slightly above the water level. When the chain is pulled the bell is lifted causing the water to spill over the outlet pipe and starting the syphonic action due to which the whole water rushes towards the outlet and flushes the W.C.

Due to shortage in the water supply, there was urgent demand to reduce the quantity of water consumption. All the flushing cisterns available and existing in the building fittings, discharge their full quantity of water even for small purposes or even when small quantity of water will be sufficient for that purpose.

C.B.R.I. Rookee has developed dual flushing cistern, which allows fractional or full discharge of cistern at a time. All the existing cisterns can be converted into dual flushing cisterns by making arrangement to cut the vacuum seal at the fixed water level. To obtain the fractional discharge the chain is pulled and left but for obtaining full discharge the chain is pulled and kept in position till full capacity is discharged.

For converting the existing cisterns to dual flushing cisterns, 6 mm dia, rubber tube is fixed in the bell of the cistern at the fixed height. The other end of the rubber

tube is connected to a plastic pipe with a stop cock at the end to control the entry of air. The cistern will give full discharge with the stop cock and fractional discharge with the stop cock open.

C.B.R.I. has also developed an automatic flushing cistern for the urinals. This cistern has eliminated the use of copper fittings which are presently provided with the public urinals cisterns. The new developed fittings consist of a U-tube made of plastic pipe. When the water level in the cistern rushes the level of the bend, the syphonic action takes place and the water present in the cistern rushes, to the urinals. This new automatic flushing cistern can be cheaply manufactured and easily fixed in the position.

Fig 14 illustrates the flat bottom type flushing cistern provided with valve. When the chain is pulled it lifts the disc which also suddenly lifts the water above it and starts the syphonic action. The valve allows the water to rush in the outlet pipe.

The flushing cisterns are provided with inlet pipe, over-flow pipe and automatic closing float ball valve.

Specifications of flushing cisterns, float valve and flushing pipe

The flushing cisterns shall be automatic or manually operated, high level or low level, as specified, for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and the under side of the (Fig 13 to 17).

Installation of Flushing Cistern

Fixing

High level cistern

The cistern shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement concrete (1 : 2 : 4) block 100 x 75 x 150 mm. The cistern shall be provided with 20 mm nominal bore G.I. overflow pipe 180 cm long with fittings. The outlet or flush pipe from the cistern shall be connected to the pan by means of cement or putty joint. The flush pipe shall be fixed to wall by using holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts. The clamps shall be embedded in brick work in cement mortar 1 : 3 (1 cement : 3 coarse sand). If connection between cistern and pan is made with G.I. pipe the bends and offsets shall be made cold.

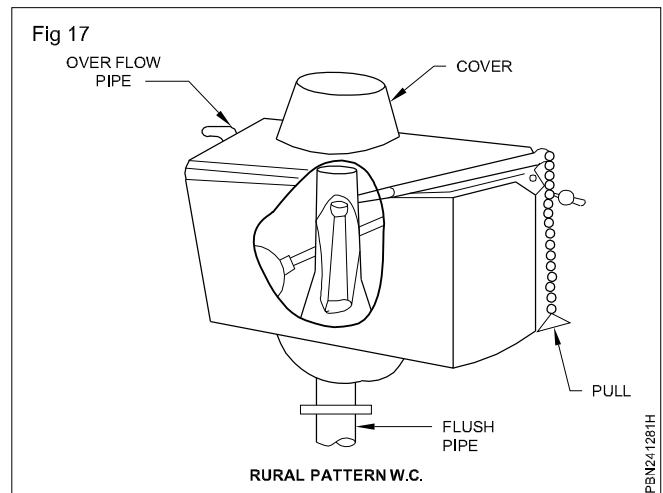
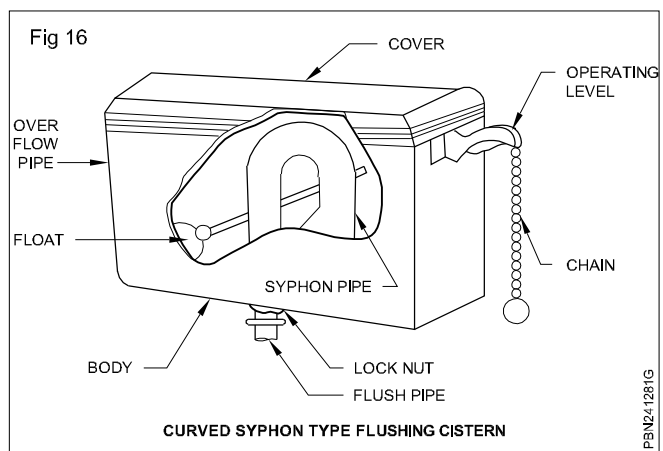
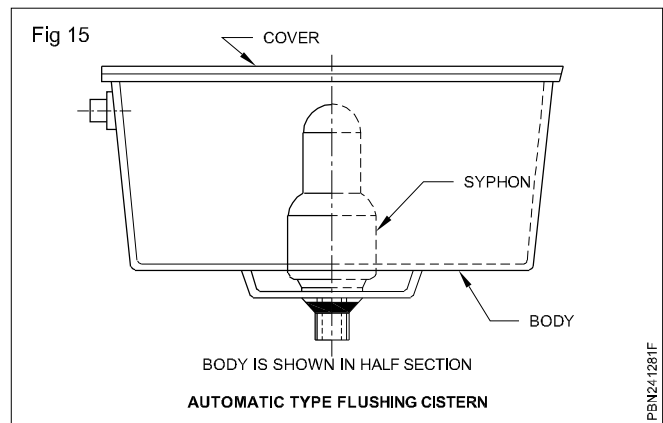
Low level cistern

High level cistern shall apply except that connection between cistern and closet shall be made by means of 40 mm dia. flush bend with rubber or G.I. inlet connection as specified.

Automatic Cistern (Fig 15 & 16)

High level cistern shall apply except that C.P. brass stop cock shall be provided for cisterns having a capacity of more than 5 litres. The main and distribution flush pipe shall be fixed to the wall by means of standard pattern holder bat clamp.

Cisterns shall be of cast iron, vitreous china or pressed steel and plastic, as specified, complying with the requirement of I.S. 774-1971, I.S.: 2326-1970 and I.S.: 7231 - 1974 respectively.



The body thickness of a cast iron cistern shall not at any place be less than 5 mm and that of vitreous china 10 mm. The body of a pressed steel cistern shall be of seamless or welded construction, of thickness not less than 1.6 mm before coating, and shall be porcelain enamelled. The cistern shall be free from manufacturing faults and other defects affecting their utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof. A cistern shall be considered mosquito proof only if there is not clearance anywhere which would permit a 1.6 mm wire to pass through in the permanent position of the cistern i.e. in the flushing position or filling position.

The breadth of a low level cistern, from front to back, shall be such that the cover or seat, or both, of water closed pan shall come to rest in a stable position when raised.

The cistern shall be supported on two cast iron brackets of size as approved by the Engineer in-charge and embedded in cement concrete 1 : 2 : 4 block 100 x 75 x 150 mm. The cast iron brackets shall conform to I.S. : 775-1962. These shall be properly protected by suitable impervious point. Alternatively the cisterns shall have two holes in the back set above the overflow level for screwing into the wall, supplemented by two cast iron wall support. A 5 litre cistern, however, may be supported by large brackets cast on the body of the cistern.

The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover, this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. In the case of high level cisterns, the outlet shall be of 32 mm nominal bore and in the case of low level cisterns the outlet shall be of 40 mm nominal bore.

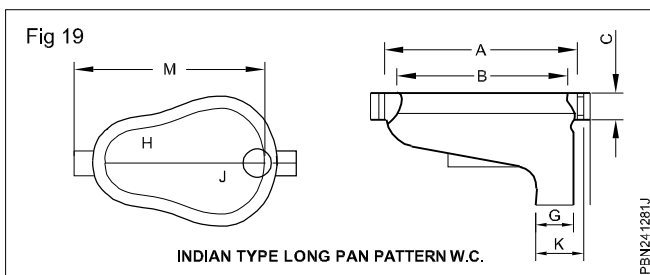
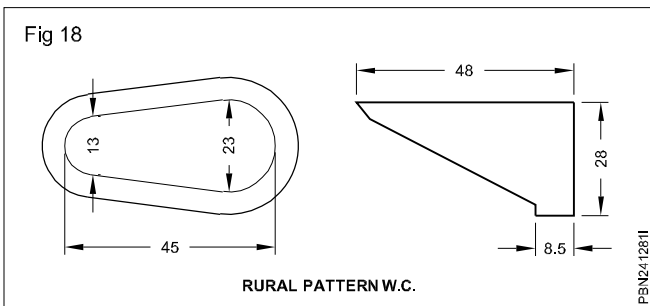
Water closet

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

- i Long pan pattern (length 450, 580, 680 mm) (Fig 19)
- ii Orissa pattern (length 580, 630, 580 mm) (Fig 20)

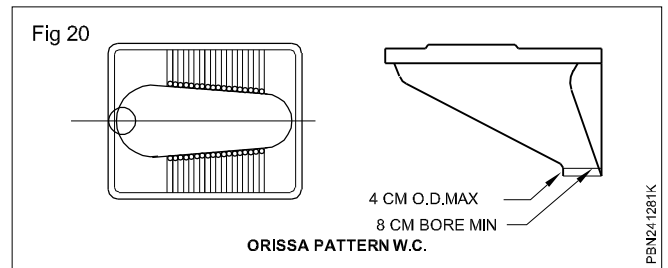


- iii Rural pattern (length 425 mm) (Fig 18)

B European water closet

Fig 19 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, unless otherwise specified or ordered by the Engineer-in-charge. 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. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia. vent horn, where required by the Engineer-in-charge.

The following tolerances may be followed on the dimensions specified.

i Long pattern and Orissa pattern :

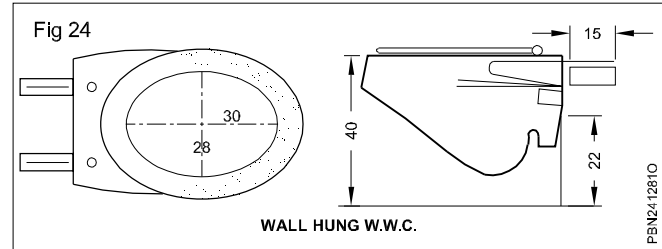
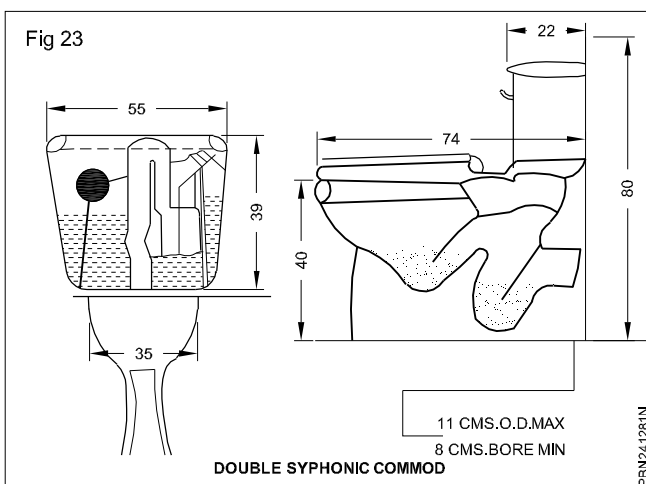
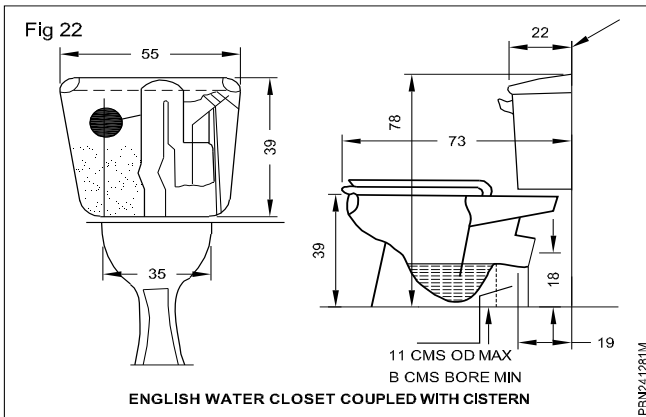
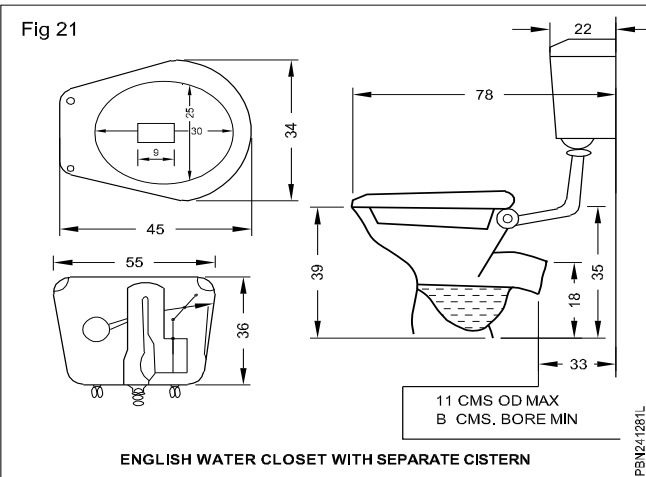
- a On dimension 75 mm and over ± 4 percent
- b On dimension of less than 75 mm ± 2 mm
- c On all angles $\pm 3^\circ$
- d The top surface of long pattern pan shall not at any point vary from its designed plane or contour by more than 6 mm for size 580 mm and by more than 10 mm for size 630 mm and measured vertically.

This value shall not exceed 10 mm in case of Orissa pattern pans.

ii Integrated squatting pan :

- 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 21 to 24 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 syphonic water closets are very popular.



either 'S' or 'P' outlet with atleast 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 litres of water between the normal water level and the highest possible water level of the water closet as installed.

The following tolerances may be allowed on dimensions specified :

- a On dimension 75 mm and over ± 4 percent
- b On dimension of less than 75 mm ± 2 mm
- c On all angles $\pm 3^\circ$

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

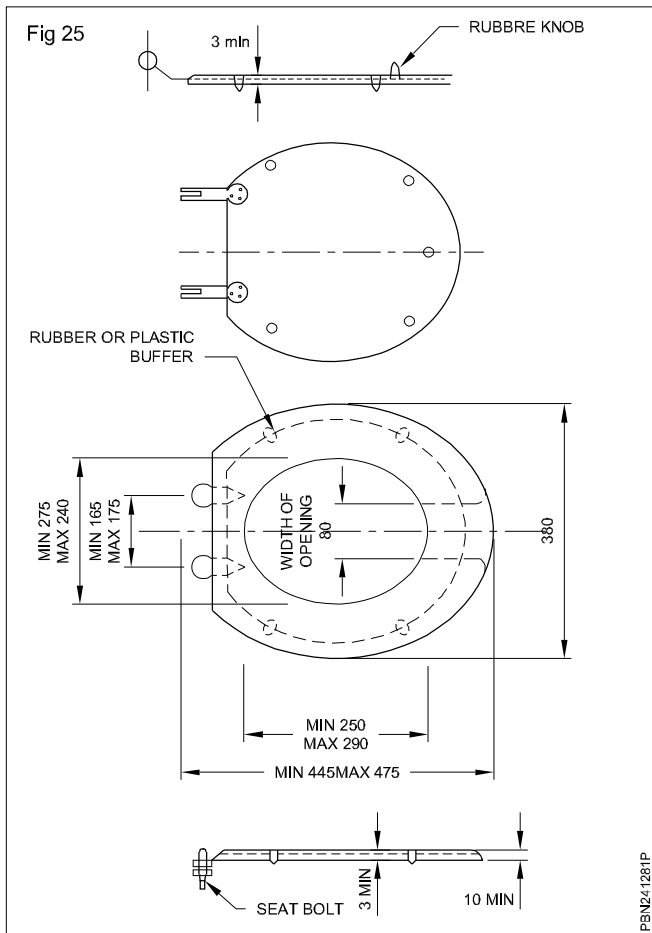
These shall be of type I conforms to I.S. : 776 - 1962. These shall be made of timber, such as well seasoned teak wood or mahogany, as specified, and shall have C.P. brass hinges and rubber buffers. These shall be free from twist and the underside, shall be flat. Underside edge shall be arised. This shall be in a single piece. Each seat shall have atleast four rubber buffers of suitable size. All seats and covers shall be finished smooth. They shall be plain or finished with french polish or cellulose liqueras as specified.

b Plastic seat and cover (Fig 25)

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. These shall be free from twist and the underside shall be flat and underside edge shall be arised. Each seat shall have atleast for buffers of suitable size. All seat and covers shall be finished smooth. Lacquer shall not be used for surface finishing.

W.C. seat cover : The following tolerances may be allowed on the dimensions

- a On dimension 50 mm and over ± 4 percent



b On dimension of less than 50 mm \pm 2 mm

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.

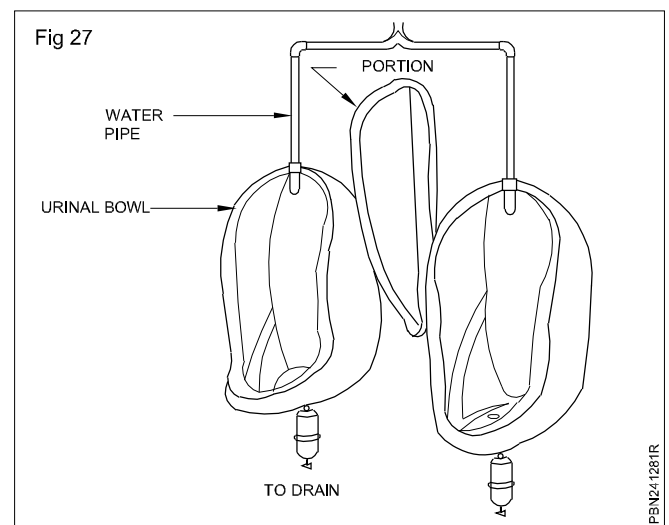
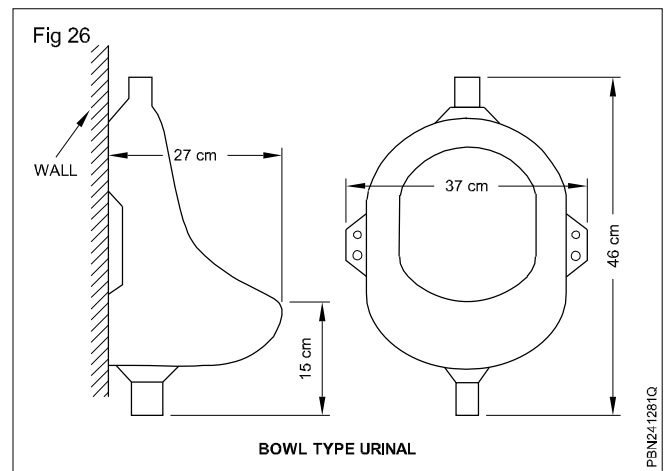
- Flat back
- Corner type
- Stall
- Half stall
- Squating plate
- Senso type
- Water less urinal

Senso type urinals (Fig 26 & 27)

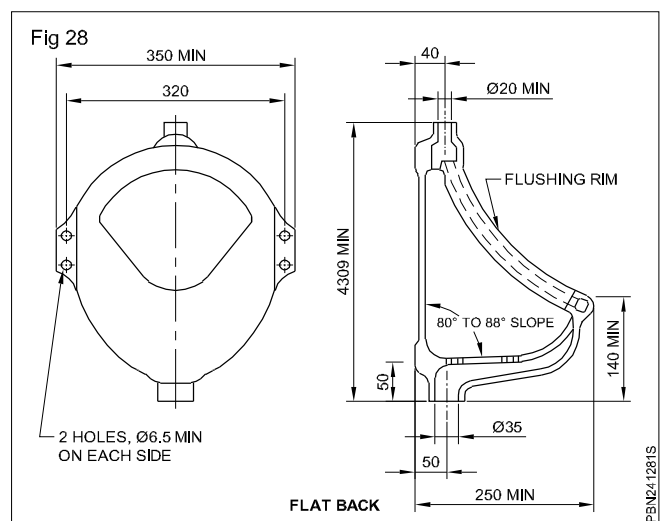
Manufactures from white vitreous china clay. These urinals are fitted with sensors so that automatic flush tank will work only when it is used. Thus there is a lot of saving in water and at the same time immediately after use it is flushed automatically size 61 x 39 x 38cms. (Fig 26)

Water less urinals

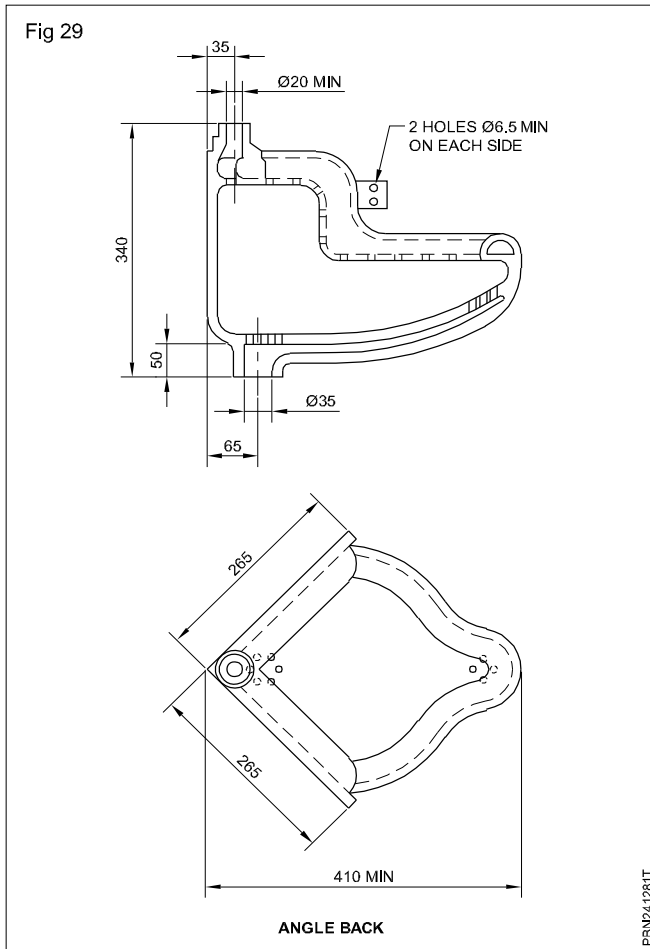
Aqua free white vitreous chine clay. This can be put into use without water connections size available is 60 x 30 x 31.5cm. it is costly.



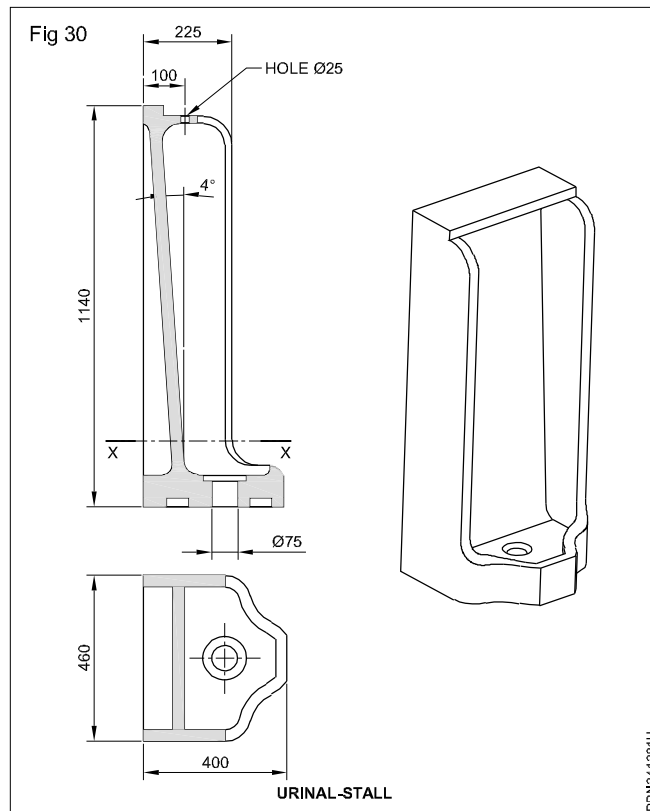
Flat back/corner urinal (Fig 28 & 29)



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 \varnothing 6.5mm each side. It has an connect an outlet pipe. Inside surface of urinals are uniformly smooth. The bottom of pan has sufficient in the front towards the outlet.



Stall urinal slope (Fig 30)

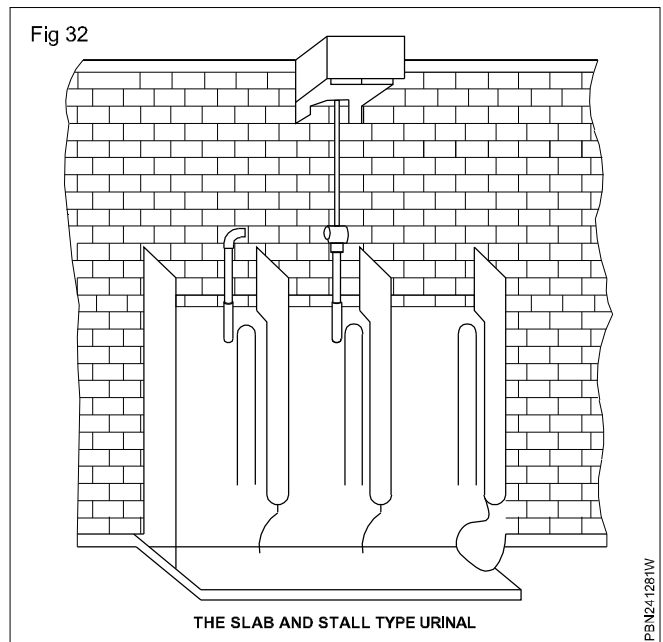
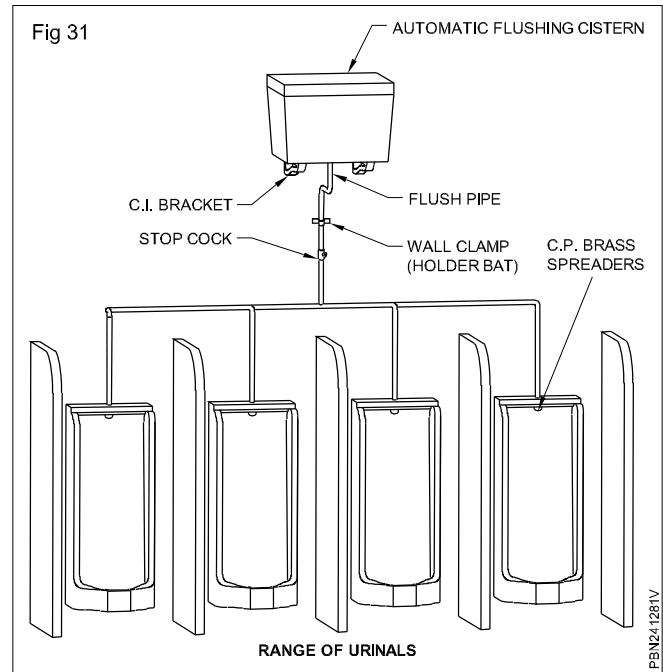


The stall urinal and its screen are of white glazed fire clay and confirm to IS771 (Part 3 sec 2). It is 1140mm high 460mm wide with 400mm overall depth at the base. Screen

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 (PVIse6) is provided. (Fig 30)

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 to be provided if integral flushing rim is not provided.

Squatting plate urinal (Fig 31 & 32)



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 while glazed vitreous china channel with stop and outlet piece in front is also a part of this.

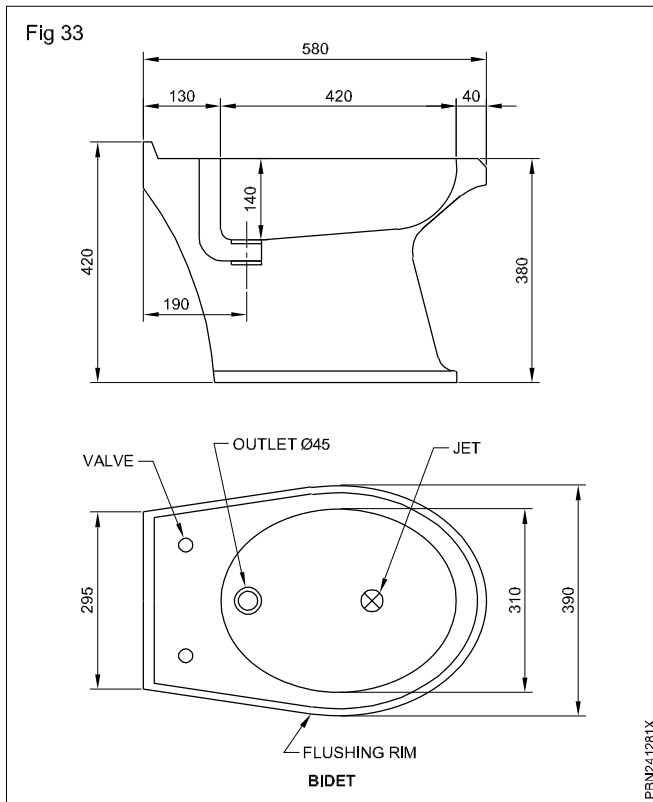
Automatic cistern for flushing are fixed at a height of 1900 from floor to bottom. If urinals are fixed in a row it shall be at 690mm centre to centre.

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 one piece 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. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals. At the exterior of the outlet horn shall not be glazed.

Bidet (Fig 33)

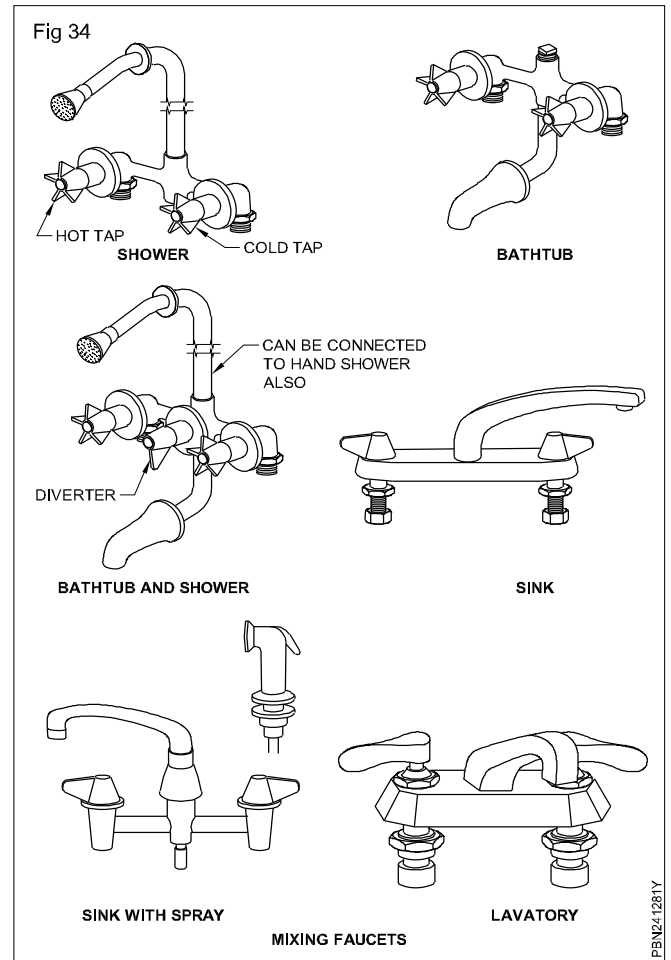


The bidet is pronounced as "beday". The bidet is designed for cleanliness of localized parts of the body especially of genitor urinary cleanliness. The bidet is equipped with valves for both hot and cold water and with popup waste plug, a flushing rim, an integral jet operated by means of valve. When the Jet is "ON" a stream of water flows upward from bottom section of bowl enabling cleaning.

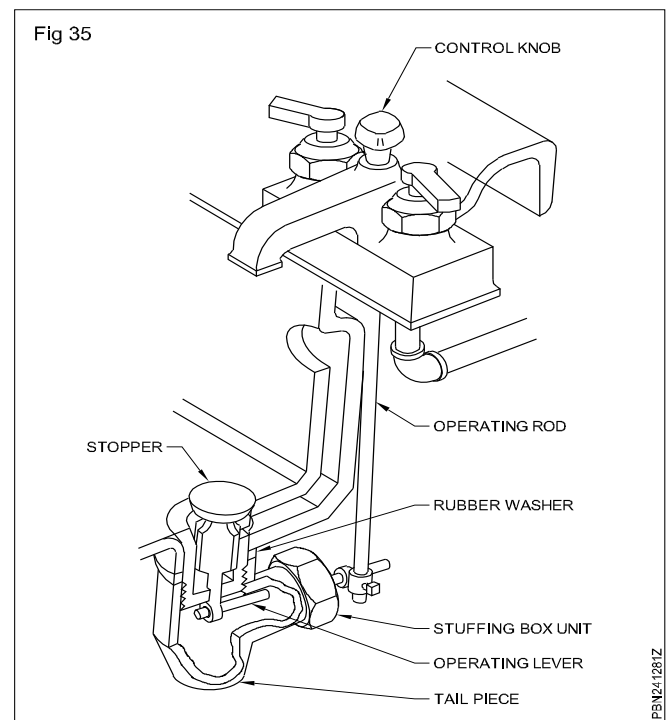
Mixing tap (Fig 34)

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 35)



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, pop up 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.

Table 1
Office Building

Fitments	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'

Pipe alignment and slope in plumbing

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

- explain pipe alignment and slope.

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 except that where the drainage piping is upstream of a grease interceptor, the slope of the piping shall be not less than ¼ inch per foot (2 percent slope)

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, elboes, 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 and parallelism (rotation) is within 0.0573 degrees then the alignment is accepted otherwise means to be devised to bring the deviation within those values.

Water hammer

Objective: At the end of the lesson you shall be able to

- state the water hammer.

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 to 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:

- 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.

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.

- 1 Reduce the pressure of water supply by fitting a pressure regulator.
- 2 Reduce fluid velocity in the pipes.
- 3 Install slow closure faucets.

- 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:

- 4 Use start up and shut down procedure on an existing installation.
- 5 Use SCV check valves which is specifically designed to protect from water hammer.
- 6 Always use stronger pipe.
- 7 Use surge alleviators.
- 8 Use pressure relief valves.

Storage tanks for water supply

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

- explain the elevated storage tanks
- name the different components of storage tanks
- explain the sump.

Storage tanks for water can be either at ground level, below ground level or at elevated position. (Fig 1)

The parts of elevated tanks are

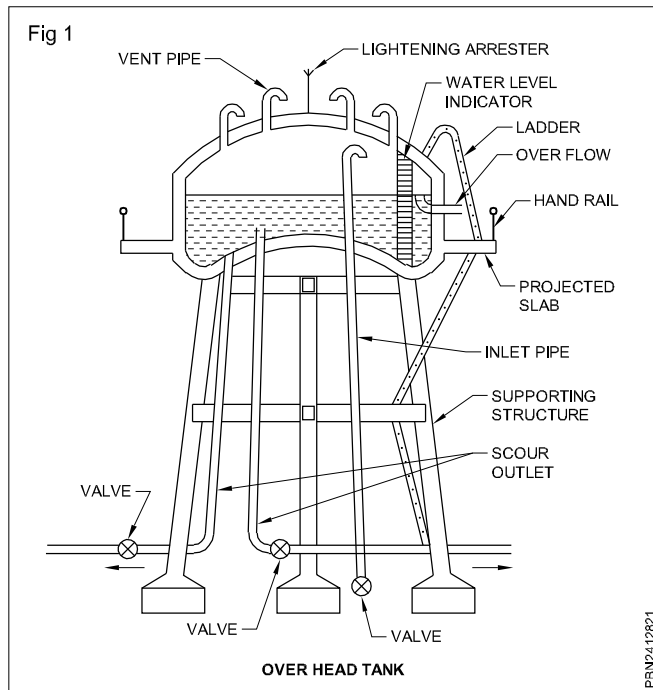
- foundation
- supporting super structure
- tank
- pipes and valves
- ladder
- water level indicator
- lighting arrester

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 water supply, 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.

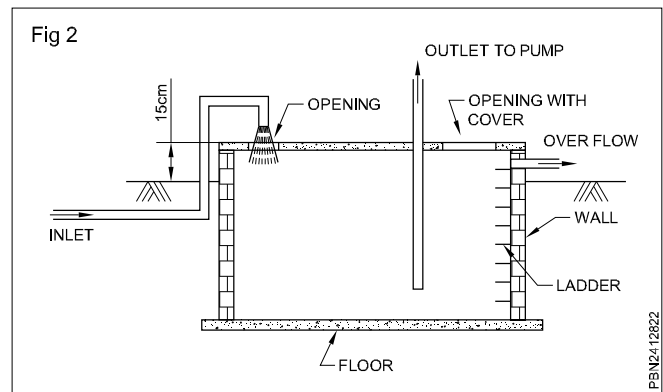
Water level indicator: In order to findout the water level at tank from ground, a water level indicator is required. It consists of a scale, float, string and indicator. When water raises float rises and indicator will lower as such the marking on scale will be the full depth at bottom and empty position 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 3)

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 2)

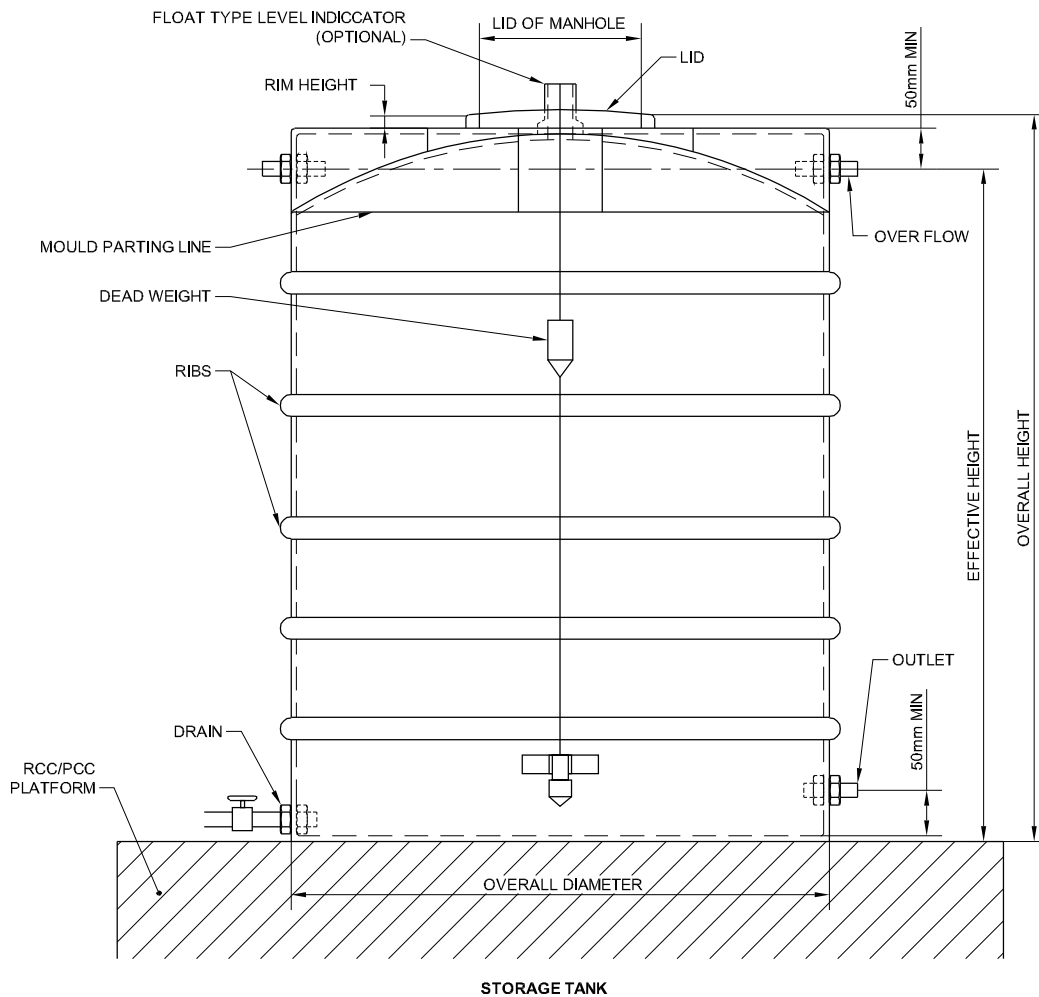


Manhole lid: The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

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 3)

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 some what less.

Fig 3



PBN24/12823

Cleaning & maintenance of storage tanks

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

- need for cleaning the storage tanks
- state the maintenance of storage tanks.

Cleaning of storage tank

Storage tank must be clean with periodical intervals. If its not carried out, water may contaminated 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 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:

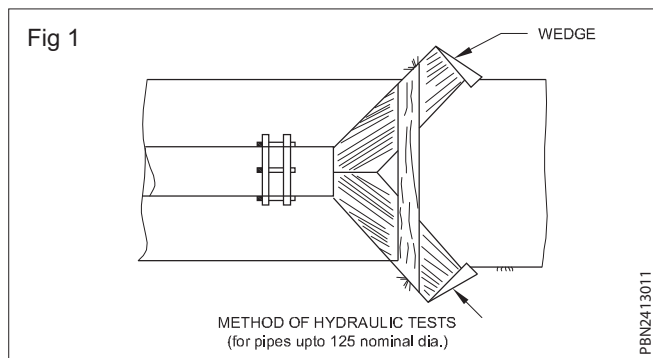
- Pressure test at a pressure of at least double the maximum working pressure-pipe and joints shall be absolutely water tight under the test.
- Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for a duration of two hours.

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.

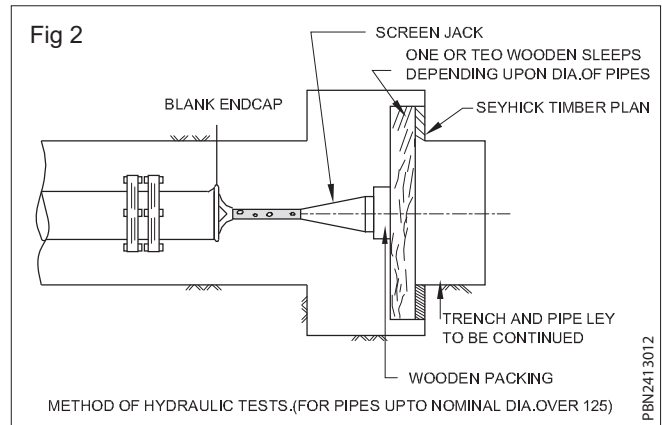
Prior two testing, enough back fill as described shall be places over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

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

Objective: At the end of the lesson you shall be able to

- state the soundness of the pipe line 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:

$$q_L = N.D\sqrt{P}$$

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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)

Description of sanitary fitting

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

- description of sanitary fitting.
-

Refer Ex. No.2.4.128 & 129

General points to be observed when choosing sanitary

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

- explain general points to be observed when choosing sanitary.
-

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 your 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

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 opt for sanitarywares 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 smaller 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.
- 5 Marble/ stone toilets basins are strong and durable and easy to clean the ceramic toilet basin is economy and easy to clean.
- 6 Before buying toilet basin you must ensure that the type of mounting to be taken into consideration.

Method of bending galvanized and heavy pipes

Objectives: At the end of this lesson you shall be able to
 • explain the methods of bending galvanized pipes.

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.

Automatic Pipe Benders and Handheld Pipe Benders: Determining whether to bend your galvanized pipe by hand or with an automatic tool can be tricky. If you don't have either of these tools already on hand, you'll want to be certain that you're making a smart investment.

What's more, you'll want to make sure that you have the appropriate safety gear on hand before putting either tool to use. Which tool, then, should you use?

Automatic : Automatic pipe benders take a lot of the stress out of pipe bending. These benders lend artificial strength to your efforts.

What's more, they can often stop themselves before bending your pipe past your preferred angle. That said, automatic pipes may damage your pipe more readily than handheld ones. Similarly, these benders tend to be a hefty financial investment.

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.

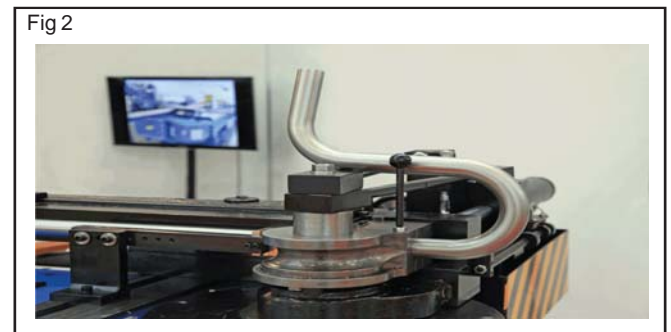
You'll also need to prepare yourself to put a lot of sweat into your DIY piping efforts. That said, using a handheld pipe bender can save you money on tools. These tools can also limit the amount of damage your pipes endure during their initial installation. (Fig 1)



Alternative Bending Techniques (Fig 2) : That said, there's more than one way to bend a galvanized pipe, whether you're using a handheld bender or an automatic one. Some of the most common techniques put to use today include:

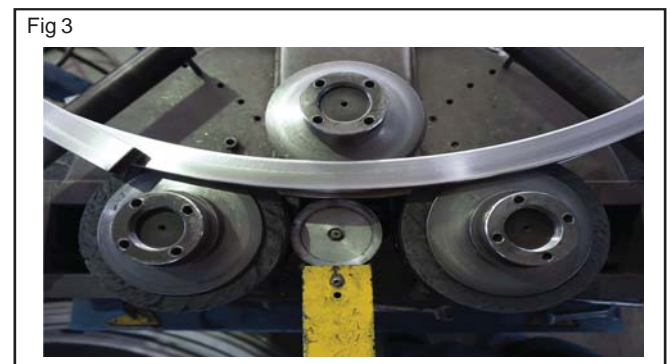
Compression Bending : To complete a compression bend, fit the pipe around a die. Once the pipe is secure,

you can either bend it by hand, using your knee, or with the help of a pair of pliers. If you try to bend the pipe by hand, be sure to wear gloves.



Ram Bending : Ram bending tends to be an automatic process. Fit your pipe underneath a hydraulic ram and let said ram fall down against it. Note that when using the ram method, it's best to fill your pipe with some sort of supportive material. If you try to ram-bend a pipe that isn't well-supported, you run the risk of kinking or otherwise damaging your line.

Roll Bending (Fig 3) : Roll bending looks a lot like pasta making, though using metal instead of flour and eggs. To roll a bend, you can guide your pipe through tube rollers, setting your preferred angle ahead of time. Again, you'll want to fill your pipe prior to this kind of rolling or else risk kinks.



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 valvanized 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.

Contrary to popular belief, this layer of zinc doesn't make it more difficult for you to bend a galvanized pipe. Instead, you can cold bend galvanized pipe with the help of a pipe bender and other appropriate power tools.

If your galvanized pipe is on the older side, there is a chance that the zinc coating may crack. In these cases, you may need to replace the bent pipe to ensure its overall longevity.

You can opt to work with the professional plumbers in your area if you don't feel confident operating a pipe bender or if you've had bad experiences with cracked zinc before. An initial consultation may also help you determine which of your potential bending methods may best suit your tools, not to mention the project you have in mind.

Method of bending tube accurately : You can bend home tubing using the same methods you would to bend piping. Specifically, you can ram, roll, compress, and rotary draw tubing. All of these methods, when used appropriately, will ensure that your tubing can adequately fit into your preferred set-up. (Fig 4)



Bend A Pipe Without A Bender : There are a few different ways to successfully bend a pipe without a bending tool. What method you use will depend on the size of your galvanized pipe and the degree to which you want the pipe bent.

First and foremost, cap and fill your pipe with sand or dirt. These materials will prevent kinks and other kinds of pipe damage during the bending process. Once you have your pipe full of compact material, locate a sturdy object around your home. You'll want this object to be broader than your pipe.

Once you've located your object of choice, slip your pipe around it. Then, while wearing gloves, use your body weight and strength to bend the pipe to your preferred angle. The filling, as mentioned above, will keep the pipe from cracking or kinking.

Bend A Pipe Without Kinking : If you're concerned about the structural integrity of your pipe, you can take steps to

prevent it from kinking. The best way to limit pipe damage is to fill your pipe with sand prior to its bending. When you fill a pipe with compact sand, you force the pipe to better hold its shape.

Note that you'll want to use duct tape or some other kind of cap to keep the sand from spilling out through your pipe. Once you've got your pipe at your preferred angle, you can remove your cap and the compacted sand before the rest of your installation.

Find The Degree Of A Bend : The easiest way to determine the angle of a bent pipe is to reach for your pipe bender. You won't be re-bending the pipe in question. Rather, pipe benders often come equipped with a protractor.

If you fit your bender to the angle of your pipe, you'll have an idea of what degree the pipe is bent at. Alternatively, you can purchase a handheld protractor and fit it to the angle in question.

If you're not sure what angle your pipe needs to be bent at, or you want to double-check your measurements, call on area professionals. Plumbers near you can help you determine the angle of all of the pipes throughout your home. They can even give you an idea of what angle you may need to bend new pipes, should you want to install new pieces. (Fig 5)



Making Galvanized Pipes Suit Your Home : The layer of zinc on the outside of galvanized pipes ensure that they resist rust and other forms of damage for a long time. That additional strength can make galvanized pipes more difficult to bend than other types of pipes, though. With that in mind, you'll need the right kind of tools on hand if you want to modify any of your to-be-installed pipes.

Both manual and powered pipe benders can help you safely bend your pipes to your preferred angle. That said, professional plumbers can also help you better fit your pipes to your home. Even if you do want to install your pipes on your own, an initial consultation with area professionals can make the process a little simpler.

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. This system is sometimes referred to as the system.

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 if 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.

It is true that the water carriage system has become the universal technique of collection and transport of domestic or sanitary waste of a community. But the irony lies in the fact that the system generates liquid wastes nearly 100 times the volume of the actual domestic waste products, in order to transport in closed conduits or sewers to the final point of disposal. Thus, the water carriage system generates enormous quantity of waste having high pollution potential. It also ultimately leads to the pollution of land and water resources.

The use of filtered processed water for flushing of closets and cleaning of small sewer lines is appreciably high in this system. For instance, a typical flush toilet will contaminate each year about 60000 litres of fresh water to move a mere 800 litres of body waste. Thus, the valuable fresh water is mixed with body wastes having high fertilizing potential and then we pay dearly to separate them again. The load on treatment plant, pumping station, etc. is increased and it results in high investment and recurring costs. It is therefore quite likely that in future, the possible alternatives of the water carriage system may be thought of such as decentralized treatment and disposal, on-site treatment and disposal system, conveying system requiring less quantity of water for its functioning, etc.

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 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 above 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 AE of pipe plus 30cm.

If depth is above 120cm it should be AE 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.

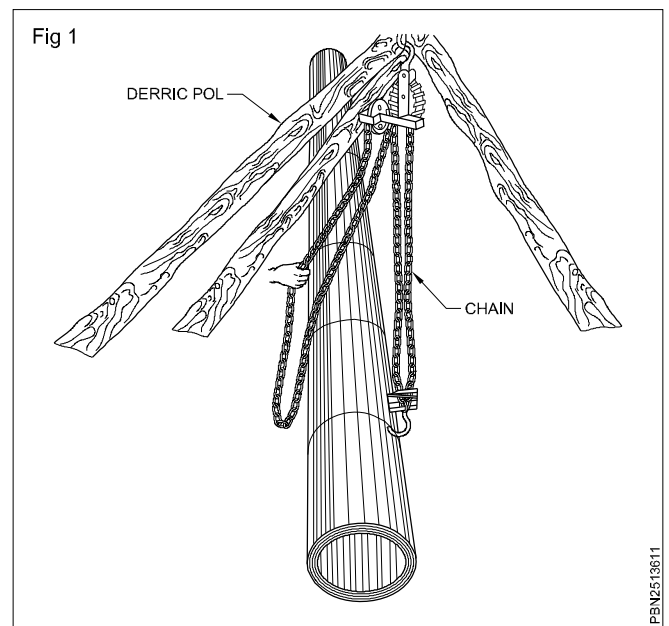
When the pipe line cross an existing road, the road crossing are to be excavated half at a time, the 2nd half to be commenced only after the pipe have been laid in the 1st half and trenches are refilled. Necessary safety measures for traffic like barricade, red flag, red light etc. are to be installed. 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.

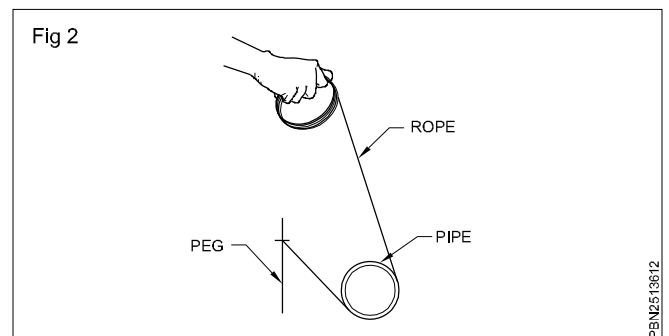
Expansive clay soil may damage pipes. Therefore it is necessary to give an envelope of a minimum 100mm of tamped sand around the pipe line.

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 of 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 traps.

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 provided 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.

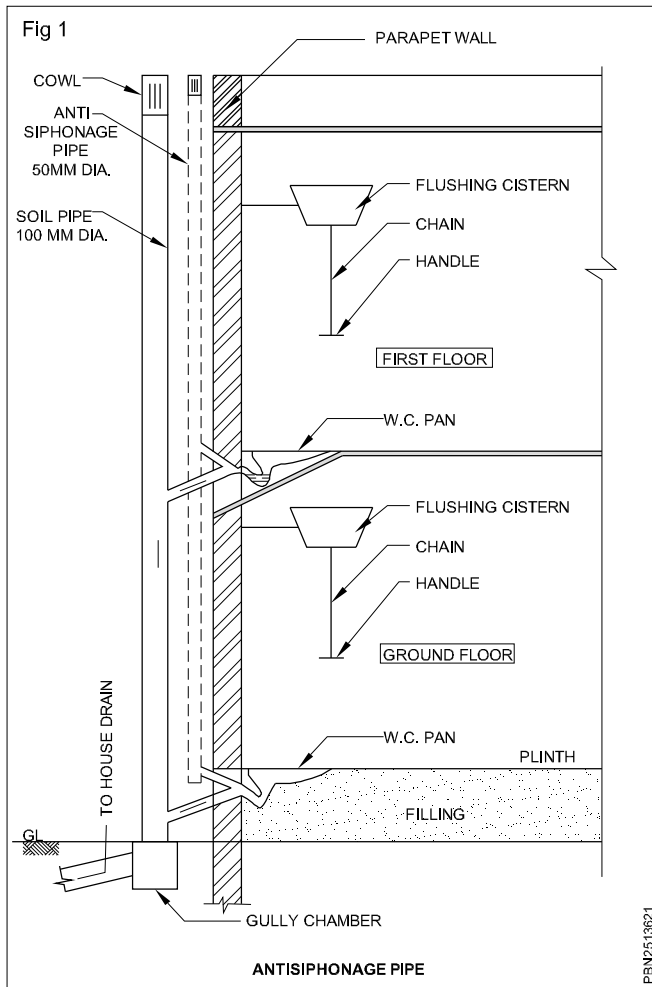
Terms related to house drainage (Fig 1)

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.

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: There are four system adopted in plumbing of drainage work in a building.

- 1 Single stack system
- 2 One pipe system
- 3 One pipe system partially ventilated
- 4 Two pipe system

1 The single stack system: This is the name given to a simplifide one - pipe system. All ventilating pipes are committed. The stack itself provides ventilation by restricting the flow into the stack upto certain limits. (Fig 2)

The single stack system is used only in buildings with a maximum ground floor and four upper floors having two bathroom units and two sinks at each floor.

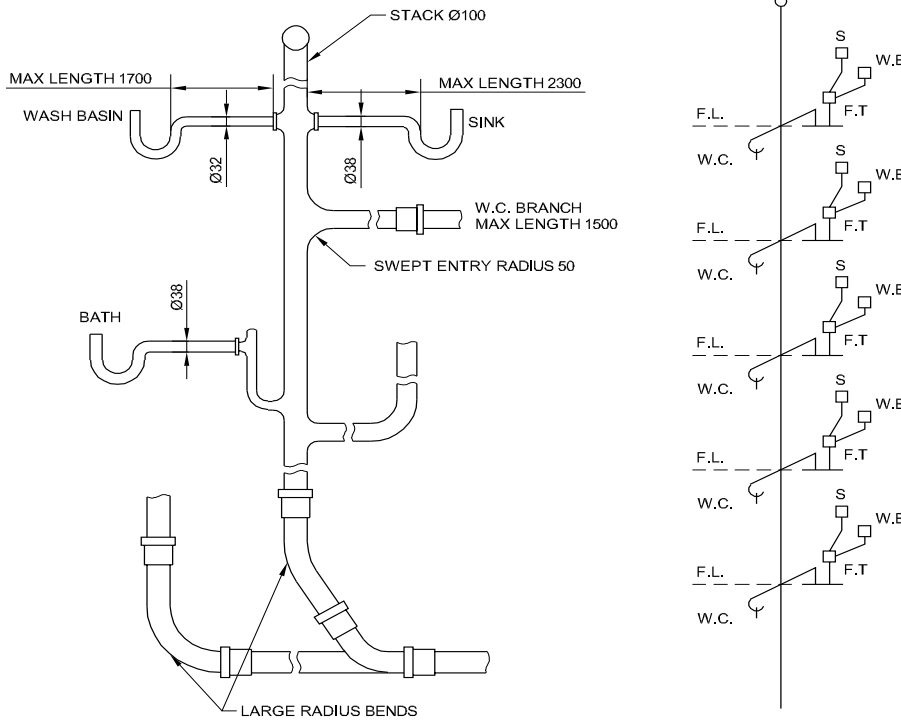
2 The one - pipe system: In this system a single soil waste pipe conveys both soil and waste from all appliances directly into the building drain. It is an easy to install and economical system. Fig 3 shows a single pipe system.

3 One pipe system partially ventilated: This system combines both the one - pipe and single stack system. In this system, only one soil waste pipe conveys both soil and waste. The separate vent pipe provides ventilation only to the traps of water closets.(Fig 4)

4 The two - pipe system: Different waste pipes are used for drainage of waste from bath, kitchen and W.C's. The soil pipe conveys discharges from water closets, urinals, and similar soil appliances directly to the drainage system. The waste pipe conveys waste from ablutionary and culinary (sinks, wash basins, showers, bathrooms and kitchens) appliances to the drainage system directly or through a trapped gully where desired.

This system is installed on the face of a side wall or a pipe duct in the case of multistoreyed buildings. In multistoreyed buildings where the number of floors exceeds four, this system is preferred.

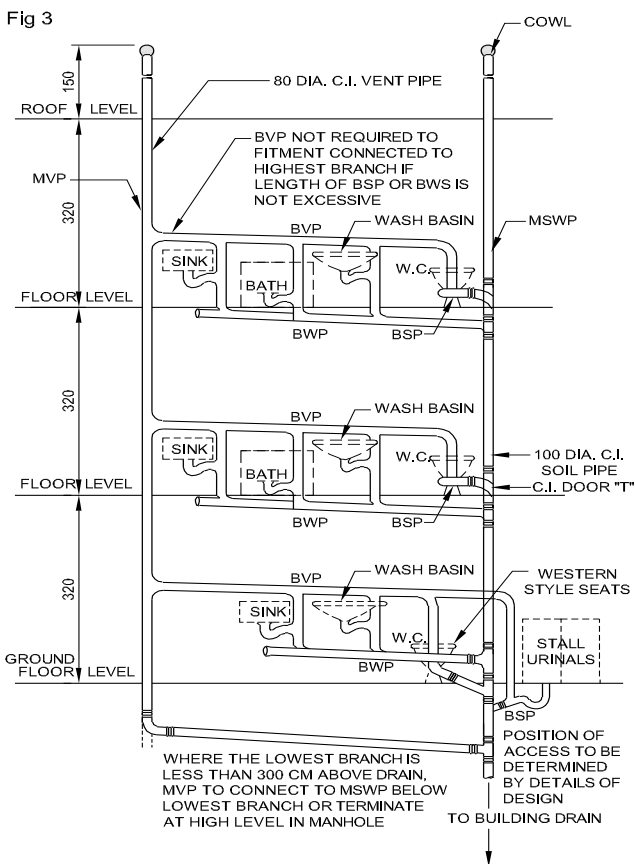
Fig 2



SINGLE STACK SYSTEM

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Fig 3



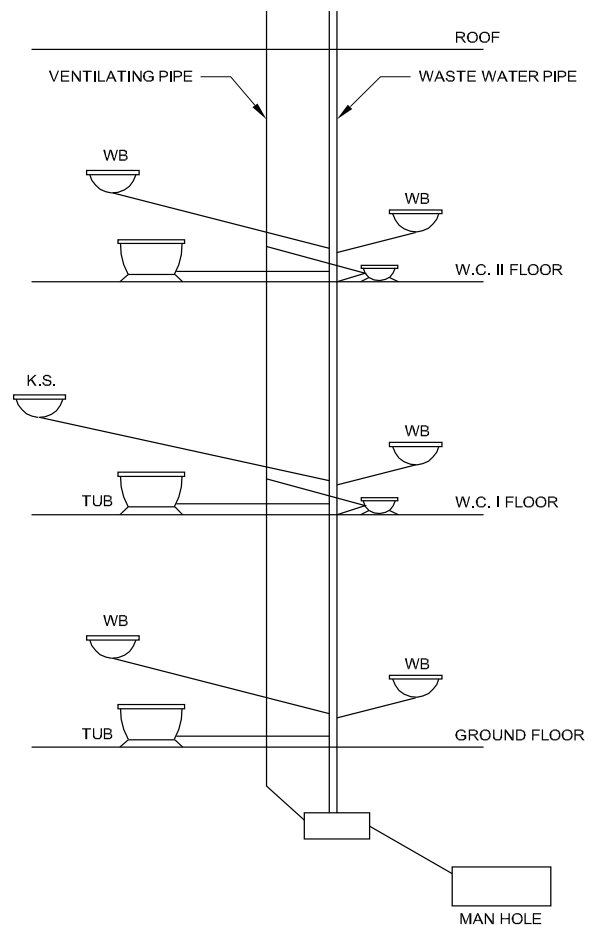
REFERENCE:-

- MVP :- MAIN VENT PIPE
- MSWP :- MAIN SOIL AND WASH PIPE
- BSP :- BRANCH SOIL PIPE
- BVP :- BRANCH VENT PIPE
- BWP :- BRANCH WASTE PIPE
- BSP :- BRANCH SOIL PIPE
- W.C. :- WATER CLOSET

ONE PIPE SYSTEM

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Fig 4



ONE PIPE SYSTEM (PARTIALLY VENTILATED)

PBNS2513624

Drains

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

- describe the drains
- condition of ideal drain section
- 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. Dur to their cheapness and low maintenance cost, certain municipalities and local bodies adopted them fro the conveyance of unfoul water. They require cleaning after short intervals.

Drains sections

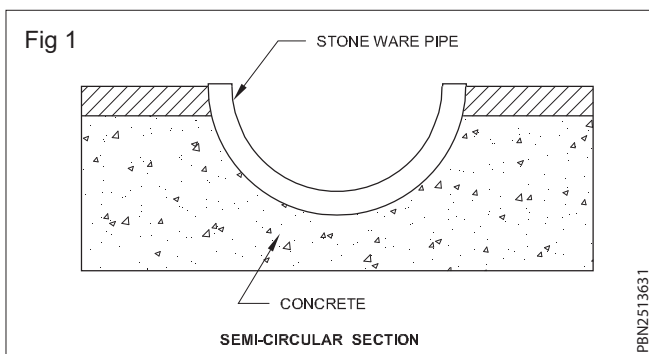
An ideal drain should fulfil the following conditions:

- It should develop self-cleaning velocity with minimum dry weather flow.
- It should have sufficient free board at its top, even during maximum discharge.
- It should be clean in construction and maintenance.
- It should be such that it can be easily cleaned.
- It should be structurally safe and stabel.
- 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 sucessfully tested experience. They are:

- a Semi-circular section b U-section
c V-section, and d Rectangualr section

a Semi-circular section (Fig 1)

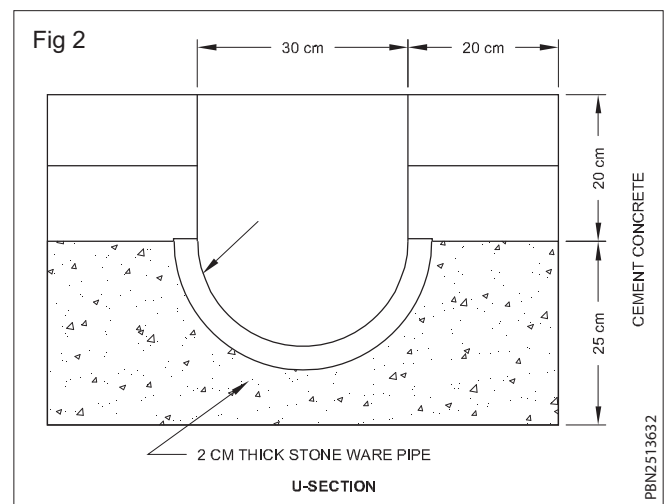


This type of drain is mostly used for small drains due to its easiness in laying, stability and cheapness. Half round glazed stone-ware pipe is used for its construction. If the discharge in this section decreases, the self-cleaning velocity will not develop and deposits will settle down in the bottom and will cause obstruction to the flow sewage.

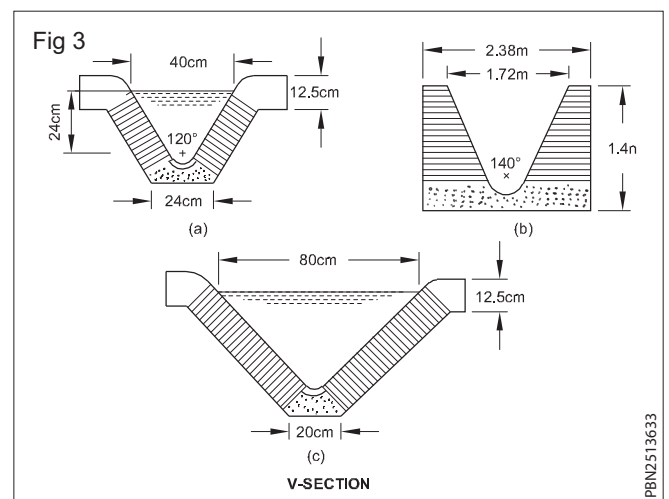
Semi-circular drains are not suitable for large discharges, because in such casses they occupy more space. If this drain is deep, there are always chances that the wheels of the vehicles may drop in it causing damage both to the vehicle and the drain. In sandy area during high winds, these sections are 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)



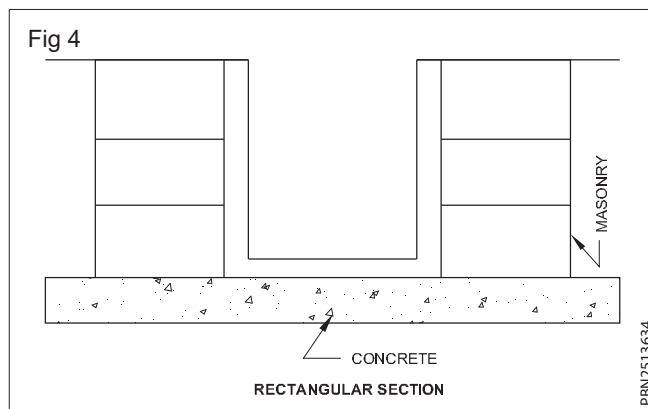
This section gives sun-cleaning velocity even for very small discharge because greater depth is available in each case. In the invert one-third to one-fourth stone ware pipe or concrete block is laid and the sides are constructed with brick or flag stones and are plastered. It is easy to clean this type 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.

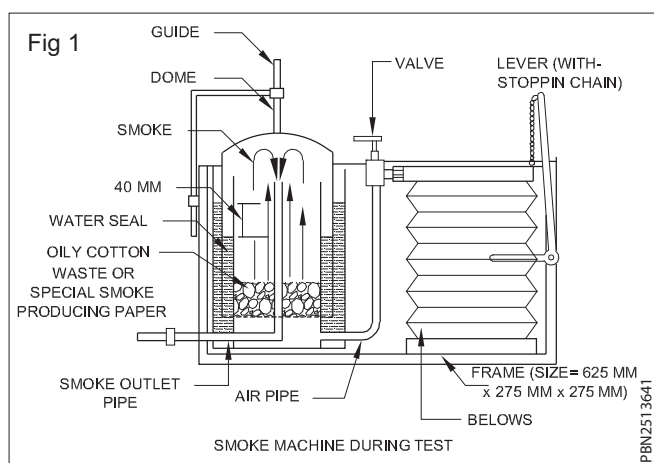


Method of testing leakage

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 leakaging 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 offlowing 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
- types of traps.

Refer Ex. No. 2.3.112 & 113

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)

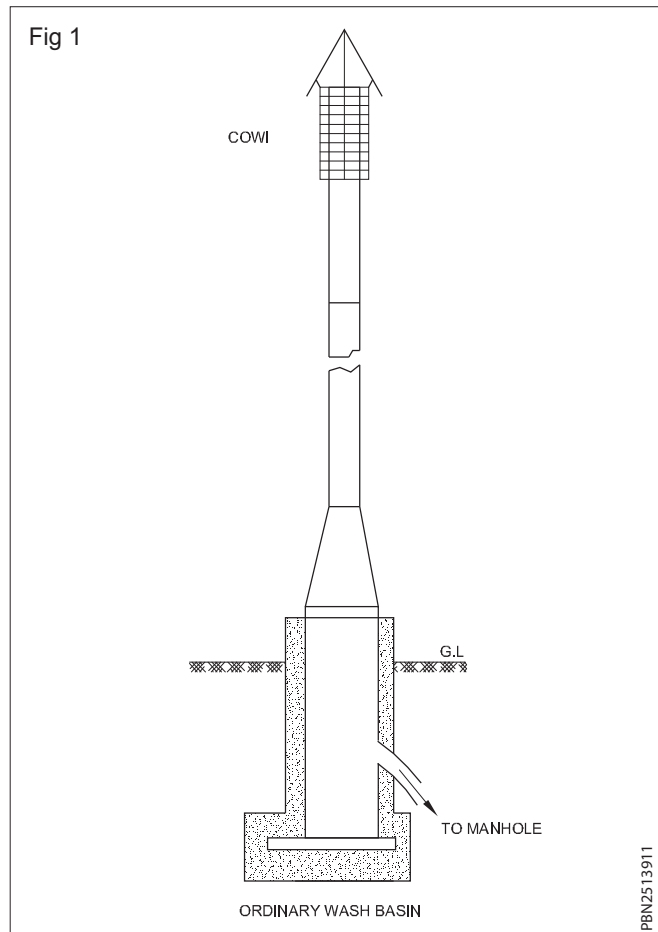
Various gases are produced in sewers due to purification of organic materials of sewage. These gases are very foul in nature, cause harm to human health and corrode the sewers reducing their life. The gases so produced are highly explosive and in high concentration may cause fatal accidents to the maintenance 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.

Antisiphonage pipe (Fig 2)

The main function of the anti-siphonage pipe is to prevent water seals from being destroyed. If several lavatory blocks situated on different storeys are discharging into a common soil pipe, anti-siphonage pipe is always necessary.

When waste water is suddenly discharged from a sanitary fixture on the upper floor, it moves down rapidly through the soil (or the waste) pipe; and in its movement, it may suck some air from the lateral pipe connecting the soil pipe with

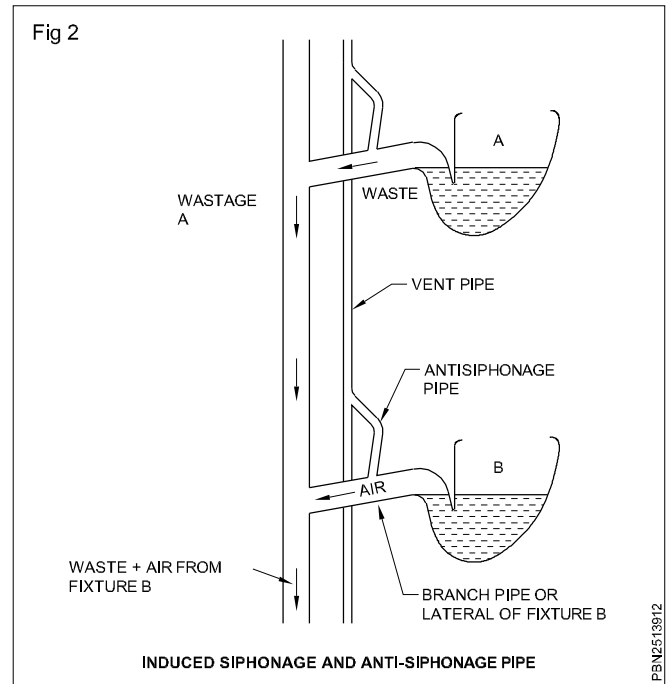
the fixture at the lower floor. This sucked air causes syphonic action, resulting in the flow of water from the trap of the fixture to the soil pipe and thus, breaking its water seal.



To overcome this difficulty, a separate pipe of smaller diameter is attached to the traps, which connects the trap with the vent pipe. This pipe is known as anti siphonage pipe and it supplies air to the short branch pipe of the lower fixture, at the time of suction; otherwise, it acts as a vent pipe connection of the lower fixture. This pipe, thus will

normally serve as a vent pipe, and as an anti-syphonage pipe in case suction takes place, as explained above. Hence, some people get confused when anti syphonage pipes or vent pipes are sometimes described separately and sometimes written as one and the same thing.

Anti Syphonage pipes: Water seals of traps in multi-storied buildings or houses may sometimes get broken due to siphonic action, as explained below: (Fig 2)



Types of sinks

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

- explain different types of sinks.

Refer Ex.No. 2.4.127 & 128

Fire hydrants and their fittings

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

- describe the fire hydrants
- properties of good fire hydrants
- state the hydrants.

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.

They are also sometimes used for filling the municipal water carts to the water requirement during construction of roads, washing of roads, drains, sewers, sprinkling of public lawns etc.

In the case of fire breakout in a locality, the fire fighting 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. In case of big cities water pressure upto 100 m may be required, therefore, engines, fire hose, nozzle etc. must be designed to bear this pressure.

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.

In case of serious fire the water is drawn from served fire hydrants from the locality.

Following are the requirements of a good hydrant:

- It should be easily connectable to the hose pipe.
- It should be cheap in cost as well as maintenance.
- It should be easily detachable during the panicky atmosphere of fire in the locality.
- It should be reliable and should not go out of order during fire and operation.

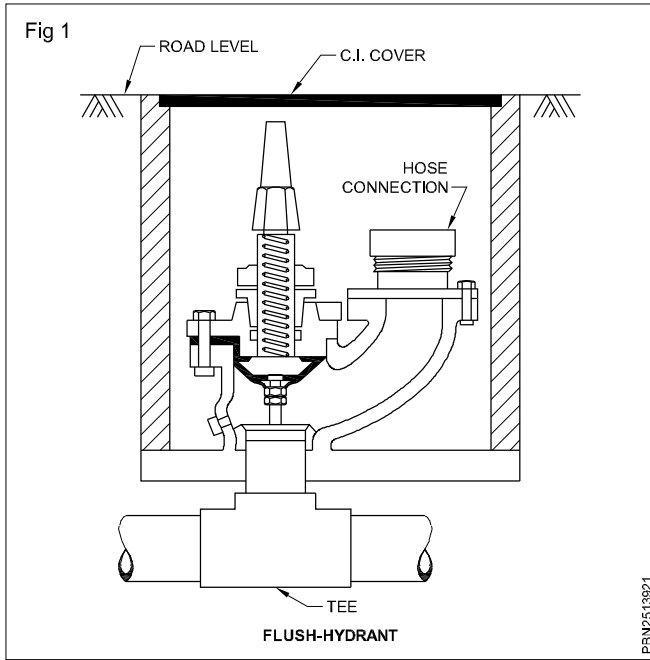
Hydrants are of two types

- Flush hydrant
- Post hydrant

Flash Hydrant (Fig 1)

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

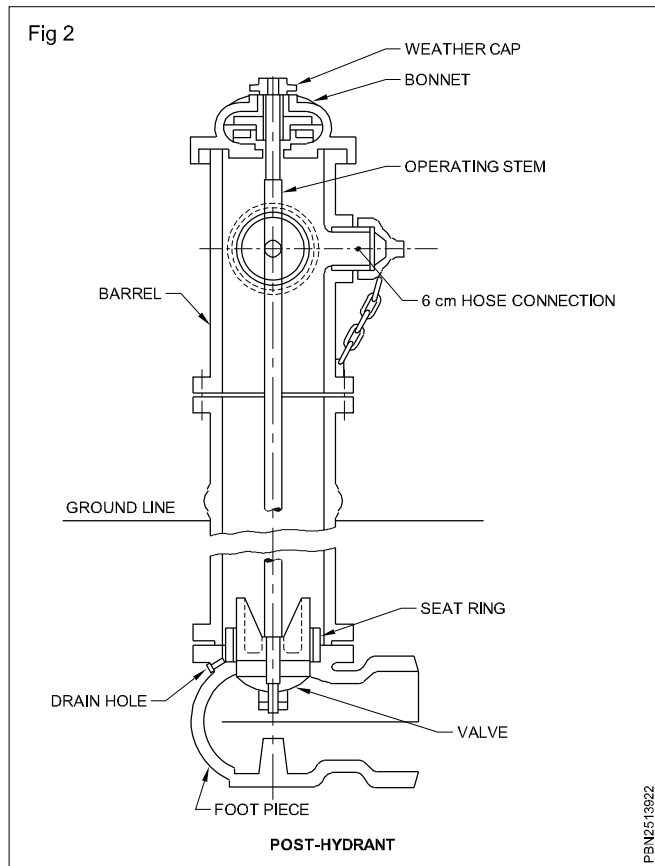
distinct sign is provided near it at the side of road with letters 'F.H.' written on it.



Post hydrant (Fig 2)

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 2)



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.

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

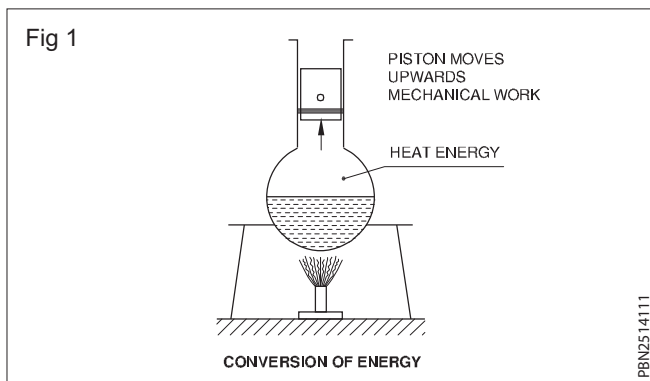
Temperature is the degree of hotness (or) coldness of the body. Its the averae kinetic energy of the body.

Temperature is measured by thermoneter

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.

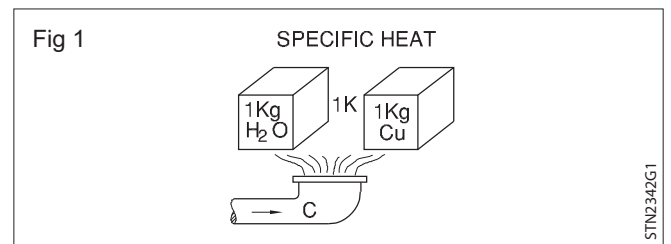
Joule : S.I. Unit (1 Calorie = 4.186 joule)

Effects of heat

- Change in temperature
- Change in size

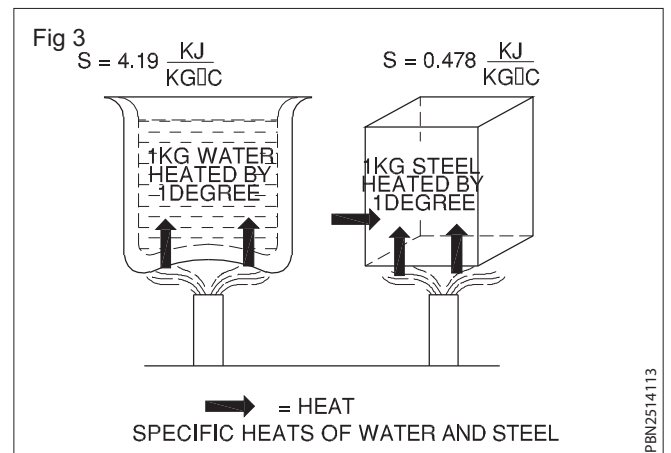
- Change in state
- Change in structure
- Change in Physical properties

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.

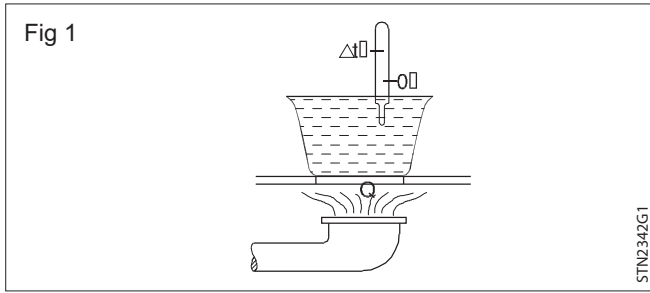
Therefore water equivalent = ms

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:



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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

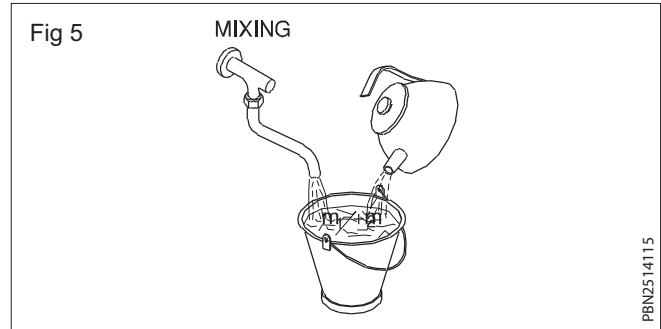
The amount of heat needed for heating 1 kg of the substance through 1°C is equal to the specific heat of the substance 's'. For heating a mass of 'm' kg of the

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)



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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.

$$m_1 \times s_1 \times t_1 + m_2 \times s_2 \times t_2 = (m_1 s_1 + m_2 s_2) t_m$$

$$\therefore 40 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \times 15^\circ\text{C} + 80 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \times 60^\circ\text{C}$$

$$= \left(40 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} + 80 \text{ kg} \times \frac{4.2 \text{ kJ}}{\text{kg}^\circ\text{C}} \right) t_m$$

$$t_m = \frac{22680}{120 \times 4.2} \text{ }^\circ\text{C} = 45^\circ\text{C}$$

Heat transmission

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

- state the three types of heat transferring
- state the thermometer and pyrometer.

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

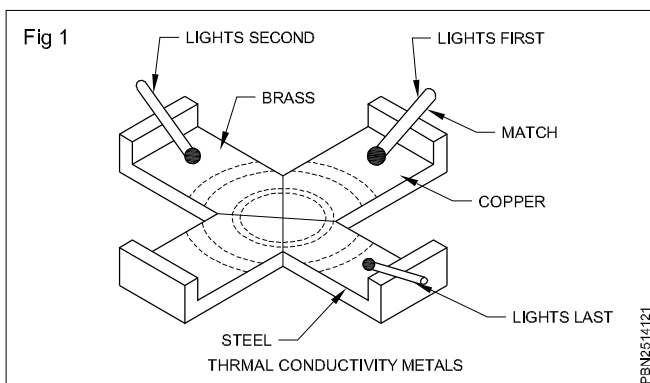
Radiation is a mode of heat transfer which requires no material medium. Heat energy is carried by infrared electromagnetic waves from one place to another.

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.

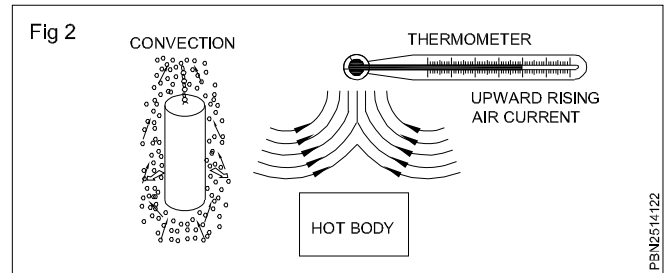
- By Conduction
- By Convection
- By Radiation

Conduction (Fig 1)



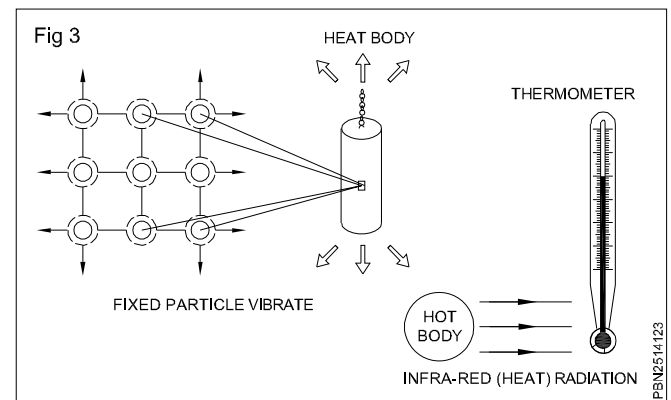
Conduction is the name given to the transmission of heat energy by contact. The heat source is in contact with the Conductor. (metal rod). The rod is in contact with a thermometer. Due to Conduction heat is transferred from the heated end to the free end. In general good electrical conductors are also good heat conductors and good electrical insulators are also good heat insulators. A good heat insulator does not necessarily withstand high temperature.

Convection (Fig 2)



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 3)



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

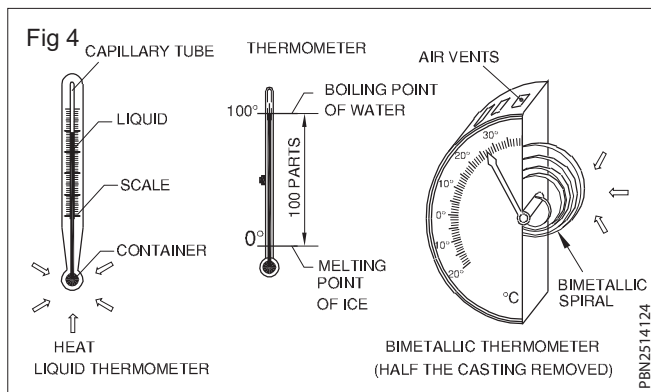
Temperature is generally measured in degrees Celsius. In this system the freezing point of water is defined as 0°C and the boiling point of water is defined as 100°C. The Kelvin temperature scale begins from absolute 0. i.e.—273°. The temperature intervals are the same.

$$\therefore 273K = 0^{\circ}C, 20^{\circ}C = 273K + 20K = 293K.$$

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 4)



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.

Heating system by different thermal units

Objective: At the end of the lesson you shall be able to

- state heating system by different thermal unit.

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

- 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)
- 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.

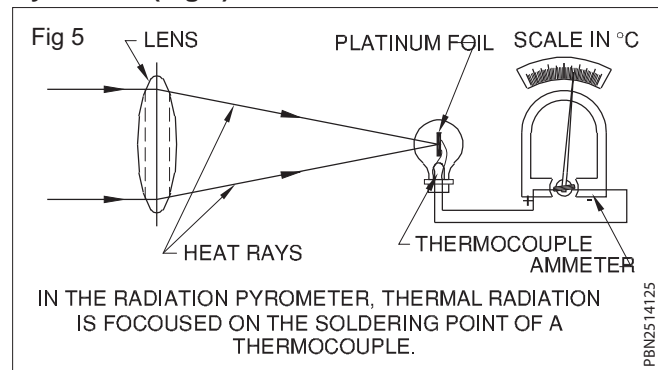
Water heater

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

- explain water heater.

Domestic water heater: Domestic water heaters are used to heat water for the use of houses and for smaller

Pyrometer (Fig 5)



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 thermo element. The scale of the ammeter is calibrated in degrees Celsius or Kelvin.

Calorie

A calorie is commonly defined as

- The amount of heat required to raise the temperature of one gram of water 1°C.
- 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.
- 1 calorie (cal) - 1/860 international watt hour (Wh)
- 1 kcal = 4186.8 J = 426.9 kpm = 1.163, 10⁻³ kwh = 3.088 ft lbf = 3.9683 Btu = 1000 cal.

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 alongwith 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 suddently there is possiblity 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 overheat 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 choosen 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.

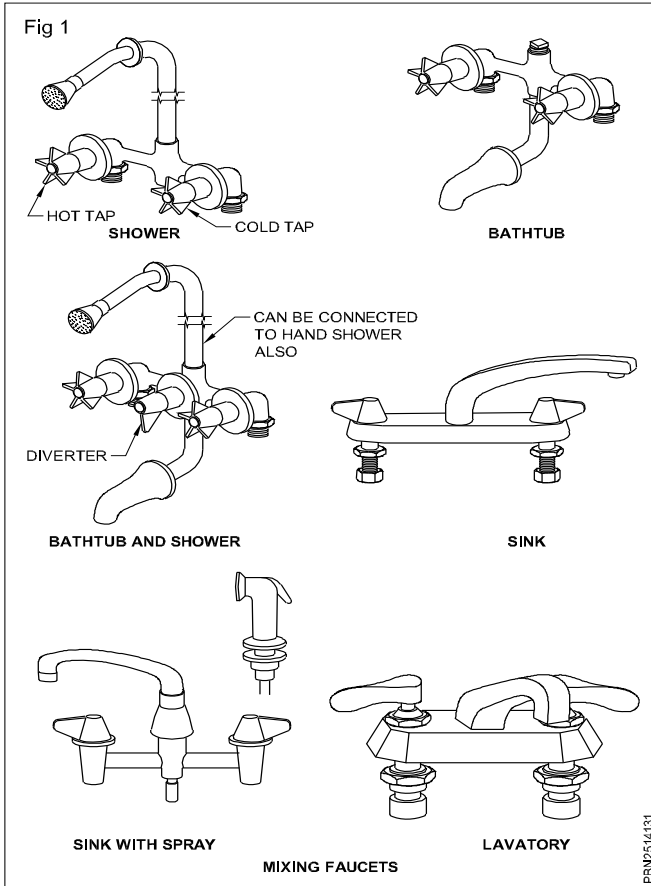
Connecting of hot and cold water line into bath tub

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

- explain hot and cold water mixer.

Mixing tap: 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 one for cold water the mixing faucets (tap) has the 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.

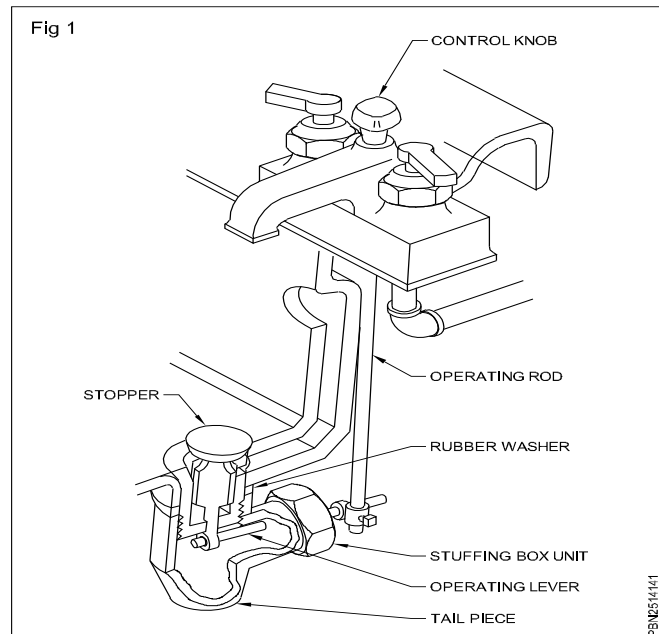


Popup waste

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

- explain the popup waste.

Popup waste: 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.



General layout of connection of pipes to mains

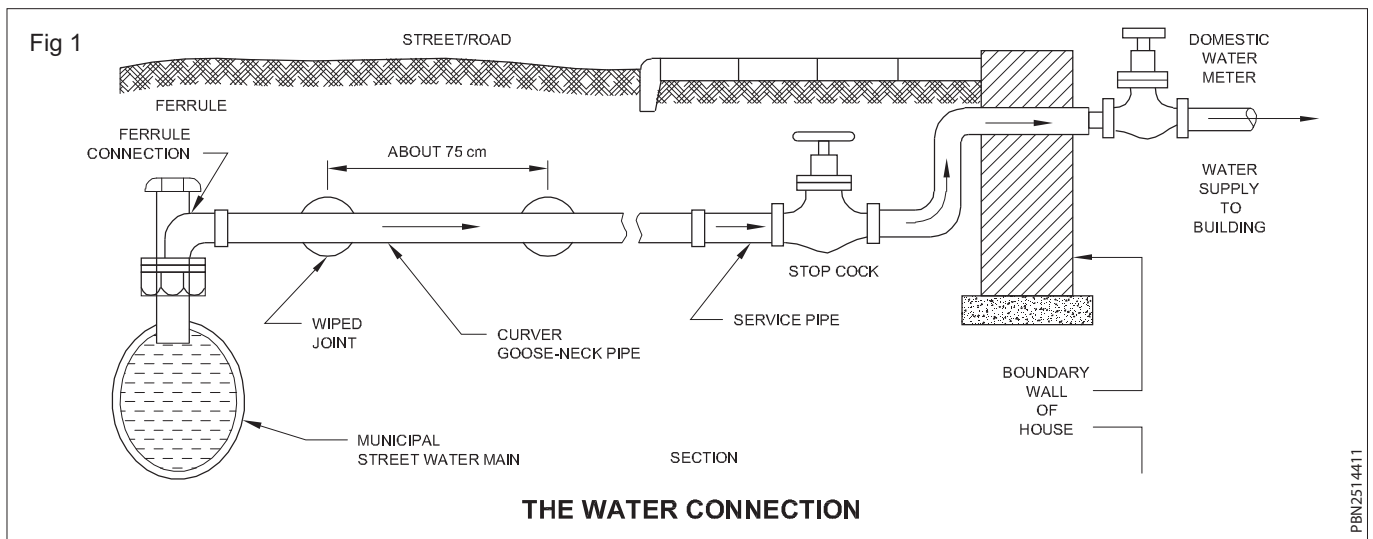
Objectives: At the end of the lesson you shall be able to

- 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, because the water supply to a house or a building can start only from

this point. 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.

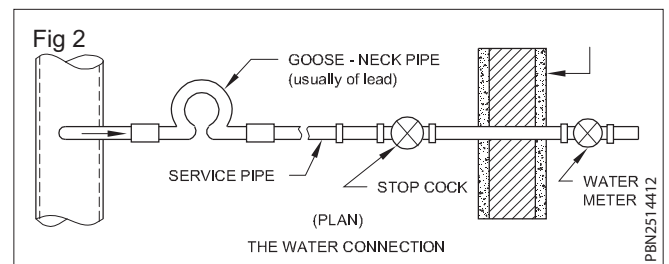
Service pipe

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 cocks (Fig 3)

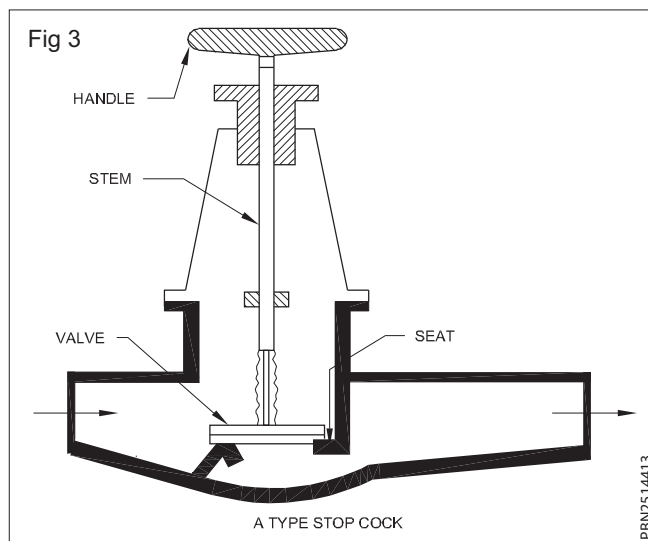
The stop cock is provided before the water enters the water meter in the house. It is housed in a suitable masonry chamber with a removable cover, and is fixed in the street close to the boundary wall in an accessible position. Sometimes, it is provided just before the water meter inside the house, keeping 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

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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 in water supply system by sound test

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 defection and repair strategies check the leakages.

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.

Repairs to service main

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

- **explain repair to service main.**

Water mains are generally repaired and completed between four to eight hours one factor that may delay the repair is location of the break. A water main that is buried deep inside the earth or under another utility will take much longer.

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

- 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.

- 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 and now reactive with most chemicals only ductile iron pipe is used as often for water applications.

Causes of water main break

As the weather turns cold water main breaks become more common. This is due to the expansion and contraction of the pipe material which weakens it. Pipe corrosion soil conditions age and ground movement can also cause water main breaks. Creating unexpected problems for customers and motorists.

Repair on PVC pipe

Repair epoxy is putty or viscous liquid that can be used to repair pipe leaks on PVC and its joints while repairing PVC pipe first clean and dry the damaged area ensuring water cannot reach the affected area. Then apply the epoxy and let it cure for ten minutes.

HDPE (High density polythylene)

Pipes are considered the best choice for under ground water lines. HDPE pipes are non- toxic, tasteless and

considered a green building material. The pipes are designed to be high crack and corrosion resistant.

According to the department of environment they recommended that pipes should be buried at least 600mm (two feet) under ground. At this depth the soil acts as a natural insulator and prevents then freezing.

Repairs of drainage and main water supply

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

- explain the maintenance of drainages and water supply.
-

Leakage in bath and toilet: While attending leakage of slab, all fittings and floor finishings are to be removed upto slab. RCC slab is cleaned. Holes are driven 50mm deep at suitable intervals. Chemical acrylic with a mix of cement slurry is passed through the pipes in these holes under sufficient pressure. The entire area is cement plastered with cement mortar 1:4 (1 cement : 4 fine sand) and apply two coat of waterproof chemical like "Ceroplastic". Introduce a 40mm warning pipe at the top of slab outside. After 24 hrs the slab can be refilled and fittings introduced.

Waterline: Inadequate 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 it can be immediately repaired with G.I pipe clamp and rubber padding. For more permanent repair it will need to 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 pipe 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 or washer has deteriorated or broken or seat is broken or pitted. 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.

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.
-

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. Boilers and associated systems are efficient heat exchange systems. However, they can be dangerous if not properly maintained and operated.

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 older heating system where the higher pressures used by other types of boilers could not be accommodated or where the water supply pressure is low.

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. This can be more efficient type of boiler as the 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. However the water supply is limited to the size of the cylinder.

CHP boilers: Micro CHP or micro combined heat and power is the small scale generation of heat and electricity from a single energy source. It can be installed as direct replacement for gas fired boilers.

Bio mass boilers : The boilers run on renewable fuel such as wood pellets. The emission produced is much lower than emissions from fossil fuels and traditional boiler types. The price of biomass boiler is cheaper than other heating options and can be locally sourced. This boiler occupy more space than other standard boilers.

Geysers

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

- explain the function and use of geysers.
-

Definition

The geysers are electronic devices which are utilised primarily for water heating purpose. They are very useful for heating water as the rattling of teeth and the shivering body can only be stopped by a warm, relaxing bath. That's where our hero, "geysers" comes in. Geysers are widely used within bathrooms, kitchens, and showers for heating water within homes. They can be easily installed, are user-friendly and can be used by people of any age groups. Taking cold showers is an uncomfortable experience for kids and elderly women. Simultaneously sleeping during winter night under blankets while shivering isn't a pleasurable experience either. To resolve these issues, Moglix presents a wide range of geysers to keep users warm and cosy.

What are The Different Types of Water Heater ?

At Moglix, we offering three types of water heating Options- Immersion Rods, Geysers and Water Heaters. They are discussed below for your reference:

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. In order to use the immersion heater rod, you will only need to fill a water bucket and place it within the bucket directly or with the help of a cloth hanger. Then, connect the plug into the socket and switch it on. A few models come with an indicator to show that they are functioning well.

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. While selecting a new water heater for domestic use, select an energy saving water heating system which will provide sufficient water, thereby ensuring substantial saving. There are different types of water heaters. Some of them are mentioned below:

Fig 1



Fig 2



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. If you don't have a tank but have a hot-water heating system for heating, it's possible that hot water reaching your tap will be heated by the boiler. In other circumstances, hot water can be supplied by a stand-alone instantaneous water heater which is mounted near the fixture it serves. The normal water heaters are of two types- Electric and Fuel-Fired. In the case of the latter, the fuel normally used is gas, either propane or natural.

Fuel-fired units come with a vent pipe at the top for carrying away exhaust gasses. In contrast, electric models are only equipped with a power cable which connects the heater to the electric service panel. At Moglix, we are offering water heaters from brands such as Eveready, Marc, Bajaj, Venus etc. The primary task of the tank-type heater is not only for heating the water but also storing it till it's ready for usage. Additionally, all tanks are equipped with insulation for maintaining the warmth of water during heating rounds. The upper part of every tank is equipped with a water supply and delivery pipes. The supply pipe water moves cold water to the bottom of the tank through the dip tube. The hot-water delivery pipe takes water from the top.

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. The valve is connected to a pipe which runs outside the tank and ends 6 inches from the floor. It's wise to keep a bucket under the pipe end to catch water if the valve opens. The T & P valve shouldn't be connected to a drain. In case the valve did open, there is a sign that such an issue within the water heater.

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. Once the rust creates a hole, there are momentary fixes. However, the tank needs to be replaced in the long run. All tanks are equipped with an anode rod for controlling corrosion. The tanks are protected by the magnesium anode rod by corroding the tank in place of steel. Since the rod is designed to corrode, it will eventually wear away.

Once this happens, the corrosion of steel will speed up. It's wise to check the anode rod once annually and replace it if is necessary. 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)

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—normally two, one in the middle of the tank and the other at the bottom. Power is delivered to each element through a thermostat—a switch senses the water temperature. Once the temperature drops, the switch closes to allow current to flow. It opens once the temperature reaches its stipulated limit.

Horizontal Water Heaters (Fig 4)

Usually, geyser water heaters are vertically mounted. Vertical water heaters require at least two feet of vertical height on the wall. In case the bathroom ceiling wall is low, you will have decorated with false ceiling or have attic then you won't have sufficient vertical space on the wall for mounting the geyser vertically.

Fig 4



Kitchen Water Heaters (Fig 5)

Fig 5



Electric instant geysers with a capacity of 1 liter to 3 liters are suitable only for kitchens. Since you need instant hot water for cleaning, you cannot wait for 5 minutes for only cleaning for only cleaning a cup if it is a storage geyser. Last but not the least ensure that you have sufficient wall space for mounting the instant geyser.

Fuel-Fired Water Heaters (Fig 6)

Fig 6



Rather than using heat resistant elements, gas-fired heaters are equipped with a gas-fed burner through a

control valve and a thermostat switch. In an oil-fired heater, the burner is similar to the one used in an oil furnace. In both the cases, the burner is normally located at a location for throwing a flame under the tank. The exhaust gasses are released either through a hollow core at the tank's center or around its sides. Since fuel-fired heaters heat the tank, which in turn heats the water. As a result, there will be more wear and tear on the tank than with electric heat. Fuel-fired heaters, therefore, have a shorter durability as compared to an electric heater.

Water Heaters for High Rise Buildings (Fig 7)

Fig 7



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 and an essential geyser pressure control valve. Geyser pressure control valve releases much water pressure on geyser tank for avoiding geyser tank breakage. Glass-lined coated inner tanks are more suitable since they will resist high pressure.

Solar Water Heaters (Fig 8)

Fig 8



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. Though the initial investment is extremely high but it will prove fruitful in the long term. However, it will take some time for

solar geysers to become economical for use. They are not suitable for large apartments. These geysers are unsuitable for bigger apartments.

Horizontal Heaters (Fig 9)



Usually, water heaters are vertically mounted. Horizontally mounted geysers are new to the market. Vertical water heaters require at least two feet of vertical length on the wall. If you have a low bathroom ceiling is low, you have decorated with false ceiling, or attic then you won't have enough space on the wall for mounting the geyser vertically. In such cases, it is sensible to opt for horizontal geysers.

Geysers

There are numerous types of tank geysers. Some of them are mentioned below:

Storage/Tanker Geyser

A storage/tanker is a tank which is used for storing hot water. There are different sizes of tank measures in liters. You will need to decide on the capacity based on the usage. These geysers are normally big in size and require more space for installation.

Tank Less Geyser

As its name suggest, there will be no tank for water storage. Rather water will be heated instantly. There is a very slow in water outflow based on installation.

Electric Geyser : They utilize electricity for heating water. These geysers utilize electricity for water heaters. Storing a large amount of water even when it is not necessary to ensure that wastage of power is high.

Gas Geysers : This type of geysers is cheaper as compared to electronic geysers but they need to very careful about chances of gas leakage. While using geysers, there is no need for water storage. Solar geysers prove to be quite cheaper in the long run but include high investments in the long run.

How Do Electronic Geysers Work?

Geysers have three major components- Heating Element, Water Tanks, and Thermostats. Each of these components is explained below: -

Geyser Heating Element

The heating element is a vital component of the geyser, apart from the container or inner tank. Therefore, you will need to inspect the quality of the geyser element. Extremely hard and very soft water affects heating elements, like the inner tank. The geyser's heating elements are coated with a glass lining which is high effective for checking scaling. It also increases the durability of the geysers.

Geyser Water Tanks

Geyser tanks hold hot water. Therefore, tanks need to be corrosion resistant and strong. There are two types of Geyser water tanks: -

- i The older models are made from stainless steel and have become obsolete now. Corrosion and hard water scaling are the major problems with these water tanks.
- ii Vitreous enamel glass coated geyser water tanks are the latest models in geyser technology. During the manufacturing process, the stainless steel water tank is coated with advanced polymers to make the tank corrosion resistant. This mixture is known as Vitreous Enamel glass coated geyser water tank. They are corrosion resistant and can help in hard water scaling also. Vitreous Enamel water tanks usually come with 5-7 years' warranty also. It is quite similar to glass lined coating.

Geyser Thermostat : The geyser thermostat is the operating system of a geyser. It decides when to start and stop the heating of water. A bimetallic strip is utilised for converting a temperature change into mechanical displacement. The bimetallic strip is made from steel and copper. The thermostat is a wrapper on this strip which takes the action on the bimetallic strip response. A high-quality thermostat protects the geyser from overheating of water. It also helps in saving power consumption to an extent, but partially. Users normally have a misconception that they do not need to switch off the geyser because they have a thermostat. The thermostat has a temperature range between 30-60 °C for heating water.

Thermostats have a dial to set the maximum water temperature-usually between 130 °C or as low as 120 °C for higher energy savings and scald protection. Once a hot-water tap is opened, cold water enters the tank through the dip tube and drops in temperature initiates the thermostat at element at the bottom. As water at the tank's top is substituted by cool water, the temperature at the thermostat top drops and exits. Once the tap is turned off, the heating elements continue carrying currents till the thermostats are satisfied.

Effectiveness of A Geyser : Since water heaters heat as well as store water, the rate of water heating and capacity of the tank affects the supply of water at your fittings. The speed at which the water heats is known as its recovery rate. Once you draw water faster than it is heated, there is a drop in temperature. However, since the tank stores hot water, its capacity also affects the constant water availability at the tap.

Ventilating pipe

Objective: At the end of the lesson you shall be able to

- state about the installation of vent pipes.

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 revent 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.)

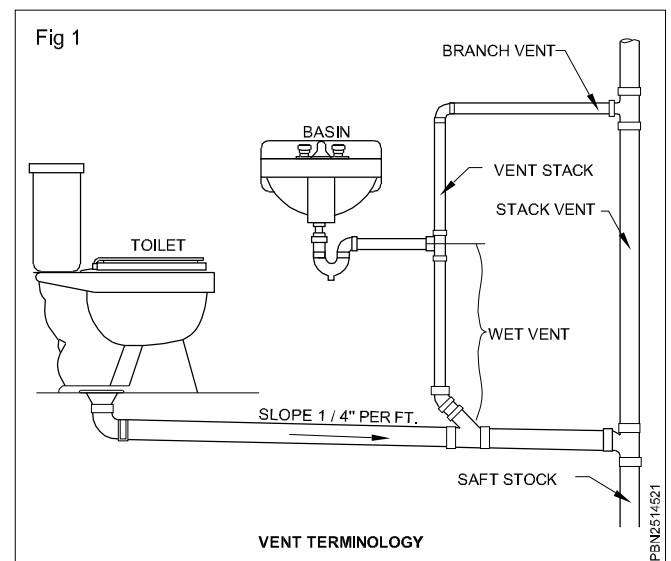
The main drain

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 1)

A true vent pipe must remain dry while water runs down the drain. A wet vent also serves as a drain but is large enough that it never actually fills with water.



Solar water system

Objective: At the end of the lesson you shall be able to

- state solar water system.

Solar water heating (SWH)

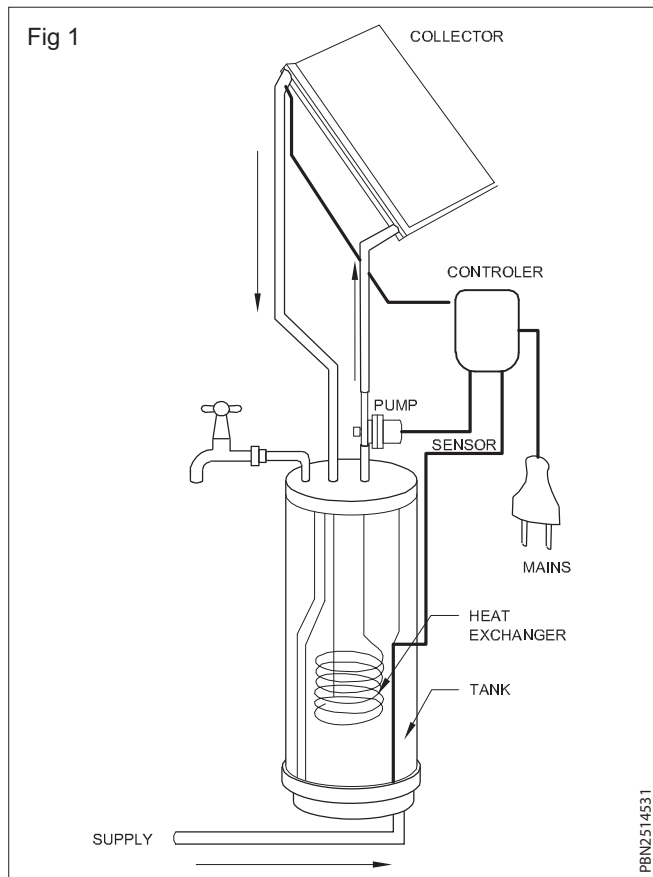
Solar water heating (SWH) is the conversion of sunlight into renewable energy for water heating using a solar thermal collector. Solar water heating systems comprise various technologies that are used worldwide increasingly.

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 1)



Freeze protection

Freeze protection measures prevent damage to the system due to the expansion of freezing transfer fluid. Drainback 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

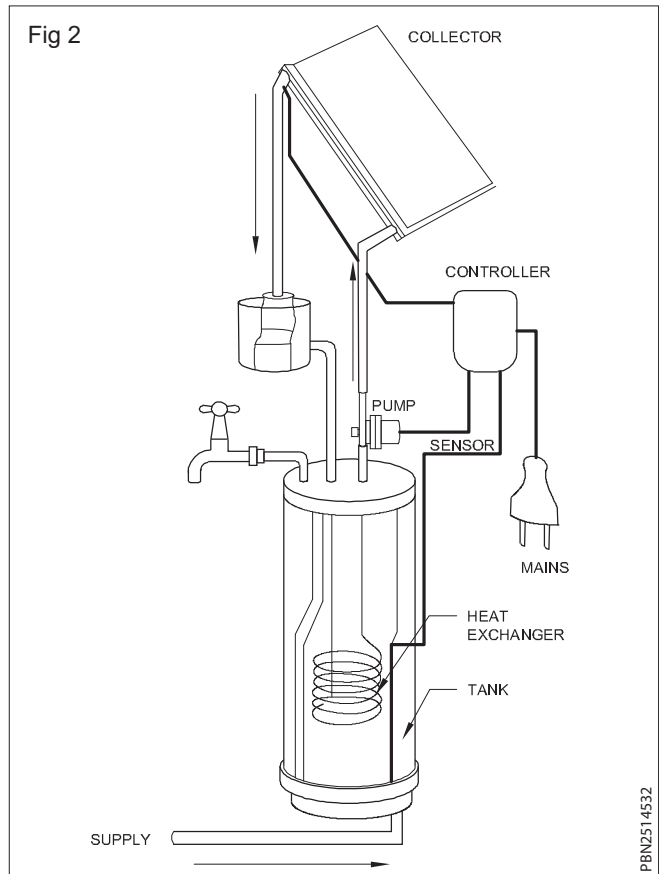
When no hot water has been used for a day or two, the fluid in the collectors and storage can reach very high temperatures in all systems except for those of the drainback variety. When the storage tank in a drainback system reaches its desired temperature, the pumps are shut off, putting an end to the heating process and thus preventing the storage tank from overheating. (Fig 2)

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:

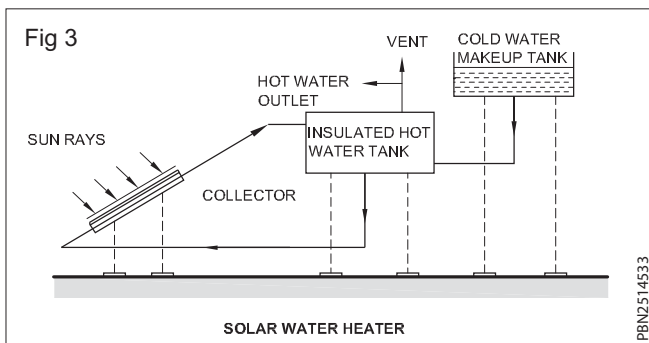
- The storage tank can be situated lower than the collectors, allowing increased freedom in system design and allowing pre-existing storage tanks to be used.
- The storage tank can be hidden from view.
- The storage tank can be placed in conditioned or semi-conditioned space, reducing heat loss.
- Drainback 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 1 & 2. 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 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 siphon action.

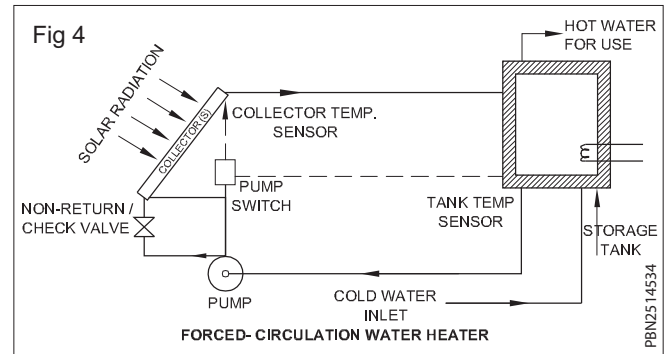
When the collector is fixed above the level of the hot water tank, a pump is required to induce circulation of the water in the loop, and the scheme will be known as active or forced solar thermal system. Water is pumped through flat plate solar collector, where it is heated and flows back into the storage 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 3 & 4)



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.

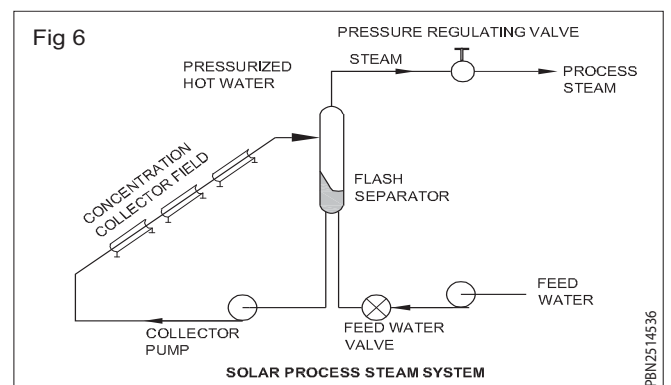
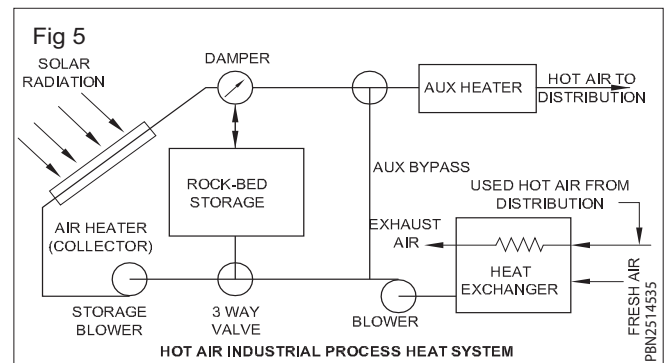
Solar industrial heating system



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 1 to 4). 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 4. 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 5 & 6)



Precaution against air poisoning

Objectives: At the end of this lesson you shall be able to
• explain precaution of air poisoning.

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.
- 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.

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





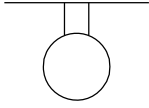

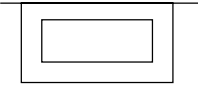
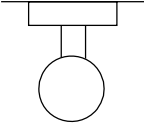
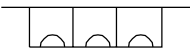

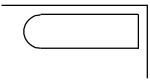

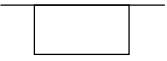
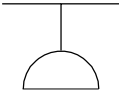
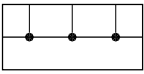
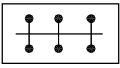
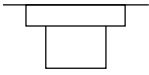
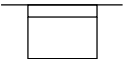
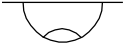

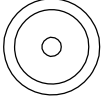
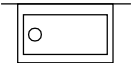
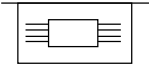
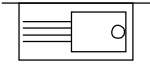
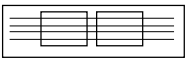

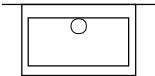
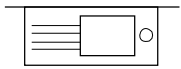
IS : 771 - Specification for Glazed fire - clay sanitary appliance


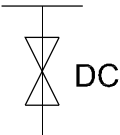

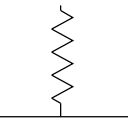
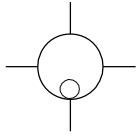
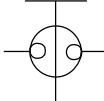
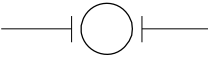

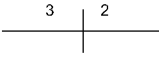



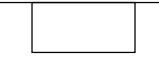

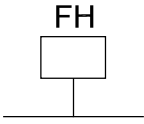



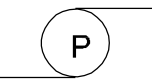

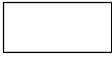
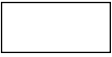
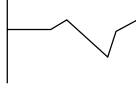
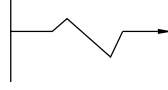



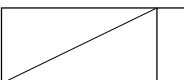
Part 1 : 1979 - Part 1 - General requirements

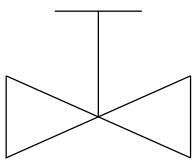
IS : 772 : 1973 - Specification for General requirements of enamelled cast iron sanitary appliances.

IS : 774 : 2004 - Flushing cistern for water closets & urinals (other than plastic Cistern) Specification

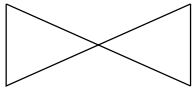
IS 2548 : 1996 - Specification for Plastic water & cover for water closet

			
URINAL FLOOT	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

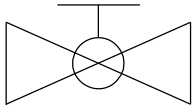
 <p>HOT OR COLD WATER DRAIN</p>	 <p>DRAIN COCK</p>	 <p>STOP VALVE OR SLUICE VALVE</p>	 <p>SAFETY VALVE</p>
 <p>MIXING VALVE HAND CONTROL</p>	 <p>MIXING VALVE THERMOSTATIC</p>	 <p>W.M WATER METER</p>	 <p>HMC HOT WATER CYLINDER</p>
 <p>CHANGE OF PIPE SIZE</p>	 <p>HMT HOT WATER TANK</p>	 <p>HB HOSE BIB</p>	 <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>



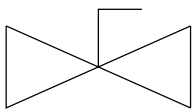
Gate valve



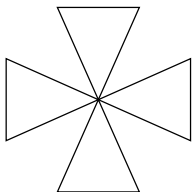
Isolating valve



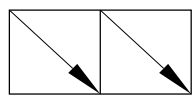
Globe valve



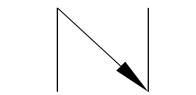
Ball valve



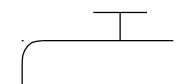
4 way valve



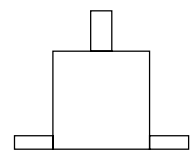
Back flow valve



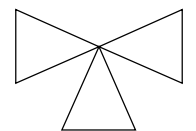
Check valve



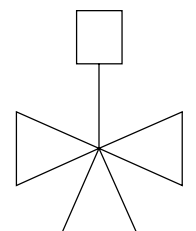
Drain Valve



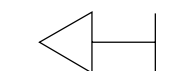
Air separator



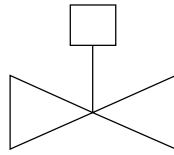
3 way mixing valve



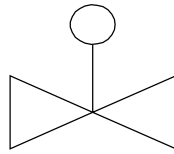
Diverting 3 way valve



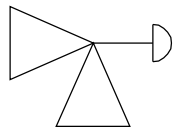
Manual air vent



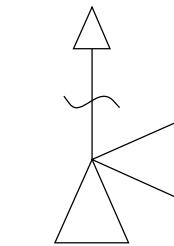
Motorized valve



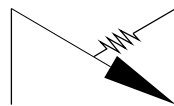
Pressure reducing valve



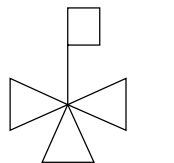
Pressure balancing bypass valve



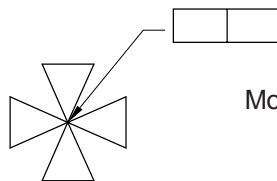
Pressure relief valve



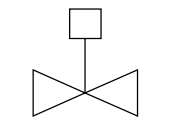
Spring loaded check valve



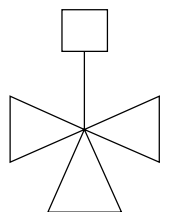
Motorized 3 way valve



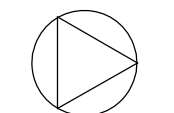
Motorized 4 way valve



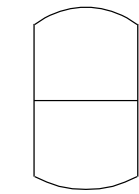
Thermostatic valve



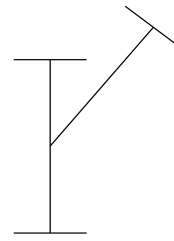
Thermostatic 3 way valve



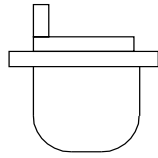
Circulator



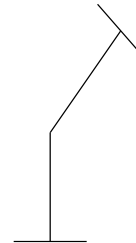
Expansion tank



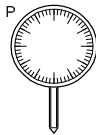
Wye



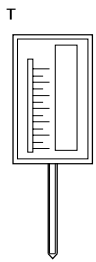
Floating air vent



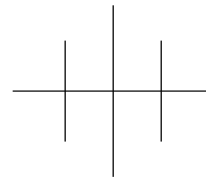
45°



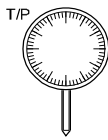
Pressure gauge



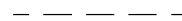
Temperature gauge



Union



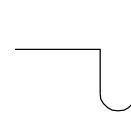
Thermo pressure gauge



Vent

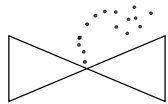


Post indicator valve

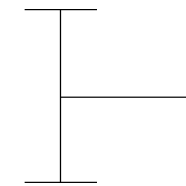


P trap

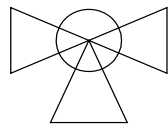
Float operated valve symbol



Three way plug valve



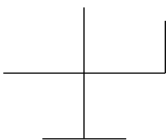
Tee



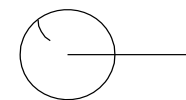
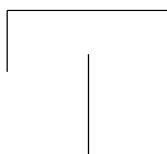
90 degree elbow



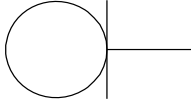

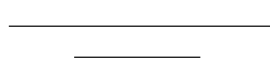
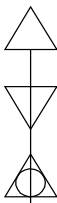
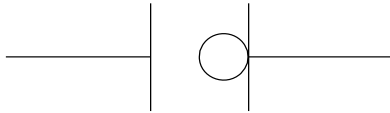
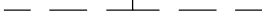
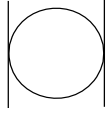



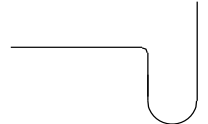
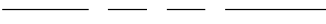
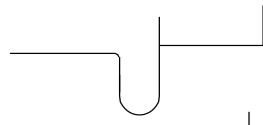

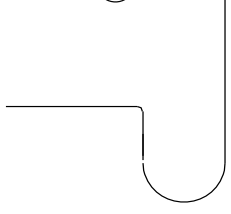

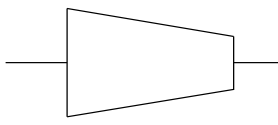
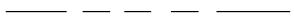
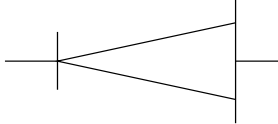

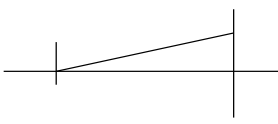

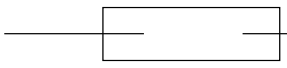

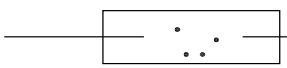



Running trap

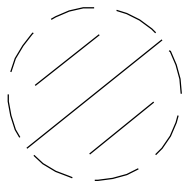


Cap

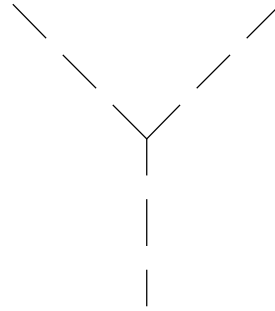


Pipe going down

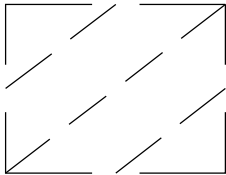
	Pipe going up		Cub stop
	Pipe guide symbol		Fire hydrant and isolation valve
	P-tee up symbol		
	P-cross up down symbol		Comp. air line
	WC		Domestic cold water hot
	Floor drain		Hot water return
	K. Sink		Hot water
	Lavatory		Cold water
	Bushing symbol		Hot
	Concentric reducer		Gas line
	Ecentric reducer		Sanitary drain above ground
	Expansion joint		Below ground
	Flexible Connector		Storm sewer symbol size and D of pipe
			Water main symbol with size and type of pipe
			Trap primer symbol



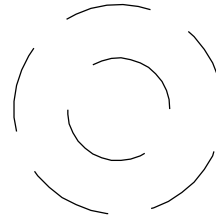
Floor drain round



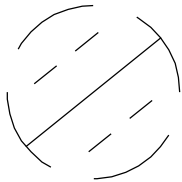
Funnel drain elevation



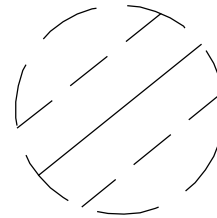
Floor drain



Hub drain



Funnel floor drain



Roof drain

Sensor system for urinals and wash basin sensor taps

Objectives: 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)

Fig 1



Fig 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.

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 duct 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.

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.

Corrosion - causes and remedies and prevention

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

- explain the corrosion, causes and remedies.

Meaning

Corrosion is natural process that converts a refined metal into a more chemically stable form such as oxide, hydroxide, carbonate or sulphide. 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 substances 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.

Corrosion due to electrolytic action

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

- **explain corrosion caused by electrolytic action.**

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 electromotive 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.

Effect of water and frost on our materials

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

- **state the 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.

Effect of frost action

The effects of frost action on its bulk density, porosity and hydraulic conductivity were investigated. The results

indicate that freezing and thawing significantly reduced the bulk density of plough pan and increased its porosity and hydraulic conductivity. Freeze injury occurs in all plants due to ice formation. During warm periods, plants exhibit growth which reduces solute concentration and INA bacteria concentration increases which makes plant less hardy frost damage occurs when ice forms inside the plant tissue and injures the plant cells.

Layout of pipes as per drawing and estimation

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

- plan layout of pipes as per drawing
- state the method of layout of pipes.

Before starting plumbing work. It is most essential way as detailed drawings are required before the starting of 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 in such a way so as 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 at such 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 in such a way so as to ensure their safety in future.
- 6 The plumbing pipes laid should be laid in such a way that in future extension can be done easily if desires.

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 and should be disconnected from the drain.

Piping layout

This is first an activity (or a process) and then a product. A piping designer does piping layout. This is the process of defining the piece of equipment, the maintenance spaces and the related electrical needs. Then routes the piping to accomplish the process function of the piece of equipment then add the space requirements for operating and you have a piping layout. The final location of any piece of equipment is impacted by the piping layout. This final location is added to the GA (or LCP) which is then routed to the structural group. As you can be there is a normal understood cycle and recycle between the piping group with the piping layout the GA's and the structure group and their foundation location plan.

Fig 1

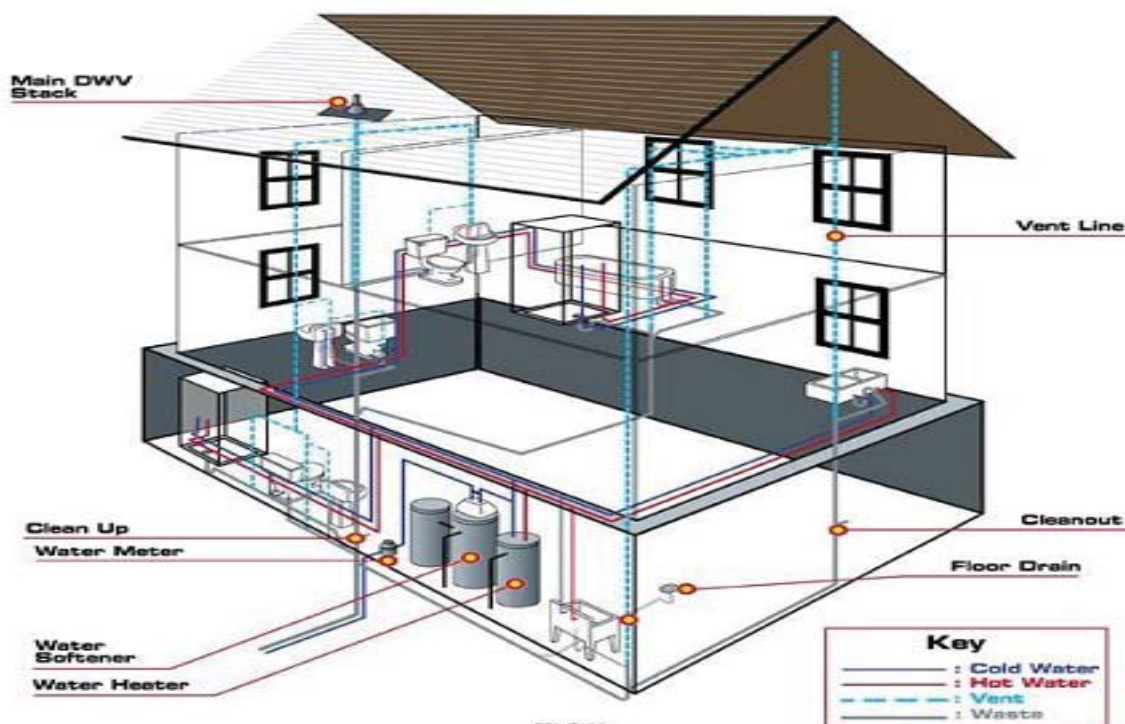
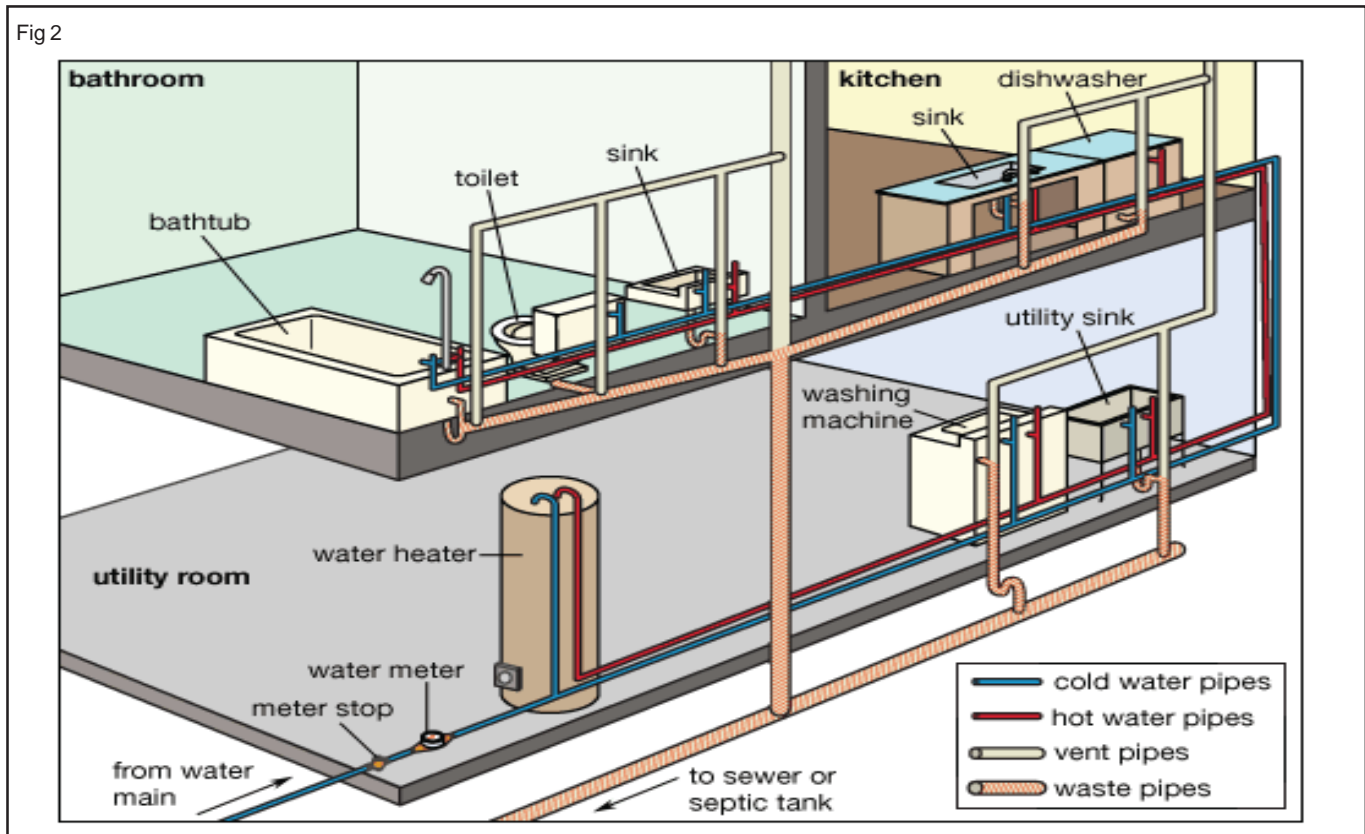


Fig 2



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 1) 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 5.

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	WATERCLOSET	WC
GALVANIZED IRON	GALI	WATER HEATER	WH
HOSE BIB	HB	WATER SOFTENER	WS

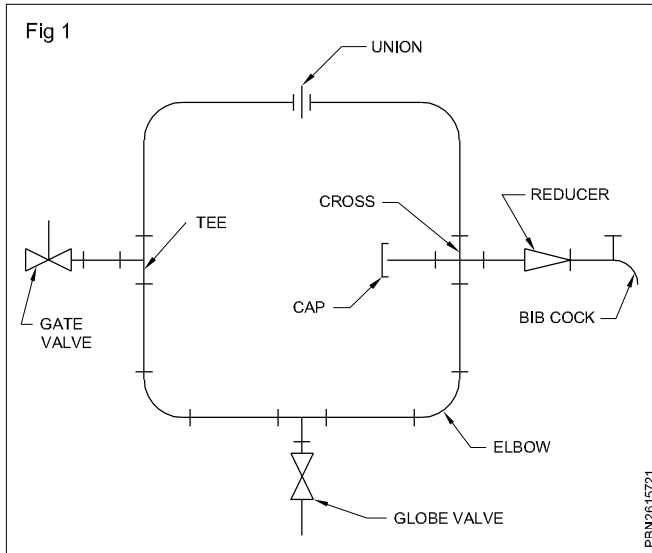


Fig 2

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 3

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Welded		Soldered/brazed	
	OR 	Bell and spigot	
Flanged		Flexible	
Screwed (plain coupling)			OR
			OR

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Fig 4

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
Lateral		Plug screwed	
Cap		Plug bell and spigot	
Union		Reducer concentric	
		Reducer eccentric	

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Fig 5

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
- estimate abstract rote of plumbing of sanitary work.

It is believed that 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 tops storage tanks and valves. The drainage system consists of water closets, urinals solid waste pipes vent pipes wash basins

Water pipes: used for internal and external water supply systems in building. This PVC pipes provides energy

saving, service cost effective, maintenance free, and safe check the required quantity and calculate abstract rate.

Analysis of quantity measurement

It is 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 y and (yd) are commonly used.

Basic quantity of measurement

The quantitative concepts used in mechanics can be classified into two groups one known as the fundamental concepts consisting of three quantities length time and mass which form the bases of mechanics and a second

group know as the derived concepts consisting of the other quantities used in mechanics.

Quantity is a measurement of a physical entity in units that depend on the nature of that entity. This means that potential tenders know exactly how much of a given quantity will be required for the work and so they can price for it.

Measurement of physical quantities: It is expressed in terms of units which are standardized values for example the length of a race which is physical quantity can be expressed in units of meters (for sprinters) or kilometers (for distance runner)

Types of measurement: you can see there are four different types of measurement scales (nominal, ordinal, interval and ratio) Each of the four scales respectively typically provides more information about the variables being

measured than those preceding it. Reading plan and calculating plumbing quantities.

Unit descriptor: This unit of competency specify the outcome required to use and interpret plans and specifications associated with construction work and accurate with construction work and accurately complete the measurement calculation to establish quantities of materials for the plumbing and service industry. The unit require the interpretation of plan drawing and specification to interpret requirements and making measurements and calculation to determine quantities of plumbing materials.

Application: Site location for work application may be either domestic or an existing structure being renovated extended, restored or maintained. It may be a customer premises or employers work place either on or off-site.

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	8120
2	Supplying PVC water storage tank of approved quality with closed top with lid multi layer a 1000 litre capacity	3 Nos	Each	5128/- each	15384
3	Labour for hoisting plastic water storage tank upto 1500 liter capacity	3 Nos	Each	9600/-	288
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	1383	11064
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	59	472
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	555 each	4440
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

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.
-

Man differences between a bill of quantities and a cost estimate the bill of quantities determines the quantities of the various work sections involved in a project the cost estimate is the economic value of such quantities and the estimated total cost of works.

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.

Objectives of bill of quantity

- 1 To provide sufficient and precise information on the work to be performed to enable bids to be prepared accurately.
- 2 To systematize the tendering process.
- 3 To provide a detailed idea regarding the work and its rates and also the final amount.

Importance of bill of quantities

- 1 Bill of quantity is one of the most important document used in the construction industry.
- 2 It gives a proper idea to the constructor to quote the precise rate for the same information.
- 3 A bill of quantities gives a specific idea regarding the whole project on which a contractor has to work on.
- 4 BOQ describes the scope of work to be completed in the respective areas of work. For example an agency fielding the tender for plaster work can have detailed idea about its work like specifications unit rate of work completion time etc.
- 5 BOQ provides a base to the client for valuation tender comparison and contract comparison.
- 6 It is important for preparing the final bill for the contractors.

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 BOQ involves three main steps. They are as follows

- 1 Describing work
 - 2 Quantity take off
 - 3 Describing the rates per unit of work
- 1 Describing work:** This is the first and foremost step of preparing a BOQ. The work to be carried out is described in detail and in simple languages that the constructor can easily understand what he/she has to do.
- 2 Quantity take off:** Once the work is described the quantity of work is worked out and taken off. It gives a detailed idea of amount of work to be performed by a contractor. The quantity of work is given in units like M3, M2, m², etc.
- 3 Describing the rates:** The last step in preparing a BOQ is to describe the rates of items of work per units. The rates of each item are worked based on factors like market survey current rates schedule of rates (SOR) etc. At last the total quantity of work is multiplied by the unit rate of the item of work to define the total amount for a particular item of work.

Steps drafting the bill of quantities

- 1 Setup a spread sheet for your bill of quantities, which includes columns, items description unit of measurement, quantity rate, labour etc.
- 2 Prepare a list of materials you will need to complete the project.
- 3 Break down the project into specific section or categories.
- 4 Estimate the labour required to complete each part.
- 5 Make an initial cost estimate based on the architect's design.
- 6 Draft a schedule based on the estimates in the BOQ.

Preparation of estimation

Meaning: It is necessary to prepare the cost estimate for the intended work from the plans and specifications. Thus an estimate for construction work can be type of bond. The following are types of estimates.

- 1 Preliminary or approximate or rough estimate
- 2 Plain 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 helps to find out the approximate cost of a project in a very short time.

Types of estimates

- 1 A ballpark estimate
- 2 A detailed estimate
- 3 A flexible estimate

Ballpark estimate

- 1 Ball park figure is a rough numerical estimate or approximation of the value of something that is otherwise unknown. A sales person could use a ball park figure to estimate how long a product a customer was thinking about buying might be viable.
- 2 **Detailed estimate:** It is prepared after its complete set of drawings are ready. The quantities of various

items of work are worked out from such drawings and are multiplied by the present rates of items of work to arrive at the estimated cost of work. A detailed estimate is required for obtaining technical sanction from the competent authorities for the proposed work. Detailed estimate required for the preparation of contract. It serves as guide during the execution of the work.

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.

- 3 **Flexible estimate:** This type of estimate is most common approach to estimating and building complex software especially for project in the 500+ hour range. In a flexible estimate we dm a rapid planning session that takes around 1-3 days to complete and costs around Rs 7000 to Rs 21000 during this we rapidly document out the site's core feature. Then we have our developers assemble an estimated cost range by estimating the complexity of each of the main system components. This is far more accurate than a ball park estimate but less accurate than a detailed estimate.