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भारत सरकार - GOVERNMENT OF INDIA

रेल मन्त्रालय - MINISTRY OF RAILWAYS

LESSON PLAN

FOR

TRAINING OF PIPE FITTER & PLUMBER

CAMTECH/2002/C/FITTER/1.0

January - 2002

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Maintenance
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Excellence in Maintenance

Maharajpur, GWALIOR - 474 020

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LESSON PLAN
FOR
TRAINING
OF
PIPE FITTER & PLUMBER

Foreword

This handbook prepared for the improving the skills of the Fitter & Plumber. For better understanding of the subject, technical skills of different maintenance jobs detailed illustration and step by step working methods with supporting diagrams has been given. The operation and detail information regarding plumbing material, working tools has been provided in it. The Civil Engineering Directorate of CAMTECH has made excellent effort to bring out the handbook for training Fitter & Plumbers based on the modules issued by Railway Board.

I am sure that this book will certainly prove to be extremely useful to the instructor in Training Centres.

CAMTECH/Gwalior ***M.L.Gupta***
Date : 11.1.2002 ***Executive Director***

Preface

The Civil Engg. branch bears a major responsibility in a form of upkeeping the vast network of water supply system in Indian Railway. The fitter and plumber are having vital role in the upkeeping of the network. To improve their skills, they need to be educated in maintenance practices of their trade. To have uniform syllabus all over Railway, this handbook prepared based on the modules published by Railway Board.

This handbook on lesson plan will be of very useful to the instructors of all training schools for giving training to the Fitters & Plumbers.

This handbook does not supersede any existing instruction from Railway Board, IRWM, RDSO etc. except where necessary correction slips intimating the required changes are issued by Rly. Board/RDSO.

I am grateful for the assistance given to me by Shri Anupam Sharma, CTA/Civil/CAMTECH, who went through the complete text, collected information and data editing etc. Nice data entry and editing work has done by Shri Ramesh Bhojwani, CO/CAMTECH.

We welcome any suggestion for addition and improvements from our readers.

CAMTECH/Gwalior ***J.K.Nandanwar***
Date : 10.1.2002 ***Director/Civil***

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/2002/C/FITTER/1.0/CS. # XX date .....…….....

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No. of C.Slip	Date of issue	Page no. and Item No. modified	Remarks

1.0 - PRINCIPLES OF PLUMBING

The principles usually enunciated are the basic goals in environmental sanitation worthy of accomplishment through properly designed, acceptably installed and adequately maintained plumbing systems. Constant reference to sound principles is the surest way of maintaining good standards, guiding developments along the right lines and discouraging unwise departures from traditional practice.

The essential of good plumbing necessitates the observance of the principles detailed below. This relates to the plumbing fixtures, the plumbing pipes and the plumbing systems as a whole.

The plumbing fixtures are to be:

a) made of smooth and non-absorbent material;
b) located in well ventilated enclosures;
c) free from concealed fouling spaces;
d) easily accessible for the intended use;
e) able to withstand adequate pressure;
f) connected to a drainage system with water seal traps;
g) tested for leaks, defects, etc. and rectified promptly, where necessary; and
h) heating and storage water cisterns are to be proofed against contamination and explosions through overheating.

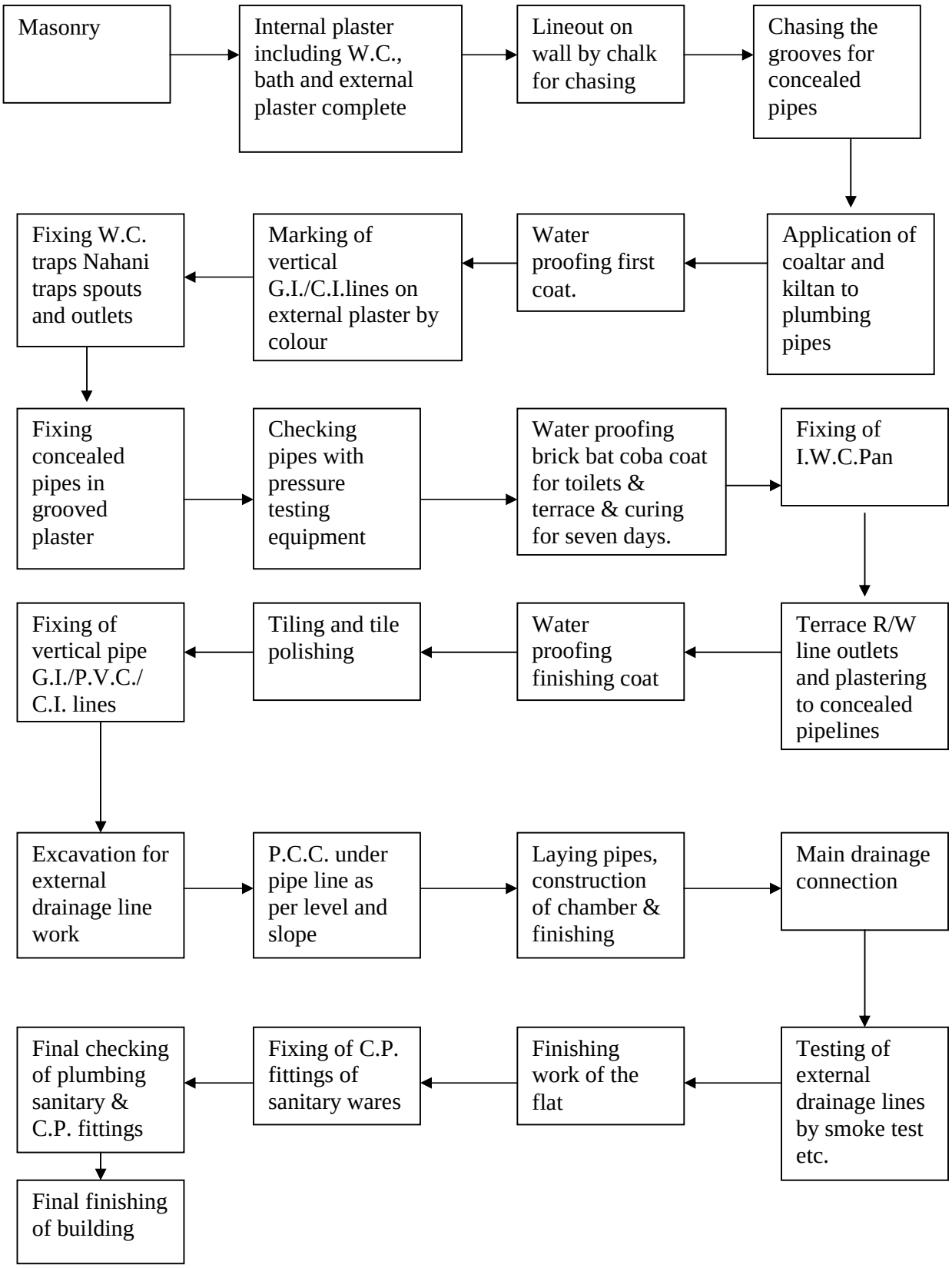
The plumbing pipes are to be:

a) made of durable material connected by suitable and satisfactory joints of good workmanship to give satisfactory service during its reasonable life expectancy;
b) located in places avoiding dead spaces which are not easily cleared.
c) easily accessible for inspection, working and repairs;
d) made rodent proof; and
e) tested for leaks, defects etc. and promptly rectified, where necessary.

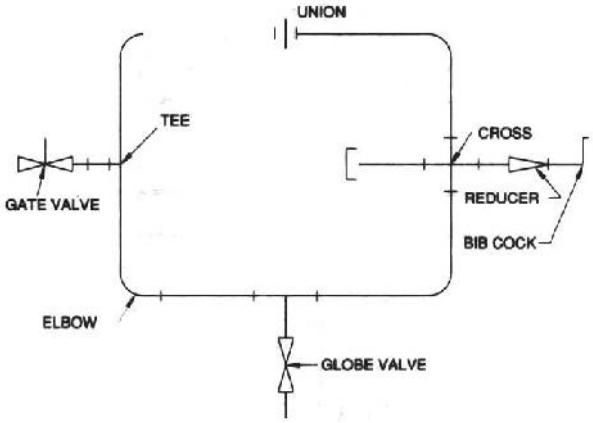
The plumbing systems are:

a) Required for minimum amount of water for proper performance and cleaning.
b) To avoid cross-connections between the protected water supply and the waste water system;
c) To be well ventilated with no danger of siphonage aspiration or forcing or trap seal under conditions of ordinary use; and
d) To be well designed, executed, operated and maintained according to national standards and statutory provisions of the local administrative authority concerned.

1.1 Activity flowchart for plumbing and sanitation work



1.2 Plumbing – Blue print reading and abbreviation



DESCRIPTION	SYMBOL
90°	
Turning down/ away	
Double branch	
Side outlet (outlet down)	

DESCRIPTION	SYMBOL
45°	
Turning up/ towards	
Base	
Side outlet (outlet up)	

DESCRIPTION	SYMBOL
Welded	OR
Flanged	
Screwed (plain coupling)	

DESCRIPTION	SYMBOL
Soldered/ brazed	
Bell and spigot	
Flexible	OR OR

DESCRIPTION	SYMBOL
Lateral	
Cap	
Union	

DESCRIPTION	SYMBOL
Plug screwed	
Plug bell and spigot	
Reducer concentric	
Reducer eccentric	

DESCRIPTION	SYMBOL
Straight size	
Outlet down	
Single sweep	
Side outlet (outlet up)	

DESCRIPTION	SYMBOL
Outlet up	
Double sweep	
Side outlet (outlet down)	
Cross	

Plumbing plan – Blue print reading

Plumbing plan describes the piping systems and plumbing fixtures.

The terms 'blueprint' will be used when referring to drawings. Ability to interpret drawing and specifications for 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. 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 figure.

Plumbing Abbreviations

These symbols should be recognised to locate fluid supply systems on drawings.

The plumbing abbreviations used in the plumbing plan are given in below :

ITEM	ABBR.	ITEM	ABBR.
CAST IRON	CL	HOT WATER	HW
CENTRELINE	CL	LAUNDRY TRAY	LT
CLEANOUT	CO	LAVATORY	LAV
COLDWATER	CW	MEDICINE CABINET	MC
COPPER	COP	PLASTIC	PLAG
DISHWASHER	DW	PLUMBING	PLAG
FLOOR DRAIN	FD	WATER CLOSET	WG
GALVANIZEDIRON	GALI	WATER HEATER	WH
HOSE BIB	HB	WATER SOFTENER	WS

2.0 - OVER HEAD WATER STORAGE TANK

Storage capacity

Normally, the storage capacity should be equal to the higher of the following figures :

a) With efficient stand by pump :

- One quarter the maximum water consumption in 24 hours.
- One-third the normal water consumption in 24 hours.

b) Without stand-by pump :

- One third the maximum water consumption in 24 hours.
- One-half the normal water consumption in 24 hours.

Local conditions should however be considered when deciding on the storage capacity. Each tank may be partitioned to facilitate cleaning or repairs.

Accessories of Reservoir

Following are the various accessories, which are commonly provided in the reservoir.

1. Inlet pipe for the entry of water.

2. Outlet pipe for withdrawal of the water.

3. Over flow pipe to prevent the over flow of reservoir. These over flow pipe is generally connected to the drain.

4. Float switch to stop the pump when the tank is full.

5. Float gauge to show the depth of water in the tank.

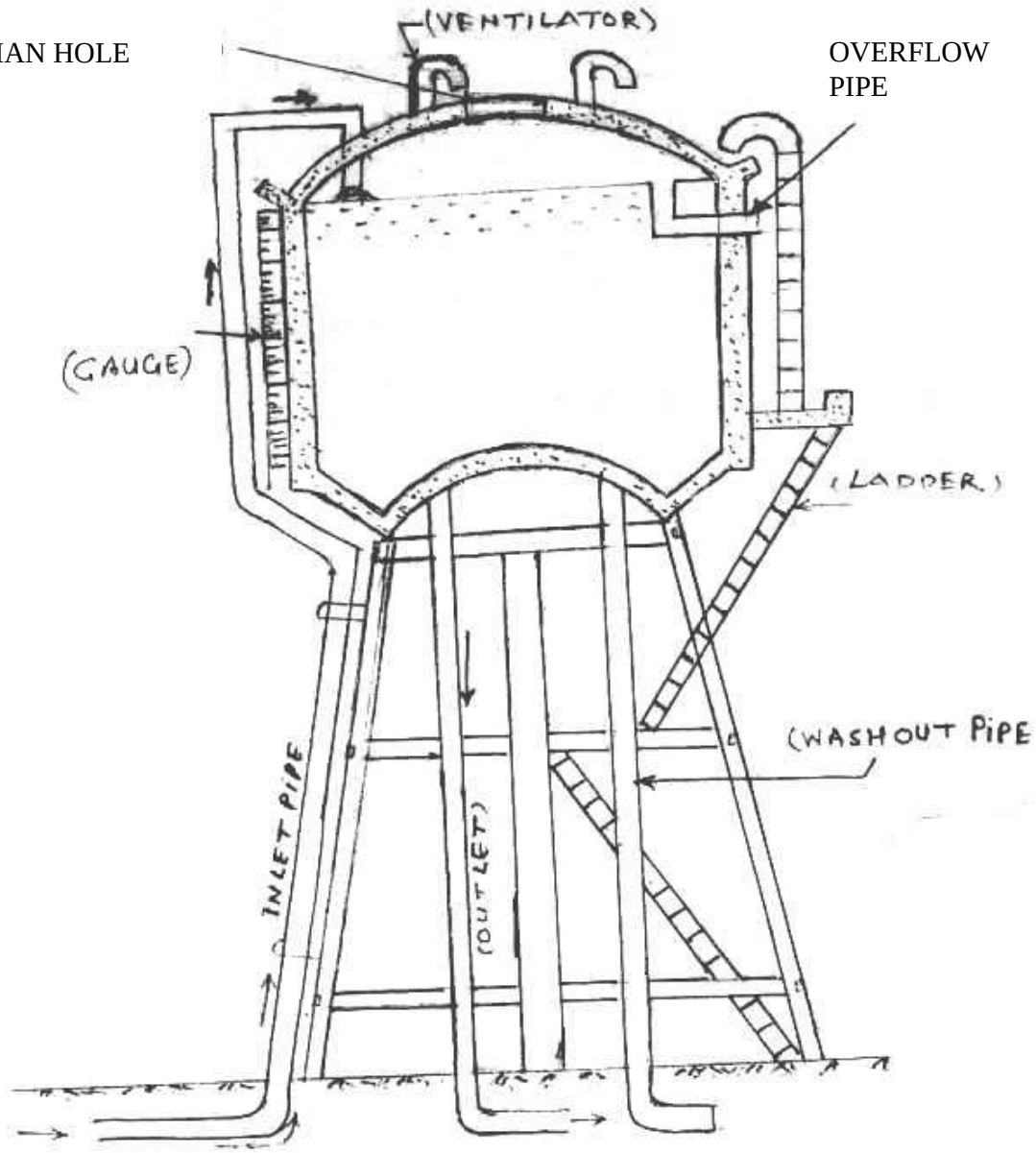
6. Washout pipe for washing out the suspended impurities in the tank.

7. Man holes for providing entry in the tank.

8. Ladder to reach the top and bottom of the tank.

9. Ventilation for fresh air circulation in the tank. Steel-mesh is provided which allows, the entry of fresh air, as well as prevents the entry of birds etc.

10. Chlorinator in case when water is directly pumped in the over head reservoir from the tube wells.


MAN HOLE
(VENTILATOR)
OVERFLOW PIPE
(GAUGE)
(LADDER)
(WASHOUT PIPE
INLET PIPE
(OUTLET)

Maintenance and cleaning of storage tank

a) For the inspection, maintenance and painting of steel-work, action should be taken as detailed in the Indian Railways Bridge Manual.

b) Tanks used for the storage of drinking water should be rubbed and cleaned at such intervals as specified by the Divisional Engineer. The cleaning of water tank and disinfection should be carried out as per recommended procedure. Tanks used for the storage of water for locomotive and carriage washing purposes should be scrubbed and cleaned at least once in six months.

   Reports on cleaning of tanks should be submitted to Assistant Engineer by the Section Engineer (Works) who shall maintain a register with complete particulars for the purpose. The periodical reports should include information regarding the condition of external and internal painting and corrosion if any.

   The dates of cleaning and of both external and internal painting should be painted on one side of the staging in such a manner that these are readily visible.

Float Gauges and Scouring Sluices

Every high level storage tank should be provided on the outside with a float gauge with a scale marked in metres divided into 5 parts to indicate the water level in the tank.

Every storage tank whether at high level or at ground level should be provided with a sluice at its sill level to facilitate the cleaning of the tank.

Protection against pollution

High service storage tanks, for drinking water in particular, should be locked and provided with gauze wire to obviate pollution by birds and growth of algae.

Points to be considered for O.H.W.T.

1. O.H.W.T. is usually rectangular in shape because of design constraints. Unlike the U.G.W.T. the length and breadth of an O.H.W.T. has less flexibility. So the capacity is adjusted by varying height.

2. The capacity can be worked out by considering water requirement of 135 litres per person per day.

3. To place the inlet, outlet and wash out pipes in position. It is required to make the provision while centering by providing the necessary holes and placing the pipes of G.I. pipes (with hold fast welded to them) before concreting.

4. A opening of size 60 cm x 90 cm is provided in O.H.W.T. top slab for man hole cover.

5. Gate valves for each outlet i.e. bath/W.C. line and kitchen line should be provided on terrace parapet for easy maintenance or replacement.

6. Minimum free board should be 150 mm.

7. Overflow should be provided 25 mm to 50 mm above inlet. The size should be little larger than the inlet pipe.

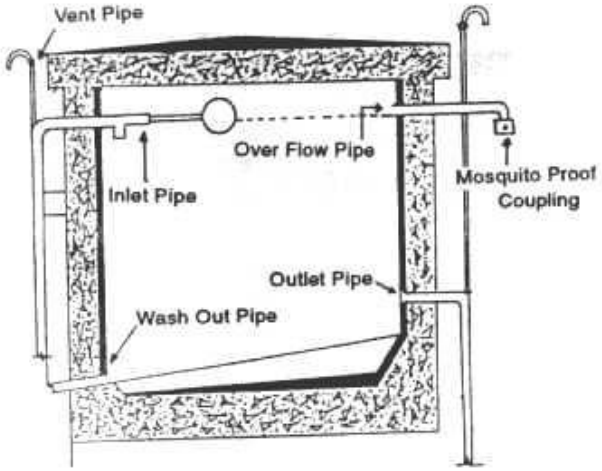
8. Outlets should be 10 cm to 15 cm above finished bottom of the tank.

9. Washout should be in flush with finished floor and plugged properly when not in operation.

10. The pipeline from the O.H.W.T. to individual units, should have minimum length of run and bends (turns).

11. Gate valve for each outlet should be provided at a height of 3.0 metre from finished terrace level for easy maintenance of the lines.

12. All joints should be checked for leakage by pressure testing equipment.



3.0 - PIPES

Pipes represent a large proportion of the capital invested in water undertakings and therefore of particular importance. These are of various types and sizes consisting of spun or cast iron (CI) steel, reinforced concrete (RCC), prestressed reinforced concrete (PSC), and asbestos cement (AC), polyethylene (low and high density) and polyvinyl chloride (rigid PVC) are particularly used for smaller size pipes.

Choice of pipe material: General technical factors affect the final choice of pipe material including internal pressures, hydraulic and operating conditions, maximum permissible diameters, external corrosion, and any special conditions of laying. Due to its strength and corrosion resistance, CI can be used in soils and for waters of slightly aggressive character. Their disadvantage lies in their being unsuitable for corrosive soils unless special steps are taken to combat them, their weight adding to transportation problems in hilly and difficult terrains. Coating inside and outside of the pipe is always preferred. They are well suited for pressure mains and laterals where tapings are made for house connections.

Steel mains being light in weight are used for large dia especially greater than 900 mm where CI pipes become very heavy and costly. In undulating areas and where subsidence is likely to occur, they can be used because of their resilience but they are more subject to internal and external corrosion compared to other pipes.

Prestressed concrete pipes are ideal for a pressure range of 0.5 to 2.0 Mpa (5 to 20 kgf/cm^2) where CI and steel are not economical.

AC pipes are relatively more corrosive resistant than steel or CI, light and easy to handle and these are used in lateral and minor distribution systems. However, these pipes cannot take high internal pressures. In soils containing sulphates, concrete and AC pipes are liable to corrode.

Being more flexible and more corrosive resistant compared to metallic and concrete pipes, unplasticized PVC and polyethylene pipes can be extensively used in hotels and house service connections as also plumbing systems. The plasticized PVC is not recommended because of the uptake of lead by the water. PVC pipes are well suited for use in mountainous terrains and undulating areas. They have the advantage of ease and simple jointing unlike polyethylene. Polyethylene pipes can be used successfully in river crossings.

3.1 CI and Spun Iron Pipes

General: Most old CI pipes are cast vertically but this type has been largely superseded by spun iron manufactured up to a dia of 900 mm. CI flanged pipes and fittings are usually cast in the larger diameters. Smaller sizes have loose flanges screwed in the ends of double spigot-spun pipes. The CI pipes vertically cast for water, gas and sewage are governed by IS: 1537-1976. The specification covers pipes of nominal dia from 80 to 1500 mm and in lengths from 3.66 to 5.5 metres. Up to 600-mm size the socket and spigot pipes are in 2 classes. Class A is for a test pressure of 2.0 Mpa (15 to 20 kgf/cm^2) and class B is for a test pressure of 2.5 MPa (25 kgf/cm^2). For sizes over 600 up to 1000 mm, the test pressure for the two classes A and B are reduced to 1.5 to 2.0 MPa (15 and 20 kgf/cm^2) respectively. For sizes over 1000 mm and upto 1500 mm, the test pressures are further reduced to 1.0 and 1.5 MPa (10 and 15 kgf/cm^2)

respectively. Cast (spun) iron pipes for water, gas and sewage are governed by IS:1536-1976.

The metric pipe sizes have same external barrel diameter for any size irrespective of the classes. Also the internal socket dia is same for the same size irrespective of the class.

CI flanged pipes and fittings are usually cast in the larger diameters. Smaller sizes have loose flanges screwed on the end of double spigot-spun pipes.

Joint of CI pipes: Generally the pipes have spigot and socket (S and S) ends while for special purpose flanged ends are adopted. Jointing of pipes may be done in accordance with IS 3114-1985 with any one of the following materials:

a) molten lead (under dry condition)
b) lead wool (under wet condition)
c) portland cement, and
d) tarred yarn (for sewers only where considered necessary)

Caulking joints

After section of convenient length has been laid, caulking shall be commenced. The lead shall be driven into the sockets with properly shaped caulking tools and small hammers weighing not less than 2 kg.

Lead shall heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour. Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling of the entire joint space with solid lead. The usual jointing for S and S pipes is by pig lead.

Instead of using melted lead for filling the joint, lead yarns/lead wool confirming to IS may be used if approved by engineer. The lead yarn/lead wool is to be driven into joints with caulking tools until a solid water tight joint is obtained.

Substitute material for lead in view of its acute shortage, etc. with the several alternatives. They are given below.

Tyton joint: This is a patented joint and involves the manufacture of spun CI pipes with a modified socket design and the use of a special rubber gasket to effect a sound and efficient joint. A rubber gasket of a special shape with a bulb and groove is kept compressed between the spigot and socket with a projecting head from the socket pressing against the groove in the gasket. The rubber ring is of two different qualities cast monolithic and provides water tightness by its shape and flexibility. The joint is now adopted invariably in all projects.

Screwed gland flexible joint: Here the jointing is essentially a screwing arrangement to hold the rubber ring in position. Screw threads are cast inside the socket of pipe and on the outside of the CI gland. A flexible rubber ring is inserted in the joint and when the CI gland is screwed on to the socket the rubber ring is pressed tight in the annular space between the spigot and socket. The flexibility is claimed only up to 3^0 against 5^0 in the case of Tyton joint.

Electrolite joint: This is similar to the tyton joint but this a difference. In the tyton joint a projecting ring or bead from the socket presses against a groove in the rubber gasket compressed between the socket and spigot. In the electrolyte joint, however, a projecting bead or lug in the rubber ring presses against a groove in the socket. The efficiency is yet to be established.

Use of CI detachable joint after cutting the socket ends : This is an effective way of utilising CI pipes with conventional S and S ends if already available in stock without going in for lead joints. In this method, the socket ends are cut and the pipe jointed in the same way as AC pressure pipes with CI detachable joints. The cost will be less than that of a lead joint and compares favourably with that of the tyton joint. The use of this joint is recommended where working pressure is greater than 30 m.

Cement joints : The joint does in the same manner as for stoneware pipes except that the jute or hemp yarn must be free from oil or tar. Standard Portland cement is sued neat and very dry in the proportion of 15 kg of cement to 1 kg of water. The joints are caulked with special tools and cured for 10 days before subjecting to pressure. The joint may sweat in the beginning between the pores which may soon get filled up and the joint becomes watertight. Cement joints are rigid and necessitate a firm foundation for the pipeline for minimising movements. Lead joints are used however at suitable intervals to give flexibility. The cement joint has give satisfactory results and is adopted in some states in India where the working pressure does not exceed 30 m.

Testing of pipeline : After a new pipe has been laid and jointed, it shall be subjected to the following two tests in accordance with IS : 3114-1965.

a) Pressure test at a pressure of at least double the minimum working pressure, pipe and joints shall be absolutely watertight under the test ; and

b) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for duration to two hours.

Before testing, the trench shall be partially back-filled except the joints.

Each valve section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through hydrants and blow off. If these are not available at high places, necessary tapping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.

If the trench has been partially back-filled, the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory tot he Authority. The duration of the test shall not be less than 5 minutes.

Examination under pressure : All exposed pipes, fittings, valves hydrants and joints should be carefully examined during the open trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked untial tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced.

Any cracked or defective pipes, fittings valves or hydrants discovered in consequence of this pressure test and the test shall be repeated until satisfactory results are obtained.

If the trench has been back-filled to the top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found, they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure test shall be least one hour.

Procedure for leakage test : Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valve section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation shall be accepted until the leakage is less than the number of cm^3/h as determined by the formula

$$q1 = ND \sqrt{P}/3.3$$

Where, q1 = allowable leakage in cm^3/h
N = number of joints in the length of the pipeline.
D= diameter in mm, and
P = the average test pressure during the leakage test in kgf/cm^2.

3.2 Steel Pipes

General : Steel pipes of small diameter can be made from solid bar section by hot or cold drawing processes and these tubes are referred to as seamless. The large sizes are made by welding together the edges of suitably curved plates, the sockets being formed later in a press. The thickness of the steel used is often controlled by the need to make the pipe stiff enough to keep its circular shape during storage, transport and laying as also to prevent excessive deflection under the load of the trench back-filling. Specials of all kinds can be fabricated without difficulty to suit the different site conditions. Due to their elasticity, steel pipes adopt themselves to changes in relative ground level without failure and hence are very suitable for laying in ground liable to subsidence. It must be borne in mind, however, that steel mains need protection from corrosion.

Electrically welded steel pipes for water, gas and sewage for sizes from 150 to 2000 mm nominal dia are covered by IS:3589-1981. The pipes are designated by the method of manufacture followed by a number corresponding to the minimum tensile strength in MPa as, for example, EFW410 indicates electric fusion (arc) welded steel pipes having a minimum tensile strength of 410 MPa.

The steel pipes shall have minimum specified wall thickness as given in Table.

Laying and jointing : Mild steel pipes can be of threaded ends with one socket. They are lowered down in the trenches and laid to alignment and gradient. The jointing materials for this type of pipes are white lead and spun yarn. The white lead is applied on the threaded end with spun yarn and inserted into socket of another pipe. The pipe is then turned to get it tightened. When these pipes are used in the construction of tube wells, the socketed ends after positioning without any jointing material are welded and lowered down. In the case of pipes lined and outcoated with cement concrete, dense cement mortar is applied by means of

centrifugal process. While laying the pipes already stacked along the trenches are lowered down into the trenches with the help of a chain-pulley block. The formation of bed should be uniform. The pipes are laid true to the alignment and gradient before jointing. The ends of these pipes are butted against each other, welded and a coat of rich cement concrete is applied after welding.

MINIMUM SPECIFIED THICKNESS OF PIPES	
Nominal Dia of pipes **mm**	**Minimum Thickness of plates** **mm**
200 to 400	5
450 to 700	6
800 to 900	7
1000 to 1200	8
1400 to 2000	10

Steel pipes may be joined with flexible joints or by welding but lead or other filler joints, hot or cold are not recommended. The welded joint is to be preferred. In areas prone to subsidence, this joint is satisfactory but flexible joints must be provided to isolate valves and branches.

Type of joints and ends of pipes given in IS:3589-1981 are :

a) plain ends or levelled ends for field butt welding, and
b) sleeve joint or swelled and plain ends for welding.

When welding is adopted, plain-ended pipes may be jointed by butt welds or sleeved pipes by means of fillet welds. For laying long straight lengths of pipelines, butt joint technique may be employed. Where deflection is required, the short sleeve joint with fillet weld is preferable. The steel pipes used for water supply include hydraulic lap welded, electric fusion welded and spiral welded pipes, the latter being made from steel strip and at present available up to a size of 1150 mm. for laying of welded steel pipes, IS:5822-1970 should be followed.

3.3 Concrete pipes

General : IS 458-1971 gives the specification for reinforced concrete pipes with and without reinforcement and does not cover prestressed concrete pipes. The classification, test pressure, etc. of pipes are given in table. Perforated concrete conforming to IS:7319-1974 are used for under drainage water logged areas and for similar other purposes. Porous concrete pipes conforming to IS:4350-1967 are also used for these purposes.

Smaller sizes can be used in distribution systems with infrequent house service connections.

Laying and jointing : The concrete pipes should be carefully loaded, transported and unloaded avoiding impact. The use of inclined plane or chain block is recommended. Trench shall provide sufficient free working space on each side of the pipe which shall not be greater than one-third dia of the pipe but not less than 15 cm on either side. Laying of a pipe shall preceed upgrade of a slope. If the pipes have spigot, socket joints, the socket ends shall face upstream. Where the natural foundation is inadequate the pipe shall be laid in a concrete

cradle supported on proper foundations, or any other suitable designed structure. If a concrete cradle is used, the depth of concrete below the bottom of the pipes shall be atleast one-fourth the internal diameter of the pipes with the range of 10-30 cm. It shall extend up the sides of the pipe atleast to a distance of one-fourth the diameter for larger than 30 cm. the pipe shall be laid in the concrete bedding before the concrete has set. Trenches shall be back-filled immediately after the pipe has been laid to a depth of 30 cm above the pipe subject to the condition that the jointing material has hardened (say 12 h at the most). The back fill material shall be free from boulders, roots of trees, etc. The tamping shall be done by hand or by hand operated mechanical means. The water content of the soil shall be as near optimum moisture content on simultaneously on both sides of the pipe to avoid development of unequal pressures. The back-fill shall be rammed in 150 mm layers upto 90 cm above the top of the pipe.

Jointing may be of any of the four types specified below :

a) bandage joint.
b) Spigot and socket joint (rigid and semi-flexible),
c) coller joint (rigid and semi-flexible), and
d) flush joint (internal and external)

For jointing procedures IS:783-1959 may be followed.

In all pressure pipelines, the recesses at the ends of pipe shall be filled with jute braiding dipped in hot bitumen. The quantity of jute and bitumen shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or any other suitable method.

The number of pipes that shall be jacked together at a time depends upon the dia of the pipes and the bearing capacity of soil. For small pipe upto 250-mm dia, six pipes can be jacked together at a time.

Before and during jacking, care shall be taken to see that there is no offset at the joint. Loose collar shall be set up over the joint so as to have an even caulking space all round and into this caulking space shall be rammed a 1:1.5 mix of cement and sand just sufficient moistened to hold together in the form a clod when compressed in the hand. The caulking shall be so firm that it shall be difficult to drive the point of a penknife into it. The caulking shall be employed at both ends in a slope of 1:1. In case of non-pressure pipes, the recess at the end of the pipes shall be filled with cement mortar 1:2 (1 cement: 2 sand), instead of jute braiding soaked in bitumen. It shall be kept wet for about 10 days for maturing.

Pressure test : When testing the pipeline hydraulically, the line shall be filled completely with water and kept filled for a week. The pressure shall then be increased gradually to full test pressure and maintained at this pressure during the period of test with the permissible allowances indicated therein.

Steel cylinder reinforced concrete pipe : Ordinary RC pipes being unsuitable for pressures are met with the steel cylinder, reinforced concrete pipes are used if concrete is unaffected by soil conditions. These pipes have the advantage that they provide the required rigidity even when very thin shells are used to form the steel cylinder.

Steel cylinder RC pipes conforming to IS:1916-1963 are used in water mains and, to a limited extent, in the pressure sewer lines and irrigation works. When used for carrying highly acidic sewage or industrial wastes, necessary precautions should be taken to prevent exposure of steel cylinder to the action of sewage or industrial waste. When the pipes are likely to be in contact with corrosive soil, proper precautions are to be taken such as coating with bitumen on the outside, using richer mix and/or using sulphate resistant mixes.

Sizes : The nominal internal diameter may vary from 200 to 1800 mm. the increment in size is 50 mm from 200 to 500 mm, 100 mm from 500 to 700 mm and 200 mm from 700 to 1100 mm and 1200 to 1800 mm.

The ends of either spigot and socket or plain ends or slip in type ends suitable for field welding.

The classification and test pressures are as given in Table.

CLASSIFICATION OF STEEL CYLINDER REINFORCED CONCRETE PIPES

Class	Test Pressure
1	0.5 MPa (or 50 m head of water)
2	0.5 MPa (or 50 m head of water)
3	0.5 MPa (or 50 m head of water)
4	0.5 MPa (or 50 m head of water)
5	0.5 MPa (or 50 m head of water)
Special	Above 2.5 MPa or above 250 m head of water (exact pressure is to be indicated)

The Steel cylinder is to be made from steel plates satisfying IS: 226 –1975 or IS:2062-1980. Where the thickness of steel plate is greater than 20 mm, IS:2062-1969 it to be followed.

The concrete and mortar shall have a minimum cement content of 380 kg for every cubic metre of concrete or mortar and a minimum compressive works cube strength of 20 N/mm^2 (200 kgf/ cm^2) at 28 days. The maximum tensile stress in reinforcement under the specified hydrostatic test pressure should not be more than 200 N/mm^2 (2000 kgf/cm^2), assuming no tension is taken by the concrete. The barrel thickness shall be such that under half the specified hydrostatic test pressure, the maximum tensile stress in concrete or mortar when considered as effective to take stress along with the tensile reinforcement should not greater than 4.0 N/mm^2 (40 kgf/cm^2) (modular ratio of steel and concrete to be assumed as 15).

Laying and jointing : IS : 783-1959 for laying of concrete pipe applies to the steel cylinder reinforced concrete pipes also. The fillings and specials required for curves, bends, branches, manholes, air valves, blow off and connection to main line valves are used conforming to IS:7322-1974.

3.4 Prestressed Concrete Pipes

General : While ordinary RCC pipes can cater to the needs where pressures are upto 0.3 MPa (3.0 kgf/cm^2) and CI and steel pipes cater to the needs of higher pressures around 2.4 MPa (24 kgf/cm^2), the prestressed concrete pipes cater to the intermediate pressure range for which the metallic pipes are expensive.

In these pipes, permanent internal stresses are deliberately introduced by tensional steel to counteract to the desired degree stresses caused in the pipe under service. These stresses are entirely independent of the stresses caused by external loads or internal pressures. The sizes range from 80 to 1800 mm. The lengths are 2 m for the sizes up to 400-mm dia and 2.5 m for the higher sizes. The pipes can not be cut to size to close gaps in the pipeline. Special closure units consisting of a short double spigot piece and the plain-ended concrete lined steel tube with a follower ring assembled at each end, are manufactured for this purpose. The closure unit (minimum length of 1.27 m) must be ordered specially to the exact length required, Specials such as bends taps, etc. are generally fabricated as mild steel fitting lined and coated with concrete.

IS : 784-1978 is to be followed for prestressed concrete pipes.

Laying and jointing : IS : 783-1959 for laying concrete pipes applies to prestressed concrete pipes also .

Pressure testing : The details as given in applies to prestressed concrete pipes also.

3.5 Asbestos Cement Pipes

General : The asbestos cement pipe is made of mixture of asbestos and Portland cement compressed by steel rollers to form a laminated material of great strength and density. Its carrying capacity remains substantially constant particularly in soft water district since it is free from its effects. It is not affected by electrolyte action and is light in weight. It can be drilled and tapped from connections but has not the same strength or suitability for threading as iron and any leakage at he thread will become worse as time passes. However, this difficulty can by overcome by screwing the ferrules through malleable iron saddles fixed at the point of service connections as is the general practice. These pipes are not suitable for use in sulphate soils.

The available safety against bursting under pressure, through less than that for spun iron pipes, is nevertheless adequate and increases as the pipe ages. Good bedding of small-bore asbestos cement pipes is important. The larger diameter pipes have ample beam strength for normal main laying conditions.

This pipe can meet general requirements of water supply undertakings for rising main as well as for distribution mains. IS :1592-1980 should be followed. The sizes range from 80 to 600 mm. the length of pipes for all diameters are 3, 4 or 5 m.

Pipes are classified with respect to the hydraulic test pressure as given in Table.

CLASSIFICATION OF ASBESTOS CEMENT PIPES	
Class	**Hydraulic Test Pressure**
5	1.5 MPa (5 kgf/cm^2)
10	1.0 MPa (10 kgf/cm^2)
15	1.5 MPa (15 kgf/cm^2)
20	2.0 MPa (20 kgf/cm^2)
25	2.5 MPa (25 kgf/cm^2)

The working pressure is not to exceed 50 % of the test pressure.

The relationship between the test pressure (TP) the bursting pressure (BP) and working pressure (WP) are given in Table.

RELATIONSHIP BETWEEN HYDRAULIC TEST PRESSURE (TP) BURSTING PRESSURE (BP) AND HYDRAULIC WORKING PRESSURE (WP)		
Nominal dia **mm**	**BP** **TP**	**BP** **WP**
50 to 100	2	4
125 to 200	1.75	3.5
250 to 600	1.5	3.0

Laying and jointing : IS: 6530-1977 shall be followed for laying and jointing of asbestos cement pressure pipes. The width of the trench should be uniform throughout the length and greater than the outside dia of the pipe by 300 mm on either side of the pipe. The depth of the trench is usually kept 1 m on the top of the pipe. For heavy traffic, a cover of atleast 1.25-m is provided on the top of the pipe.

The AC pipes to be laid are stacked along the trenches on the side opposite to the spoils. Each pipe should be examined for any defects such as cracks, chipped ends, crusting of the sides, etc. The defective pipes are to be removed forthwith from the site to avoid mixing up with good pipes. Before use the inside of the pipes will have to be cleaned. The lighter pipes weighing less than 80 kg. can be lowered in the trench by hand. If the sides of the trench slope is too much, ropes must be used. The pipes of medium weight up to 200 kg are lowered by means of ropes looped around both the ends. One end of the rope is fastened to a wooden or steel stack driven into the ground and the other end of the rope is held by men and is slowly released to lower the pipe into the trench. After lowering, the pipes are aligned for jointing the bed of the trench should be uniform.

There are two types of joints for AC pipes.

CI detachable joint : This consists of two CI flanges, a CI central collar and two rubber rings along with a set of bolts and nuts for the particular joint. For this joint the AC pipe should have flush ends.

Rubber rings positioned between the collar ends and flanges provide compression sealing. Compression is obtained by uniform tightening of the bolts.

AC coupling joint : This joint consists of an AC coupling with three inner grooves fitted with three special rubber rings. The pipes for these joints have chamfered ends. The rubber rings are positioned in the grooves inside the coupling. Then grease is applied on the chamfered end and the coupling pushed with the help of a jack against the pipe. The mouth of the second pipe is then placed in the mouth of the coupling and then pushed so as to bring the two chamfered ends close to one another.

Where ever necessary, changeover from CI pipe to AC pipe or vice-versa is done with the help of suitable adapters.

Pressure testing : The testing shall be done according to IS: 5913-1970. The pipeline should be tested for soundness in portion as laying progresses. The procedure for the test as adopted generally is as follows:

(a) at a time section of the pipeline between two sluice valves is taken for the testing the section usually taken is about 500 m long.

(b) one of the valves is closed and water is admitted into the pipe through the other manipulating air valves in between the section, the end of the section can be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line as may be required ; the pipeline after it is filled should be allowed to stand for 24 h before pressure testing.

(c) after filling, the sluice valve is closed and the pipe section is isolated.

(d) pressure gauges will be fitted at suitable intervals on the crown into the holes meant for the purpose;

(e) pipe section is then connected to the delivery side of a pump through a small valve;

(f) pipe is then worked till the pressure inside reaches the desired value which can be read form the pressure gauges already fixed;

(g) after the required pressure has been obtained, the valve is closed and the pump disconnected; and

(h) pipe is then kept under desired pressure during inspection for any defect, that is, leakage at the joints, etc, and the water will then be emptied through scour valves and defects observed during the test will be rectified.

Pipelines carrying potable water shall be suitably disinfected before commissioning. For this purpose, guidance may be obtained from IS:3144-1965 or IS:5822-1970.

3.6 Plastic pipes

General : Plastic pipes are produced by extrusion process followed by calibration to ensure maintenance of accurate internal diameter with smooth internal bores. These pipes are of three kinds for potable water supplies. They are covered by Indian Standards as follows:

a) Low-density polyethylene pipes – IS:3076 –1968.
b) High density polyethylene pipes – IS:4984-1978 and
c) Unplasticized PVC pipes – IS:4985-1968

Polyethylene pipes : These are extruded form a compound consisting of virgin polyethylene in which carbon black and a suitable non-toxic anti-oxidant are evenly dispersed. Low-density polyethylene shall have a density not greater than 0.93 g/ml and high-density polyethylene shall have a density greater than 0.94 g/ml at 27^0C. The compound for low density polyethylene shall have a melt flow index not greater than 2.6 and high density polyethylene pipes shall have a melt flow index not greater than 0.6. The test shall be conducted according to IS:2530-1963. The anti-oxidant in the material should be physiologically harmless and not greater than 0.3 percent by weight. The other details regarding composition are as given in Table.

CLASSIFICATION OF POLYETHYLENE PIPES

Working pressure MPa (kgf/cm^2)	**Outside dia range, mm**	
	Low density polyethylene	**High density polyethylene**
0.20 (2.0)	-	75-500
0.25 (2.5)	40-140	63-500
0.4 (4.0)	32-140	40-500
0.6 (6.0)	20-110	32-500
1.0 (10.0)	12-63	20-500

The polyethylene pipes are classified according to pressure ratings (working pressure), namely, 0.2,0.25,0.4,0.6 and 1.0 MPa (2.0,2.5, 4.0, 6.0 and 10.0 kgf/cm^2).

The low-density pipes are to be generally supplied in coils of nominal lengths of 25, 50, 100, 150 and 200 metres. The high density pipes are to be generally supplied either as coils measuring 25 times the minimum dia of the pipes or in straight lengths of 5 to 20 m. laying and jointing shall be done in accordance with IS:7634 (Part 2)-1975.

Unplasticized PVC pipes : The material shall be substantially poly-vinyl chloride plus necessary additives for getting good surface finish, mechanical strength and capacity. These shall not cause toxicity and no detrimental effect in the composition of water passing through the pipes. The quantity of lead and other toxic substances shall not exceed as given in table.

CONCENTRATION OF LEAD AND OTHER TOXIC SUBSTANCES	
Substance	**Concentration**
Lead (first extraction)	1 ppm by mass
Lead (third extraction)	0.3 ppm by mass
Dialkyl tin (as tin) (third extraction)	0.02 ppm by mass
Other toxic substances (third extraction)	0.01 ppm by mass

The pipes are classified according to ratings as in the case of polyethylene pipes as 0.25, 0.6 and 1.0 MPa (2.5, 4.6 and 10 kgf/cm^2) pipes. The temperature range recommended is 1 to 45^{0}C. The maximum safe working stress is 10 MPa (100 kgf/cm^2) at 20^{0}C. At higher temperatures up to 45^{0}C, the strength of pipe reduces and can be worked out according to IS:4985-1981.

The pipes shall withstand a hydraulic pressure equal to 36.0 MPa (360 kgf/cm^2) for one hour at 27^{0}C. The range of diameter for various working pressures are as given in Table.

RANGE OF DIAMETER FOR VARIOUS WORKING PRESSURES	
Working Pressure MPa (kgf/cm^2)	**Range of Diameter in mm**
0.25 (2.5)	90-630
0.4 (4.0)	63-630
0.6 (6.0)	40-630
1.0 (10.0)	16-630

The wall thickness of pipes given in the standard are based on a sage working stress of 8.6 MPa (86 kgf/cm^2) at 27^{0}C. At higher temperatures the working pressure gets reduced.

Rigid PVC pipes and high density polyethylene pipes have been used or water distribution systems mostly ranging from 15 to 150 mm diameter and occasionally up to 350 mm.

The PVC pipes are much lighter than CI or AC pipes. Because of this lightweight, they are easy to handle, transport and install. Solvent cementing technique for jointing PVC pipe lengths is cheaper, more efficient and far simpler. PVC pipes do not become pitted or tuberculated and are unaffected by fungi and bacteria, and are resistant to a wide range of chemicals.

They are immune to galvanic and electrolytic attach, a problem frequently encountered in metal pipes especially when buried in corrosive soils or near brackish waters. PVC pipes have elastic properties and their resistance to deformation resulting from earth movements is superior compared to conventional pipe materials especially asbestos. In soils containing aromatic compounds, PVC pipes shall not be used. Plastic pipes are not suitable for hot water systems.

Precautions in handling and storage : Because of their light weight, there may be tendency for the PVC pipes to be thrown much more than their metal counterparts. This should be

discouraged and reasonable care should be taken in handling and storage to prevent damage to pipes. On no account should the pipes be dragged along the ground. Pipes should be given adequate support at all times. These pipes should not be stocked in large piles, specially under warm temperature conditions as the bottom pipes may be distorted thus giving rise to difficulty in pipe alignment and jointing. For temporary storage in the field where racks are not provided care should be taken that the ground is level, free from loose stones. Pipes stored should not exceed three layers and should be so stacked as to prevent movement. It is also recommended not to store one pipe inside another.

Laying and jointing : The trench bottom should be carefully examined for the presence of hard subjects such as flints, rock projections or tree roots. In uniform, relatively soft fine grained soils with the bottom of the trench brought to an even finish to provide a uniform support for the entire length of pipes, they may be laid directly on the trench bottom. In other cases the trench should be cut deeper and the pipes laid on a prepared under bedding which may be drawn from the excavated material, if suitable.

As a rule, trenching should not be carried out too far ahead of pipe laying. The trench should be as narrow as practicable. This may be kept from 0.3 m over the outside diameter of the pipe and depth may be kept at 0.6-1.0 m depending upon traffic conditions. Pipe lengths are placed end-to-end along the trench. The glued spigot and socket jointing technique, as mentioned later, is adopted. The jointed lengths are then lowered in the trench and when a sufficient length has been laid the trench is filled.

If trucks, lorries or other heavy traffic will pass across the pipeline, concrete tiles 60X60 cm of suitable thickness and reinforcement should be laid about 2 m above the pipe to distribute the load. If the pipeline crosses a river, the pipe should be buried at least 2 m below bed level to protect the pipe.

For bending, the cleaned pipe is filled with sand and compacted by tapping with a wooden stick and the pipe ends plugged. The pipe section is heated with flame and the portion bent as required. The bend is then cooled with water, the plug removed, and the sand poured out and the pipe (bend) cooled again. Heating in hot air oven, hot oil bath, hot gas or other heating devices is also practised. Joints may be heat welded or flamed or made with rubber gaskets or solvent cement according to IS:7634 (Part 2)-1975.

a) **Satisfactory welded joints :** These are permanent in nature and strong in tension. They are used for service pipes of water mains. These joints are commonly used and economical for PVC pipe works.

   This technique is used with both spigot and socket type joints, in which the socket is made specially to form a close fit on the pipe end and with injection moulded fittings.

   The solvent welded joint may be achieved either by heat application method or by non-heat application method. The non-heat application method is easier and is recommended for water supply installations.

b) **Flanged joints :** These are used for jointing of PVC pipes particularly of larger sizes to valves and vessels, and larger size metal pipes where strength in tension is required. The joint is made by the compression of a gasket or a ring seal set in the face of the flange.

The flange may be formed in several ways as under :

1) By upsetting the pipe end on a mandrel after heating the pipe ends. A backing ring of metal or thermoset plastics compresses the upset pipe end on the fitting face of the gasket. Crinkles are formed too easily in the collar and the whole unit loses much of its strength.

2) By solvent cementing a plastic stub flange on to the pipe end and again using a backing ring. The pipe end may also be welded to the PVC flange.

3) By solvent cementing a plastic full faced flange on to the pipe end and bolting this to the fitting face. A backing ring or wide washer should be used to distribute the bolt loads. This prevents the distortion of the PVC flange.

Union joint : this is a form of flanged joint in which the faces are held together by a screwed connection. A composite metal and PVC socket union is a very satisfactory method of jointing PVC to screwed metallic fittings.

c) **Screwed joints :** These are similar to the joints used with metal pipes. If pipe has to be jointed by screw threads, only thick walled pipe should be used and cut with taper pipe treads. The die should be clean and the thread should be made in one pass. The threaded pipes shall not be subjected to pressures exceeding two-thirds of the pressure rating for unthreaded pipes.

Short pieces of thick walled pipe may be threaded at one end and solvent cemented on to normal walled pipe at the other end to make the connector pieces to screwed metal fittings. This system may be used up to 50 mm outside diameter pipes.

Jointing with hemp and paste shall not be used. The joint should be made to firm hand tightness using only strap trenches.

There is no well-defined increase in the tightness at assembly as there is with metal-to-metal fittings and these joints can therefore very easily be over strained.

d) **Rubber ring joints :** Rubber ring joints can provide watertight seal but are not designed to resist pull. In these joints, the rubber and the fluid to be transported should be compatible. The material of rubber rings should conform to IS:5382-1969. Where aggressive soils are met with synthetic rubbers perform better. Generally speaking, rubber ring joints are used for large sized pipes (63 mm and above). Such joints may be provided on pipes which are buried in the ground and supported throughout on bedding so that they are not subjected to movement and longitudinal pull.

The strength of a rubber ring joint to longitudinal forces is not high and for same joints a flange or a shoulder is made on the pipe end to provide the necessary strength in tension. For buried water supply mains, the installed pipes and joints are supported by the continuous bed of the trench and no tensile strength in the joint itself is necessary. However, care shall be taken to anchor the pipe and fittings at bends and at connections to valves. If used above ground, they shall be anchored to provide the required strength.

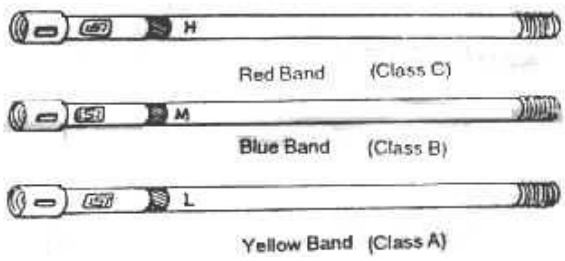
Unplasticized PVC pipes may be jointed by methods employing a rubber ring to provide the watertight seal. The ring may be housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and the housing. The ring shape and the method of compressing the ring vary considerably in different types of joints. Most joints often require the application of lubricating paste. Where natural rubber rings are used mineral oils or petrol or grease of any type should, on no account, be used.

Pressure testing : Solvent jointed pipeline should not be pressure tested until at least 24 hours after the last solvent connected joint has been made. Testing shall be done in accordance with IS:4985-1981.

3.7 G.I.Pipes

Class identification mark for G.I.Pipes

SIZE	DIAMETER OF PIPES										
In mm	15	20	25	32	40	50	65	80	100	125	150
In inch	½	¾	1	1 ¼	1 ½	2	2 ½	3	4	5	6
TYPE	**WEIGHT OF G.I. PIPES (KG/METRE LENGTH)**										
Light class L mark (yellow strip)	1.01	1.48	2.10	2.72	3.40	4.32	6.10	7.20	10.48	---	---
Medium class M mark (blue strip)	1.28	1.65	2.54	3.27	3.76	5.31	6.81	8.85	12.68	17.04	20.20
Heavy class H mark (red strip)	1.51	1.97	3.08	3.97	4.58	6.38	8.20	10.51	14.97	18.64	22.20
TYPE	**WALL THICKNESS OF G.I. PIPE IN MM**										
Light class	2	2.35	2.65	2.65	2.90	2.90	3.25	3.25	3.65		
Medium class	2.65	2.65	3.25	3.25	3.25	3.65	3.65	4.05	4.50	4.85	4.85
Heavy class	3.25	3.25	4.05	4.05	4.05	4.50	4.50	4.85	5.40	5.40	5.40



Laying and jointing :

Small size G.I. steel pipes can be of threaded ends with one socket. They are lowered down in the trenches and laid to alignment and gradient. The jointing materials for this type of pipes are white lead and spun yarn/teflon tape. The white lead is applied on the threaded end with spun yarn and inserted into socket of another pipe or teflon tape can be applied instead of spun yarn and white lead. The pipe is then turned to get it tightened. The formation of bed should be uniform. The pipes are laid true to the alignment and gradient before jointing.

4.0 - TYPES OF VALVES

General : To isolate and drain pipeline sections for test, inspection, cleaning and repairs for satisfactory maintenance and regulating the flow, and for the evacuation of air in water main under pressure and for the exhaust of air when such mains are being charged with water and for ventilating the mains when they are being emptied of water, a number of appurtenances, such as sluice valves, flow regulating valves, air valves, etc, are generally installed in the line.

Sluice valves :

a) These are used for varying the flow or completely stopping the flow in a pipeline.

Gravity conduits are commonly provided with gate chambers at points strategic for the operation of the supply conduit, at the two ends of sag pipes and pressure tunnels, and wherever it is convenient to drain given sections. Sluice valves are normally installed in grade conduits particularly in large ones. In the case of pressure conduits, the valves are usually placed at major summits. Summits identify the sections of line that can be drained by gravity and pressures are least at these points permitting cheaper valves and easier operation.

In the case of large valves, the operation is made easier by by-pass valves. These are used with the main valves to relieve the upstream pressure on the gate and by equalising the pressure on both sides.

In special situations, variation of sluice valves suited to the needs are used. Needle valves are preferred for fine control of flow. Butterfly valves are preferred for ease of operation. Cone valves are used for regulating the time of closure and controlling water hammer.

Sluice valves are not used for continuous throttling, as otherwise erosion of the seats and body cavitation will occur. If small flows are required, the by-pass valve is more suitable.

b) **Structure of sluice valve :** The material for different component parts of sluice valves shall conform to Table.

Sr. No. **(1)**	**Component** **(2)**	**Basic material** **(3)**
i	Body, bonnet, wedge stuffing box, gland, hand-wheel cap.	Grey cast iron
ii	Stem	High tensile brass
Iii	Wedge nut	Leaded tin bronze
iv	Body seat ring wedge facing ring	Leaded tin bronze
v	Bolts	Carbon steel
vi	Nuts	Carbon steel
vii	Bonnet gasket	Compressed fibre
viii	Gland packing	Jute and hemp

The majority of sluice valves used in water works practice have inside screws. This totally enclosed construction, protects the spindle thread from external influences. Sometimes, however, there are conditions such as erosive action or a tendency for deposits on metal surfaces from the water which are likely to be more damaging than external influences and the external screw cannot, of course, be cleaned or lubricated in service, whilst the external screw can be maintained in perfect order especially in any station installation. The cost of external screw valves is some what higher than that of internal screw valves.

The direction of opening of a valve may be clockwise or counter-clockwise marked on the outer end of the spindle.

Use of Sluice valves : Sluice valves are used in the transmission main as well as in the city distribution system. Sluice valves are generally placed at major summits of pressure conduits. Summits identify the sections of line that are points permitting cheaper valves and easier operation. In the distribution system Sluice valves are located on at least three sides of a cross-junction. In long mains, one Sluice valve is used for every kilometre of the pipeline. For the sake of economy, valves smaller in diameter than the conduit itself together with the necessary reducers and increasers are used for mains larger than 300 mm dia. Usually the size of the sluice valve shall be the same as the size of the main up to 300 mm dia and upto two-thirds the size of the main for bigger diameters. Large valves are often fitted with a by-pass valve to relieve the upstream pressure on the gate and for easier operation as already discussed.

Surface boxes and protecting tubes for sluice valves : Surface boxes provide access to underground valves installed on lines. The valves are located in brick masonry or concrete chambers, which do not rest on the pipe and transmit the traffic loads to them. Surface boxes are provided on top. In some cases, instead of a chamber, the operating points or the spindles of valves are given protection from the surrounding earth by protecting tubes or vertical iron guard pipes and o top the surface box is provided.

Surface box is provided for covering the valve chamber for safety and easy identification of valves. Iron surface boxes shall conform to IS : 3950-1979. If the surface box mounted on a guard pipe, is fixed over the underground valve merely to give access for operating the latter, the limited space provided by this arrangement will not permit the repacking of the stop valve gland or other repairs to be carried out without excavation. The guard pipe may be supported on bricks and not rest on the supply pipe.

Selection, installation and maintenance of sluice valves : These will conform to IS:2685-1971. A clear space of about 200 mm should be kept between the top of the sluice valve spindle and surface box so that valve cap may be easily provided, when the surface box is kept in flush with road level. If any leakage is detected at the valve seats, it should not be attempted to set right this by applying extra torque on the valve spindle but the valve seats should be scrapped or replaced, if need be. The direction of opening and closing should be indicated. Suitable identification plates should be provided as near to the actual location of valves as possible. A valve normally kept open or shut in a pipe should be operated once every three months to full travel of gate and any jamming developed should be freed. For T-key operation, the end of the key should have good fit on the square taper at the top of spindle. Over size keys should not be used direct to the spindle as this may result in rounded square top and the key may eventually slip.

Power operation of sluice valves : Opening or closing an unloaded 60 cm valve by hand may take 15 minutes continuous effort and, it the valve be loaded, a still longer period. Power operation is employed to avoid the arduous efforts required for manual operation and to increase the speed of operation. Other important advantages include the possibility of automatic and the remote control of valves in ways suitable to different circumstances.

Modern power driven sluice valves include valves operated by hydraulic pressure, compressed air, steam and electricity.

Float valves or ball valves : The float valve is essentially an automatic flow control valve in which the regulating principle is the level of some free water surface. A float valve may be arranged to allow water to flow until a predetermined level is reached, when the valve will shut and to open again as soon as the level drops as in the case of a float valve in a flushing cistern or it may be arranged to regulate flow of water so that a constant delivery level is maintained irrespective of variations of level (or of pressure) upstream as in the case of a float valve on the inlet side of a slow sand filter when the water is supplied from a storage tank with varying levels while the level in the slow sand filter is constant. Or it may be arranged to maintain a constant level in a tank with the varying inflow and equivalent outflow from the tank as in the case of a float valve in a break pressure tank, the opening of the valve depending upon the rate of flow through the tank. The movement of the float and the corresponding stroke of the valve may extend over the full range of variation of level so that progressive valve throttling occurs as the level rises as in the case of the float valve in the inlet side of the slow sand filter mentioned above or in the case of break pressure tank where the maximum draw-off through the tank is when the valve is fully open, or the float action in the movement of the valve may be limited to a given distance below top water level; the valve remaining fully open whenever the water level is below the actuating range.

In general, the float valve is a direct acting valve in which the weight of the float and its buoyancy provide alternately, the actuating forces (either directly on the spindle or through a lever).

Scour valves : In pressure conduits, small gated take-off known as blow-off or scour valves are provided at the low points in line such that each section of the line between valves can be emptied and drained completely. They discharge into natural drainage channels or empty into a sump from which the water can be pumped to waste. There should be no direct connection to sewers or polluted watercourse but through a specially designed trapped chamber or pit. Their sizes depend upon local circumstances especially upon the time in which a given section of line is designed to be emptied and upon the resulting velocities of flow. Calculations are based upon orifice discharge under a falling head equal to the differences in an elevation of the water surface in the conduit and the blow-off less the friction head. Frequency of operation depends upon the quality of the water carried especially on silt loads. In the distribution system scour valves are inserted in the scour branch from the main at low points and at all dead ends. The size of the scour valve depends upon length of the main to be scoured. It is, however, about half the size of the main which is to be scoured. The scour branch takes off from the main through a scour tee, which is a special tee with its branch connection having its invert at the same level as the main with a view to drain sediments.

Reflux valves : Reflux valves are valves through which flow can proceed in one direction only. Any tendency for the flow to reverse causes a Reflux valve to close and to remain closed until flow is re-established, in the unique direction. It should close without causing shock. They are also called non-return valves, check valves and retaining valves. In one application, a Reflux valve can be described as a foot valve. The term check valve is generally restricted to small size mains and which are of the disc type. Check valves can be had for the vertical as well as horizontal flow conditions. They are used in the house plumbing system as well as in industrial installations. It has the advantage of rapid closure but has simultaneously and disadvantage of causing high resistance to flow. Single door type Reflux valves should conform to IS:5312 (Part 1) 1984.

Flap Valves : Flap Valves are the simplest form of reflex valves and have a single door or flap hinged so that when hanging freely the valve is closed. Flow in the forward direction causes the door to swing open, the amount of opening depending upon the velocity of flow is high enough to raise the door to its full extent, a clear waterway is prescribed and the hydraulic resistance to flow is accordingly relatively low. As the forward velocity decreases, the valve door should approach its seat until at zero velocity the valve should be closed. Any tendency for the flow to reverse will than cause the flap to press against the seat with a force proportional to the difference of upstream and downstream pressures, the greater the difference the greater being the force holding the valve closed. The travel of a flap valve is relatively great compared with that of other types of reflex valves but this is not necessarily a disadvantage and the flap valve is, in fact very widely used on account of its simplicity and economy, its effectiveness and the low hydraulic loss it causes at ordinary working velocities. Two patterns are available, one for horizontal mains and other for vertical mains. The valve seat is inclined to the valve axis. This ensures that, when the valve is installed with its axis horizontal, the flap can not hang in a partly open position unless there is some flow through the valve. This point deserves attention in any case where flap valve is to be installed in a main sloping downwards in the direction of flow. They are normally constructed of cast iron with gun metal face on valve body and flap. Valves 10 cm and smaller have solid gunmetal doors on which the faces are machined direct. In a single stroke pitcher suction pump or a force pump, the suction valve and the plunger valve are of the non-return type.

Pressure-relief valves : These are used to keep the pressure in the line below a given value by causing water to flow to waste when the pressure builds up beyond the designed value. Usually they are spring or weight loaded and are not sufficiently responsive to rapid fluctuation of pressure to be used as surge protection devices. They are installed on the main near the pumping station and usually on the outside.

A special type of this valve, called the subsoil relief valve, is used to prevent the accumulation of pressure of water under the floor of any concrete structure, such as swimming pools, dry docks and concrete tanks which is built below the surface of the ground. This pressure, if allowed to accumulate, would tend to lift the structure or crack the floor.

Another type is the loaded equilibrium valve which is used for the purpose of maintaining a head on any pumping main when delivering to high level areas. The surplus water passes through the valve to the service reservoir. The present practice is to have the overhead service reservoir without any inlet control.

Pressure reducing valves : These are used to automatically maintain a reduced pressure within reasonable limits in the downstream side of the pipeline.

Pressure sustaining valves : These are similar to the pressure reducing valves and are used to maintain automatically the pressure on the upstream side of the pipeline.

Air valves : These are fitted to release the air automatically when a pipeline is being filled and also to permit air to enter the pipeline when it is being emptied. Additionally, air valves have also to release any entrained air which might accumulate at high points in the pipeline during normal operations. For most cases in water works and pumping practice, two types of air valves are required. These are known as large orifice and small orifice air valves.

Large orifice air valves : The purpose of this type of valve is to discharge air during filling or charging of mains and to admit air to mains while they are being emptied. They pass air at high rates of flow with small pressure differences either into or out of the pipes on which the valve is fixed. The ball which forms the valve element although buoyant is rigid being covered with vulcanite. During normal service condition, this ball is maintained in contact with its seating usually of leather backed rubber by the pressure in the main and cannot leave this seating except when the pressure falls practically to that of the atmosphere. This occurs at various sections of a main when it is either being charged or emptied . when the pipes carrying a large orifice air valve are empty, the valve is open and remains in that position until the ball is carried on to its seating by the arrival of water. Once on this seating and under pressure, the valve cannot open even if the pipe becomes full of air until the pressure drops. It will be seen, therefore, that this valve will not release air accumulations under conditions of normal working pressure. When such a valve is discharging at a high rate, as during, as during the filling of a min, there is a risk that the ball although lying in a fully open position in the absence of water may nevertheless suddenly be caught in the escaping air stream and closed when it may refuse to open again until the pressure has been reduced. The ball of the valve in such a case would have to be held down during filling operation. This defect has been overcome in a large orifice air valve of the advanced design known as ‘kinetic air valve’. In this the air or water enters from the bottom side of the ball and the air rushing around the ball exerts the pressure and loosens the contact with the top opening and allows the ball to drop down. When solid water reaches the ball, however, it is at once displaced and instantly closed.

Small orifice air valve : The purpose of this valve is to discharge air which may accumulate in sections of a main under working conditions, that is, under the running pressure in the main. The orifice is relatively quite small and is sealed by a floating rubber covered ball at all pressures above atmosphere except when air accumulates in this valve chamber. When air has accumulated to depress the water level sufficiently, the ball falls away from the outlet orifice and the air escapes through this orifice until the water level rises again causing the ball to re-seal the orifice. The diameter of the ball in a small orifice air valve is related to the maximum working pressure and for a given size of orifice increases with this pressure. The orifice is not less than 2.5 mm in diameter.

Double air valves : In many instances, both large and small orifice air valves are required at the same point on a main and it is usual in such cases to fit a combined or double air valve in a single fitting.

Location of air valves : Air valves are required at all peaks. Peaks are not judged solely with respect to a horizontal datum but also with respect to the maximum hydraulic gradient is the virtual free water level along the pipeline. It may vary with changes of pipe diameter possibly with different condition of pipe surfaces and with variation of velocity caused by branch mains and local points of draw-off. Any portion of a pipeline running parallel with the hydraulic gradient above is constitutes a peak and air valves at each extremely of such a parallel stretch of main are necessary, in addition to intermediate ones for long length of main as shown in fig.

Air valves are necessary at all points where the pipeline approaching the hydraulic gradient changes its slope to recede from this gradient, thereby forming a peak which is not necessarily a peak with respect to the horizontal.

Air is liable to be trapped in a pipeline at any point where a downward grade increases as shown in figure. Although there is no peak as defined above, it is nevertheless desirable to install a double air valve at every such point of change or atleast a small orifice air valve.

Air locks can similarly occur at any section of a pipeline where an upward grade changes down to decreased upward grade as shown in figure.

Generally, air valves fitted at all the peaks should be double air valves comprising large orifice and small orifice units.

In long ascending stretches, additional air valves will be required primarily to ensure adequate discharge of air when filling the pipeline and ample ventilation when it is being drained.

Large orifice units should be installed at intervals from ½ and ¾ km along the section. In long descending stretches also additional air valves should be installed at intervals from ½ to ¾ km along the section as shown in fig. Double air valves should be used in this case. Long horizontal stretches of main or long stretches with gradients of the order of 1 in 500 should. Wherever possible, be avoided. If this cannot be done, double air valves will have to be provided along the main at intervals of from ½ to ¾ km, in addition to those provided at the ends of such horizontal or near horizontal stretches. The size of large orifice air valve is based upon the diameter of the main. A ratio of the branch diameter to the diameter of the main is about 1/6. This ratio for a small orifice air valve may be roughly 1/12.

Gravity conduits are commonly provided with gate chambers at points strategic for the operation of the supply conduit at the two ends of the sag pipe and pressure tunnels, and wherever it is convenient to drain given sections. Sluice gates are normally installed in grade conduits particularly in large ones. In special situations variations of sluice valves suited to the needs are used. Needle valves are preferred for fine control of flow, butterfly valves for ease of operation and cone valves for regulating the time of closure and controlling water hammer.

The butterfly valves with no sliding parts have the advantages of ease of operation, low cost, and compact size, reduced size of chamber or valve house and improved closing and retarding characteristics. A maximum operation velocity of 5 m/s in the fully opened position is usually specified for rubber seated valves and 17 m/s for metal seated ones. These would involve slightly higher head losses than sluice valves and also are not suitable for

continuous throttling. Sluice valves are not intended to be used of continuous throttling; otherwise erosion of the seats and body cavitation will occur. If small flows are required the by-pass valve is more suitable.

Automatic control : Electrically operated sluice valves can readily be adapted to automatic control under different circumstances. Controlling factors may be time, pressure, and velocity of flow, water level and mechanical or electrical synchronisation.

Valves for pressure or flow control :

a) Automatic pressure control and automatic flow control valves for pipelines, flow regulating valves for closed conduits, needle regulating valves for open discharge and various types of float valves are the different types that come under this category.

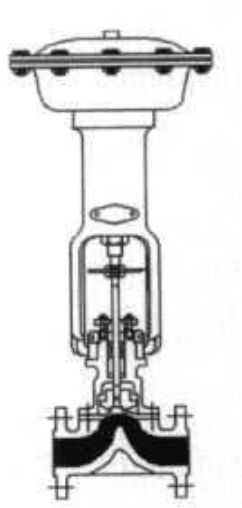
b) Automatic valves : Automatic regulating valves are actuated by changes of pressure or of flow. In the case of float operated valves they are actuated by changes of the free surface level of water. The automatic control valves are used in the water system which maintain a given regime of pressure or flow by self-adjustment from time to time as necessary under the action of forces arising from changes of pressure or flow in some part of the system, these changes tending to upset the regime but not doing so because of the resulting action of the control valve.

Some types of automatic control valves are given in table.

c) Constant flow valves maintain a constant set rate of flow in what would otherwise be variable flow conditions. There are a number of different forms of module, some suitable for pipelines, others suitable for open channels, filter outlets and weir discharges. The controlling factor can be the differential head across a venturi tube, flow nozzle or similar device, the head on a weir or measuring flume or the pitot head resulting from velocity of flow.

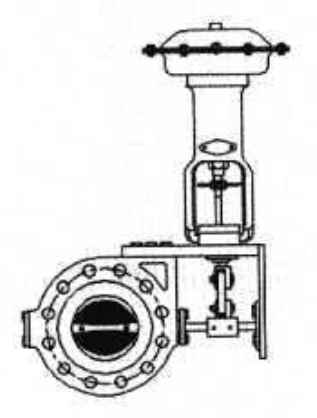
A typical constant flow valve is operated by a diaphragm which is subjected to the differential head resulting from the passage of flow of water under control through a flow nozzle incorporated in the valve. In action the main valve element is normally in equilibrium at some partly open and the rate of flow for which the valve is set. Any tendency for the flow to increase, induces an increasing differential head which causes the valve to close down in compensation and conversely any falling off in the rate of flow induces a decreasing differential head which causes the valve to open up. In this way the valve automatically maintains a constant rate of flow under widely varying pressure conditions. Means are provided for adjustment over a considerable range of the rate of flow for which the valve can be set. Such a valve is used to obtain a constant rate of flow through a rapid gravity filter under a constant head over the filter and with varying filter head by allowing increased opening of outlet valve.

TYPES OF AUTOMATIC CONTROL VALVES		
Sr. No.	**Requirement**	**Type of Valve**
i	To obtain a constant outlet pressure from a higher constant or variable inlet pressure.	Standard pressure reducing valve.
ii	To limit a variable inlet pressure to a definite minimum value or to keep an inlet pressure constant under varying flow condition.	Pressure retaining valve.
iii	To prevent a raise of line pressure above a predetermined intensity.	Pressure relief valve.
iv	To reduce a constant or variable inlet pressure by a fixed amount.	Break pressure valve.
v	To maintain a constant rate of flow.	Module
vi	To divide a flow into two definite proportion.	Proportional flow dividing valve.
vii	To stop two flows in definite proportion.	Proportional flow mixing valve.
viii	To stop a flow when a given line pressure is reached as and when tank is full.	Internal pressure actuated control valve.
xi	To stop flow in one system when a given pressure is reached in another system.	External pressure actuated control valve.



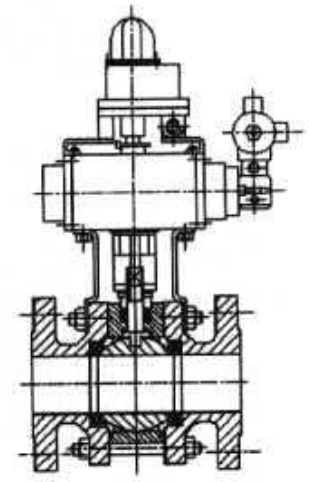
DIAPHRAGM VALVE

Type : Globe with weir & diaphragm seal
Size : 1” to 10”
Body material : C.I, C.S & S.S. 304, S.S. 316, ALLOY 20 , MONNEL
Design Pressure : Upto 200, Psig
Design Temperature : Upto – 100^0C
End Connections : Screwed upto 2" Flanged confirming to ANSI, DIN, IS, BS
Bonnet : Bolted with stuffing box
Characteristics : Between Linear & quick – opening
Leakage : Less than 1 bubble/minute
Actuator Type : Spring Diaphragm cylinder
Advantage : Low cost, body easily lined with almost any materials
Disadvantage : Poor throttling characteristics, Diaphragm wears rapidly in high pressure drop services.



BUTTERFLY VALVE

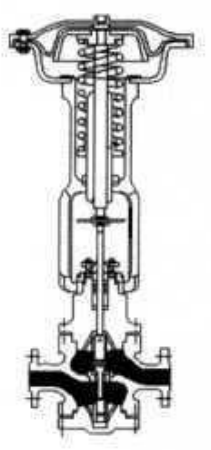
Size : 2" to 36"
Body material : C.I, C.S & S.S. 304, S.S. 316, ALLOY 20 , MONNEL
Design Pressure : Upto 600 lbs
Design Temperature : Upto – 650^0C
End Connections : Flanged confirming to ASA, DIN, IS, BS
Packing : Teflon, asbestos, Graphited, asbestos
Vane Rotation : 0 -60^0 or 0-90^0
Tirm Design : Conventional-On-Off Fish tail-approximate throttling
Unlined : 3% of max. capacity.
Lining : N.I.Hard, Natural Rubber, Teflon PVC.
Leakage : Lined less than 2 bubble/minute
Actuator Type : Spring Diaphragm cylinder
Advantage : General Service, Slurries, High Capacity, High rangeability, Continuous puring of low activity, Zone prevents, Solids build-up or entrapment, Excellent Control Characteristics.



AUTOMATED BALL VALVES

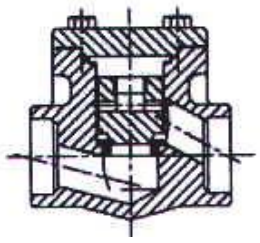
Size : 1" to 8"
Design Pressure : Upto 300 Psig
Design Temperature : Upto – 650^0C
Characteristics : On-Off Equal percentage having ball valve
Body material : C.I, C.S & S.S. 304, S.S. 316, ALLOY 20 , MONNEL
Trim Materials : S.S. 304, S.S. 316, ALLOY 20 , MONNEL
End Connections : Flanged throught Bolted as per ASA-DIN-IS-BS
Advantage : General Service, Slurries, High Capacity, High rangeability, Continuous puring of low activity, Zone prevents, Solids build-up or entrapment, Excellent Control Characteristics.
Disadvantage : Cavitation prone, high torque requirement, Seal wear.

GLOBE SINGLE SEATED



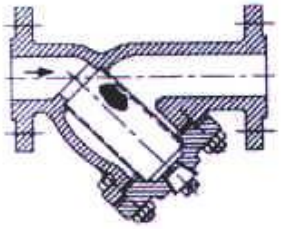
Size : ½ " to 8"
Body Material : C.S., S.S. 304, SS 316, Alloy 20, C.I., Monnel
Design Pressure : Upto 900 Psig
Design Temperature : Upto 100^0C to + 850^0C
End Connections : Screwed upto 2" Socket Weld Upto 3" Flanged confirming to ASA,DIN,IS,BS
Bellow Seal : Stainless Steel & PTFE
Packing : Teflon, Teflon Absestos Graphited absestos
Trim Design : Full capacity, 40% restricted capacity, microflow.
Characteristics : Quick opening, Equal percentage & linear
Actuator Type (1) : Spring Diaphragm 9 Direct – Revers Acting)
Spring range : 3 to 15 Psig
(0.2 to 1.0 kg/cm^2) 3 to 9 Psig
(0.2 to 0.8 kg/cm^2) 9 to 15 Psig
(0.8 to 1.0 kg/cm^2)
(II) Pneumatic – Cylinder Actuator
Spring Range : 0 to 60 Psig 3 to 15 Psig available with Power positioner
Leakage : Metal to Metal : 0.01% of full capacity
With Softseat : Bubble tight shut off
Advantage : Largest variety of types and service application, noise and canvitation control capability socket weld upto 3".
Bonnet : Plain bolted 0^0 to 200^0 C
Radiating finned - 200^0 C to 650^0 C
Extension Column + Low Temperature up to - 100^0 C

FORGED STEEL LIFT CHECK VALVES



Type : Gate Globe and Lift Check Valve
Size : From 15 mm to 50 mm
Pressure Ratings : Class 800, 1500, 2500
Design & Mfg. Standard: API 602 (Gate) BS 5352
(Gate, Globe & Check)
Testing & Inspection Standard : API 598, BS 5146
Body Material : ASTM A105, A182 F304 F316
Trim Materials : AISI 410/304/316, Stellited Monel
End Connections : Screwed, Socket welded as per ANSI B 16.11 OR welded flanges as per ANSI B16.5 in class 150, 300, 600

FORGED STEEL 'Y' TYPE STRAINER

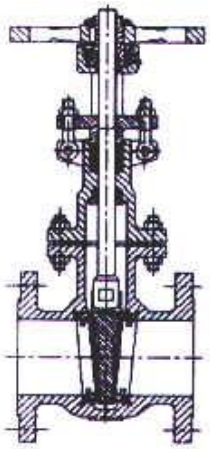


Type : 'Y' Type & Basket type
Size : 25 mm to 400 mm
Pressure Ratings : Class 150, 300, 600, 1500
Design & Mfg. Standard: BS-1873
Inspection & Testing Standard : BS 6755 Part I
Body Material : WCB, CF8, CF8M, Alloy 20, CF3, CF3M
Trim Materials : 40/60 (MESH), S.S. 304/316, Brass.
End Connections : Flanged as per ASNI B16.5 Butt Welded as per ANSI B 16.25

FORGED STEEL 'Y' TYPE STOP VALVE

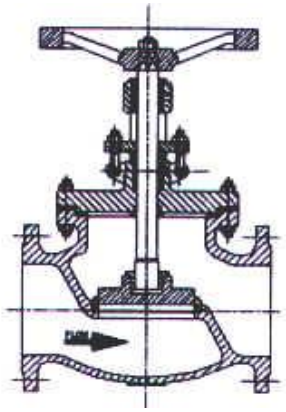


Type : Out side Screws yoke, Rising, Stem
Size : 15 mm to 300 mm
Pressure Ratings : 150, 300, 600, 1500
Design & Mfg. Standard: BS-1873, ANSI B:16.5
Testing & Inspection Standard : BS 598/ BS 5146
Body Material : WCB, CF8, C.I., Alloy 20



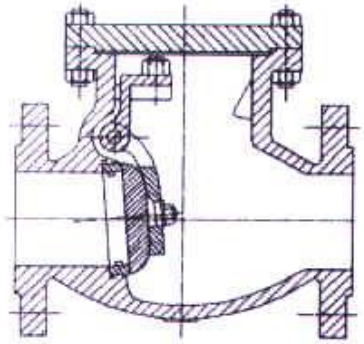
FORGED STEEL GATE VALVE

Type : Bolted Bonnet O.S. & 'Y' Type R, Sing Stem
Size : 50 mm to 600 mm
Pressure Ratings : 150, 300, 600, 900, 1500
Design & Mfg. Standard: API 600 / BS 1414
Inspection & Testing Standard : API 598
Body Material : WCB, Cast Iron, CF8, CF8M, Alloy 20
Trim Materials : 13% Cr. Stellited, AISI 304/316/Monel
End Connections : Flanged, Butt welded as per ANSI B 16.10
Face to Face Dimension : ANSI B 16.10
Optional : Manual gearbox or motorised operation



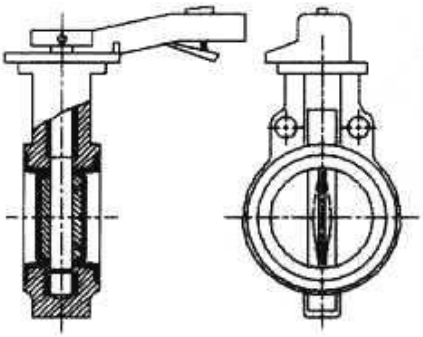
F.S.GLOBE VALVE

Type : Bolted Bonnet O.S. & Type, Rising Stem
Size : 25 mm to 500 mm
Pressure Ratings : 150, 300, 600, 900, 1500
Design & Mfg. Standard: BS 1873
Inspection & Testing Standard : API 598/ BS 6755 Part-I
Body Material : WCB, Cast Iron, CF8, CF8M, Alloy 20 CF3, CF3M
Trim Materials : 13% Cr. Stellited, AISI 304/316/Monel
End Connections : Flanged, Butt welded as per ANSI B 16.5/B 16.25
Face to Face Dimension : ANSI B 16.10
Optional : Manual gearbox or motorised operation



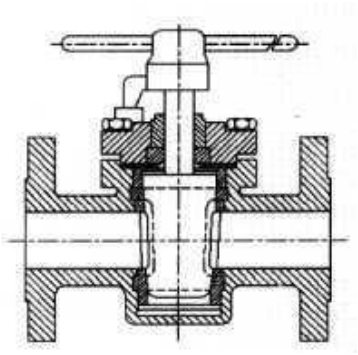
F.S. SWING CHECK VALVES

Type : Swing type, Bolted cover, Piston type
Size : 50 mm to 600 mm
Pressure Ratings : 150, 300, 600, 900, 1500
Design & Mfg. Standard: BS 1868
Inspection & Testing Standard : API 598 / BS 6755
Body Material : WCB, CF8, CF8M, Alloy 20, CF3, CF3M, Cast Iron
Trim Materials : 13% Cr. Stellited, AISI 304/316/Monel
End Connections : Flanged, Butt welded as per ANSI B 16.5/ B 16.25
Face to Face Dimension : ANSI B 16.10



F.S. BUTTERFLY VALVE

Type : Center disc/Ecentric disc
Size : 50 mm to 1000 mm
Pressure Ratings : 150, 300, 600
Design & Mfg. Standard: AWWA C 504 API609, BS 155
Body Material : Cast Iron, WCB, CF8, CF8M, etc.
Manual Operation : By lever /gear
Seat Materials : Natural & Synthetic Rubbers
Construction : Wafer, lug, Flanged ends
Other function : Pneumatic or Electrical Actuator can be provided, Gear Operation Provided for valves 200 mm & above.
Disc Materials : Cast Iron, WCB, CF8, CF8M etc.

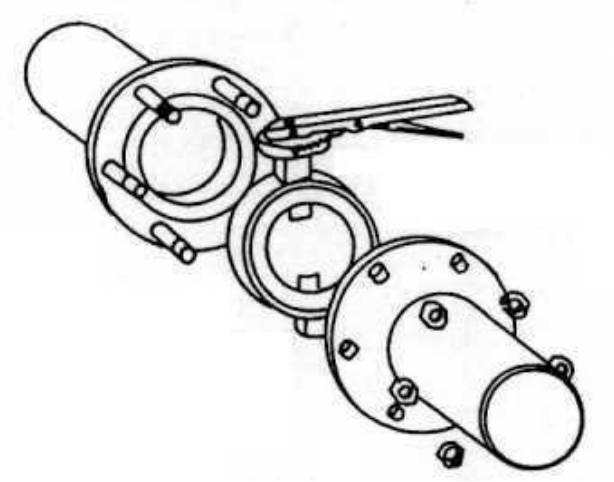


F.S. PLUG VALVE

Type : Standard/ Inverted Pressure balance Plug/ Regular Pattern
Size : 25 mm to 300 mm
Pressure Ratings : ANSI Class 125, 150, 300 , 600, Lbs.
Design & Mfg. Standard: API 6D/BS 5353
Material for construction : CI, WCB, S.S.304, S.S.316
Other Feature : PTFE Sleeve & PTF
End Connection : Flanged to BS, IS, ASA

Installation of butterfly valves

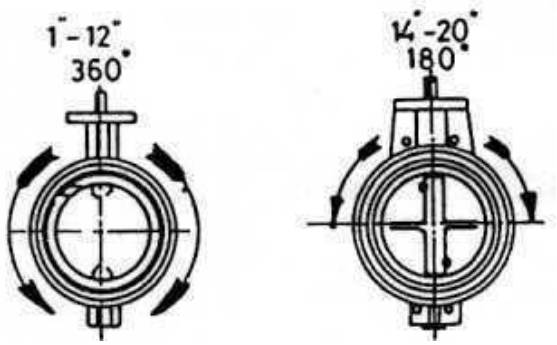
Mounting Position depending on type and size



Warning
Do not use flange seal liner also acts as gasket.

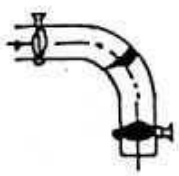
Valve Size :

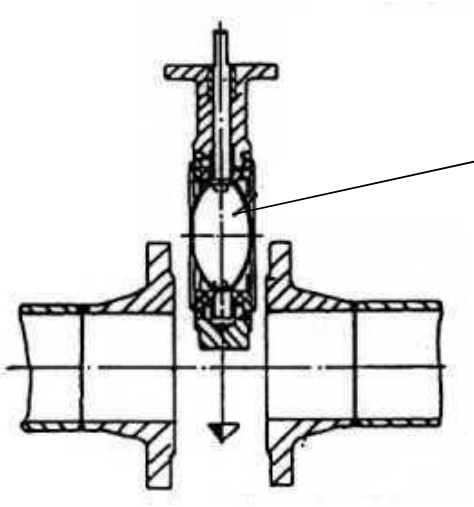
1"-12" : This valve can be mounted in any position.
14"-20" : May be mounted horizontally or vertically. We advise against mounting upside down.
24"-48" : Horizontal mounting is recommended.



Note :

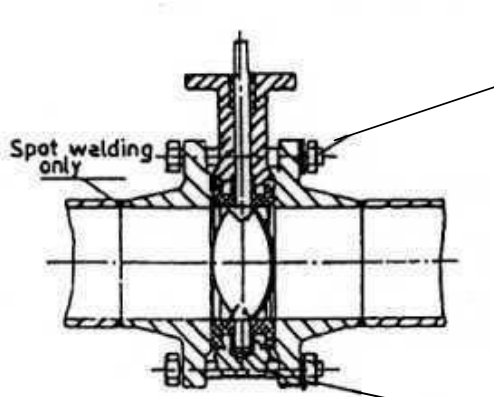
- For media containing solid matter horizontal mounting is recommended.
- For high flow rates the valve must not be installed close to a pipe bend or T-piece.
- If unavoidable the valve must be mounted in the following manner as shown in figure.





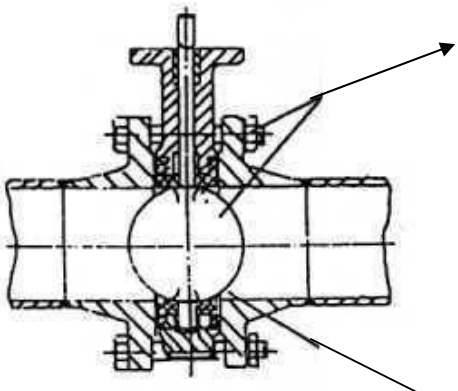
Ensure that disk is not completely closed when installed

Do not force the valve between the flanges (in necessary spread flanges)



Flange bolts must be hand tightened as valve is centered

Remove valve before welding the flange

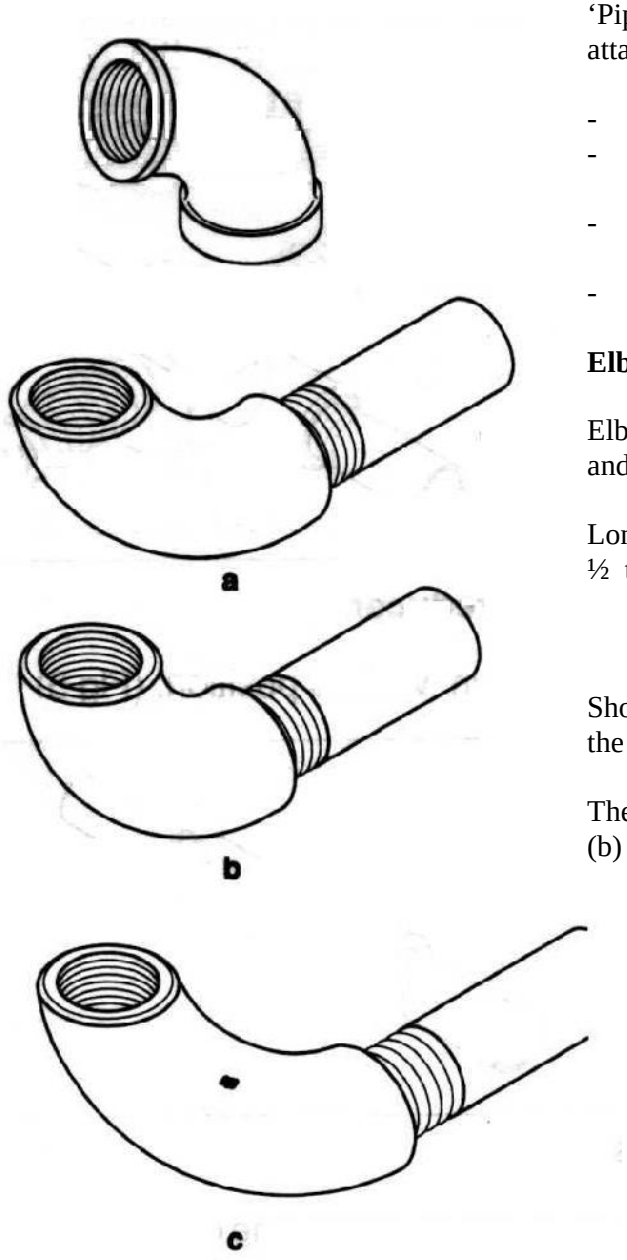


Tighten flange bolts cross wise after fully opening the valve.

Pay attention to free movement of the disc in the flange bore.

Additional Warning : If valve is incorrectly installed the liner may shift and the valve become unserviceable.

5.0 - PIPE & SANITARY FITTINGS AND SPECIALS



Standard pipe fitting

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

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

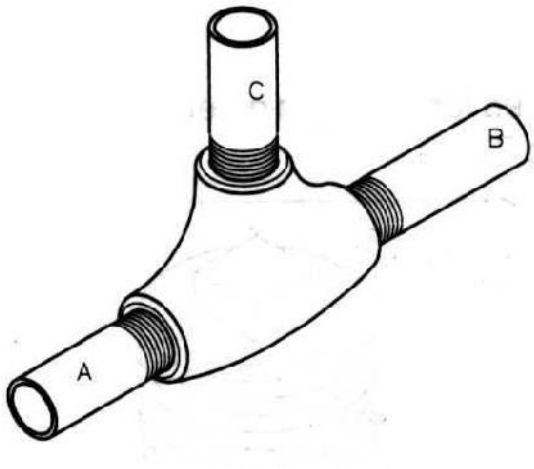
Elbows

Elbows and bends provide deviations of 90^0 and 45^0 in pipe work systems.

Long radius elbows have a radius equal to 1 ½ times the bore of the pipe. (a)

Short radius elbows have a radius equal to the bore of the pipe. (b)

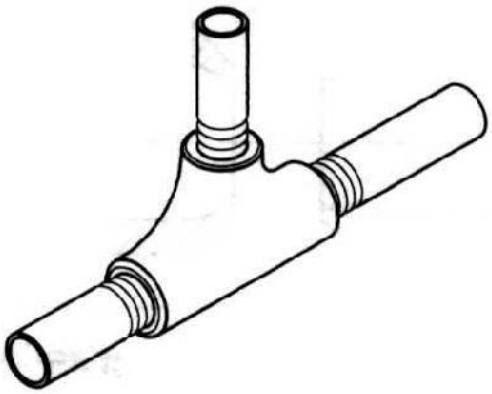
The 45^0 elbows allow pipe deviation of 45^0. (b)



Tee branch

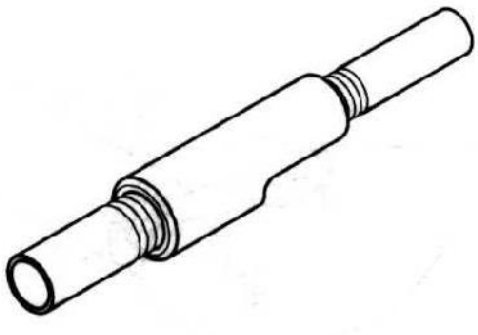
A tee joint help the pipe line to branch off at 90^0. The branch may be equal in diameter or there may be one reducing branch.

The dimensions of a branch are always quoted as A X B X C.



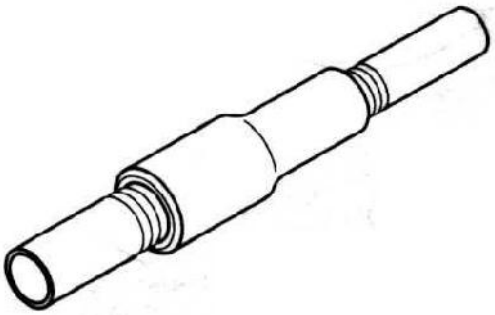
Reducing tee branch

Reducers are fitted where a change in pipe diameter is required.



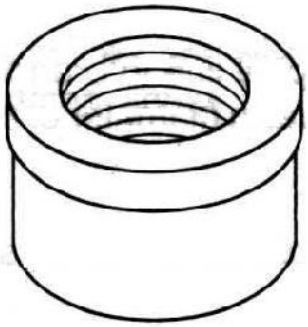
Eccentric reducer

Used mainly in horizontal position.



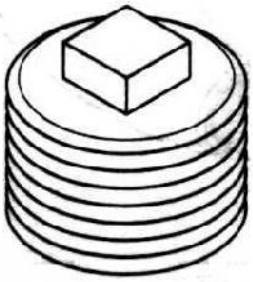
Consentric reducer

Used mainly in vertical position.



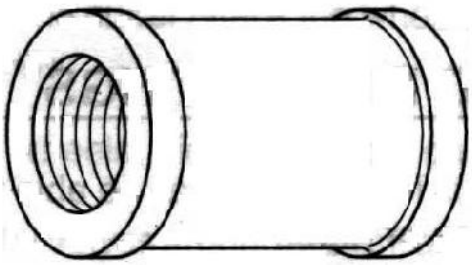
Caps

Caps are used for closing the end of pipe or fitting which has an external thread.



Plug

A plug is used for closing a pipeline which has an internal thread.



Coupling

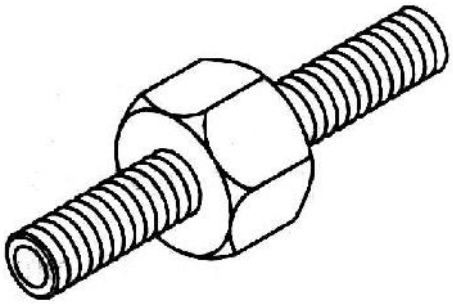
A coupling is used to connect two pipes. Couplings have internal threads at both ends to fit the external threads on pipes.



Reducer

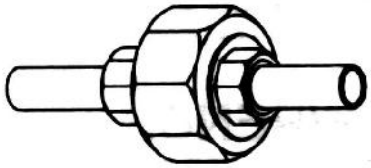
A reducer coupling is used to connect two pipes with different diameters.

FITTING	SYMBOL
Bend 90 Degrees	
Bend 45 Degrees	
Cross	
Elbow 90 Degrees	
Elbow 45 Degrees	
Tee	
Reducer concentric	
Union screwed	
Plug or cap	
Joint/socket	



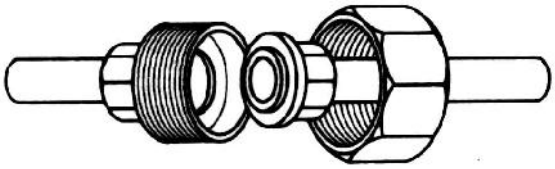
The hexagonal nut

The hexagonal nut in the centre of the nipple is for tightening with a spanner or wrench.



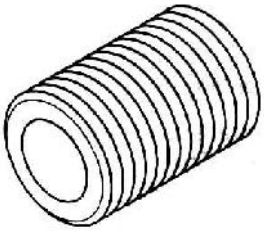
Union

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.

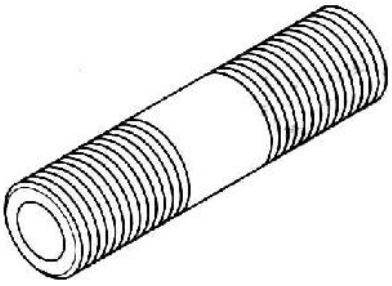


Pipe nipples

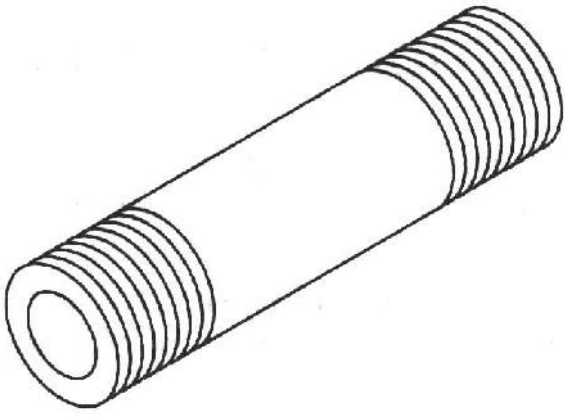
Pipe nipples are tubular pipe fittings used to connect two or more pipes of different sizes.



Close nipple

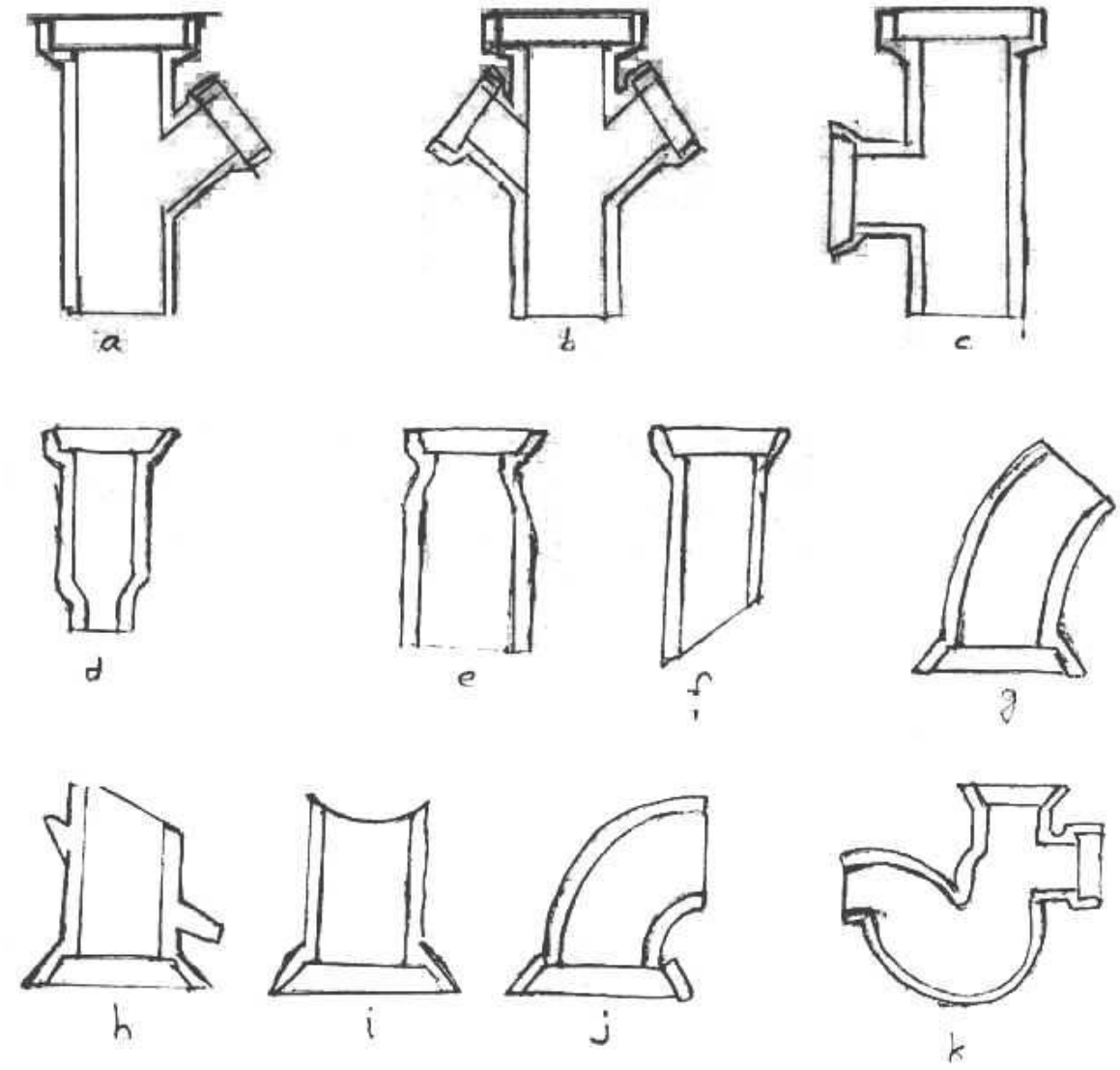


Short nipple



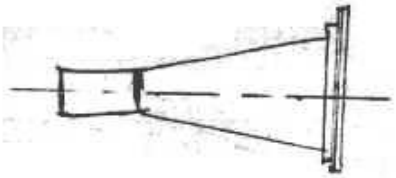
Long nipple

Connecting fittings of pipe



a) Y-branch
b) Double Y-branch
c) T-branch
d) Reducer
e) Increaser
f) Slant
g) 45^0 or 1/8 bend
h) Y-saddle
i) Saddle
j) 90^0 or ¼ bend
k) Trap

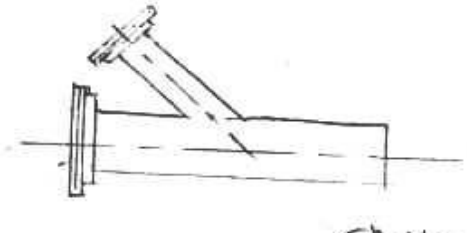
Pipe specials or fittings



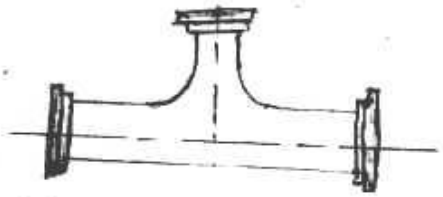
REDUCING SOCKET



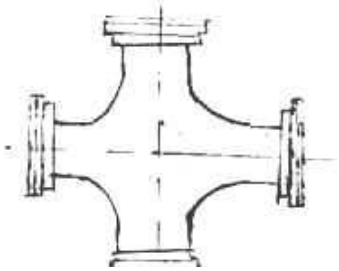
45^0 BEND



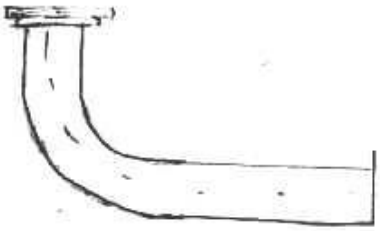
Y BEND



TEE

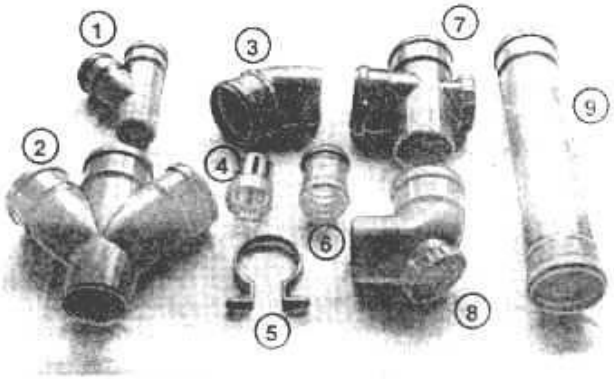


CROSS

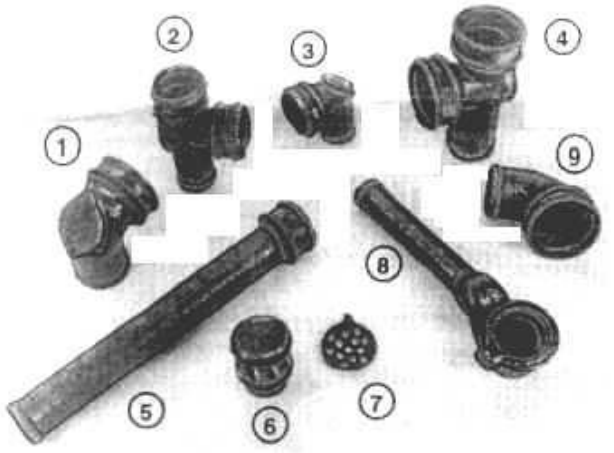


90^0 BEND

TYPICAL WATER SUPPLY AND SANITARY FITTINGS



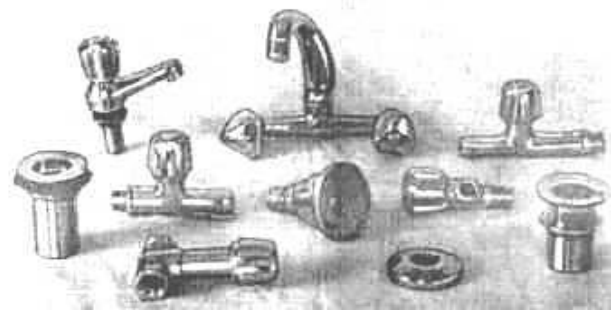
1. **Single Y**
2. **Double Y**
3. **Offset**
4. **Cowl**
5. **Clip**
6. **Loose Collar**
7. **Plug Tee**
8. **Plug Bend**
9. **D/S Connector**



1. **Plug Bend**
2. **Plug Tee**
3. **Plug Bend**
4. **Plug Tee**
5. **S/S Connector**
6. **Cowl**
7. **Nahani Trap Jali**
8. **Nahani trap**
9. **Plain bend**



Typical C.P.Fittings

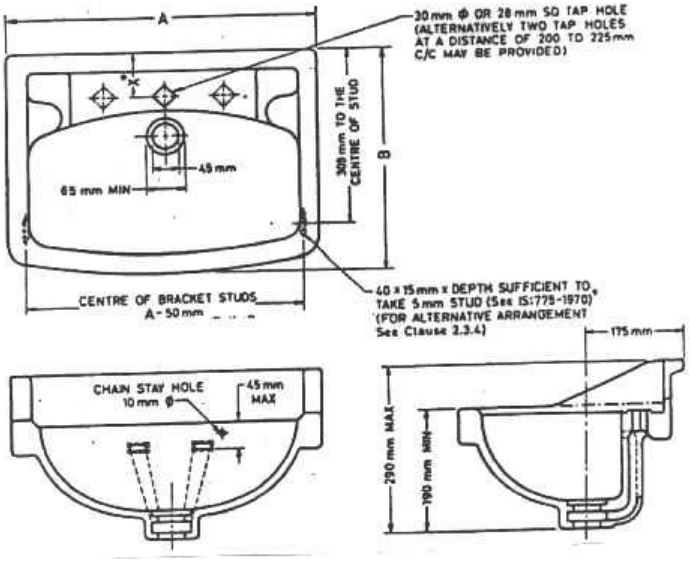


6.0 - SANITARY FIXTURES

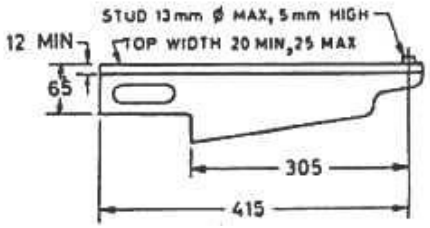
6.1 Wash Hand Basin

Wash hand basin is designed for wash upper part of the body. One WHB requires following fittings and materials :

- Wash Hand Basin – 1 no.
- Waste coupling – 1 no.
- Side bracket – 2 nos.
- 75 mm screws/nails.
- Piller tap – 2 nos. (one for hot and one for cold water)
- Stop valve – 2 nos.
- C.P.bottel trap – 1 no.
- P.V.C. inlet 15 mm – 2 nos.
- Waste pipe – 1 no.



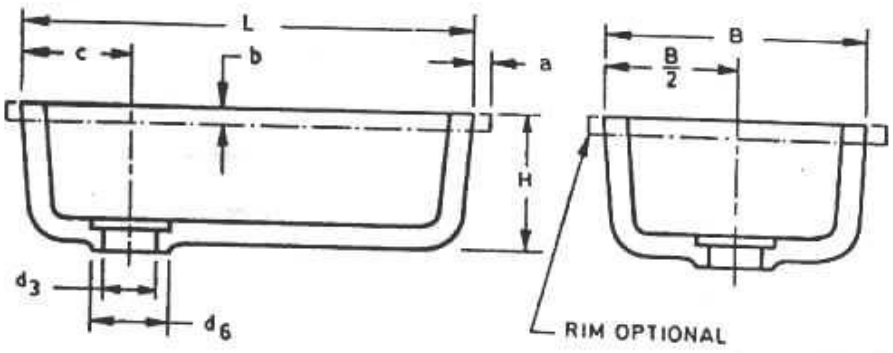
Flat Back wash basin with single tap hole



6.2 Sink

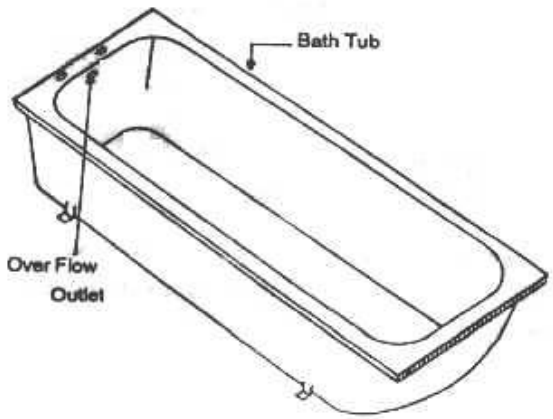
Sink is a shallow rectangular basin having flat bottom. All internal angles are rounded for easy cleaning. The bottom is sloping towards the outlet for easy drain of water. A full threaded coupling is used for outlet which is connected to bottle trap or P.V.C. pipe. It is to fixed at height of 585 mm above the finish floor level. It is required following fittings and material :

- Sink – 1 no.
- Waste coupling full threaded 32 mm – 1 no.
- P.V.C waste pipe 32 mm – 1 no.
- 15 mm C.P. bib tap (long arm) – 1 no.



6.3 Bath Tub

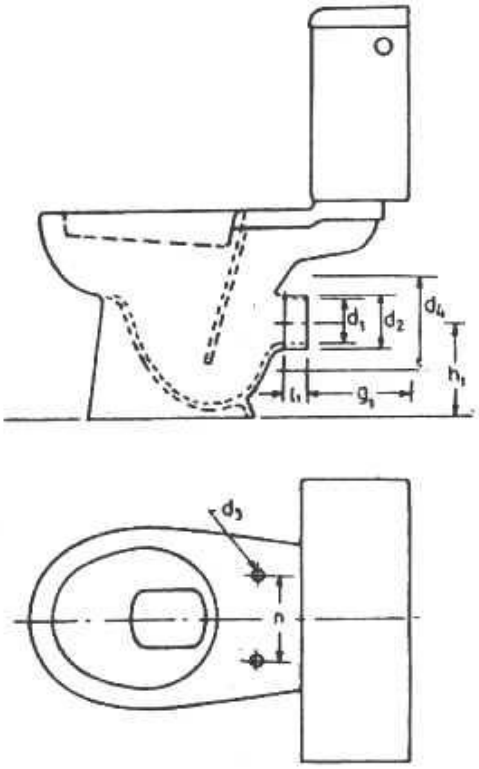
- Generally bath tubs are made of vitreous earthen ware or fibre glass. Now a days these are also available in P.V.C. or fibre reinforced plastic (F.R.P.) material with various designs and colours.
- It is provided with hot and cold water connection and inlet usually of 15 mm dia each and outlet of 32 mm dia connected to waste pipe.
- The waste pipe is connected to main vertical stack through a trap, so as to prevent the entry of foul gases in the bath-tub.
- It is also provided with an overflow pipe to drain the excess water usual dimensions of bath tub are 1.80 m length X 0.75 m width X 0.45 m depth.
- Overall height its feet is 0.60 m.



6.4 Water closet

It is a water flushing plumbing fixture designed to receive human excreta directly from the user. This term is also some time used to denote the room or compartment in which the fixture is placed. Water closets are of two types.

- Pedestal or European Type.
- Squatting or the Indian Type.

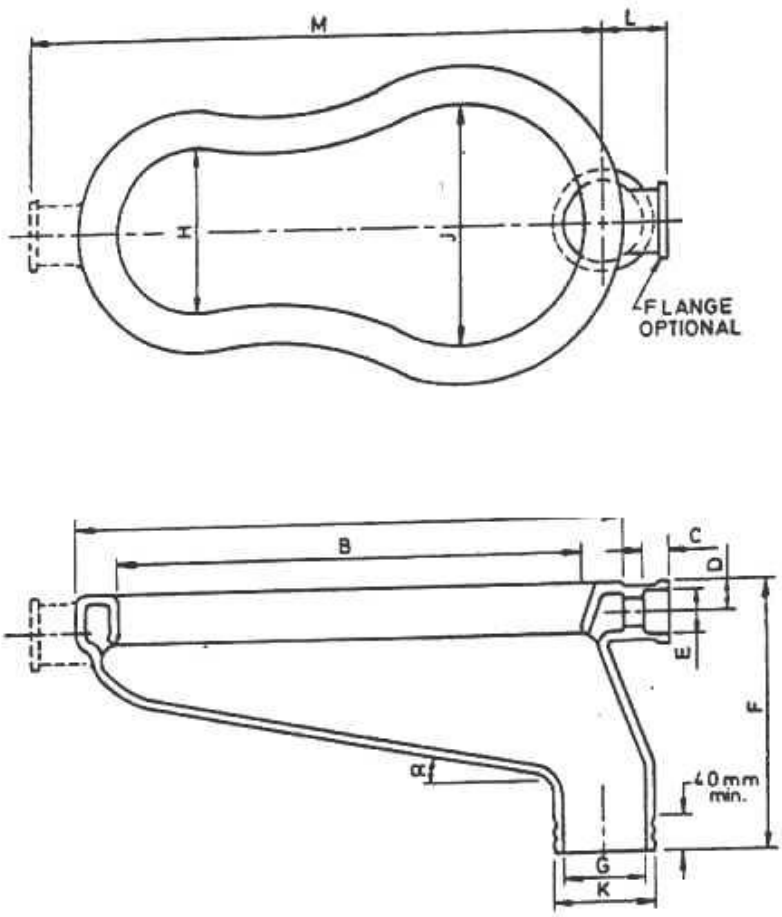


Connecting dimensions (Clause 6.1) of IS 2556 (Part 8) : 1995

S. No.	Description	Ref. in figures	Washdown. Horizontal Outlet
1	Internal diameter of outlet[1)]	d_1	80 Min
2	External diameter of outlet[1)]	d_2	102 $\pm$ 5
3	Height of centre line of outlet from floor level and P-trap only.	h_1	180 + 15 - 10
4	Distance from end of trap to floor for S-trap only	h_2	-
5	Length of grooved part of outlet	l	-
6	Distance between centre of seat bolt holes	n	155 $\pm$ 10
7	Distance of seat bolt holes	d_3	15 $\pm$ 2
8	Distance between back of cistern and outside of the outlet for P-trap or centre line of outlet of S-trap	g_1 g_2	140 $\pm$ 25 -
9	Diameter of the full space around the outlet	d_4	150 Min
10	Angle of outlet	θ	-

11	Length of straight part of outlet glazed and without groove.	l_1	40 Min
12	Distance between end of outlet and floor	X	-
13	Length of extended outlet in to the floor	X_1	-
14	Length of outlet with groove	Y	-

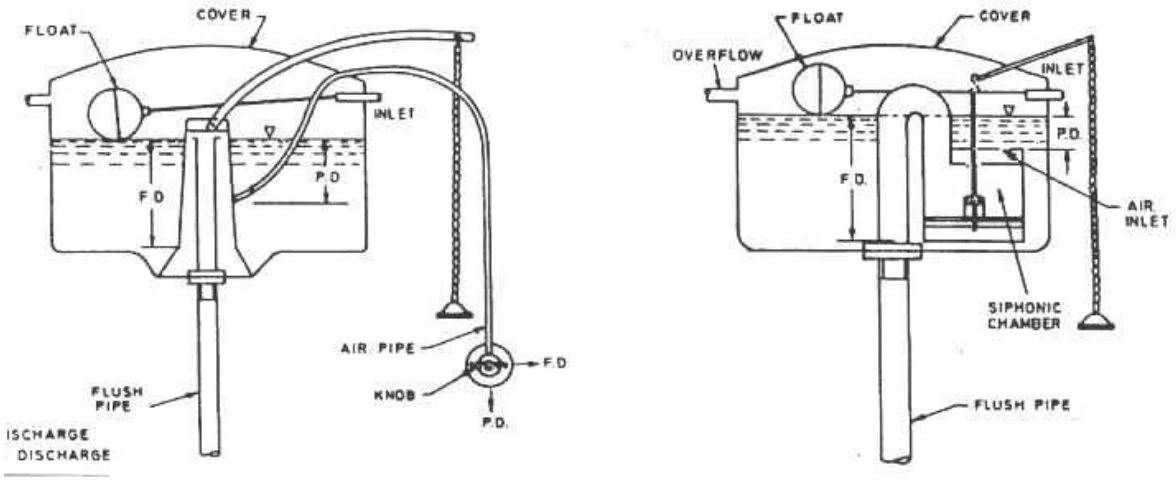
[1)] Ovality permissible within the dimensions allowed for the internal and external diameters.



6.5 Flushing Cistern

This is an appliance used for flushing out water closet, urinals etc. it is of two type :

- Bell type
- Curved syphonic type



6.6 P Trap & S Trap

'P' or 'S' trap is provided for discharging the soil waste from W.C. toilet with constant water seal to avoid entry of foul gases.

- Trap to be checked for cracks, burr, internal and base shape.
- Trap should be fixed after adjusting the height of W.C. pan or commode with respect to F.F.L.
- Trap should be protected with small gunny bag piece and then a coat of Plaster of Paris should be applied to avoid choke up due to other work activities.

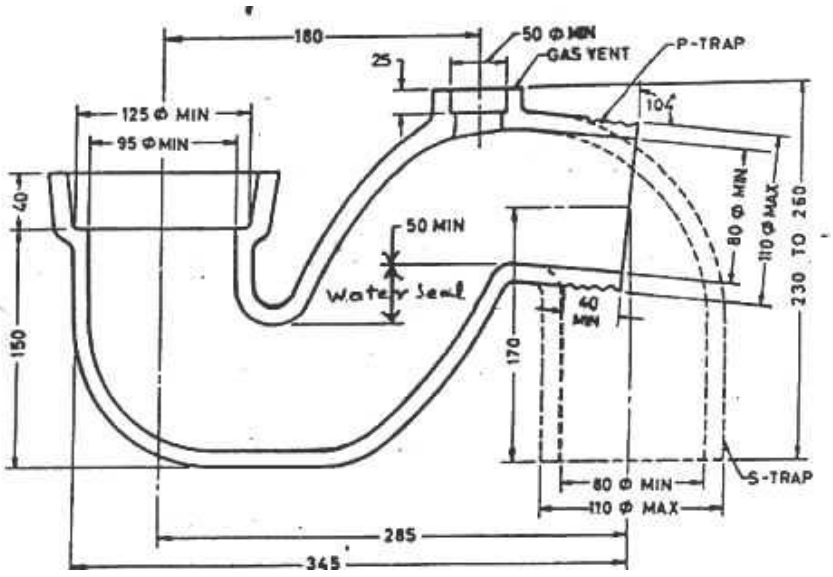
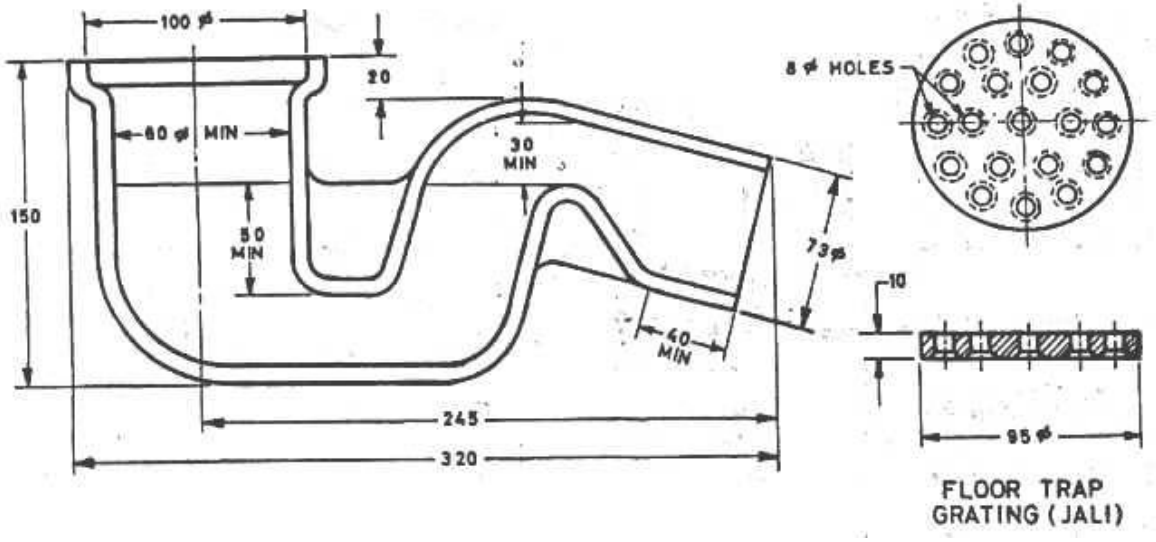


Figure of traps for long pattern and orrisa pattern pans
(Dimensions in mm)

6.7 Floor Trap

It is provided for discharge waste water from kitchen, bath etc. and is with the water seal to avoid seal entry of gases.

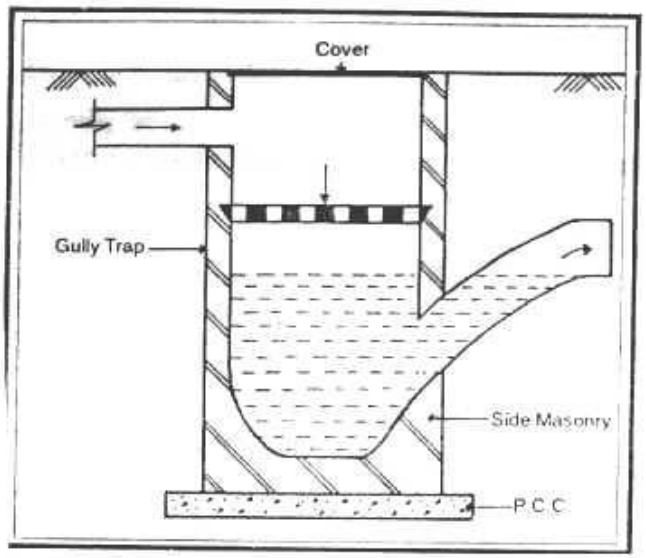
- It should be checked for cracks, burr internal shape before fixing on site.
- The connector is used to connect the Nahani trap to the vertical stack.
- Mouth of trap should be protected with small gummy bag piece and then a coat of Plaster of Paris should be applied to avoid choke up during the work activities.



6.8 Gully Trap

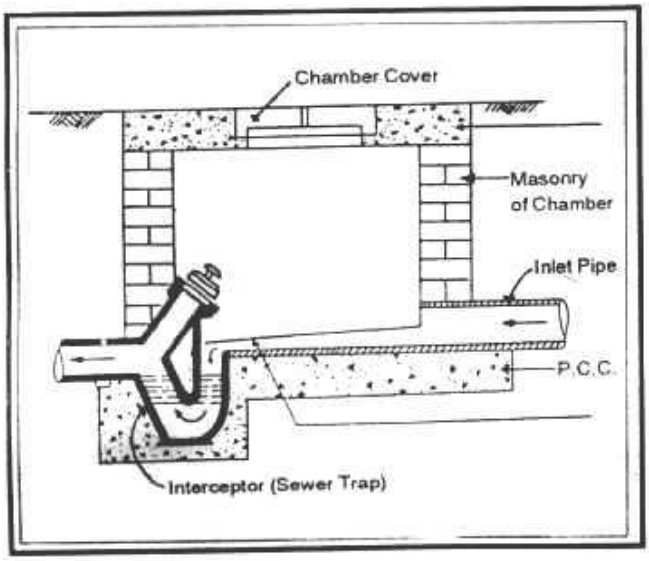
Gully trap is made of stoneware clay. Normally 15 cm x 15 cm size is used.

- Water seal depth is 75 mm.
- Used between sanitary fittings and the building drain.
- Used for admitting surface water from yard and paved walks in to the drain.
- A gully trap will disconnect a building from a building drain by means of a 75 mm water seal depth and thus prevent sewage gases entering the building.
- The top of the gully trap must be sufficiently deep to prevent splashing over.
- If planned carefully, sink and bath wastes could be discharged into one gully trap.
- Gully trap is so fixed that it's chamber top is above ground level.
- Chamber should be constructed on gully trap size of chamber should be 30 cm x 30 cm x 30 cm.



6.9 Interceptor (Sewer Trap)

- Stoneware intercepting sewer trap is used before a building drain is connected to public sewer.
- This trap has a water seal of about 10 cm. the purpose of this trap is to prevent of objectionable, poisonous and harmful gases from public sewers of building.



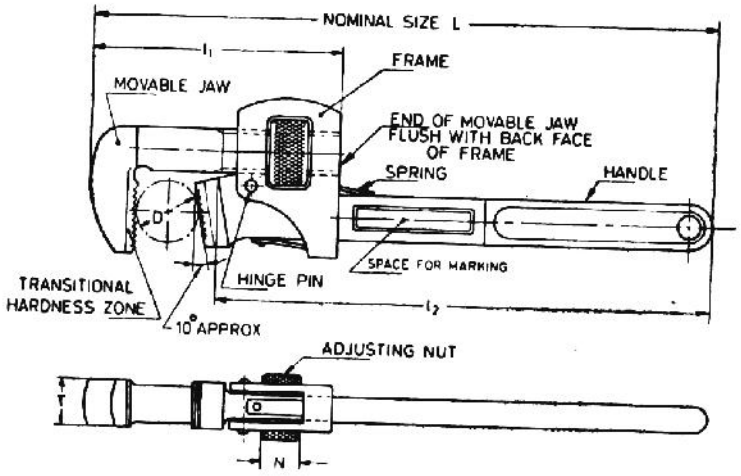
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7.0 - FITTER TOOLS

7.1 Pipe wrenches

It is mainly used in plumbing work for tightening or loosening of different diameter pipes.

The adjustable pipe wrench has two jaws that are not parallel. The outer jaw, which is adjustable, is made with a small amount of play, which provides a tight grip on the pipe when the wrench is turned into the direction of movable jaw. This is the only wrench, which takes a bite on the round objects. The jaw always leaves marks on the work and should never be used on nuts and bolts unless their corners have become rounded due to which it is not possible to use any other type of wrench.



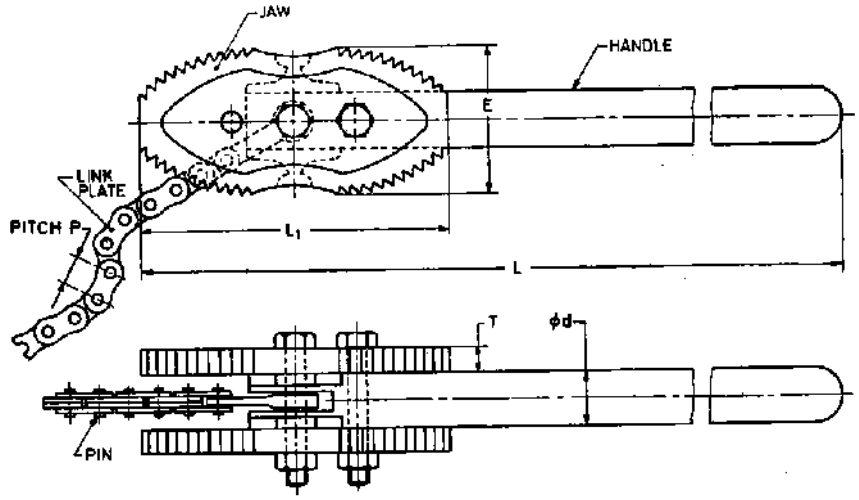
DIMENSIONS OF PIPE WRENCHES IS : 4003						
All dimensions in millimetre						
Nominal Size L	Minimum Capacity	Maximum Capacity D	Jaw Thickness T Min	Approxi – mate Length of Movable Jaw l_1	Approxim -ate length of Handle l_2	Width of nut N Min
200	6	20	15	85	160	12
250	6	26	17	110	200	13
300	9	32	19	125	240	16
350	13	38	21	140	285	17
450	25	52	24	165	370	18
600	38	65	28	200	495	25
900	50	95	34	260	750	35
1200	65	130	40	330	1000	35

Precautions

- Do not push on a pipe wrench; if the wrench slips or pipe breaks or loosens suddenly, the user's knuckles may get scratched or he may be thrown off balance.
- There are times, however, when the only way user can move the wrench is by pushing it. In this case, do not wrap the fingers around it. Push it with the palm of the hand open.
- The adjustable pipe wrench will work in one direction. Always turn the wrench in the direction of the opening of the jaws. Apply force on the back of the handle (since the top jaw is capable of a slight angular movement) to increase the grip on the work.

7.2 Chain pipe wrenches

This tool is used in plumbing work for various jobs related to pipes. It consists of a handle, a set of jaws and a length of leaf chain. The chain acts as jaw when looped around the pipe, gripping the pipe on the whole outer circumference.



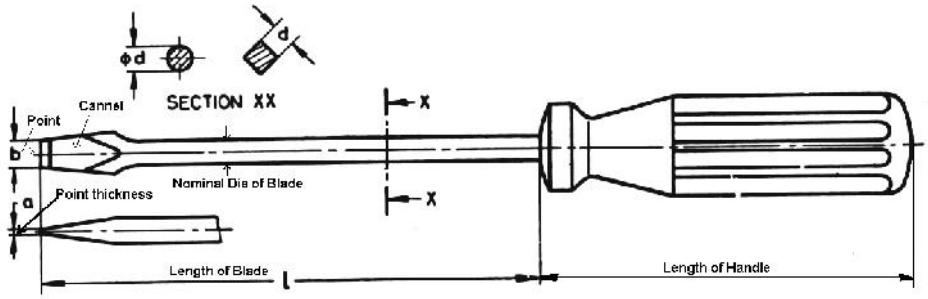
DIMENSIONS FOR CHAIN PIPE WRENCHES IS : 4123								
All dimensions in millimetre								
Capacity		L ± 10	L1 Min	E Min	D Min	T Min	**Chain**	
Nominal Size	Range						Length Min	Pitch P Min.
50	10 – 60	510	125	55	22	9.5	385	19.05
80	15 – 90	710	150	60	28	11.0	465	19.05
100	27 – 115	920	170	75	28	11.5	565	25.4
150	35 – 165	1100	180	80	30	13.5	800	25.4
200	50 – 220	1250	200	85	30	15.0	975	25.4
300	50 – 300	1610	250	105	32	16.5	1350	31.75

Precautions

- Do not use a pipe, or extend the handle in any way, to increase the leverage on a wrench, else it may break the wrench.
- Apply penetrating oil to rusted joints because these joints resist turning and give sufficient time to penetrate the oil in joints before attempting to turn.
- Do not strike wrenches with hammers to tighten or loosen nuts or bolts. Do not exert a hard pull on a pipe wrench until it has a firm grip on the work.

7.3 Screw driver

Screwdrivers are used for driving or removing screws or bolts with slotted, across recessed or special heads. Screwdriver is made in various shapes and length to perform specific jobs. The length of the blade indicates the size of a screwdriver. Special type screwdrivers are provided with a ratchet arrangement also.



I

DIMENSIONS FOR SCREW DRIVERS				IS: 844
All dimensions in millimetre				
Nominal Screw Driver Point Size a x b	dMin		l± 5	Handle Sizes *
	Round	Square		
0.6 x 5.0	5	-	75	L 80
0.6 x 5.0	5	-	100	L 80
0.8 x 5.5	5	-	100	L 90
0.8 x 5.5	5	-	125	L 90
1.0 x 6.5	6	6	125	L100
1.0 x 6.5	6	-	150	L100
1.2 x 8.0	7	7	150	L110
1.2 x 8.0	7	-	175	L110
1.6 x 10.0	-	8	175	L120
1.6 x 10.0	8	-	200	L110
1.6 x 10.0	8	-	250	L110

2.0 x 13.0	9	-	250	L110
2.0 x 13.0	9	-	300	L110
2.0 x 13.0	-	10	200	L120
2.5 x 16.0	11	-	250	L120
2.5 x 16.0	11	-	300	L120
3.0 x 14.0	10	-	250	L120
3.0 x 14.0	10	-	300	L120
4.0 x 22.0	16	-	300	L120
4.0 x 22.0	16	-	350	L120
5.0 x 25.0	16	-	300	L120
5.0 x 25.0	16	-	350	L120
* See IS : 844 (Part I)				

- Use a screwdriver that has parallel sides and exactly fits the screw slot. A poor fitting screwdriver will damage the screw head, slip off the screw, and may cause personal injury.

- Never use a screwdriver for prying or chiseling operations.

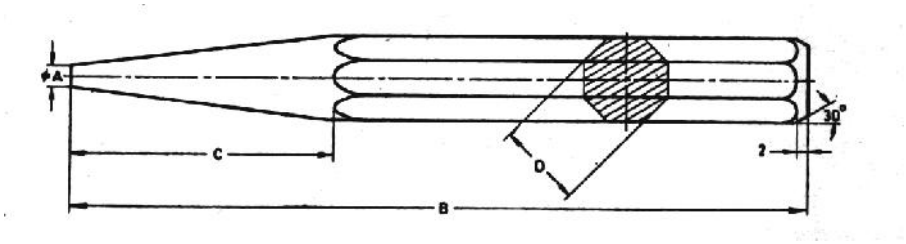
- When difficulty is encountered in driving or removing screws that are hard to turn, do not use pliers to turn the screwdriver. Pliers will damage the screwdriver.

- For turn screws, select a square bladed screw designed for heavy duty and a wrench, which properly fits the blade.

7.4 Punches

Punches are used to punch holes in metals, leather, paper and other material, to mark the metal; drive pins or rivets to free frozen pin from their holes and aligns holes in different sections of metal.

ROUND PUNCHES



DIMENSIONS FOR ROUND PUNCHES All dimensions in millimetre				**IS: 413**
Nominal Size		B ± 5	C ± 2	D ± 1
A	Tolerance			
4	± 0.2	140	50	16
5	± 0.2	150	50	16
6	± 0.5	175	60	20
8	± 0.5	200	60	20
10	± 0.5	225	70	23
12	± 0.5	250	70	23

Precautions

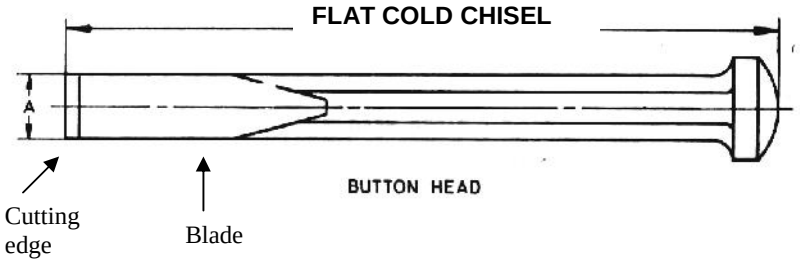
- Do not strike head of punch with a hammer until the punch is perpendicular.
- When using a punch, be sure that the hot metal is securely held and cannot be knocked off the bench or anvil. Also make certain that the handle is tight.
- Never use a punch that has mushroomed head or whose point or cutting edge is dull.

7.5 Chisels

Purpose of chisels

Chisels are made for cutting wood, metal, hard putty and other materials. Cold chisels are used to chip and cut cold metal.

Flat cold chisel



DIMENSIONS FOR FLAT COLD CHISELS IS: 402

All dimensions in millimetre

Nom Size A ± 1.0 *	Width across flats Or diameter. B ± 1	Length Of Blade C ± 5	Cut-in Edge Thick. D ± 0.5	***Over all Length L ± 5***										
				100	***125***	***150***	***175***	***200***	***225***	***250***	***300***	***400***	***450***	***600***
6	6.0	28	1.2	X	-	-	-	-	-	-	-	-	-	-
10	9.0	35	1.5	X	X	X	-	X						
14	10.0	60	3.0	X	-	X	-	X	-	X				
16	12.0	70	3.5	X	-	X	-	X	-	X	X	-	X	-
20	14.0	80	3.5	-	-	-	-	X	X	X	X	-	X	
22	16.0	90	3.75	-	-	X	-	X	X	X	X		X	X
25	19.0	100	4.0			X		X	X	X	X	X	X	X
30	22.0	120	4.5	-	-	-	-	-	-	X	-	-	-	-
32	22.0	130	4.5	-	-	-	-	-	-	-	X	-	-	-

* Nominal size of chisel is its width of cut.

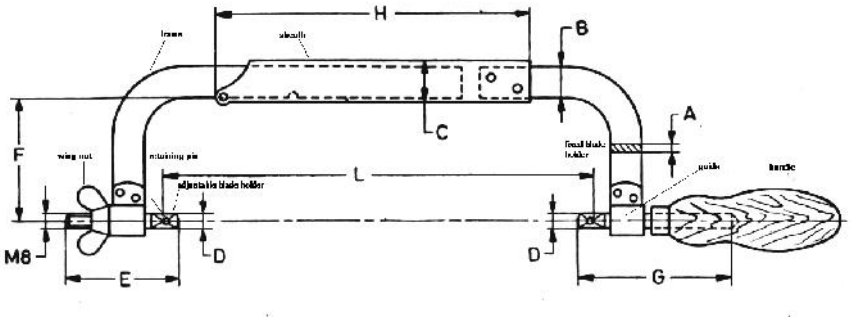
Precautions

- Secure work so that it cannot move in any way.
- Keep both hands back of the cutting edge at all times.
- Do not start a cut on a guideline. Start slightly away from it, so that there is small amount of material to be removed by the finishing cuts.
- Do not exert too much pressure against a grinding wheel when grinding or sharpening chisels.

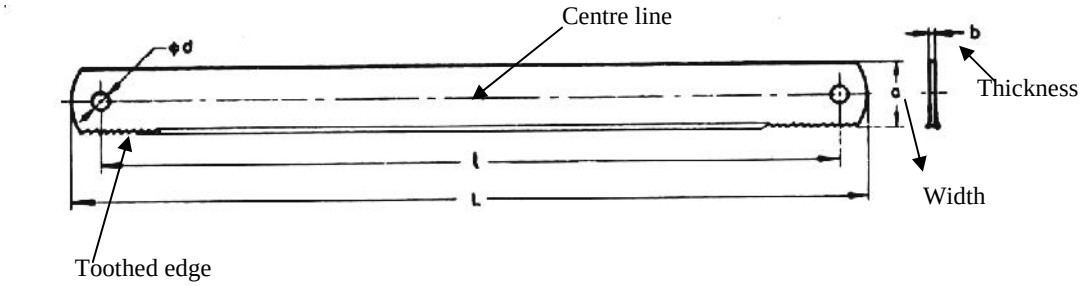
7.6 Hack Saw (Frame & Blade)

This hacksaw is used for parting off the small diameter pipes and small dimension metal pieces.

HACK SAW (Frame)



DIEMENSIONS FOR TYPE C STRAIGHT GRIP ADJUSTABLE FLAT HACKSAW FRAME								**IS : 2594**
All dimensions in millimetre								
Nominal Size	A Min.	B Min.	C	D	E	F	G	H
250, 300	5.5	18	23	8	65	70	80	180



DIEMENSIONS FOR HAND HACKSAW BLADES					**IS : 5169**
All dimensions in millimetre					
1.± 2	a.± 2	1.± 2	Teeth Spacing P (Pitch) ± 0.05	L Max	dH14
250	12.5	0.63	0.8	265	4
			1.0		
300			1.4	315	
			1.8		

Dimensions for hacksaw frames is given in above table.

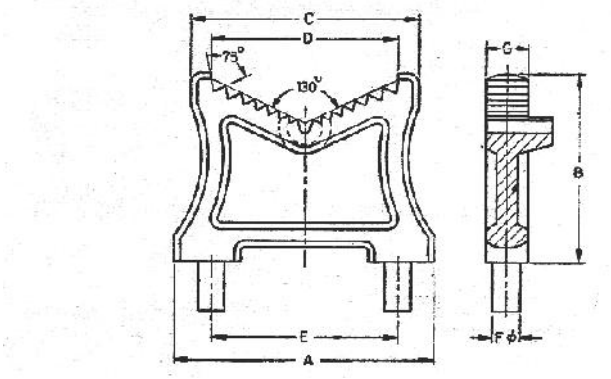
Precautions

- When cutting, the work side of work should be supported to prevent splitting off.
- It should be ensured that the saw shall go through the full stroke with out striking to any other object. If the work cannot be raised high enough to obtain full clearance for the tool, the length of each stroke shall be carefully limited.

7.7 Pipe Vice (Chain Type)

This tool is specially designed to hold round stock. One jaw is hinged so that the work can be positioned and then the jaw brought down and locked. This vice is also used on a bench. Pipe vices are generally required for plumbing jobs and erection of other types of pipelines.

The shape and dimensions of pipe vices shown in figure .



DIMENSIONS FOR PIPE VICES (Chain Type)									**IS:5684**
All dimensions in millimetre									
Nominal Size	Capacity (Outside Pipe Diameter)	A	B	C	D	E	F	G	H
63	3 to 63	135	75	100	45	75	115	11	24
102	6 to 102	213	119	160	70	121	153	11	30
152	10 to 152	248	150	197	89	153	162	12.5	36.5

Precautions while Using Clamping Device

Keep vices clean at all times. They should be cleaned and wiped with light oil after using. Never strike a vice with a heavy object and never hold large work in a small vice, since this practice will cause the jaws to become sprung or otherwise damage the vice. When the vice is not in use, bring the jaws lightly together or leave a very small gap and leave the handle in a vertical position. When closing the jaw of a vice or clamp avoid getting any portion or your hands or body between the jaws or between one jaw and the work.

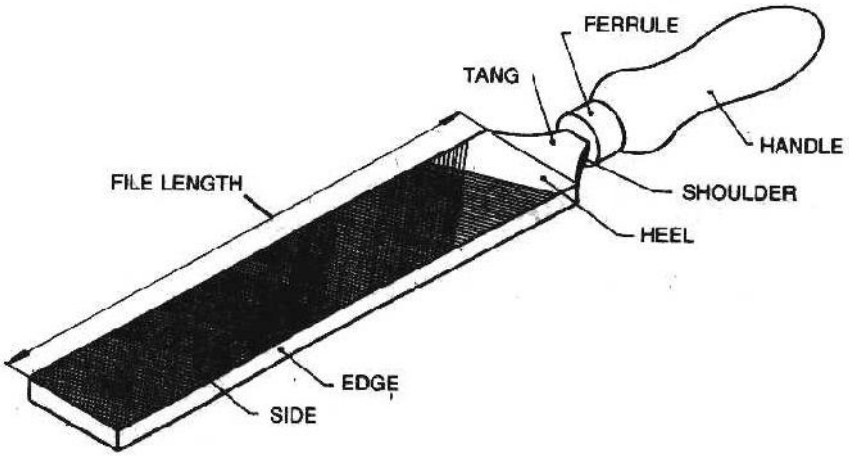
- When holding heavy work in a vice, place a block of wood under the work as a prop to prevent it from sliding down and falling on your foot.

- Do not open jaws of a vice beyond their capacity, as the movable jaw will drop off, causing personal injury and possible damage to the jaw.

8.0 - STANDARD TRADE OPERATIONS

8.1 Filing

Filing is a method for removing excess material from a work place by using a file which acts as a cutting tools.



File grades are determined by the spacing of the teeths :



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



A bastard file is used in cases where there is a heavy reduction of material.



A second cut file is used to give a good finish on metals. It is excellent to file hard metals. It is useful for brining the jobs close to the finishing size.

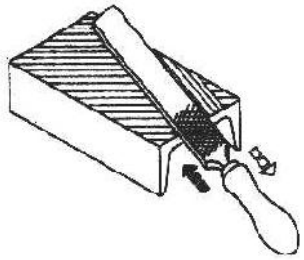


A smooth file is used to remove small quantity of material and to given a good finish.

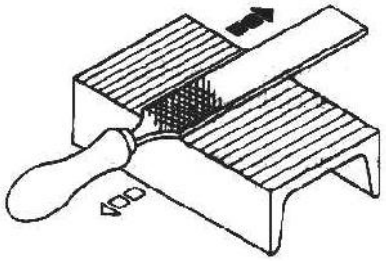


A dead smooth file is used to bring to accurate size with a high degree of finish.

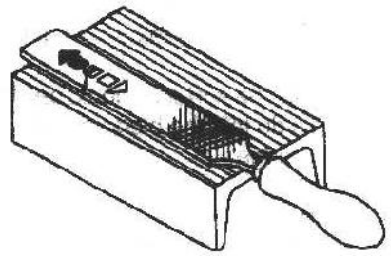
Filing Method : The method of filing to be adopted depends on the type of surface profile to be filed the type of surface texture required and the amount of material to be removed.



Diagonal filing : This type of filing is done when heavy reduction of material so required. The stokes are at an angle of 45^0, because the stroke direction cross each other, the surface texture formed can clearly indicate the high and low spots.



Transverse filing : In this method the file strokes are at right angles to the longer side of the work. This method is commonly used to reduce material from the edges of the work using this method the size of the work piece is brought close to the finishing size, and then the final finishing is given by longitudinal filing.



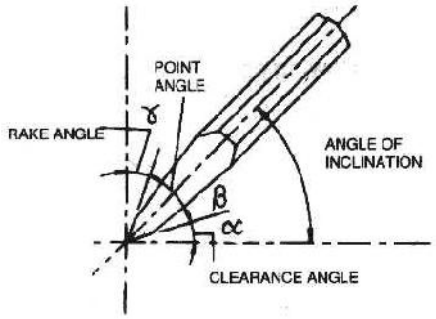
Longitudinal Filing : The file is moved parallel to the longer side of the work, usually all surfaces are smooth finished by this method. The filed surface texture will show uniform and parallel lines.

8.2 Chipping

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

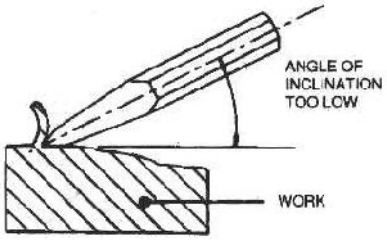
2. **Point Angles and materials :** The correct point/cutting (β) of the chisel depends on the material to be chopped. Sharp angles are given for soft materials, and wide angles for hard materials.

   (a) **Rake angle :** Rake angle (γ) is the angle between top face of the cutting point, and normal to the work surface at the cutting edge.

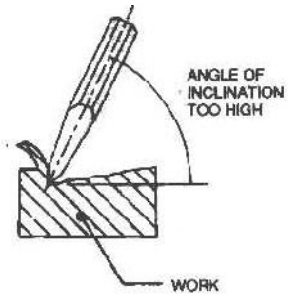


(b) **Clearance angle :** Clearance angle (α) is the angle between the bottom face of the point and tangent to the work surface originating at the cutting edge.

If the clearance angle is too low or zero, the rake angle increases the cutting edge can not penetrate in to the work. The chisel will slip.



If the clearance angle is too great, the rake angle reduces. The cutting edge digs in, and the cut progressively increases.



Table

Material to be cut	Point angle	Angle inclination
High carbon Steel	65^0	39.5^0
Cast iron	60^0	37^0
Mild steel	55^0	34.5^0
Brass	50^0	32^0
Copper	45^0	29.5^0
Aluminium	30^0	22^0

8.3 Welding

Working Steps

- Obtain and clean the job-pieces as per drawing.
- Set and tack the job-pieces at both ends as 'T' joint. (Refer to drawing)
- Ensure that a ϕ 3.15 mm electrode and a 130 amps current are used. Safety apparel should be worn.
- Clean the tacks, check alignment and reset the job, if necessary.
- Place the joint on a welding table in a flat position. (Tack side down)
- Select a ϕ 4 mm M.S.electrode and set a 150-160 amps current.
- Deposit the first bead along the joint line with a correct and uniform :

- arc length
- travel speed
- electrode angle.

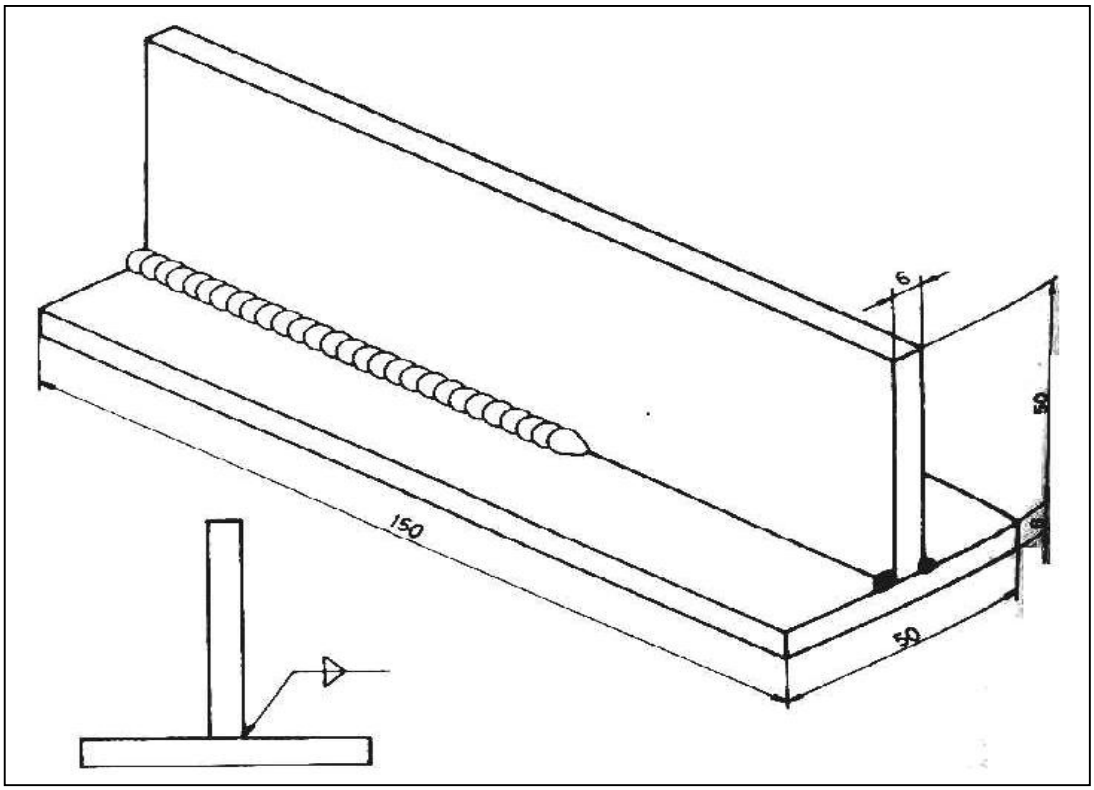
Ensure the electrode angle is 45^0 with the corner and 70^0 to 80^0 with the welding line in the direction of travel.

Clean the weldment and inspect for faults.

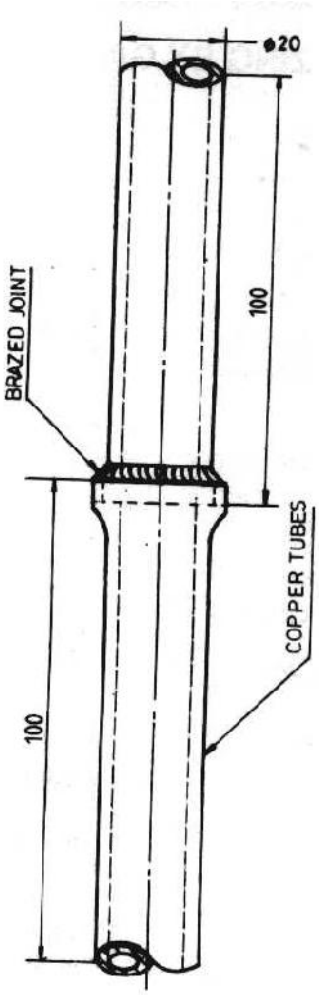
Clean the other side of the joint and grind the tacks flush.
Set the joint in a flat position (weld side down).
Make a second weld along the joint line with the same setting and technique as used for the first bead.

Clean the weld and inspect for the following weld characteristics.

- Smooth and close ripple appearance uniform width and height (equal leg lengths)
- Good fusion at the toe of the weld without undercut and overlap.
- Leg length of the fillet weld equal to the plate thickness.



8.4 Brazing



Brazing

Working Steps:

- Obtain the pipe pieces as per drawing and clean them.

Ensure the use of all safety devices.

- Set the gas welding plant, with a small size nozzle (I.O.L.No. 1)

- Make a bell-mouth at one end of the pipe and insert the other pipe in.

Ensure the fitting of pipes is in alignment.

- Apply silver-brazing flux along the root of the joint.
- Hold the joint in a vertical position in a bench-vice on a welding table.
- Adjust the soft carburising flame.

Ensure that the length of the feather is 1.5 times the length of the cone.

- Slightly pre-heat around the joint.

Colour change is restricted to dull red.

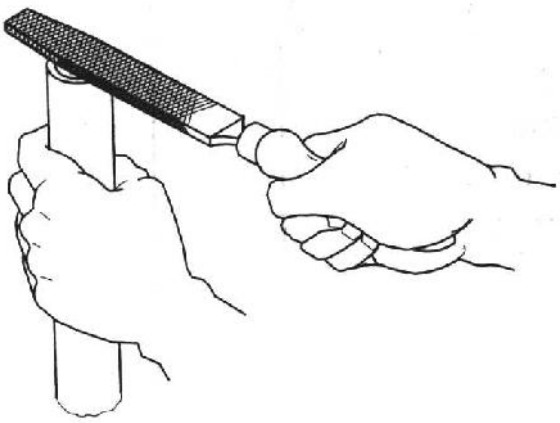
- Melt and spread the filler rod around the joint with the use of the flux.
- Play the flame gently around the joint to make the filler metal penetrate in the joint.

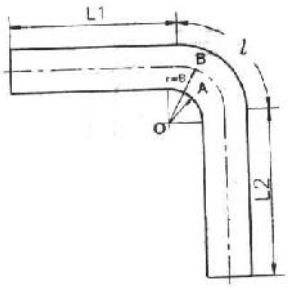
Never apply a direct flame on the molten metal.

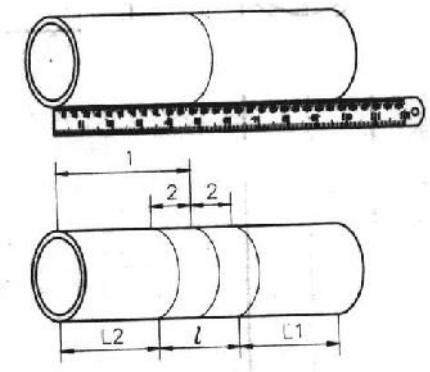
- Add more filler rods around the joint, if needed.
- Allow the joint to cool for a few seconds.
- Clean the joint and inspect.
- Repeat the same until you are able to make a well-penetrated smooth silver-brazed weld.

Avoid over heating the joint.

8.5 Bending G.I. pipes using sand, pegs and using pipe bending machine







Using sand & pegs

- Bend a G.I.pipe by hot method.

File the pipe ends square.

Remove burrs.

Calculate the length of pipe.

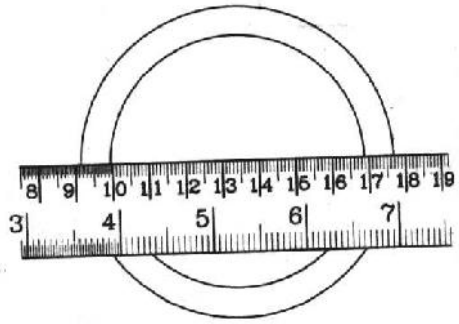
If D = diameter of bend
ϕ = angle of bend
l = length of curved portion

$$\text{then, } l = \frac{\pi \times D \times \phi}{360}$$

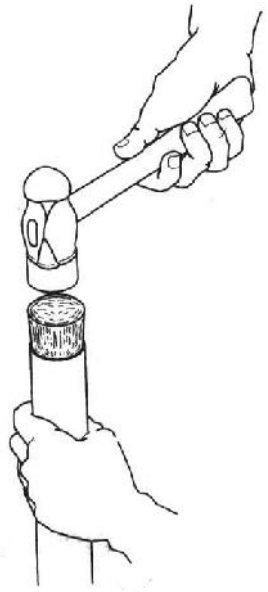
If, OA = inner radius of bend (R)
AB = radius of pipe (r)
OB = radius bend (R+r)
Then, l = (R+r) X Q X 0.01745
Total length of pipe $L_1 + L_2 + l$

Measure and mark off the :

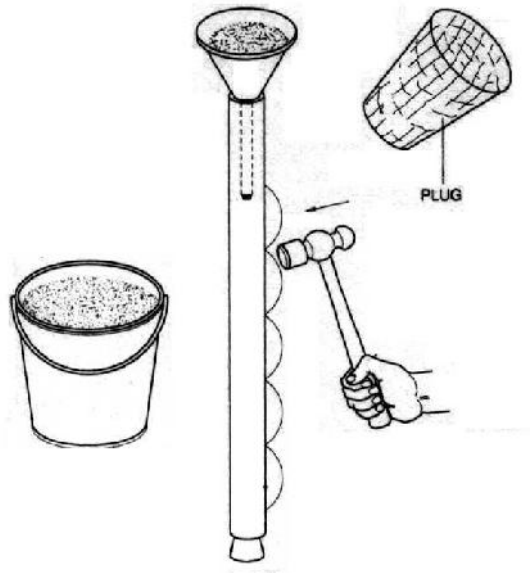
- centre of the bend
- beginning and end of the bend from the centre line.



Measure the inside diameter of the pipe and select two suitable wooden pegs for the pipe.

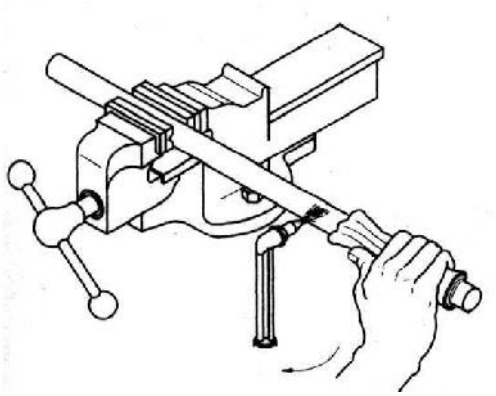


Plug one end of the pipe with a wooden peg.



Fill the pipe with clean, dry and fine sand (Compress the sand by tapping the pipe up and down with a soft hammer) and plug the end.

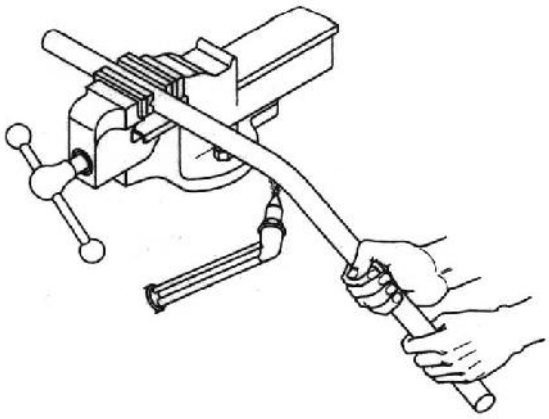
Ensure that the entire pipe is filled with sand.



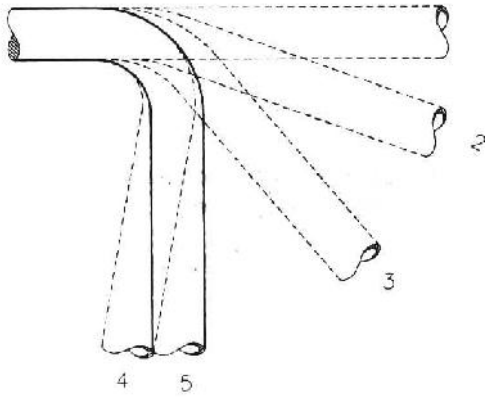
Clamp one end of the pipe in a vice and protect the clamped portion of the pipe with lead or copper shims.

Heat the area to be bent with oxy-acetylene torch evenly until it glows dull red.

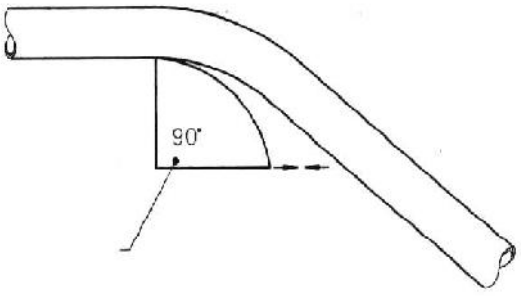
The bend area should not be overheated



Pull down the pipe gently in the direction of the bend.



Take short pulls until the correct bend angle is reached.



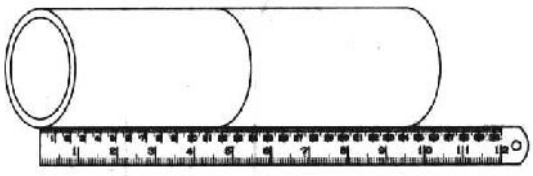
Check the bend radius with a template.

Apply heat throughout the whole operation and over bend slightly and straighten out the final bend.

Remove one end of the plug.
Ensure that the pipe is cooled before removing the plug.

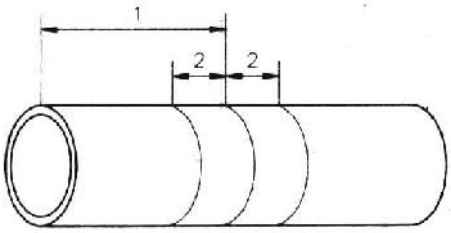
Remove the sand by tapping the pipe gently with a hammer.

Bending of pipe using bending machine

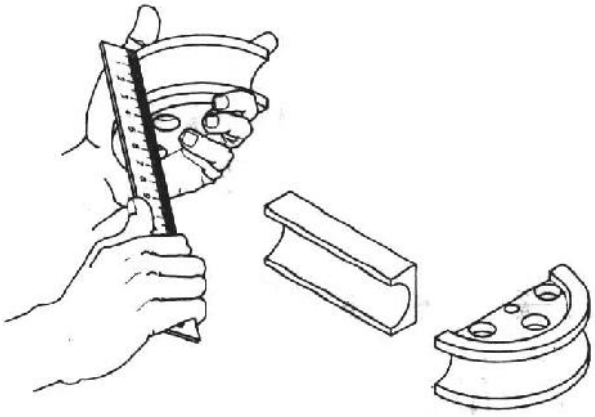


Pipe bending

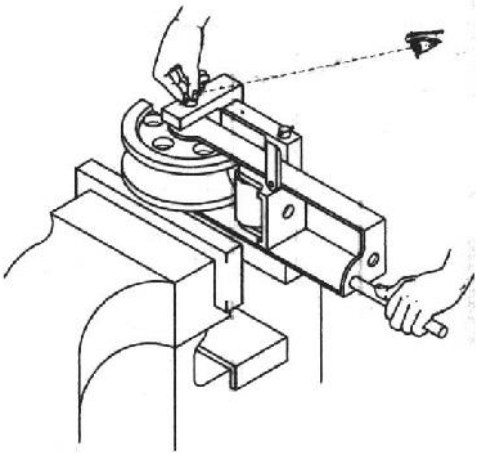
Check the pipe for squareness and ensure it is free from burrs. Measure and mark off the centre of the bend.



Mark off the beginning and the end of bend from the centre line.



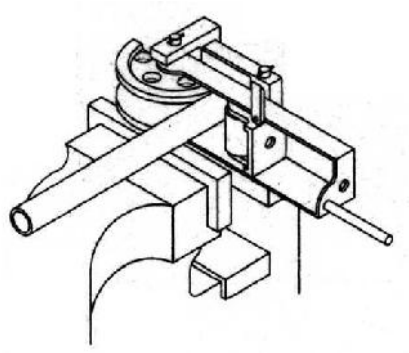
Select the former to suit the size of the pipe.



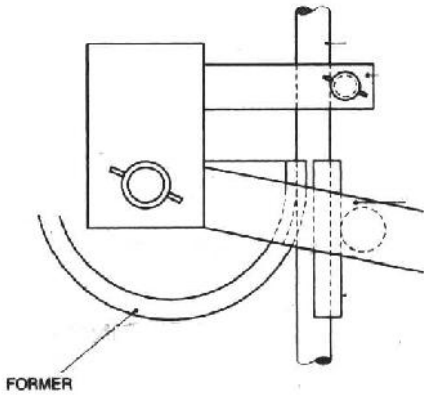
Clamp the bending machine in a bench vice.

Keep the former in position and lock with a pin.

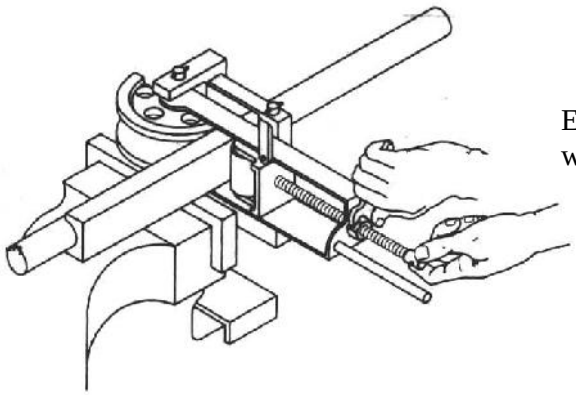
Fix the back stop with a pin.



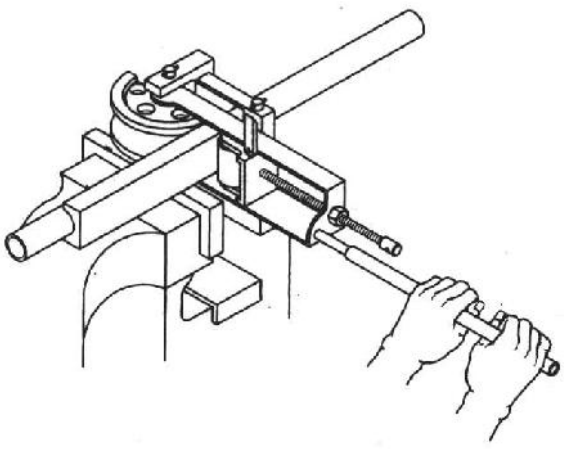
Place the pipe in the bending machine, passing it through the bending arm and ensuring that it is seated with the groove of the former and against the back stop, and set the roller on bending arm by adjusting the screw and lock nut.

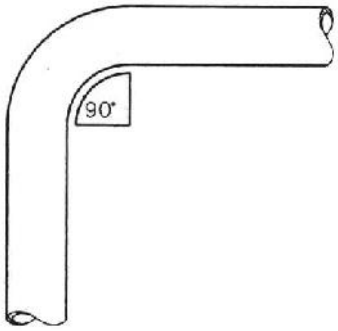


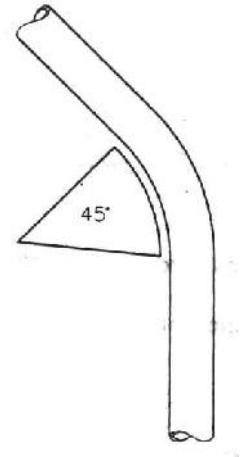
Bend the pipe by pulling the bending arm towards your body.



Ensure that the stance is properly balanced while bending.

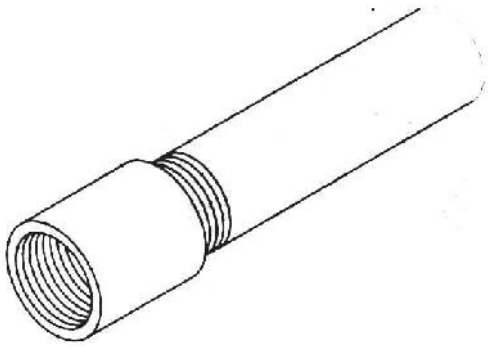


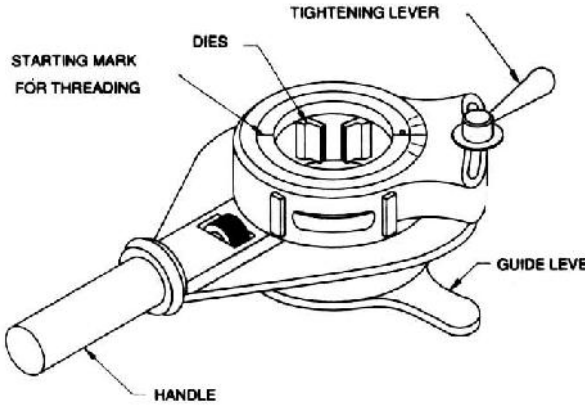


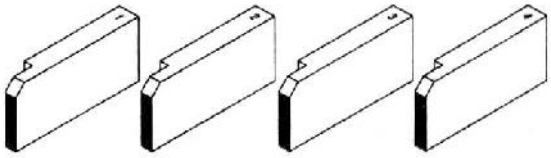


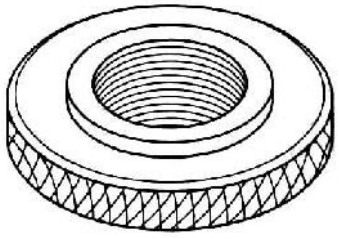
Check the angle and radius of bend using templates.

8.6 Pipe Dies, Die Stocks and Taps









Pipe dies

Most of the GI 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.

The threads on GI pipes and fittings for water supply systems are the standard pipe threads. External pipe threads are cut by pipe dies available in sizes from ¼" 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.

Die stocks

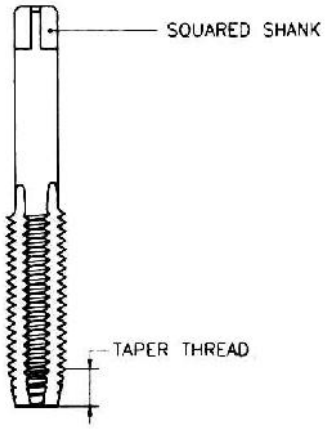
Die stocks are required to turn the dies. The ratchet type die stock is preferred because it permits the operator to use his body weight to rotate the die while standing to one side of the pipe. Die stock are adjustable

Die sets

Each die is clearly marked with its type of thread and range of pipe for which it is suitable. Each die has an identification number, that is 1 to 4. Die sets are available in various sizes

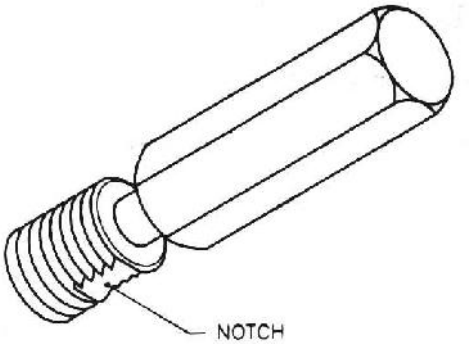
These dies must always be used and stored as a set.

Pipe threads are usually cut with threading dies and can be checked by using the pipe ring gauge.



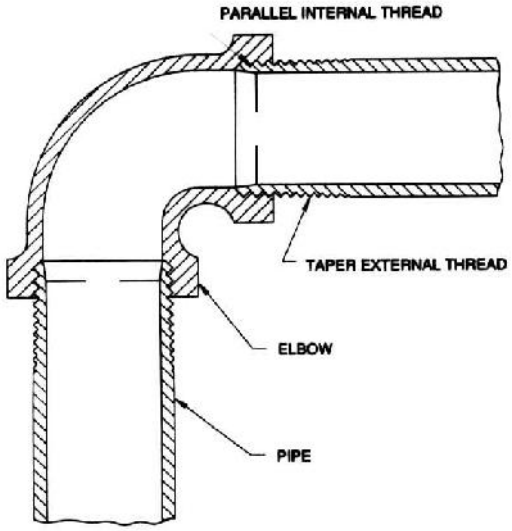
Pipe taps

Internal pipe threads are usually cut with standard taper pipe 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.

British standard pipe threads

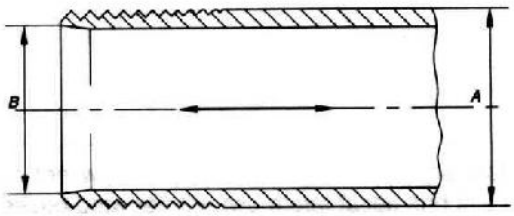


Pipe threads

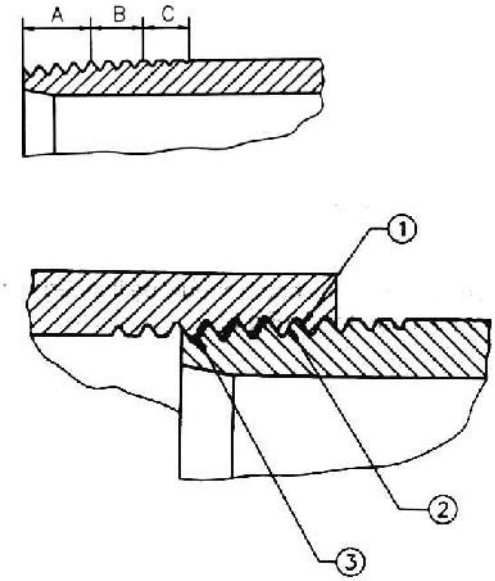
The standard pipe fittings are the threaded to British Standard pipe gauge (BSP). The internal pipe threads have parallel threads whereas the external pipes have tapered threads.

B.S.P. threads

Galvanized iron pipes are available in sizes ranging from ½" to 6" in several different wall thickness. The table shows outside diameters and threads per inch from ½" to 4".



BSP – pipe sizes or DIN 2999 (inside) (B) +	Threads/inch	Outside diameter/mm of the pipe (A) +
½"	14	20.955 mm
¾ "	14	26.441
1"	11	33.249
11/4 "	11	41.910
11/2 "	11	47.803
2"	11	59.614
2 ½ "	8	75.184
3"	8	87.884
4"	8	113.030



Sealing pipe joint

The pipe has several fully formed threads at the end

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

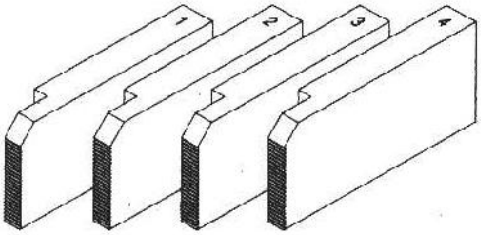
The last four threads have flat tops and bottoms.(C)

The pipe joint shown 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.

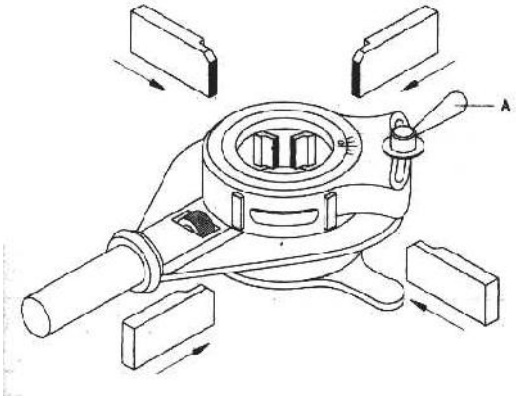
8.7 Threading G.I.Pipes using Die Stocks



Select a set of dies, and ratchet-type die stock.

Open the adjustment lever.

Coincide the zero setting mark ‘O’ die stock and then insert the four dies according to the number on the dies and die stock respectively.

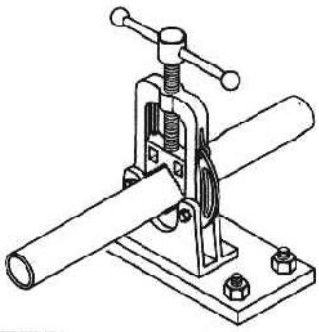


Ensure that the dies sit in the correct position.

Be sure that the number on the top edge of the die corresponds with the number of the slot into which it is to be placed.

Fix the pipe in a pipe vice and tighten to prevent if from rotating.

Ensure that the projection of ht pipe is within 150 –250 mm from the vice.

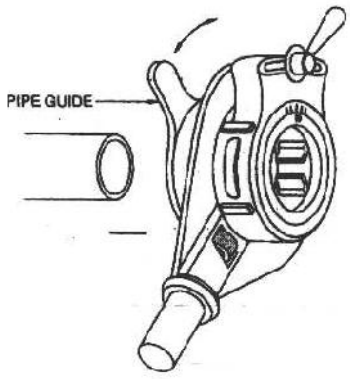


Open the self-centering pipe guide and slide the stock over the end of the pipe.

Adjust the pipe guide for correct sliding, fit and lock into position.

Apply a cutting lubricant to the part which is to be threaded.

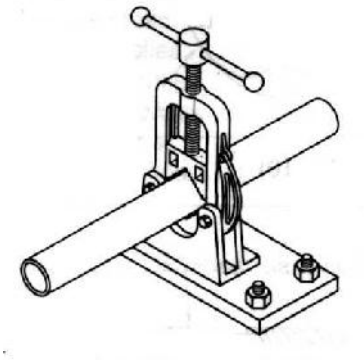
Use lard oil, or mineral-lard oil when threading G.I.pipes.



Ensure that the length of the thread is sufficient to fit half way into the socket or coupling.

Repeat the operation if the thread is too tight, by adjusting the dies.

8.8 Cutting of G.I. Pipe (using pipe cutter & using hacksaw)

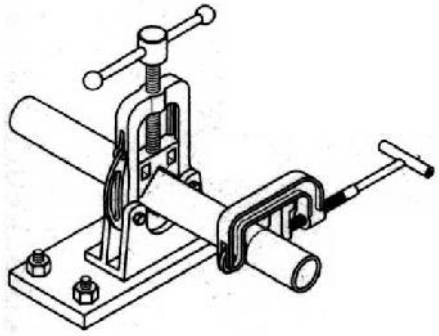


PIPE CUTTING (using pipe cutter)

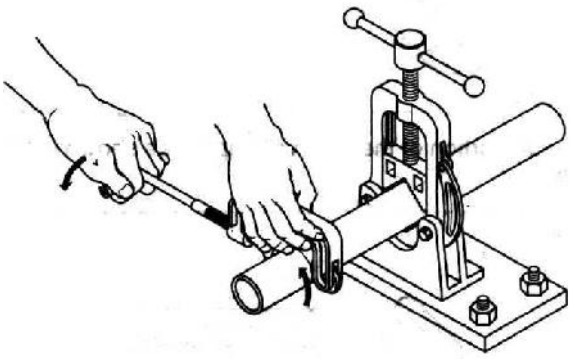
- cut a G.I.pipe using a pipe cutter.

Measure the required length of pipe and mark it with chalk.

Keep the pipe in the pipe vice and tighten it.



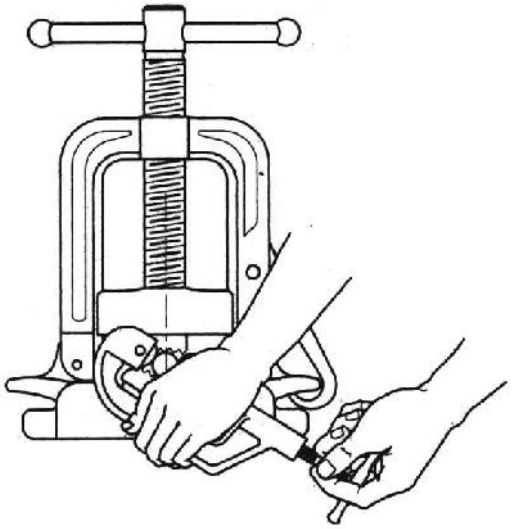
Fit the pipe cutter on the G.I. pipe (on the scribed line) and tighten the jacking screw so that the cutting wheel is touching the pipe.



Ensure that the pipe is kept horizontal and parallel to the serration such that the marking is visible at the top.

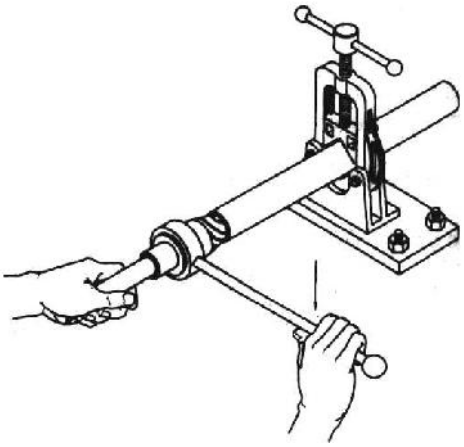
Rotate one or two turn to ensure that the cutting wheel is sitting exactly on the scribed line at 90^0 to the pipe.

Rotate the pipe cutter around the pipe.
After two or three turn use the jacking screw to apply pressure on the cutting wheel.

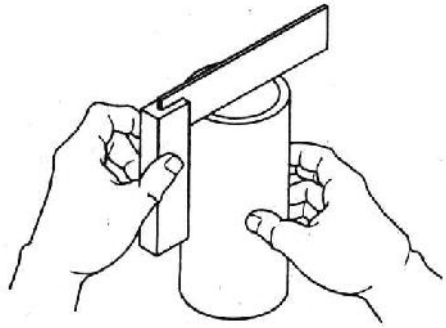


Keep rotating the pipe cutter around the pipe. Increase the pressure to the cutter repeating the cycle until the pipe is cut through.

Support the pipe with your left hand so that the free end of the pipe does not fall.

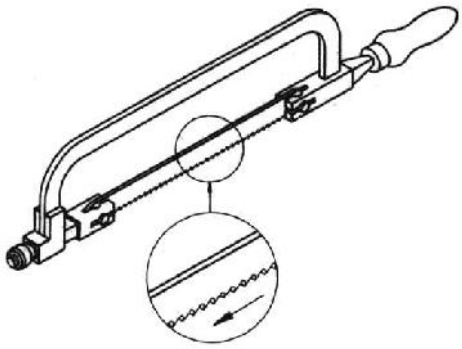


Remove burrs using a pipe reamer.



Check that the pipe ends are square.

Pipe cutting (using hacksaw)

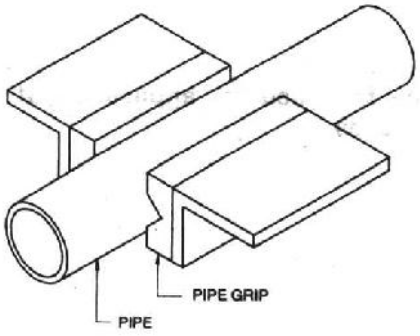


Cut pipe using a hacksaw and bench vice

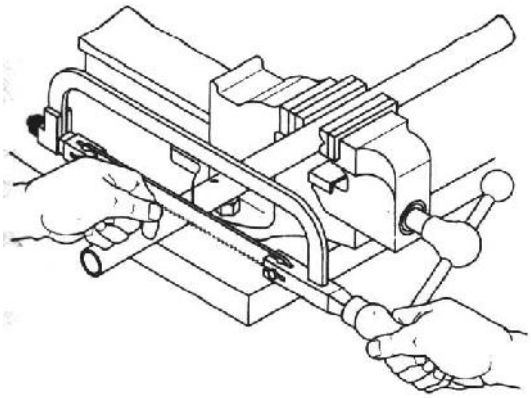
Select a hacksaw blade with fine pitch (0.8 mm pitch) and fix it in the hacksaw.

Mark the length of the pipe to be cut with chalk.

Hold the pipe in a bench vice using pipe grips, and tighten the jaws.

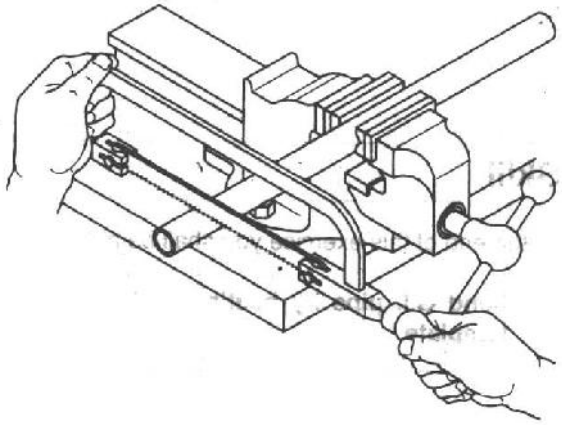


Ensure that the cut is as close to the vice as possible to prevent vibration while sawing.



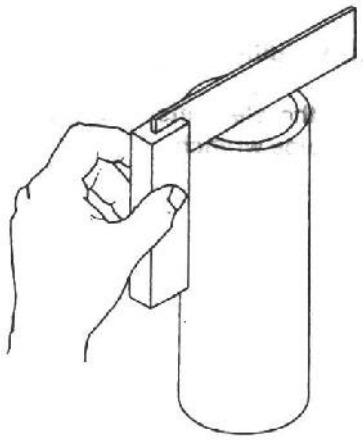
Place the hacksaw blade over the mark a nick guided by the left hand thumb.

Saw the pipe using the full length of the stroke.



Turn the pipe regularly so that several teeth are always.

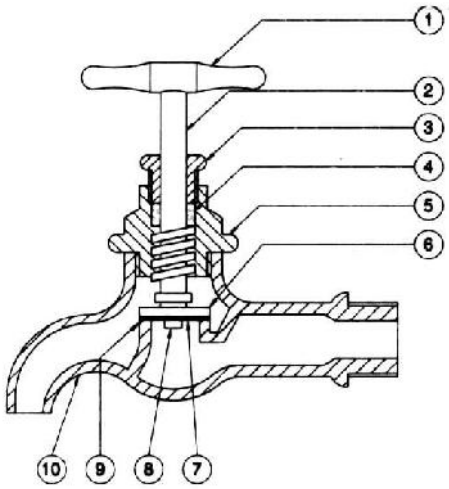
After the pipe is cut through, remove burrs and file the pipe ends square.



Check the pipe ends for squareness.

8.9 Servicing of bib cock

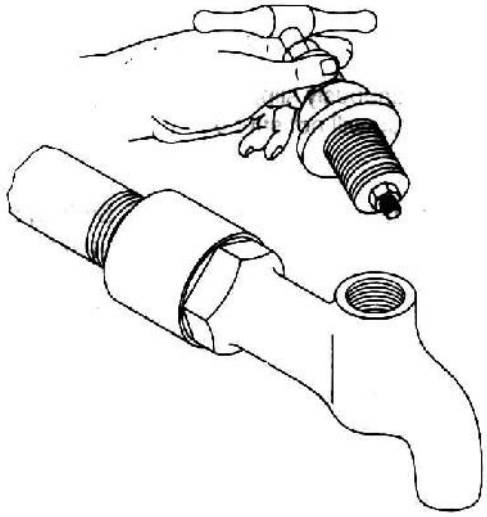
Repair and maintenance of household Water taps



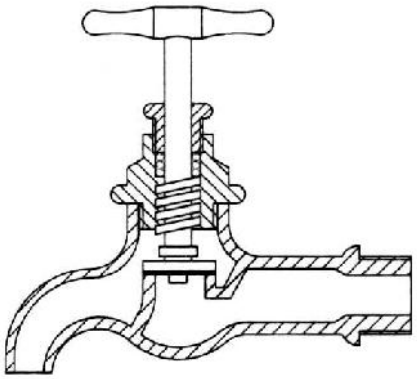
Parts of water tap

1. Handle
2. Spindle
3. Gland nut
4. Stuffing box/packing
5. Bonnet
6. Metal disk-holder/valve disk
7. Washer (rubber/leather/fibre)
8. Retainer nut/washer nut
9. Valve seat
10. Body of the tap

The body of the water tap contains the seat. The bonnet which holds the working parts is screwed on to the body.



When the water tap is screwed down, the washer is squeezed between the two metal faces and his makes the joint watertight.

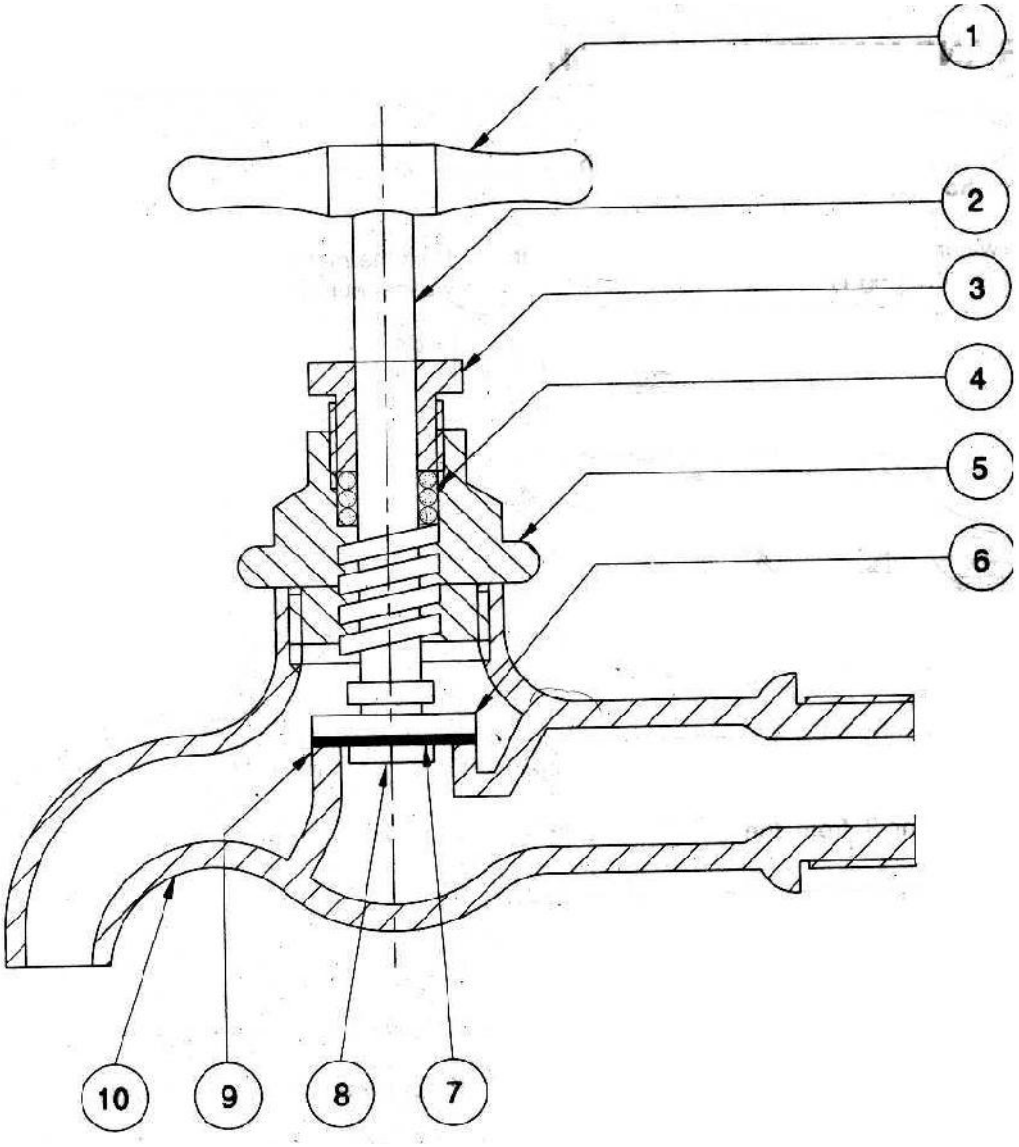


The spindle has a handle at the upper end and a threaded screw at the other end.

Resting in the bottom of the spindle is the metal disk holder containing the rubber washer which is held in position by a nut underneath.

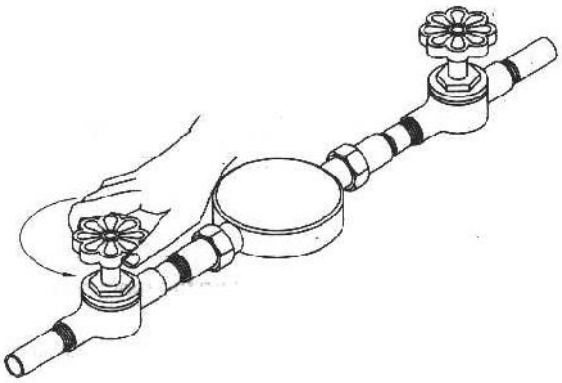
The stuffing box at the top of the water tap has a soft graphite grease hemp packing. As the stuffing box screw is tightened, this packing is compressed, thus making a watertight joint.

Water tap assembly



1. Handle
2. Spindle
3. Gland nut
4. Stuffing box/packing
5. Bonnet
6. Metal disk holder/valve disk
7. Washer (Rubber/leather/fibre
8. Retainer nut/washer nut
9. Valve seat
10. Body of the tap

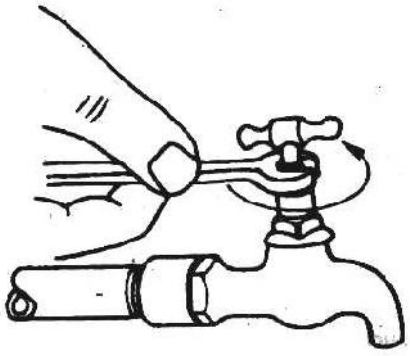
Repair and maintenance of household water taps.



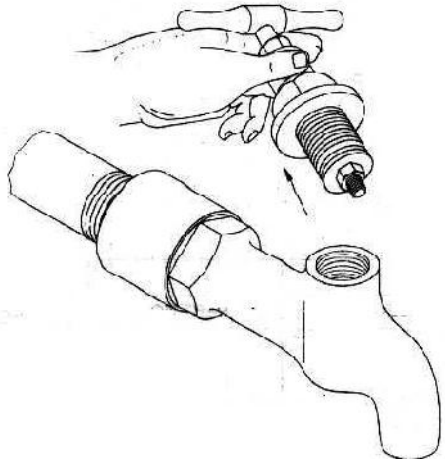
Repair and maintenance of household water taps.

Shut off the water supply by closing the main stopcock or the main gate valve.

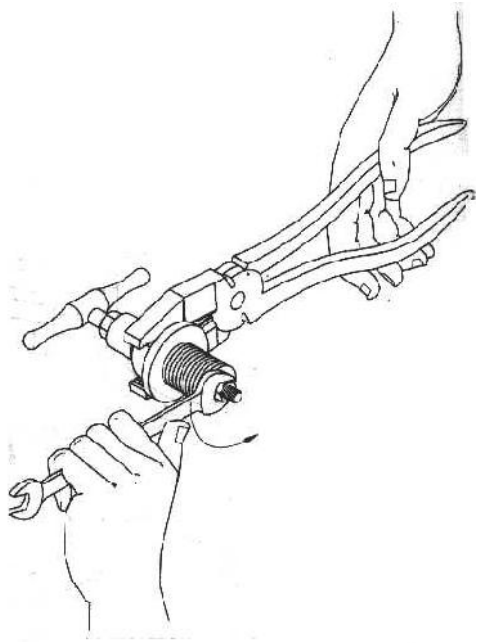
Keep the water tap to be repaired in the ‘open’ position.



Remove the bonnet from the water tap with a spanner.



Inspect the washer for damage.

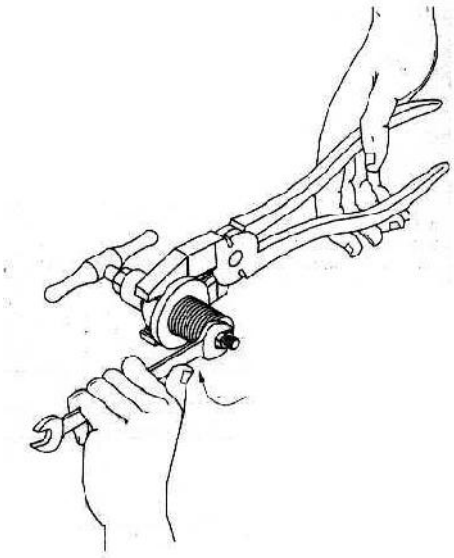


Hold the metal disk plate with a pliers and unscrew the washer nut with a spanner.

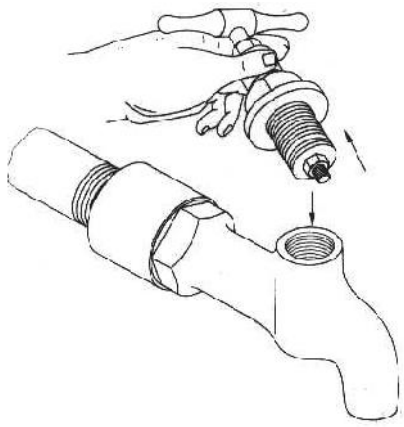
Remove the washer from its seating.

Press the new washer into position.

Use fibre washer for hot water tap.

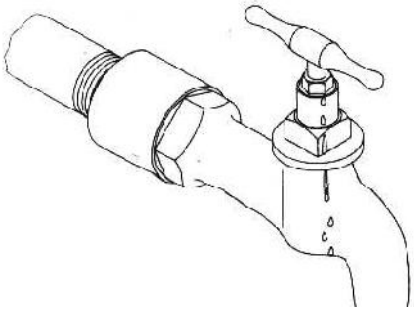


Refit the washer nut and tighten it firmly.



Replace the repaired bonnet in to the water tap. Tighten the bonnet with a wrench. Do not over tighten it as this would change the thread of the water tap body.

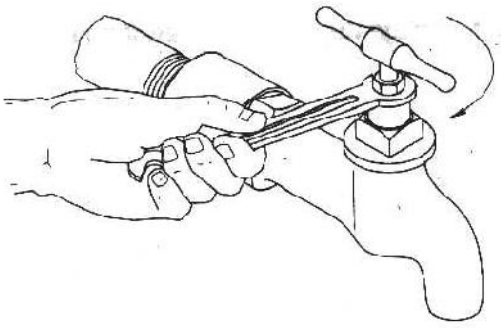
Repairs and maintenance of household water tap



Repair a water tap by replacing the packing material in the stuffing box.

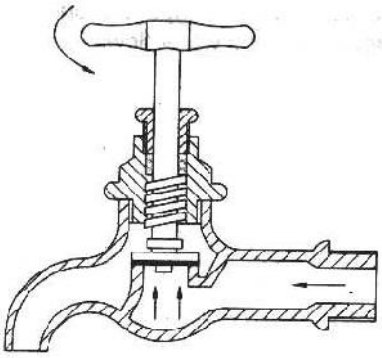
Another repair job which a plumber may need to perform is to change the packing in the stuffing box.

If water escapes from the water tap's gland nut, close the stopcock by turning the handle clockwise as this will stop the water in the tap to be repaired.

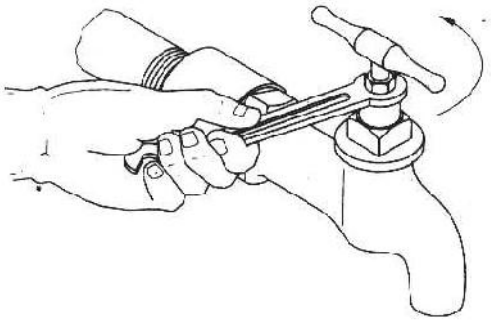


Tighten the gland nut to compress the packing around the shaft.

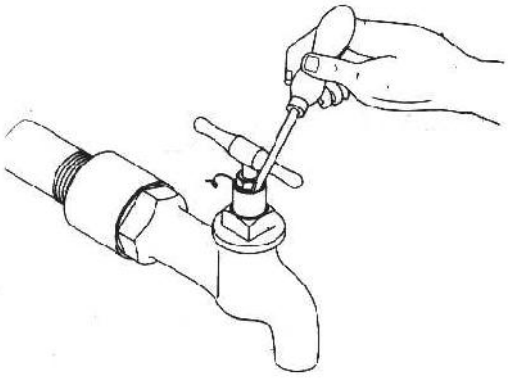
Now open the water tap to check if the leak has stopped if the water tap still leaks, the packing in the stuffing box should be replaced.



Shut off the water supply by closing the main gate valve.

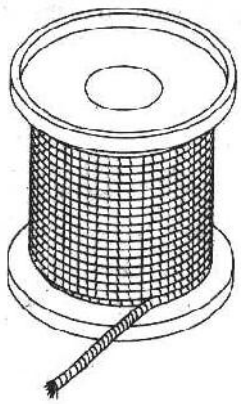


Loosen the gland nut from the bonnet by turning it anticlockwise with a spanner.

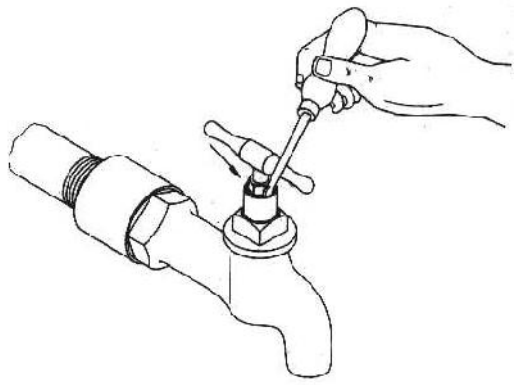


Lift up the gland nut and clean out the old packing from the stuffing box.

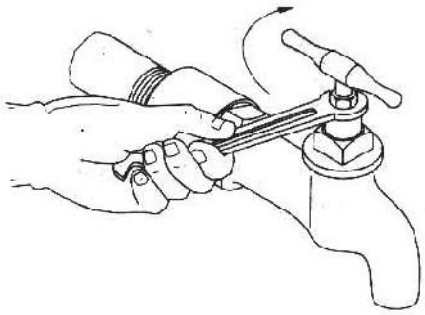
Do not damage the bore of the stuffing box.



Make a new packing out of asbestos rope.



Coil the new packing around the shaft and push it down with a small screwdriver.



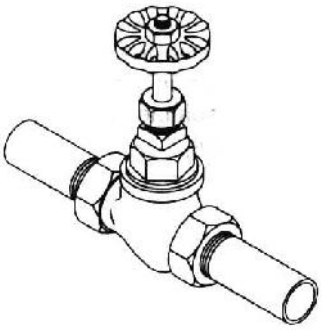
Reassemble the gland nut and tight.

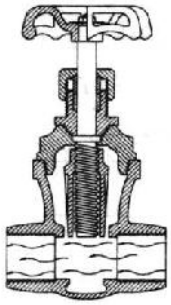
Open the main gate valve and test the water tap for leakage.

8.10 Servicing of gate valve

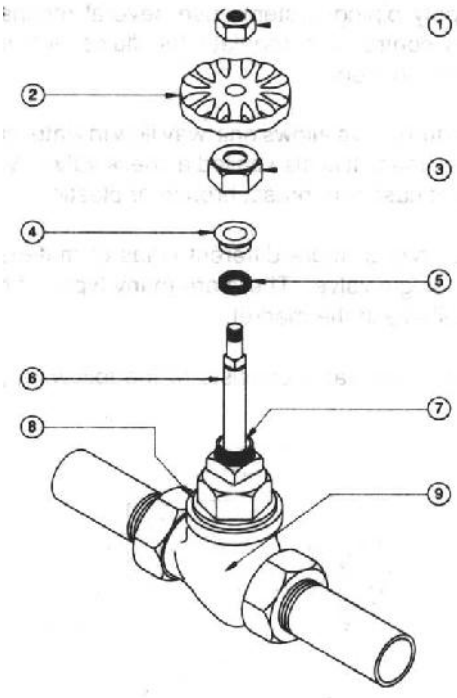
The gate valve gets its name from the gate-like disc that slides across the path of the flow. This valve provides an un-obstructed waterway when fully open. This feature makes the gate-valve useful in large piping installations. It is best suited for main supply lines and pump-lines. It should not be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





Parts of a gate valve



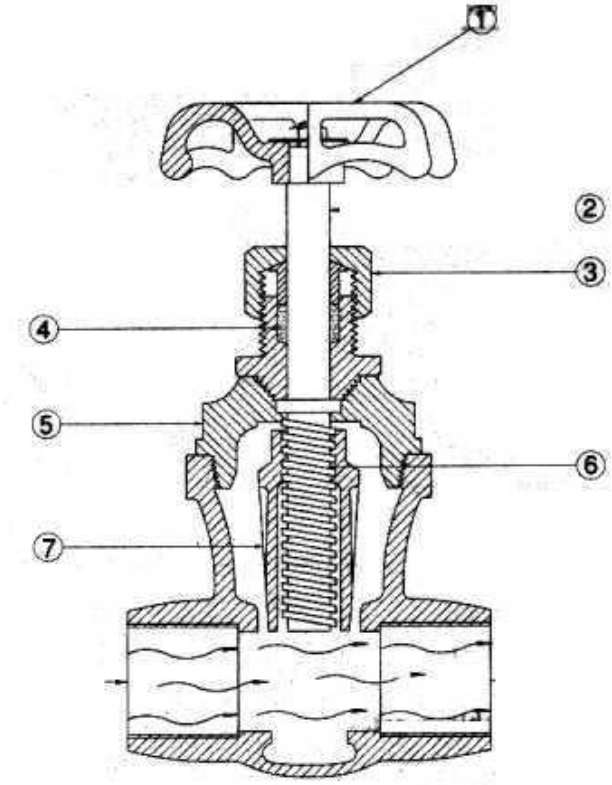
Parts of gate valve

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

Common defects in the working of gate valves, their causes and remedies

Defects	Causes	Remedies
Water flowing from around stuffing box screw	Defective packing in the stuffing box.	Renew packing with asbestos hemp and water pump grease.
	Gland nut loose	Tighten the gland nut.
Valve hard to turn on and off	Stuffing box packing is dry.	Renew packing or drop a little oil into the stuffing box.
	Spindle is bent.	Replace the spindle.
Spindle rotates continuously when turned so that the gate valve does not close.	Spindle thread badly worn out.	Replace the worn out part.

Repair a Gate-valve



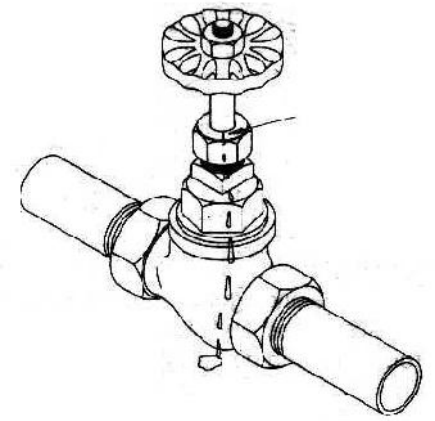
Gate valve Sectional view

1. Hand wheel or key
2. Shaft/spindle
3. Packing nut/Gland nut
4. Stuffing box with packing
5. Bonnet
6. Screw adjustment
7. Seat and disk/gate
8. Flow of water

Working Steps

- Shut off water by closing the main valve.
- Close the gate-valve and remove the wheel nut with a spanner.
- Remove the gland nut from the bonnet
- Clean out the old packing in the stuffing box.
- Remove the bonnet with a spindle from the body and clean all the parts.
- Coil the asbestos rope, smear it with water pump grease and push it down with a screw driver.
- Assemble the spindle gate to the bonnet.
- Assemble the gland nut, hand wheel and tighten the hand wheel nut.
- Open the gate-valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping form the gland nut.

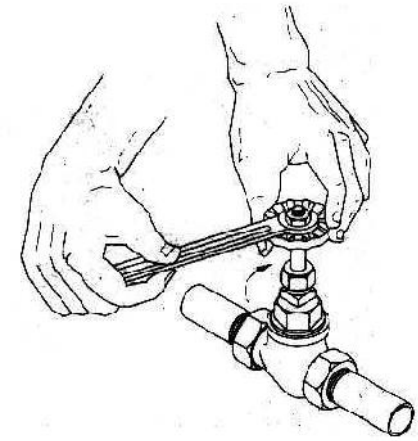
Do not use the gate-valve to regulate the flow.
It should be either in fully opened or fully closed condition.



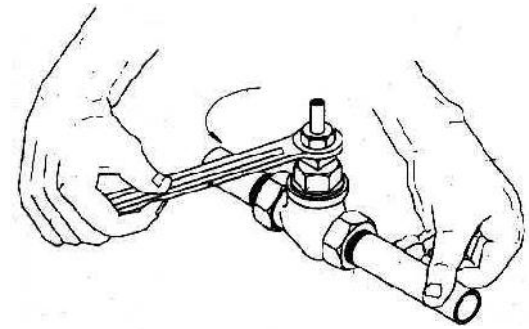
Repair a gate-valve

Close the gate valve by turning a hand wheel clockwise. This will stop the water in the valve to be repaired.

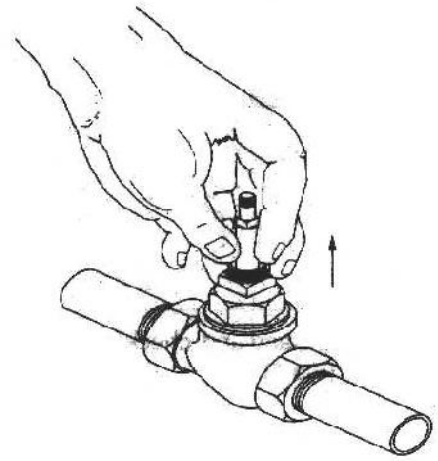
This will stop the water in the valve to be repaired.



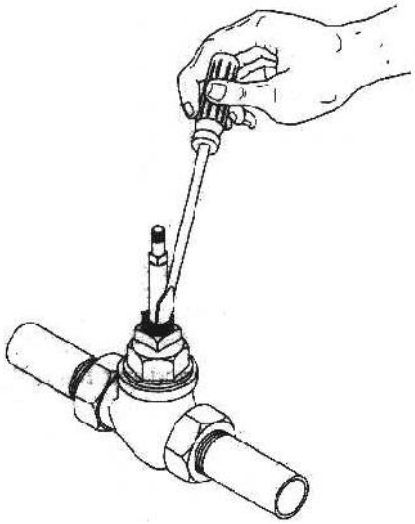
Remove the nut with a spanner and lift off the wheel.



Remove the gland nut from the bonnet by turning it in the anticlockwise direction.



Remove the stuffing gland.



Clean out the old packing in the stuffing box.

Coil the new packing round the shaft and push it down with a screwdriver.

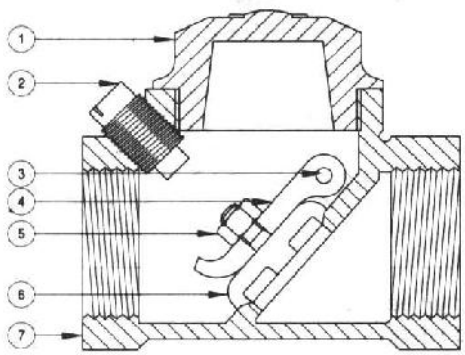
Push in the stuffing gland and check that it fits tightly in the stuffing box.

Reassemble and leave the gland nut hand tight.

Assemble the hand wheel and tighten the hand wheel nut.

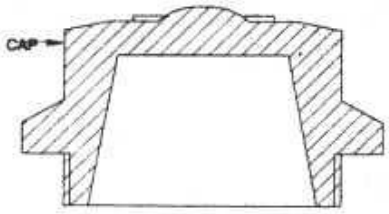
Open the gate-valve and tighten the gland nut until the packing is compressed sufficiently to stop the water escaping from the gland nut.

8.11 Servicing of non-return valve



Parts of non-return valve

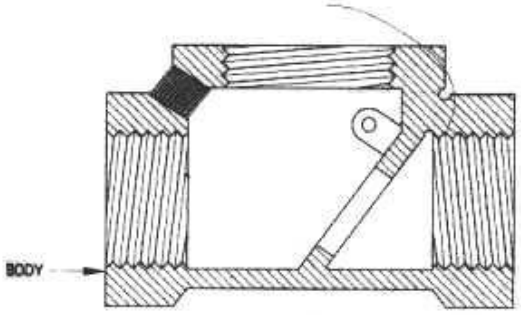
1. Cap
2. Stop plug
3. Hinge pin
4. Hinge
5. Disc hinge nut
6. Disc
7. Body

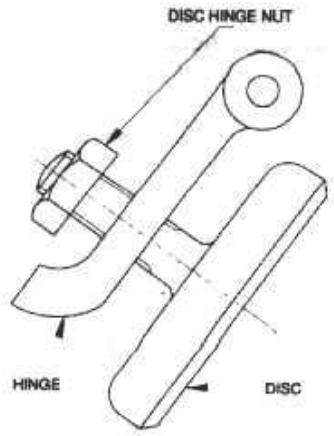


Shut off the water by closing the main valve.

Remove the cap from valve body.

Remove the hinge pin and take out the disc.





Separate the disc from the hinge.

Clean the seating area and the other parts of the disc.

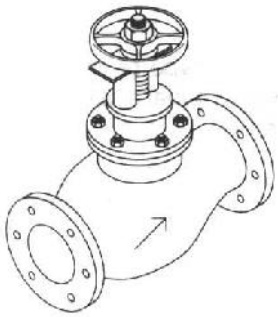
Assemble the disc and hinge plate with the pin.

Check the function of the hinge unit.

Replace the sealing material and assemble the cap to the body.

8.12 Servicing of globe valve

Globe valve – Parts - advantages



Globe Valve

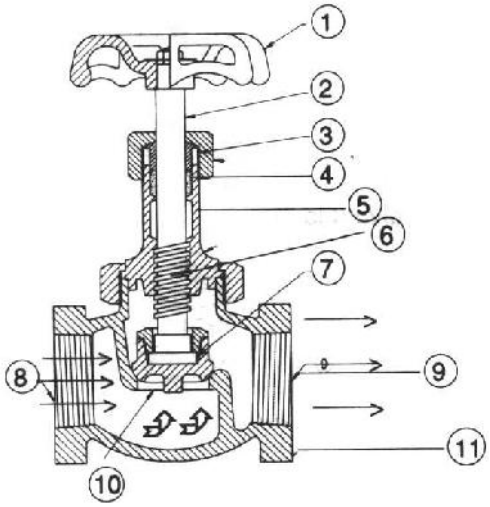
Globe valves are widely used in most piping systems for controlling air, steam and water. The globe shaped body of the valve has a partition in it. This partition closes off the inlet side of the valve from the outlet side.

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 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

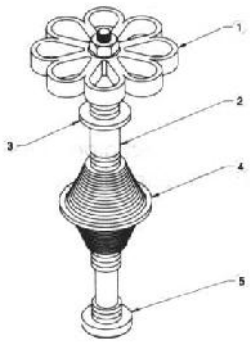


The major advantages of the globe valves are as follows :

- 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.

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
11. Globe shaped body.



Reseating tool

The parts of re-seating tool are as follows.

1. Hand wheel
2. Shaft or stem
3. Feed screw or collar
4. Tapered adapter cone
5. Cutters (interchangeable)

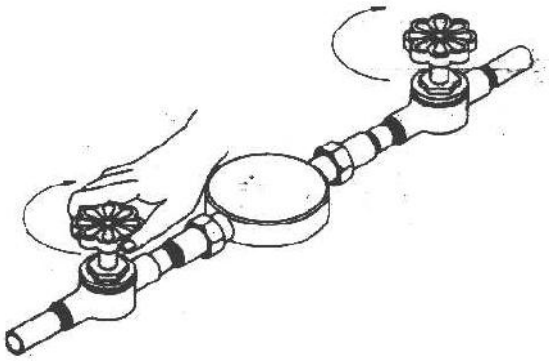
This is used to level and clean the valve seat area. The reseating tool has a steel shaft with a round handle on one end and a cutter on the other.



The cutter can be changed to the size required and is held down to the seat by a feed screw.

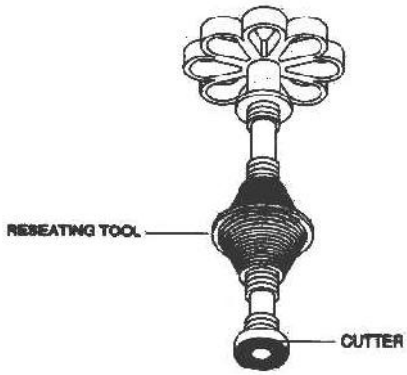
The tapered adapter cone has threads on both sides and is reversible. The threads on one side of the adapter are from 3/8" to 1 ¼". The reseating tools has three or four different cutters having sizes 3/8", ½", ¾ and 1".

Globe valve - Servicing

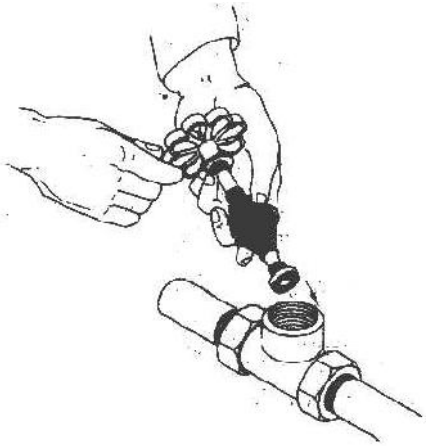


Shut off the water by closing the main gate – valve.

Drain the system and release the water pressure of the system.



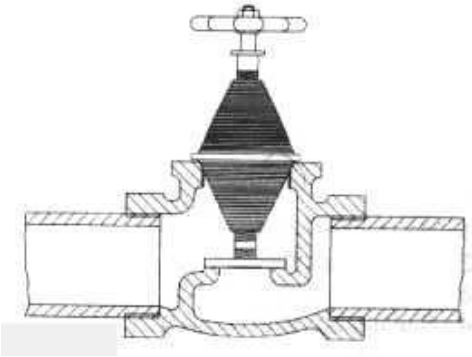
Screw the bonnet and lift off the bonnet from the body. Select the correct size cutter and assemble it to the reseating tool.



Insert the reseating tool into the body of the stopcock.

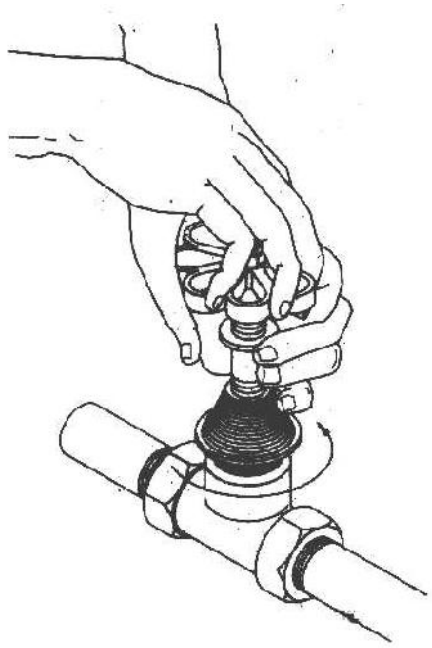


Hold the handle on the top of the tool steadily and turn the feed screw clockwise until the cutter just touches the bottom seat.



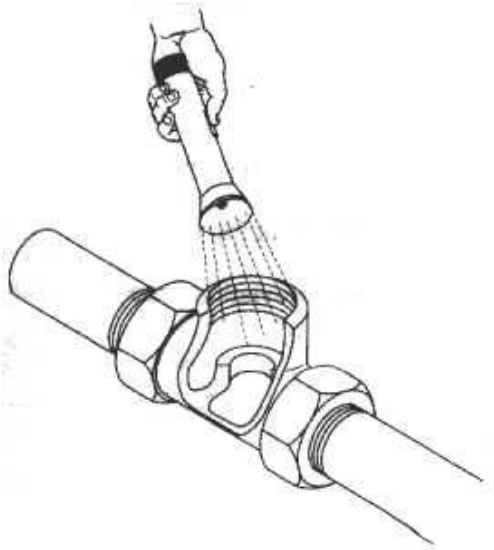


Face the bottom seat with the cutter by rotating the handle by gripping the feed screw.

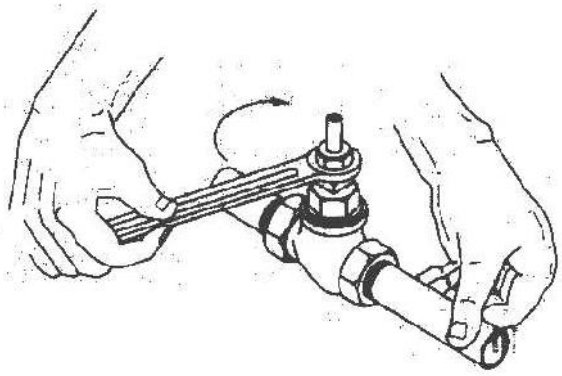


Ensure a minimum amount of metal is removed by adjusting the feed screw.

Loosen the feed screw and the adopter and remove the resetting tool from the body.



Inspect the valve seat using the beam of flash light.



Clean the seat and ensure that it is free from burrs, chips etc.

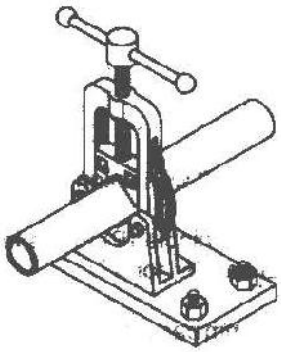
Replace the packing material into the gland box.

Tighten the bonnet.

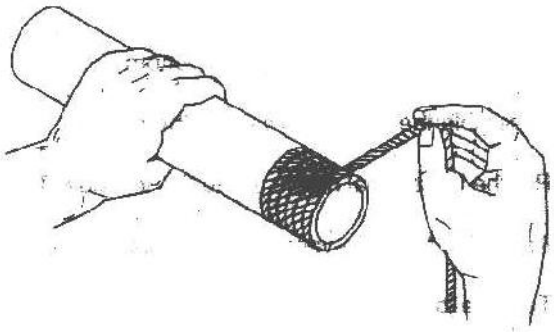
Avoid over tightening as this would damage the thread of the body.

Close all the drain taps and open the main gate valve and check the globe valve for leakage.

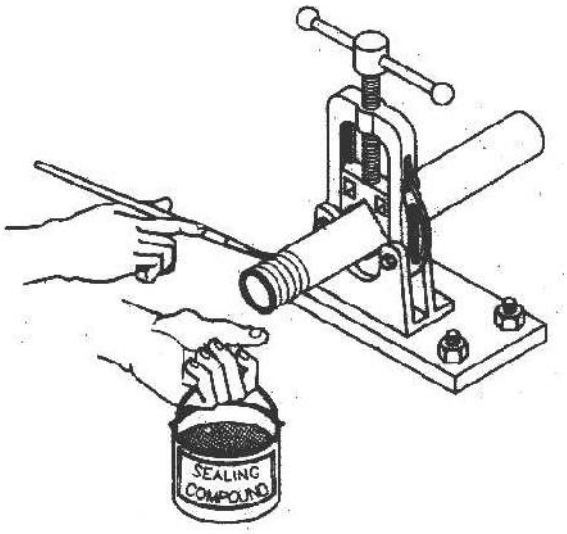
8.13 Assembling of G.I. Pipes with standard fittings



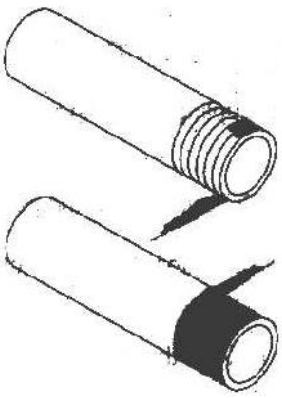
Hold the pipe in a pipe vice.



Wind the teflon tape/hemp packing/cotton thread material on the external threads of the pipe.

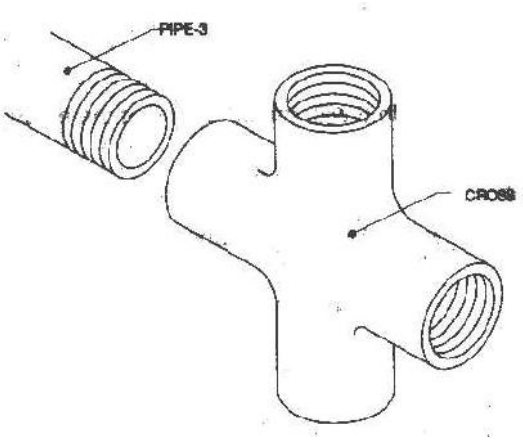


Apply sealing compound (white lead) over the pipe threads.

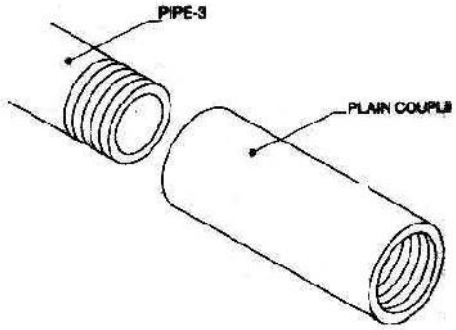


Fit the 4 way cross to pipe no. 2 and tighten it using a pipe wrench.

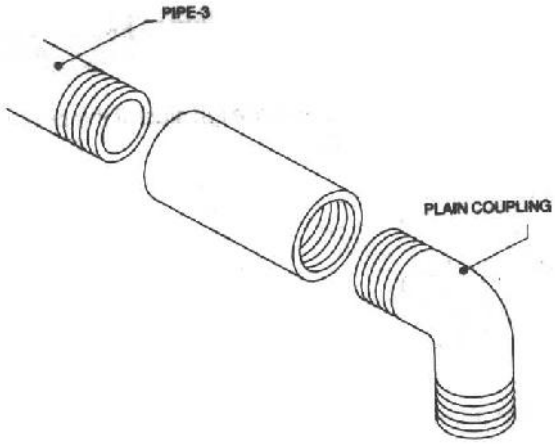
Wind the teflon tape/hemp packing to external threads of all the pipes and standard fittings and apply sealing compound over the threads before joining with the other one.



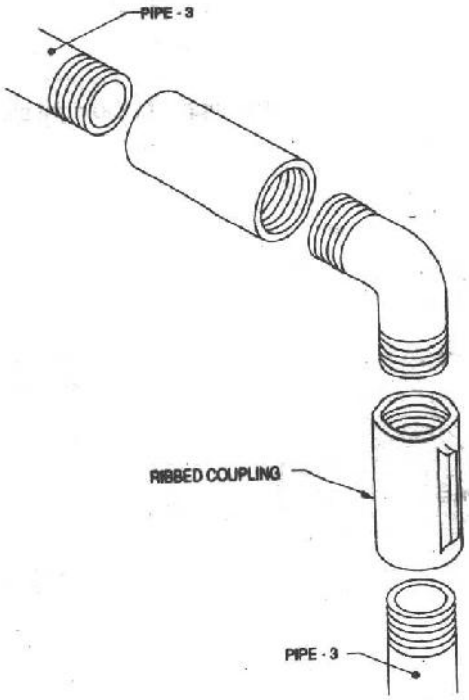
Fit pipe No. 3 with the cross.



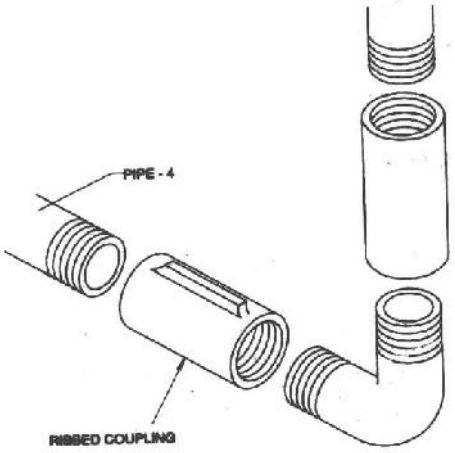
Join the plain coupling to the other end of the pipe No. 3.



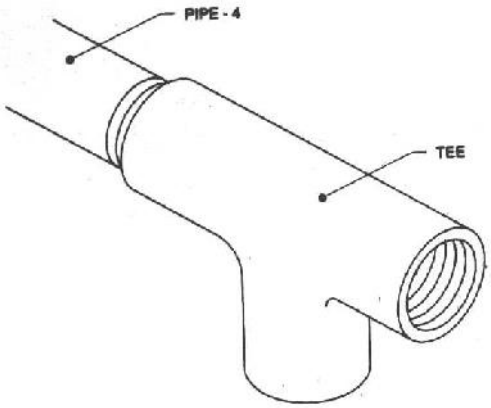
Fit the G.I. bend to the plain coupling.



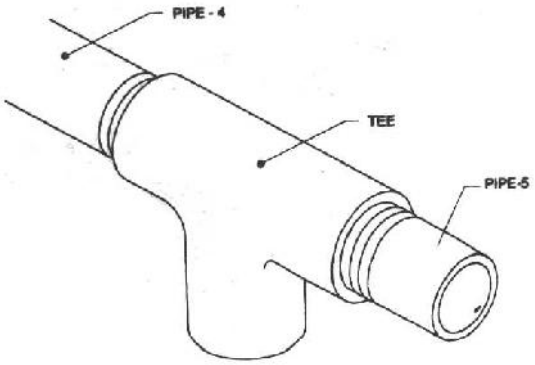
Assemble the ribbed coupling to the other end of the G.I.bend.



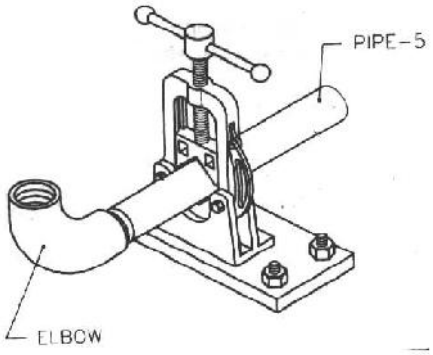
Connect pipe No. 4 to the nibbed coupling.



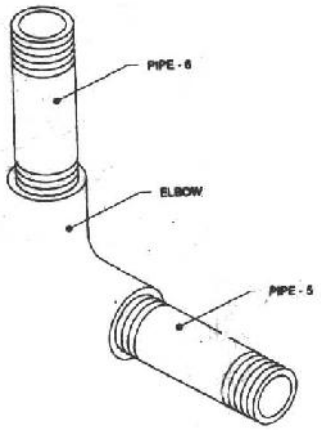
Fit ‘T’ with pipe No. 4.



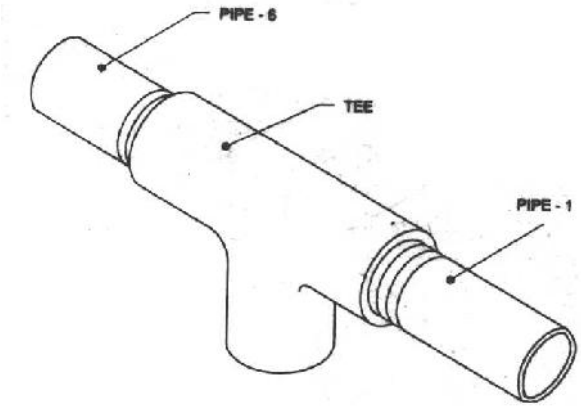
Connect pipe No. 5 to the opposite end of ‘T’.



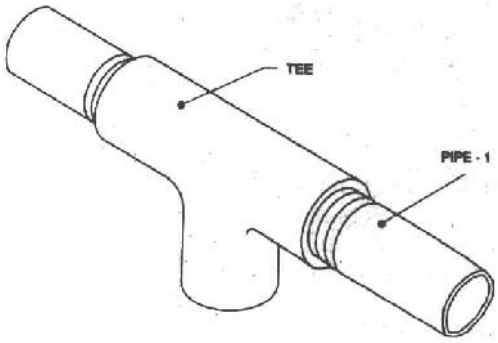
Assemble the elbow with pipe No. 5.



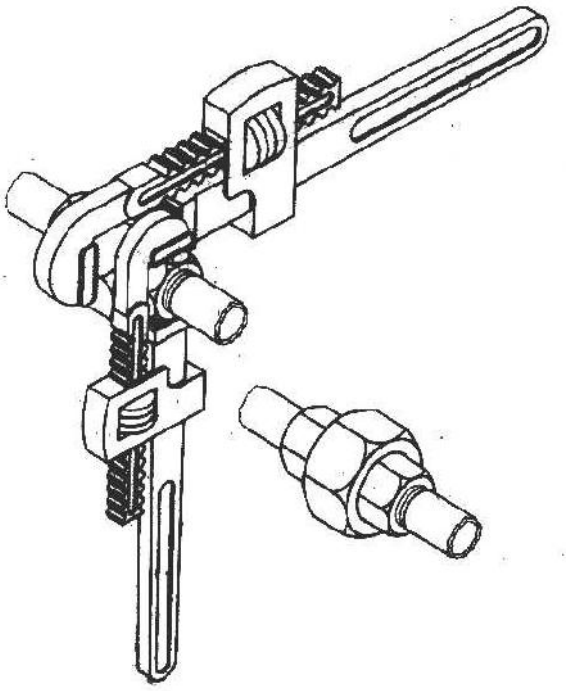
Fit pipe No. with the other end of the elbow.



Connect ‘T’ with pipe No. 6.



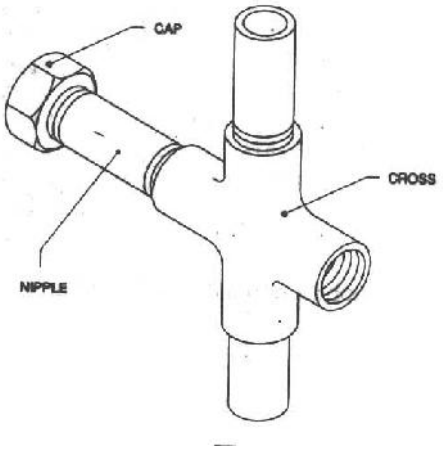
Fit pipe No. 1 with the opposite end of 'T'.



Fit the rubber washer into the union.

Set pipe no. 1 & 2 with the union.

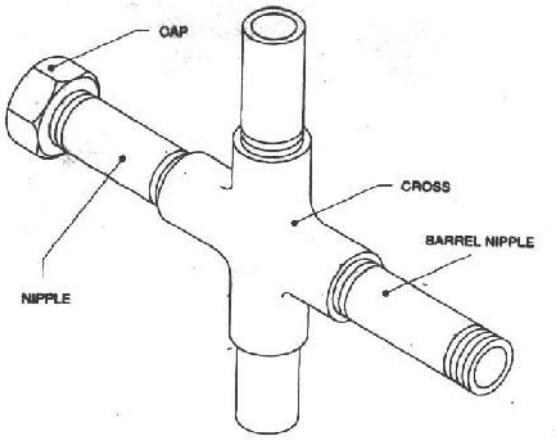
Hold one side of the union in one pipe wrench and the ring of the union in the other.



Turn the two pipe wrenches gently in opposite directions and assemble.

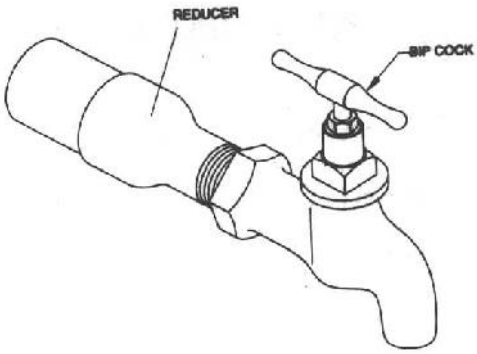
Use grease or Vaseline on the union joint for easy dis-connection.

Fit a 150 mm barrel nipple to the left side of the cross and put a cap for it.

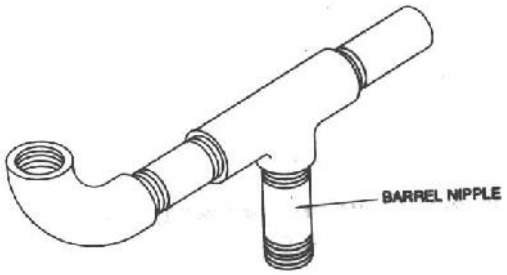


Join another 150 mm barrel nipple to the right side of the cross.

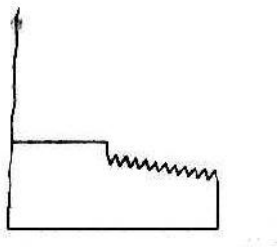
Connect the reducer to the barrel nipple.



Assemble a bib cock to the other end of the reducer.



Fit a 100 mm barrel nipple to the bottom side of 'T'.



Assemble the gate valve to the 100 mm barrel nipple.

Allow a clearance between the valve and pipe.

8.14 Maintenance of deep well hand pumps

Preventive Maintenance Schedule :

1. Tighten the handle axle nut and lock nut if found loose.

2. Lock for loose or missing flange bolts, nuts and washers, tighten if found loose and replace, if necessary.

3. Check handle for smooth and firm movement, if found heavy, look for possible reasons and rectify.

4. Open front inspection cover, and

   (a) Clean inside using wire brush;

   (b) Check the chain anchor belt for proper fitment, tighten, if necessary;

   (c) Ensure connecting rod threaded end and check nuts are tight;

   (d) Look for rusty patches, inside and outside; if found, clean with wire brush/sand paper and apply anticorrosive paint;

   (e) Apply fresh graphite grease over the chain, after cleaning;

   (f) Check alignment of connecting rod in guide bush; if movement is not free, look for possible reasons and rectify;

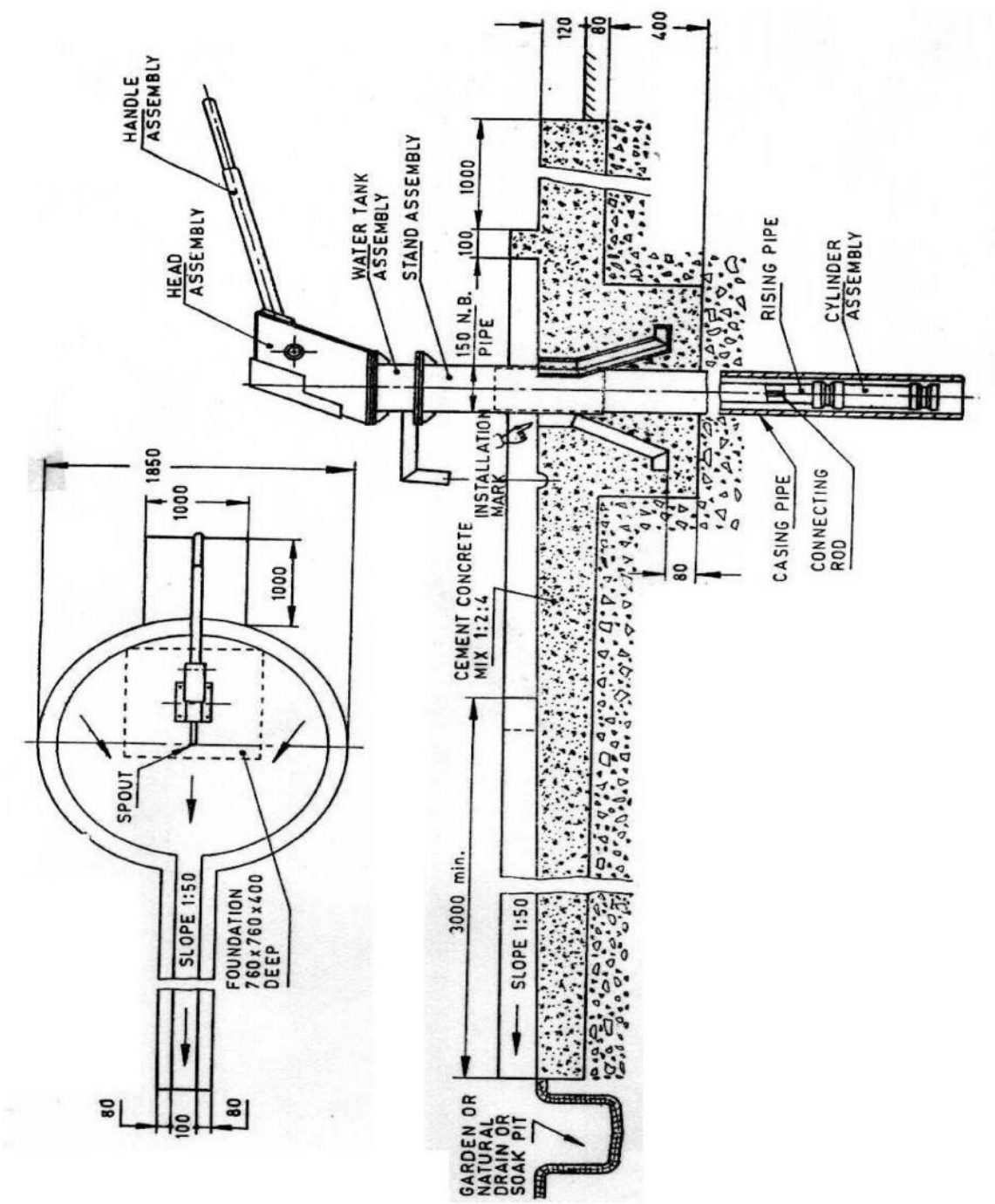
   (g) Grease the bearings, only for necessary – avoid excessive greasing; and

   (h) Refix front inspection cover and tighten cover bolt.

5. Check if hand pump stand assembly is firm in its foundation – if any cracks have developed in the platform, fill these up with cement mixture. If stand assembly is loose, arrange for fresh foundation.

6. Operate the hand pump and check whether the discharge is normal – if not, repairs of below ground assembly may be necessary.

7. In case the pump is fully galvanized, only wash the external surface of the pump head with clean water. Never apply emery paper to clean galvanized surface.



TYPICAL SET UP FOR DEEPWELL HANDPUMP

Note :

1. The free end of the casing pipe shall be minimum 300 mm above the installation mark.
2. Casing pipe is not required when the bore pipe passes through rocks.
3. Separate platform for washing clothes/utensils and cattle truffs may be provided if required.

All dimensions in millimetres

Procedure for dismantling the pump

1. Remove inspection cover from head assembly.

2. Insert chain coupling supporting tools.

3. Lift the handle to the top position and then disconnect handle from chain by removing the nylon nut and anchor bolt.

4. Remove flange bolts from head assembly.

5. Take out head assembly with chain passing through the hole in the head flange.

6. Rotate the third flange 90^0 and lift it by hand and insert connecting rod vice.

7. Fit the connecting rod vice on to the water chamber top flange and tighten vice against connecting rod and allow the third flange to sit on the connecting rod vice.

8. Take out the support coupler. Unlock the lock nut and rotate the chain till it comes out. Then remove the lock nut and third flange.

9. Screw connecting rod lifter on the connecting rod end, lift connecting rods, loosen connecting rod vice and remove. Gently lower connecting rods. Remove connecting rod lifter.

10. Remove water tank bottom flange bolts.

11. Lift water tank by using tank pipe lifter and lifting spanners.

12. Lift water tank and fit self locking clamp on stand assembly flange to hold the riser main and remove tank assembly.

13. Disassemble rising main and connecting rods. Remove connecting rod lengths, one at a time. Use one pipe wrench and one lifting spanners to lock the riser pipe.

14. When the last length of pipe is reached, remove self locking clamp and pull out the last pipe and cylinder by hand.

15. Disconnect cylinder from the last pipe.

16. Check all the pipe threads; clean out the threads by using wire brush. Remove any dirt and rust from the pipes by using wire brush or sand paper. If any pipe is damaged, replace it. Ensure that all the pipe coupling are intact and fit properly.

17. Check all the connect rod threads and couplings. Clean out threads with wire brush. Remove any dirt and rust from the rods by using wire brush or sand paper. Re-thread connecting rods if required. Check each rod for straightness. If rods are bent, try to straighten them. If not possible, replace it. If any rod coupler worn out too much or damaged, replace it.

18. Unscrew top and bottom reducer caps using pipe wrenches. Remove piston assembly and check valve. Inspect piston and check valve assembly and replace any worn out components. If necessary, replace cup washers, leather sealing ring, rubber seating etc. check for cracks which may have developed in the cylinder components. Replace parts, if necessary. Reassemble complete cylinder.

19. Clean out the cylinder components and inner cylinder lining from sedimental materials and dirt by using wire brush and water.

Trouble Experienced

A diagnostic analysis along with suggested remedies is given in Table 1.

Causes of trouble and their remedies

S.No.	Trouble	Causes	Remedy
1	Pump handle works easily but no flow of water.	a) Damaged rising main.	Replace the damaged pipe.
		b) Water level gone down much below the cylinder assembly.	Add more pipes and rods.
		c) Worn out cylinder bucket washers.	Overhaul the cylinder and replace the bucket washer.
		d) Connecting rod joint disconnected.	Pull out the pump and join the connecting rod wherever necessary.
		e) Valve seats worn out.	Replace valve seats.
		f) Pump cylinder cracked.	Replace cylinder assembly.
2	Delayed flow or little flow.	a) Leakage in cylinder bottom check valve or upper valve.	Over haul cylinder. Replace rubber seats.
		b) Leakage in pipe assembly.	Replace rising main.
3	Folding of chain during return stroke.	a) Improper erection.	Adjust the length of last connecting rod suitably.
		b) Leather bucket washers getting jammed inside the cylinder.	Overhaul the cylinder and replace leather buckets by nitrile bucket washer and modified spacer.

4	Noise during operation.	a) Stand assembly flange not levelled properly. b) Bent connecting rod. c) Hexagonal coupler welded offset.	Level the flange. Change the defective rod. Change the defective rod.
5	Shaky handle	a) Loose handle axle nut. b) Worn out ball bearings. c) Spacer damaged. d) Oversized bearing housing.	Tighten handle axle nut. Replace ball bearings. Replace spacer. Replace handle assembly.
6	Pump handle very hard to operate.	a) Rising main disconnected.	Pull out the pump and join affected rising main.

REFERENCE

1	Standard Tools & small equipment for Artisans working under SE(Works) of CAMTECH, Gwalior.
2	Indian Railway Works Manual – 2000
3	Instructional Media Packages for Fitter Trade – Central Instructional Media Institute, Chennai
4	Handbook on Water supply and drainage – BIS, New Delhi
5	Practical building construction and its management, Mantri Institute of Development and Research, Pune
6	IS- 2556 (Part IV) – Specific requirement for wash basin.
7	IS-775- C.I. Iron brackets and supports for wash basin and sinks.
8	IS-771 (Part 2) – Specification for kitchen & laboratory sink.
9	IS-2556 (Part VIII) – Specification of pedestal close coupled wash down and syphonic water closet.
10	IS-2556 (Part III) - Specification of traps for squatting pan.
11	IS- 774 (Part III) - Specification of Flushing cistern.
12	IS – 2556 (Part XII) - Specification of Floor trap.