Service Reservoir

→ The main and primary function of distribution reservoir is to meet the fluctuating demand with a constant rate of supply from the treatment plant.

→ The quantity of water required to be stored in the reservoir for equalising or balancing this variable demand against constant supply is termed as "Balancing reserve" or "Balancing storage" or storage capacity.

→ This Balancing storage can be computed by any of the following:-

(i) Utilizing hydrograph of inflow and Outflow.

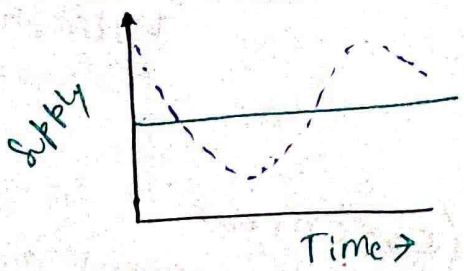
(ii) By Mass curve method.

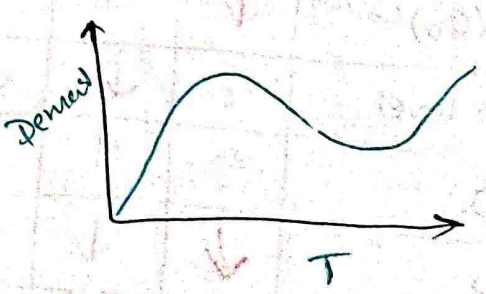
(iii) Analytical method.

→ Service reservoir are also provided (storage) to meet fire demand and emergency storage.

$100\sqrt{P}$ KL

$n \times q$

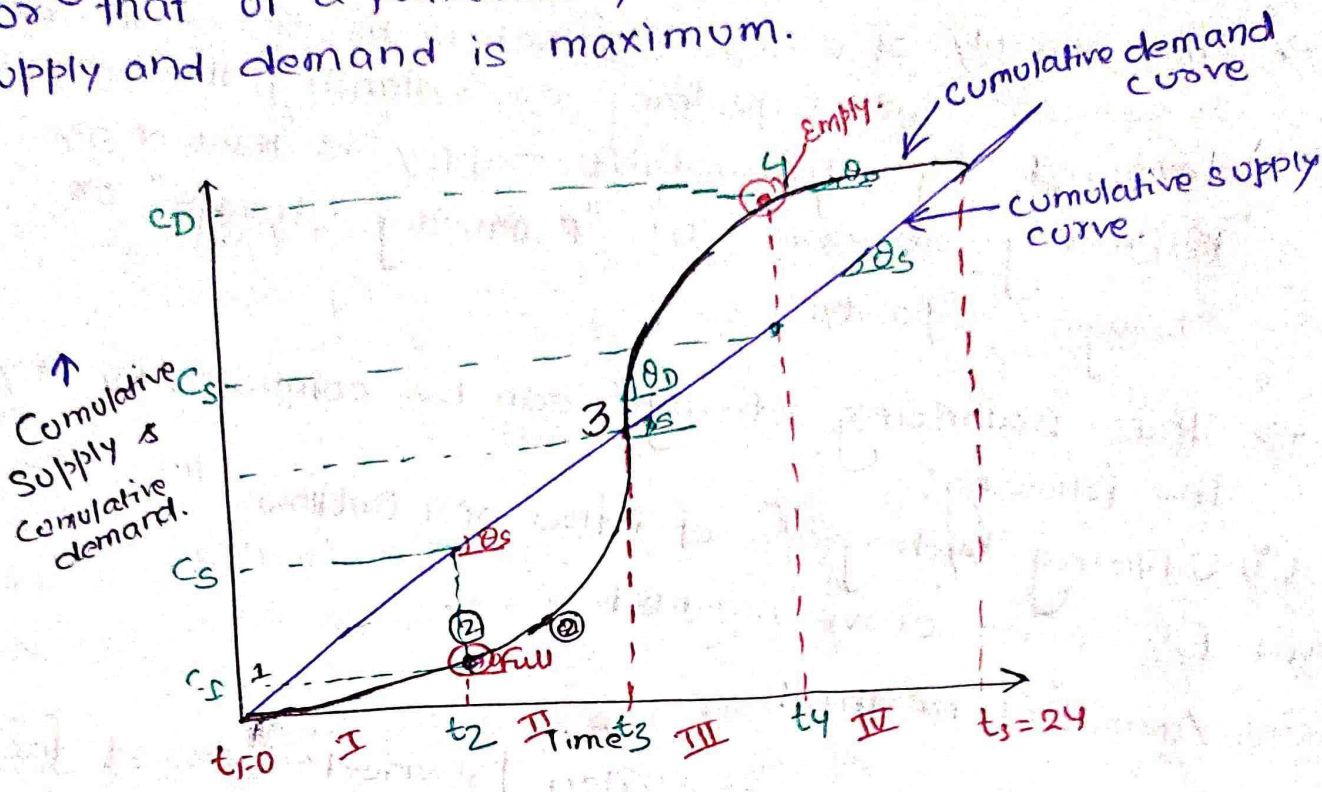




Mass Curve Method

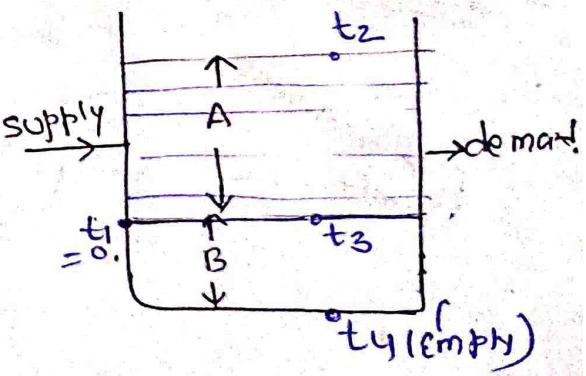
→ It is the plot of accumulated inflow i.e, supply or outflow (i.e demand) w.r.t time.

→ Using this mass curve balancing storage is found for that of a particular year when variation of supply and demand is maximum.



Mass Curve

Phase	I	II	III	IV
ROS (θ_S) cumi.	↑	↓	↓	↑
ROD (θ_D) (variable)	↓	↑	↑	↓
Water level	↑	↓	↓	↑
CS.	↑	↑	↓	↓
CD	↓	↓	↑	↑
Accumulation	✓	✓	X	X
Depletion.	X	X	✓	✓

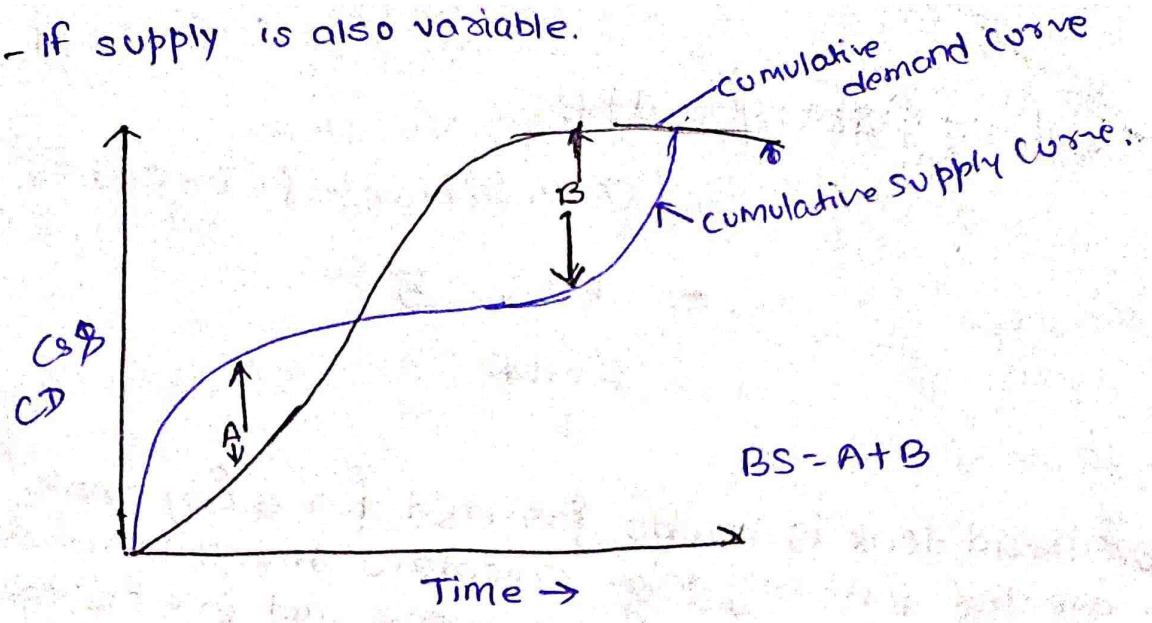


A = (CS - CD) Max
= Maximum accumulation.

B = (CD - CS) Max
= Maximum depletion

Balancing storage = A + B

Note:- If supply is also variable.



Q A town having a population of 1 lakh is to be supplied with water @ rate of 200 l/c/d. The variation in the demand is as follows:-

Time	% of total discharge	
6-9 am	40%	80
9-12 am	10%	20
12-3 pm	10%	20
3-6 pm	15%	30
6-9 pm.	25%	80

Determine the minimum capacity of reservoir when pumping is done at uniform rate from 6 am to 6 pm.

Demand = $200 \times 10^5 \times 10^{-6}$
= 20 MLD

Time	% of total discharge	Demand	CD	Supply	CS	CD - CS.
6-9 am	40	8	8	~~5~~	5	3
9-12 am	10	2	10	~~5~~	10	0
12-3	10	2	12	5	15	-3
3-6	15	3	15	5	20	-5
6-9	25	5	20	5	20	0

∴ Supply = demand = 20 MLD

∴ Rate of supply = $\frac{20 \text{ ML}}{12 \text{ hr}}$ = 5 M/hr

Balancing storage = A + B

$= (CS - CD)_{max} + (CD - CS)_{max}$

$= 5 + 3$

$= 8$ MLD

Q An overhead tank is to be provided for a city water supply given are the following data. Calculate the minimum capacity of the tank without any fire demand, and fire storage. Assuming the tank to be empty between 12 to 15 hours Compute the water level in reservoir at different time interval.

Time	water pumped	water consumed.
0-4	0	13333
4-6	50,000	40000
6-10	1,00,000	1,20,000
10-12	50,000	33333
12-15	0	25000
15-16	25000	8333
16-20	100000	106,666
20-23	75000	56,000
23-24	0	33335

CD	CS	CD-CS	Water level
13333	0	13333	8833
53333	50000	3333	18333
173333	150,000	23333	2
206666	200000	6666	25000
231666	200000	31666	-0
239999	225000	14999	16667
346665	325000	21665	10001
396665	400000	-3335	35001
400000	400000	0	31666

Balancing storage = A + B

$= 31666 + 3335$

$= 35001$ litre.

Water level = (supply - demand) + water level of previous interval

Different types of pipes require to carry water.

→ Pipes carrying water from one point to another in raw water scheme are being subjected to following types of forces:-

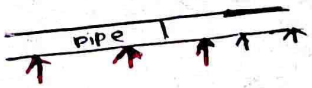
(i) Internal Pressure of water including water hammer pressure (to be resisted by using material which is strong in tension)

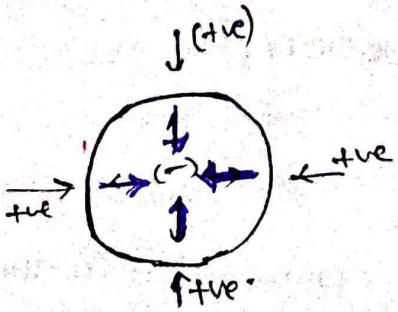
(ii) Pressure due to external loads in the form of Backfill, traffic load (to be resisted by using by using material strong in compression).

(iii) Longitudnal temperature stress which are created when pipes are laid over the ground to be resisted by providing expansion joints.

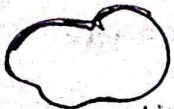
(iv) Longitudnal stress created due to unbalanced pressure at bends or at point of change in crossection (to be resisted by holding the pipes firmly by anchoring it in massive block of concrete or stone masonry).

(v) Flexural Stresses. produced when pipes are supported over trestles.





$$\frac{(+ve)}{\text{from top of pipe}} = \frac{(-ve)}{\text{from inside the pipe.}}$$



Crushing failure.

Different types of pipes available to be used to carry the water:-

(i) Cast-Iron (CI) pipe / Galvanized pipe (GI pipe).

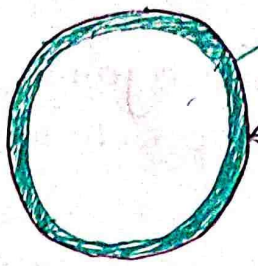
→ These pipes are moderate in cost.
→ Easy to join.
→ strong and durable. (compression)
→ Sufficiently resistant against corrosion.
→ Long life upto 100 years.
→ Service connection can be made easily.
→ Water carrying capacity decreases with time as the value of friction increases due to deposition ferric hydroxide $Fe(OH)_3$ (tubercules). termed as tuberculation.
→ Use GI pipe to prevent from it (↑)
→ It can't resist water pressure greater than 700 KN/m².
→ When these pipes is large they are heavy and uneconomical.
→ They are likely to break during transportation or while making connection.
→ They are suitable to be used as Distribution main.

(ii) Steel Pipe / Hume steel Pipe.

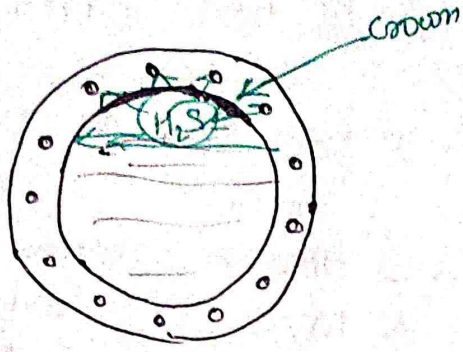
→ these pipes can withstand high water pressure as they are strong in tension but can't take heavy external load or vaccume.
→ These are susceptible to corrosion.
→ Have high maintenance cost.
→ shorted life (25-50) years.
→ It is difficult to provide service connection in them.

→ They are light in weight hence offer low transportation cost.
→ They are suitable to be used as pumping main.

Note:-
In order to increase the resistance of these pipe against corossion a layer of mortar/concrete is provided over their surface and is termed as "HOME Steel pipe".



3) Reinforced Cement Concrete Pipe (RCC pipe)
→ They can resist external compressive load and do not collapse under nominal vaccume and traffic load.
→ They are not corroded from inside by normal potable water. & from outside by ordinary soil but may undergo hydrogen sulphide crosione (H_2S) at its crown.
→ They are quite strong, and their useful life upto 75 years.
→ They are easy to construct at site or infactory.
→ Their co-effient of thermal expansion is low hence expansion joints are not required.
→ If laid under water the empty pipes donot float because of their own weight.
→ They are difficult to be repaired.
→ They can't withstand high water pressure.
→ They are heavy and bulk, and hence its difficult to transport.
→ Making connection in them is difficult and they tend to leak due to shrinkage crack.



4.) Vitrified Clay pipes.

→ It is virtually resistant against corrosion.
→ These pipes are smooth hence offer high discharge carrying capacity.
→ These pipes are not used as pressure pipe for carrying water. but are used for sewage and drainage at partial depth. (because clay is weak in tension and formation of water tight joint is difficult in them).

5.) Asbestos cement Pipe (AC pipe)

→ These pipes are light hence easy to transport
→ They can be easily assembled without skilled labour.
→ They are highly resistant to corrosion.
→ They are highly flexible (may permit deflection of 12°) when laying around the curves.
→ They are smooth hence offer high discharge carrying capacity. → do not have much strength and are brittle and soft
→ Very costly.
→ The rubber joint seal may deteriorate if exposed to petroleum product hence not used in this case.

Pipe Appurtenance.

Different units or accessories provided in the pipe for its proper functioning is termed as pipe appurtenance.

like:- (i) Valves.
(ii) Joints.
(iii) Anchorages

Valves

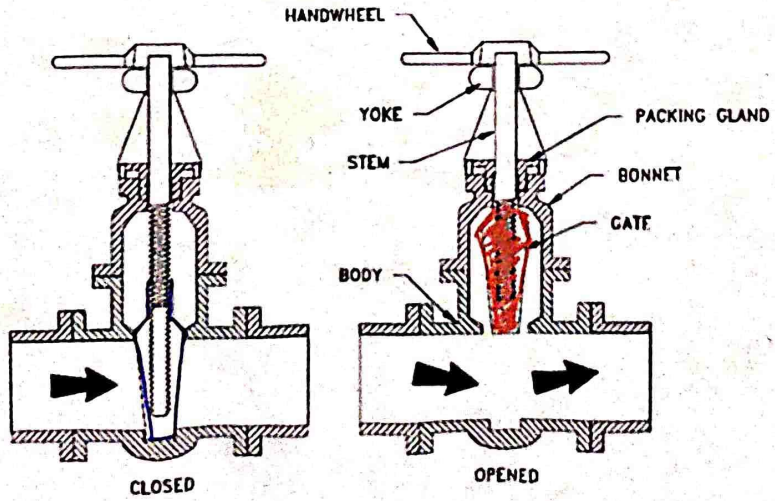
(i) Gate Valves or Sluice Valve or Cut off valve.

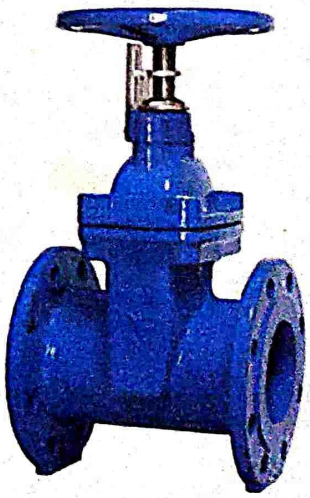
→ These valve are used to regulate the flow of water through pipes. by dividing it into number of section

→ These valve are placed at the summit point in the pipes as pressure to be resisted by these values is minimum at this points, requiring lower strength (Because of convenience) of the material that in turn reduces the cost of the valves.

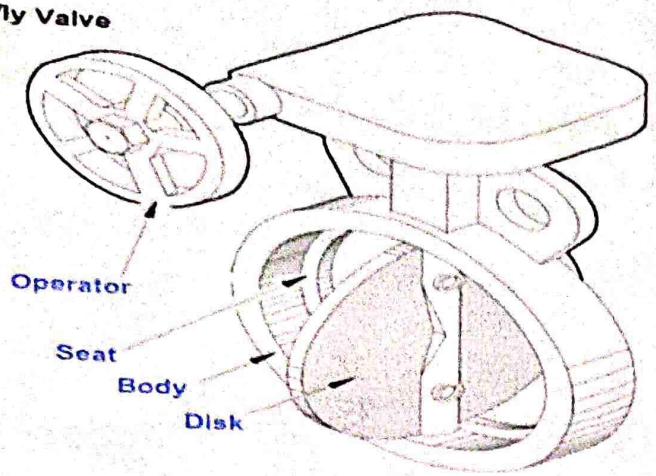
→ The valve is made of cast Iron ~~and~~ with Brass, Bronze, or stainless steel mountings.

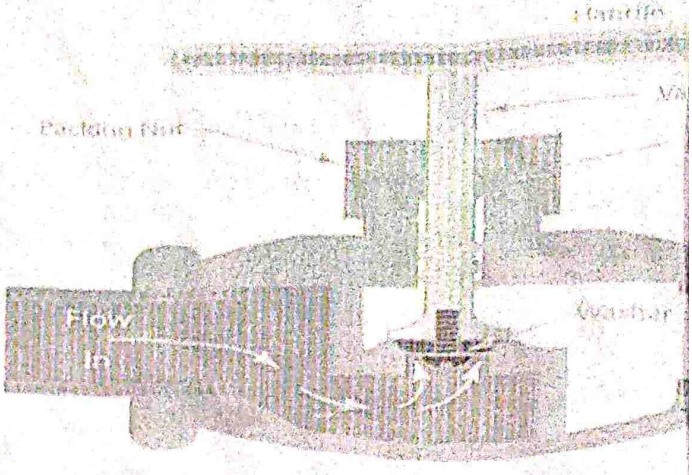
→ These are manually operated valves.





Butterfly Valve





Air Valves

→ These valves are used to ensure the safety of the pipes against failure.

→ Air valves are the special kind of valves which are generally placed along the pipe lines at "summit" on both sides of sluice valves and also on the downstream side of all the other sluice valves.

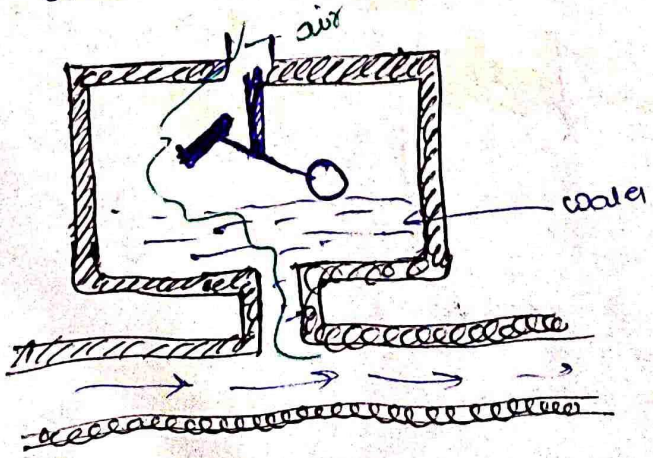
→ These valves are automatic valves.

It is further divided into two parts:-

(i) Air inlet valve - The pressure in the pipe falls below a certain fixed predetermined value and thus allowing air to enter the pipe. Such a valve is known as Air inlet valve

(ii) Air Relief Valve:-

These valve are required to be provided to all summits to remove accumulated air.



Drain Blow off/Scour Valve

→ These valves are used to remove the entire water from within a pipe (after closing the supply), small gate off-takes are provided at low points.

→ These valves are provided to drain the water & scour off the settle suspended impurities out from the pipe network.

→ These valves are placed at the lower most point in the pipe network in order to ensure the gravity drainage from either side of the gate valve.

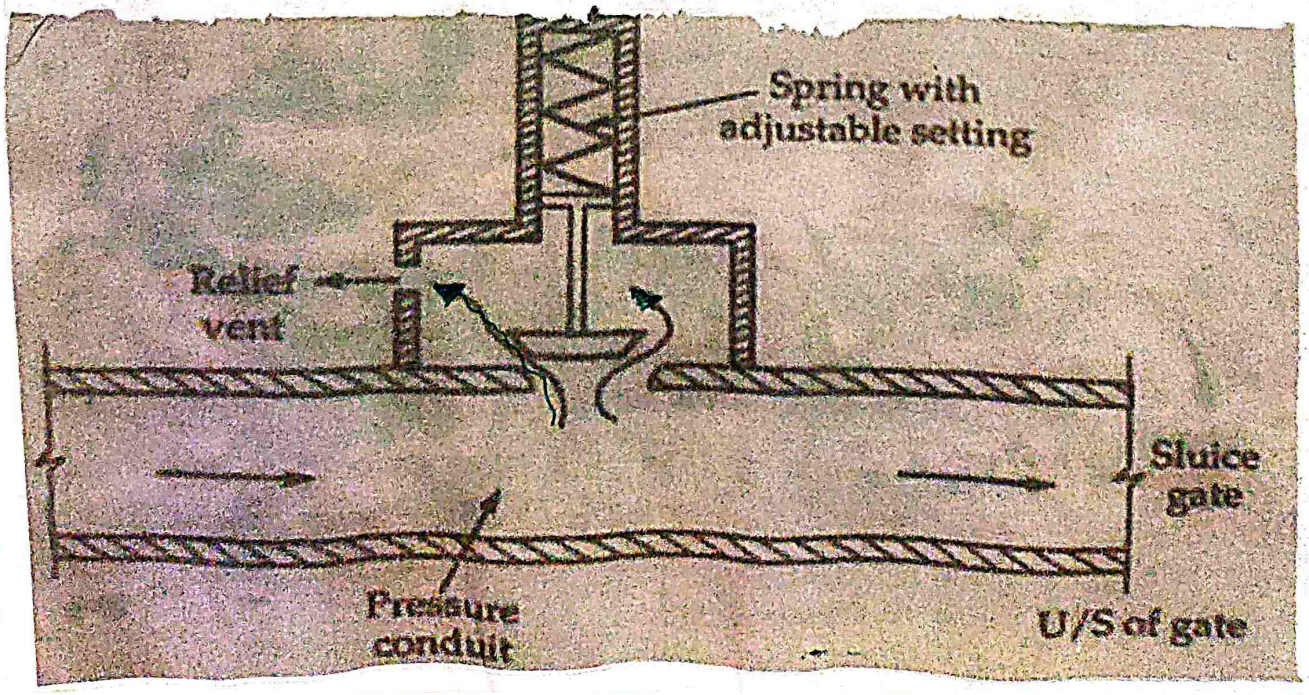
→ For safety purpose, two drains valves are generally placed in series, so as to reduce the chances of pollution reaching the water in the conduit.

→ These valves are manually operated.

Pressure Relief Valve.

→ Water hammer pressure in presure pipe can be reduced by using pressure relief valves.

→ Such a valve is adjusted to open out automatically as soon as the pressure in the pipe exceeds a certain fixed predetermined value.



Check Valves or Reflux Valves.

→ They are also called as Non-return valves because they prevent to flow back in the opposite direction.

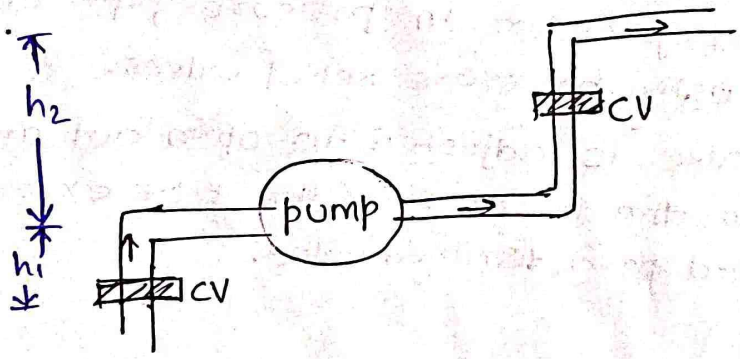
→ These valves are also installed on pump. discharge to reduce water hammer forces on the pump.

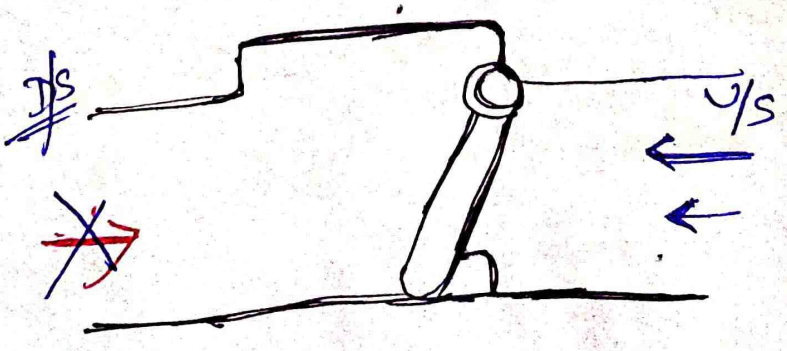
→ These valves are placed for either side of the pump. to check the flow of the water in single direction.

→ These valves are required at inter-connections between a polluted water system and a potable water system so as to prevent the entry of pollution into the pure water.

→ ~~These valves are required at inter-connection beto.~~

→ A check valve installed at the end of a suction line is called foot valve. and prevents drainage of the suction when the pump stops.





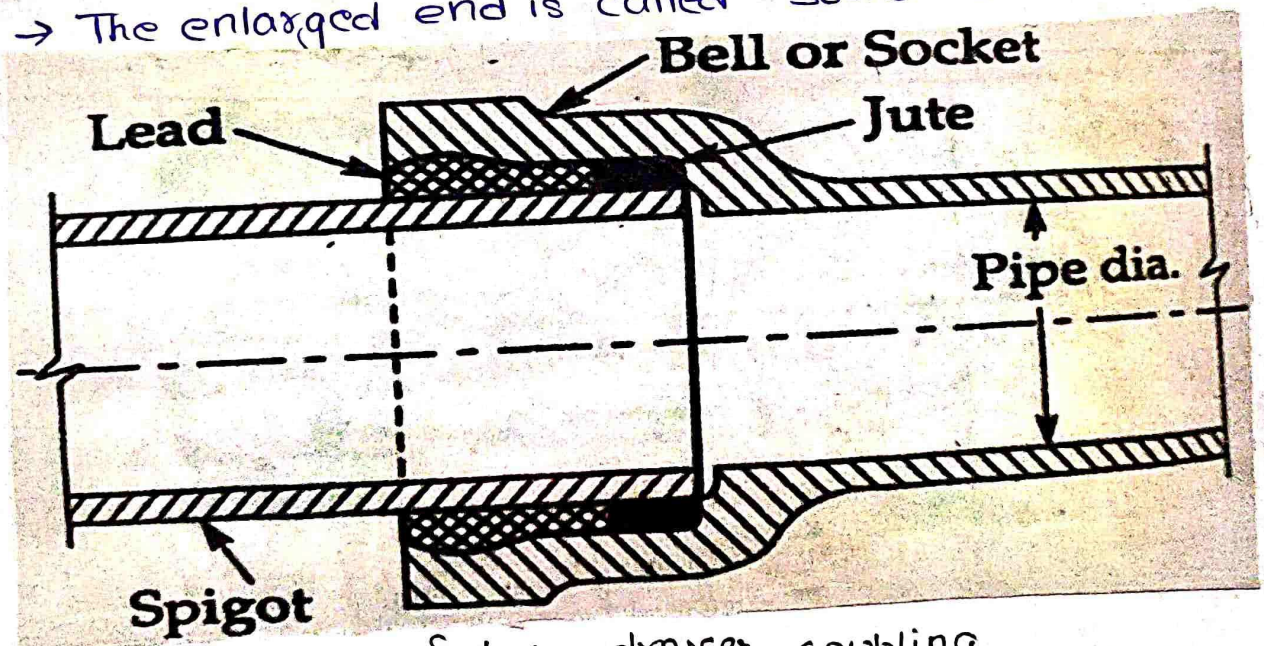
Joints

There are following types of joint provided in pipe network:-

(i) Socket and spigot joint.
(ii) Flanged joint
(iii) Mechanical joint called dresser coupling.
(iv) Flexible joint.
(v) Expansion joint.

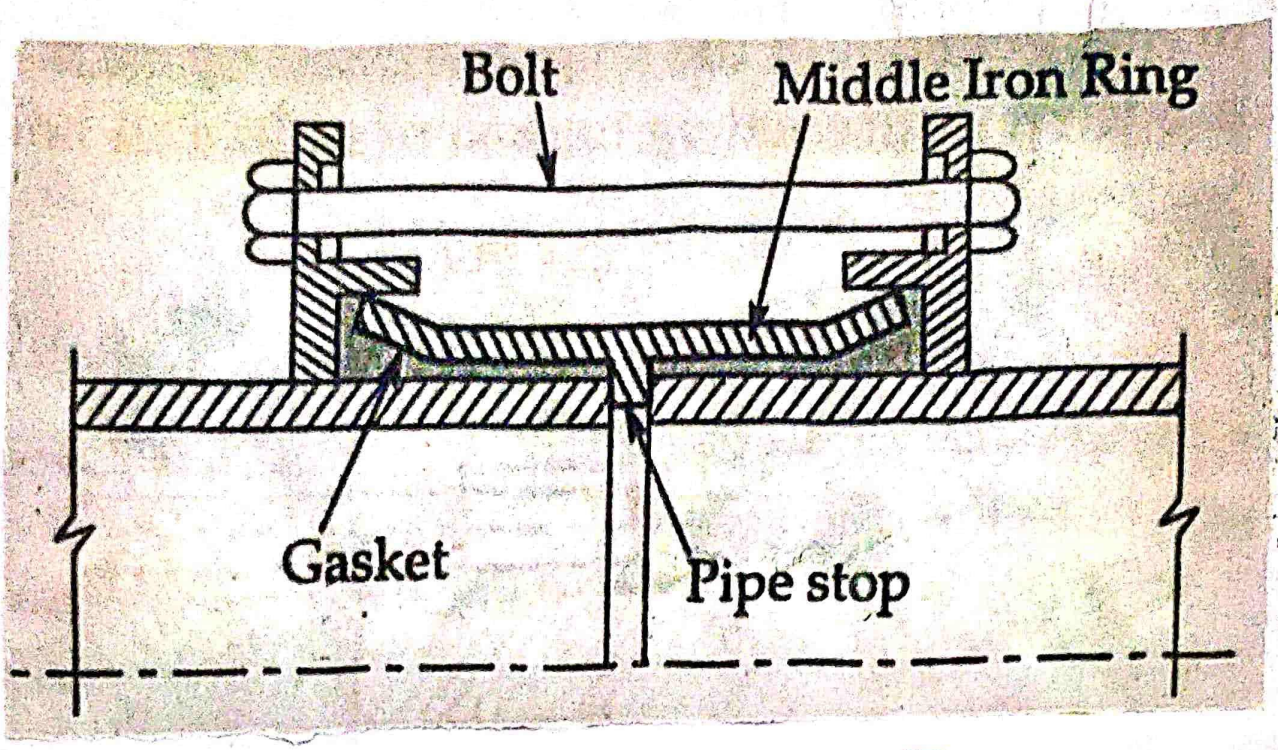
i) Socket and Spigot Joint

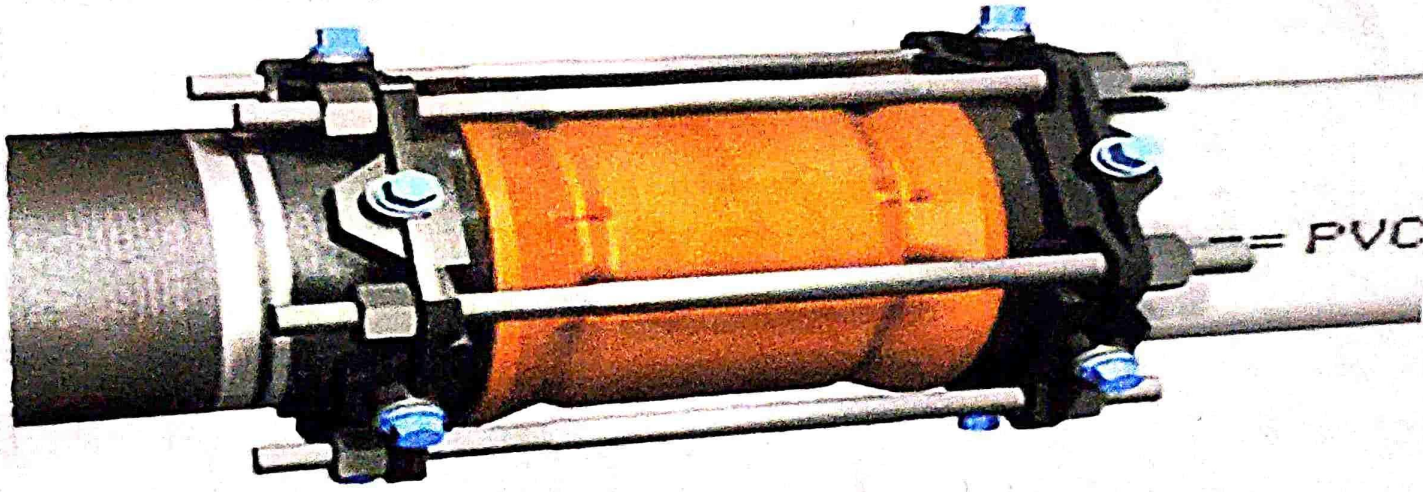
→ Cast iron pipes are being joined by a "socket and spigot joint".
→ Also used today on large scale.
→ These joints are made in such a way that one of their end is enlarged, whereas the other end is called is normal.
→ The enlarged end is called "socket" and "bell" while



(ii) Mechanical joint or dresser coupling.

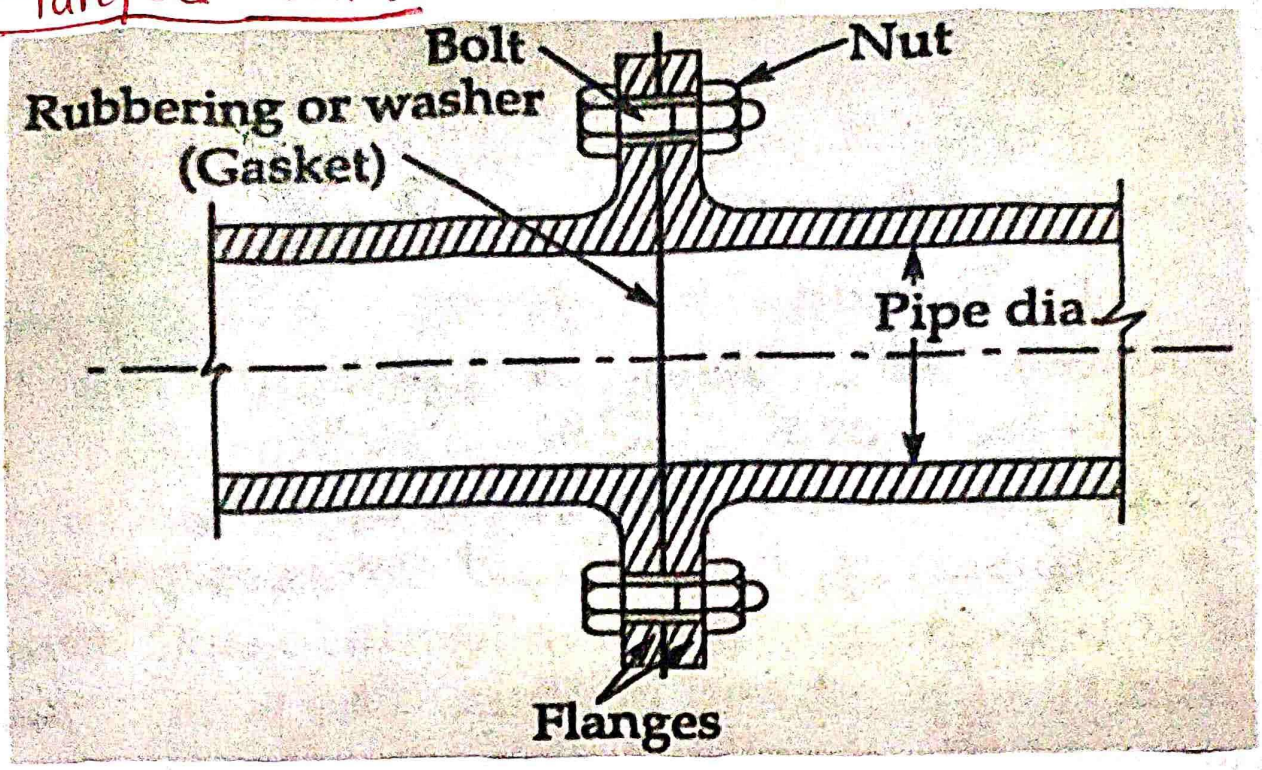
→ These type of joint is used when it is required to joint the plain ends of cast iron pipes.
→ A special type of metallic collar is then fitted and tightened over the abutting ends. thus forming a mechanical joint.
→ one of the most commonly used type of mechanical joint is a "dresser coupling".





→ These joint are strong and rigid. They can withstand vibrations and are therefore useful for pipes to be couried over bridges or below bridges in hangers.

Flanged Joint



→ These joint are used for pumping stations, filters, paints and at other location where it may be necessary to occasionally disjoint the pipe.

→ Cast iron pipe length to be joined by this joint are cast in such a way as to have flanges at both ends.

→ In case of steel pipes, flanges are separately cast and then screwed down or welded at both the ends of the respective pipe length.

→ These joint are strong but rigid, and hence cannot be used where deflection or vibration are expected.

→ They are expensive and mostly used for indor works (such as pumping station, filter plants etc.)

Flexible Joint.

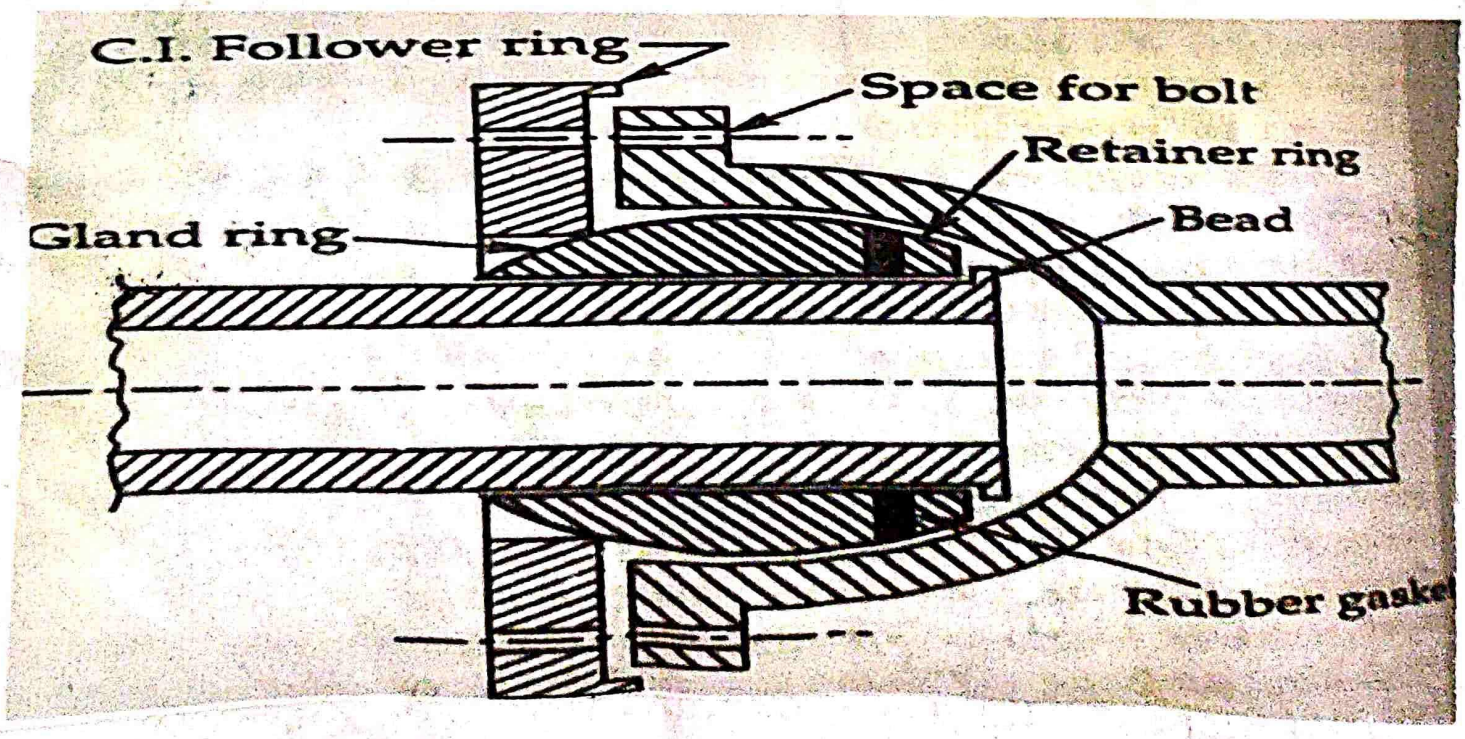
→ These are used where large scale flexibilities are required.

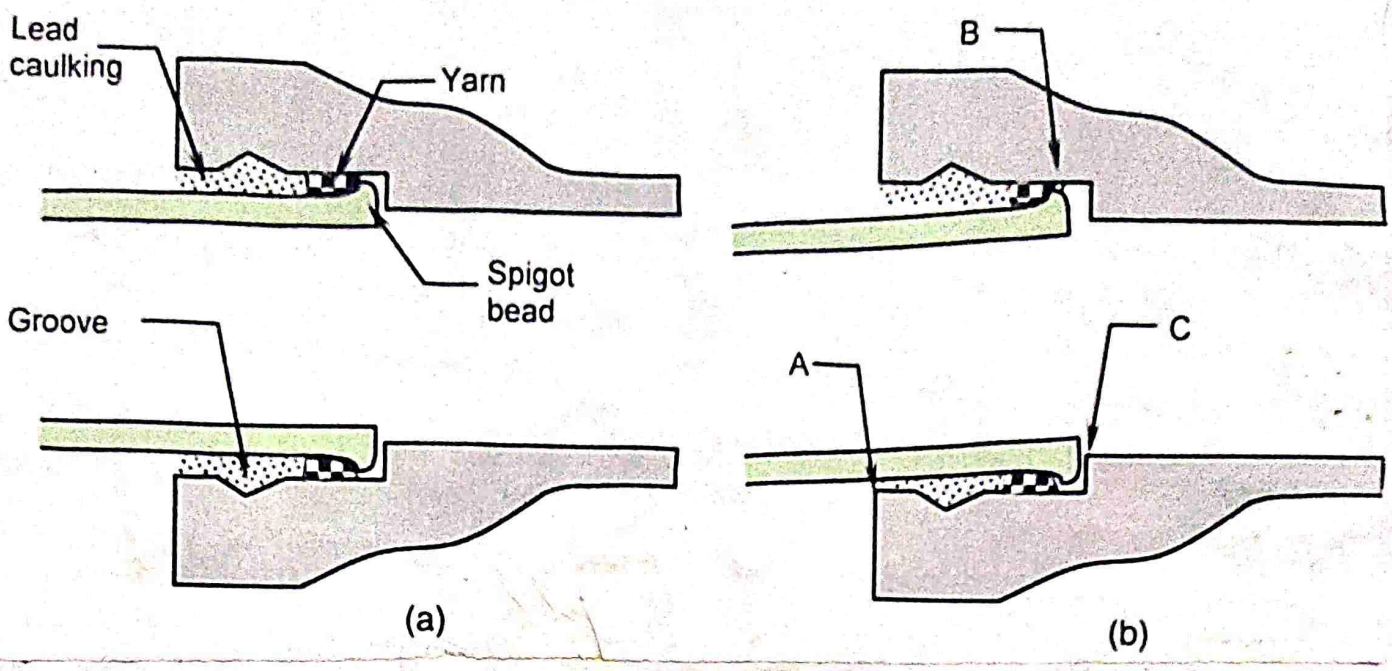
→ The pipes to be provided with such a joint are cast with special types of ends.

→ The socket is spherical, and the spigot, through the plain is having a bead at the end.

→ A retainer ring is placed over the bead which keeps the special rubber gasket (rubber gasket linked with a special kind of fabric called "duck".) in position.

→ The spigot-end can be moved to give away the desired deflection and nuts are tightened over the gland ring.





flexible Joint

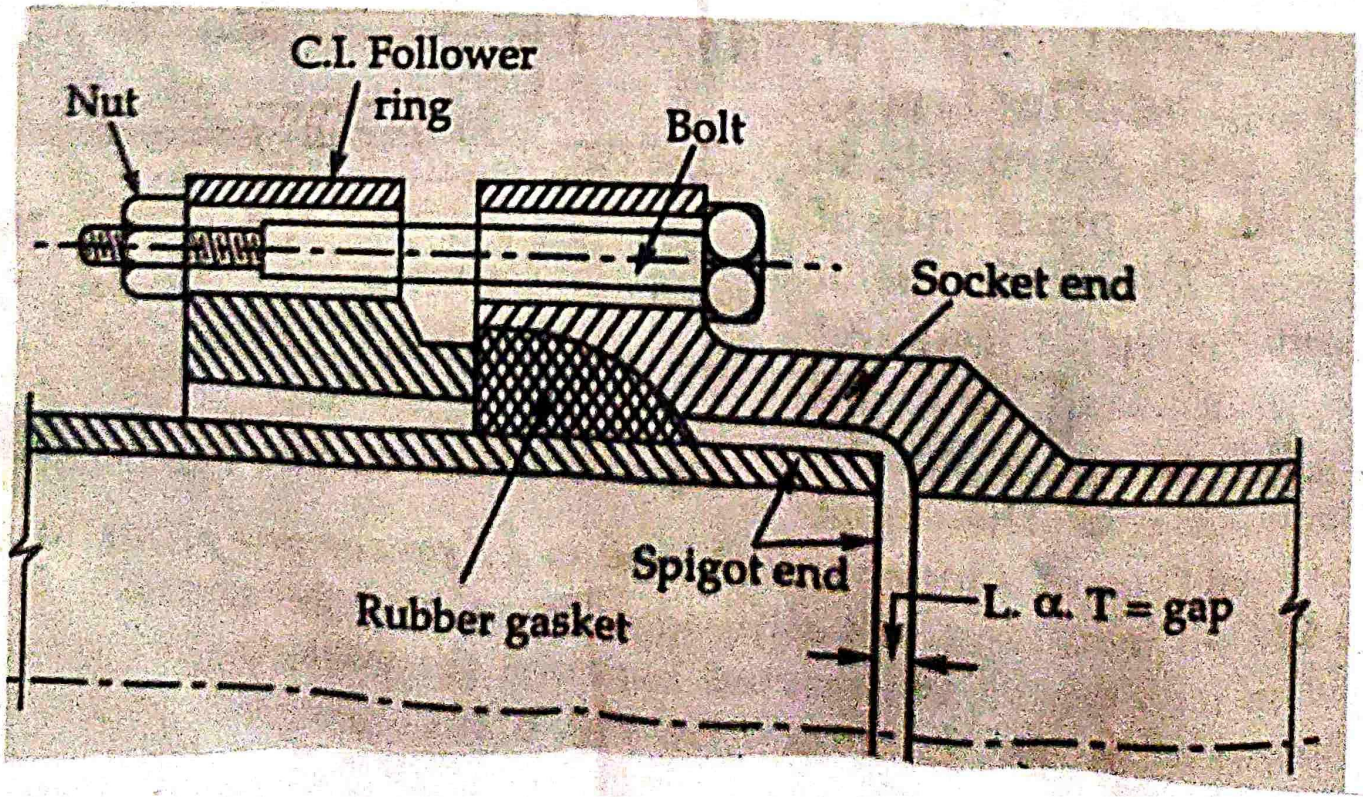
Expansion Joint.

→ These joint are provided at suitable intervals in the pipe lines, sao as to counteract the thermal stresses produced due to temp. variation.

→ for providing expansion joint in cast iron pipes, the socket end is cast flanged and the spigot-end is plain.

→ The socket end is connected rigidly to an annular ring which can slide freely over the spigot end.

→ While making this joint, a small ~~piece~~ space is kept between the face of the spigot and the inner face of the socket, and the spigot is filled up by means of a rubber gasket. The flanges are then tightened by meam of nuts and bolts.

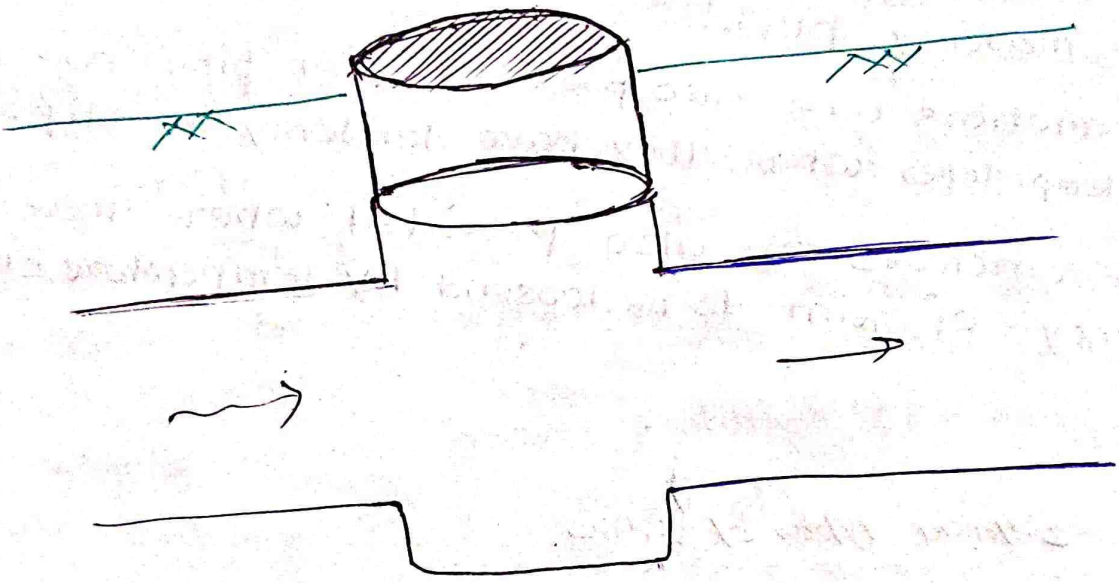


Manholes

→ They are provided at suitable interval along the pipe so as to help its laying & to serve for inspection and repair.

→ They are generally provided on large pipe, bringing water from source to the treatment plant.

→ They are provided at the spacing of 300-60 meter.



Insulation Joint

→ These Joint are provided along the pipe lines at suitable interval so as to insulate the pipe against the follow of stray electric current. & thus to check electrolysis.

→ Rubber gaskets or rings can be provided as insulator in between the pipe.

→ In some cases rubber coveing is also provided to resist the flow of current.

5 Anchorage

(2020)

→ The pipe try to pull apart and get out of the alingment at bends and other point of unbalanced pressure at such places the forces exelled on the joint due to longitudnal shearing stress caused by these unbalance pressure are more & the joints may get loosened leading to excesive leakage.

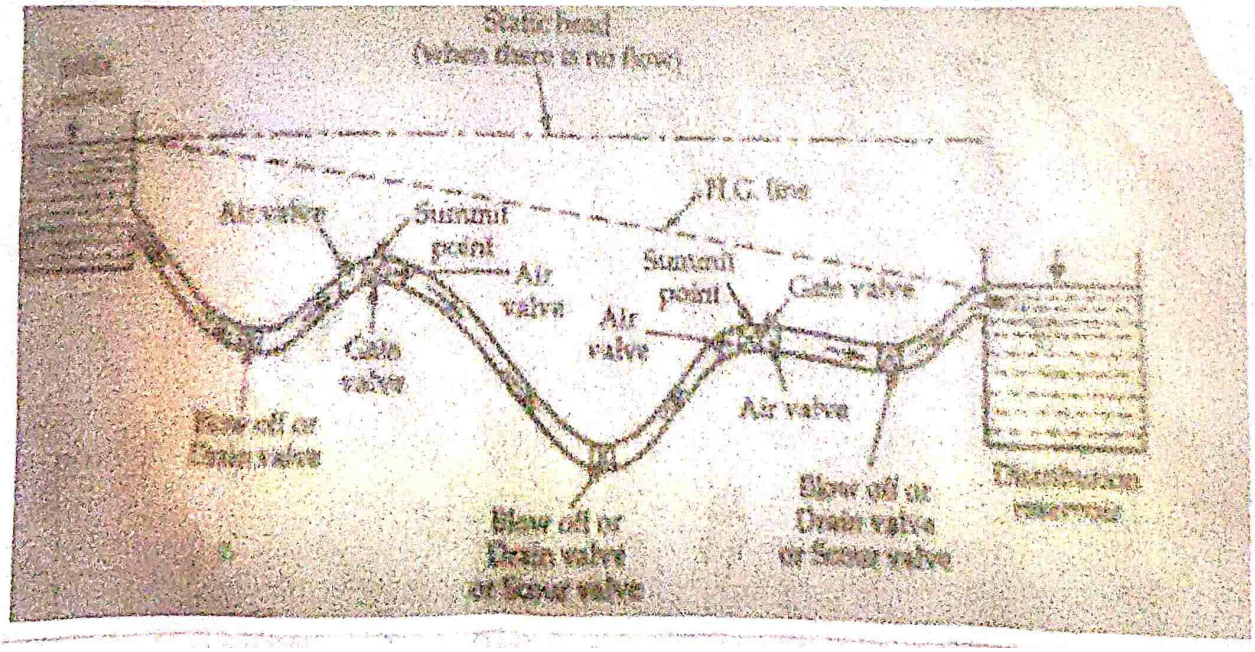
→ In order to prevent pipes & joint from pulling apart pipes are anchored by firmly embeding these postion of pipe in massive concrete or stone masonry block.

→ These anchors are also provided when pipes are laid on steep slopes where they have tendency to slip.

→ These anchors are also provided where there is tendency of joint to be loosend by tempelature stresses

T

Different types of Valves



Distribution Sysiem.

→ Distribution syslem is provided for carrying the waler from treatment plant to the individual homes.

→ Distribution syslem may therefore consist of pipelines of various sizes for carrying water to the streets, valves for controlling flow of waler in pipe, hydrants for providing connection with the waler main during fires, water meter for measuring amount of waler consumed.

→ Distribution syslem must possess following properties:-

(i) It should be capable of supplying water at all the inlended places.

(ii) It should be capable of supplying requisle amount of waler. for fire fighting.

(iii) It should be cheap and simple and easy to design operale & repair.

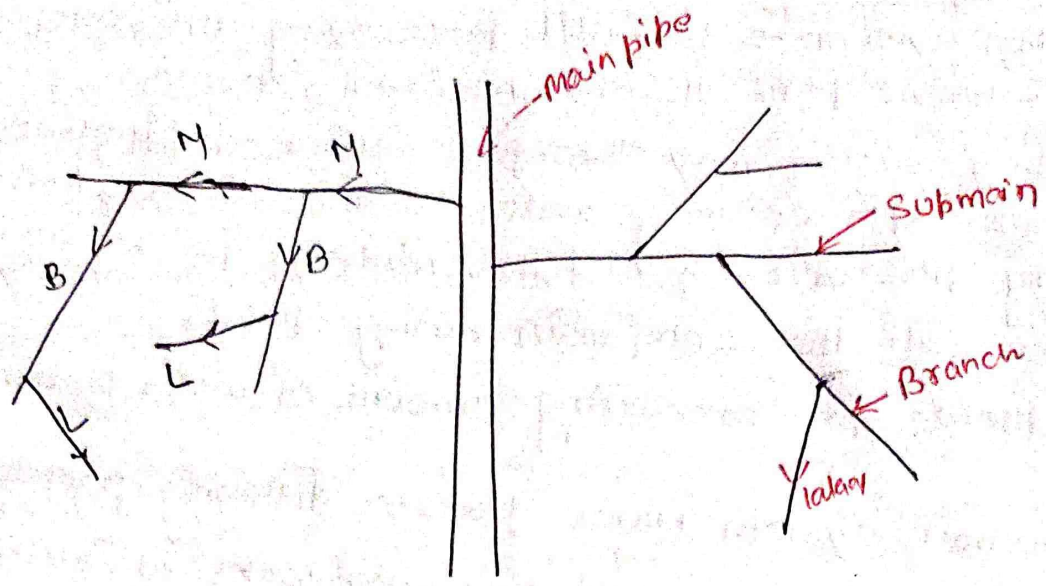
(iv) It should be safe against pollution of waler.

(v) It should be fairly water tight.

types:-

(i) Dead end/Tree syslem.
(ii) Grid iron/Reticulation/interlaced syslem.
(iii) Ring/circular system.
(iv) Radial/Star system.

(i) Dead-End tree system.



→ This system is provided for those community where development is not planned.

→ This system can be designed very easly it is comparatively economical as length of the pipe required is small & requirement of valve is less.

→ It can be expanded easily.

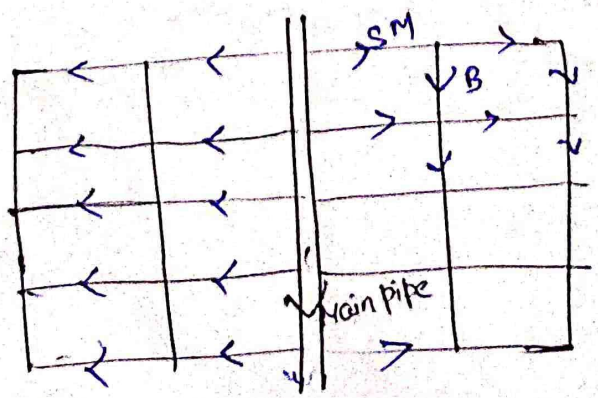
Drawback

→ As there is only one path available with the water to reach at a particular point in case of any obstruction downstream ~~Contin~~ section is affected.

→ Due to number of dead end chances of contamination of water is very high.

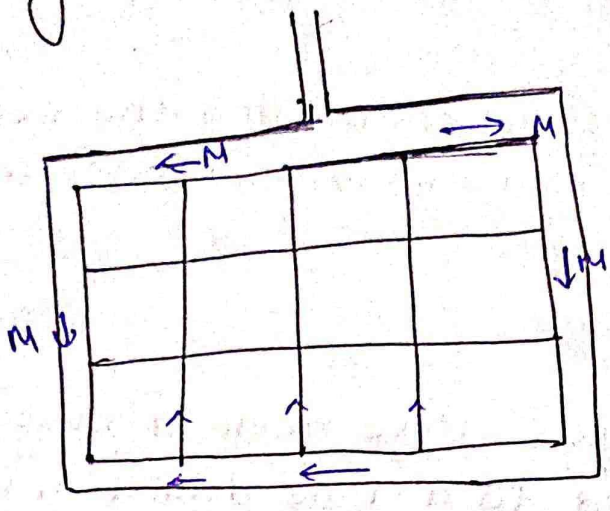
→ In case of fire breakout demand. can't be met.

(ii) Grid Iron system



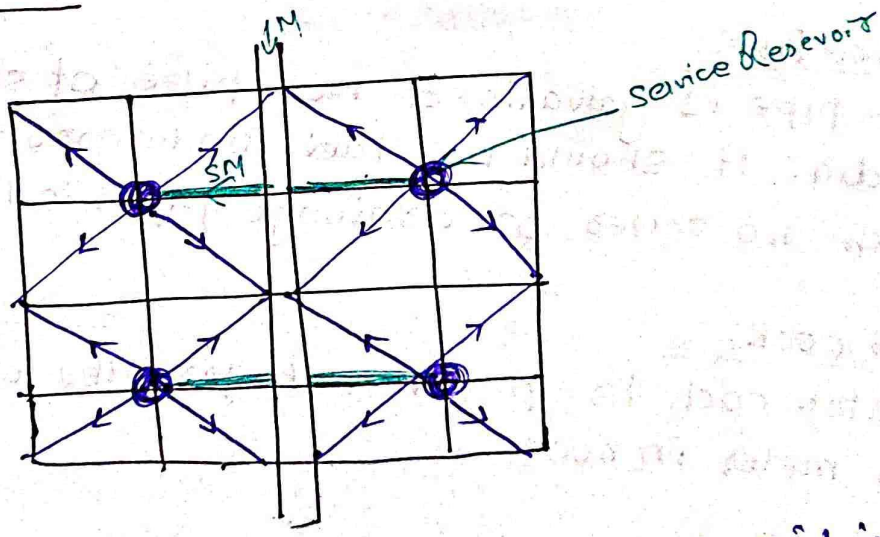
→ All the properties of the system are opposite to that of dead end system.

③ Ring System



→ It is same as that of grid iron system with only difference that main pipe in this case incircles an area of high water demand so as to maintain uniform pressure throughout the system.

④ Radial System



→ Here also all the properties are same as grid iron system with only change the water is supplied in radial direction.

→ It is comparatively costly.

House Water Connection.

→ By installing a water supply plumbing system in a building, the first and the main step is to obtain a water connection from municipal water main.

→ A typical water connection, connecting the service pipe with the municipal water main is shown, that comits of following:-

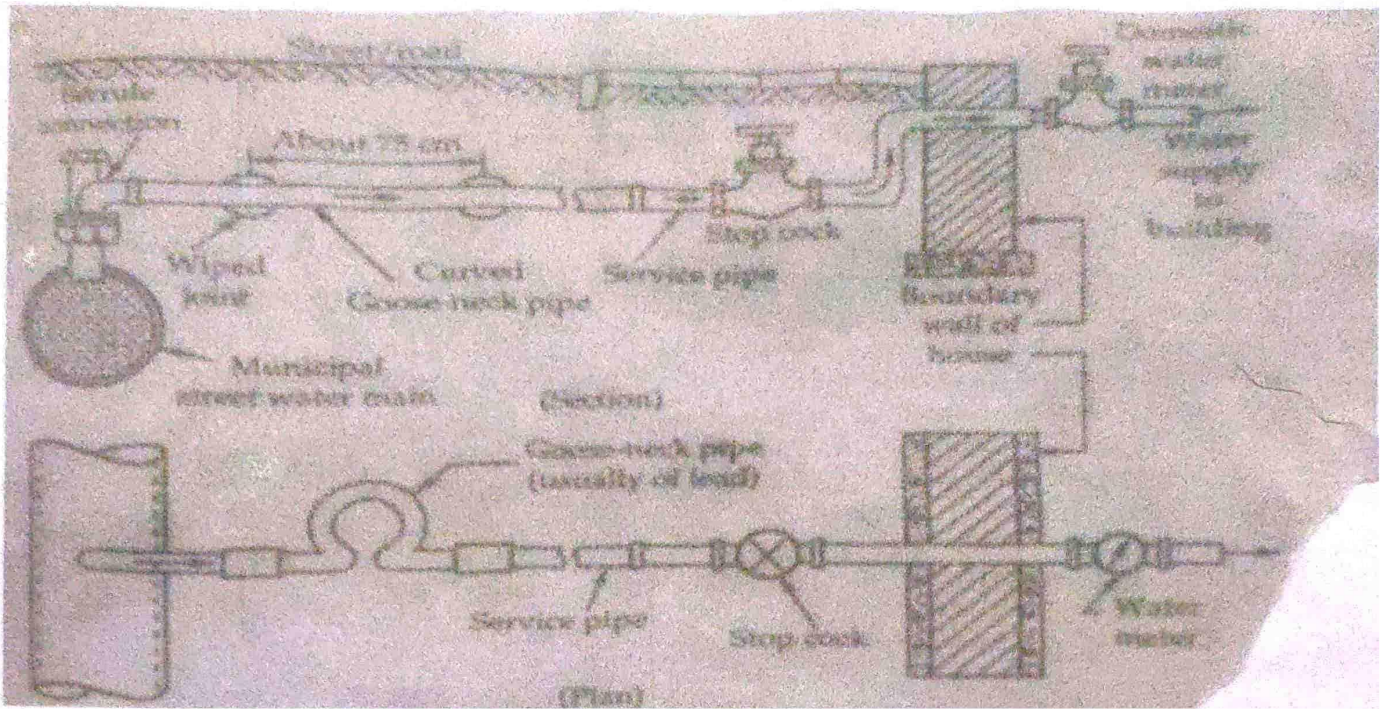
(i) Ferrule:
A ferrule is a right angled sleeve made of brass or gun metal and is joined to a hole drilled in water main. Its size varies between 10 to 50mm dia.

(ii) Goose Neck:
It is a small sized curved pipe made of a flexible material and is about 75 cm in length forming a flexible connection between the water main and service pipe.

(iii) Service Pipe:
Service pipe is galvanised iron pipe, of size less than 50mm dia. It should be laid underground in a trench in which no sewer or drainage pipes is laid.

(iv) Stop cock:
The stop cock is provided before the water enters the water meter in house.

(v) Water meter:
Water meter measure and record the quality of water consumed in the house.


Street road
Ferrule connection
About 75 cm
Wiped joint
Curved Goose-neck pipe
Service pipe
Stop cock
Municipal street water main
(Section)
Goose-neck pipe (usually of lead)
Service pipe
Stop cock
Water meter
(Plan)