CHAPTER FOUR

SEWAGE PUMPING /LIFTING

2020

SEWAGE PUMPING /LIFTING

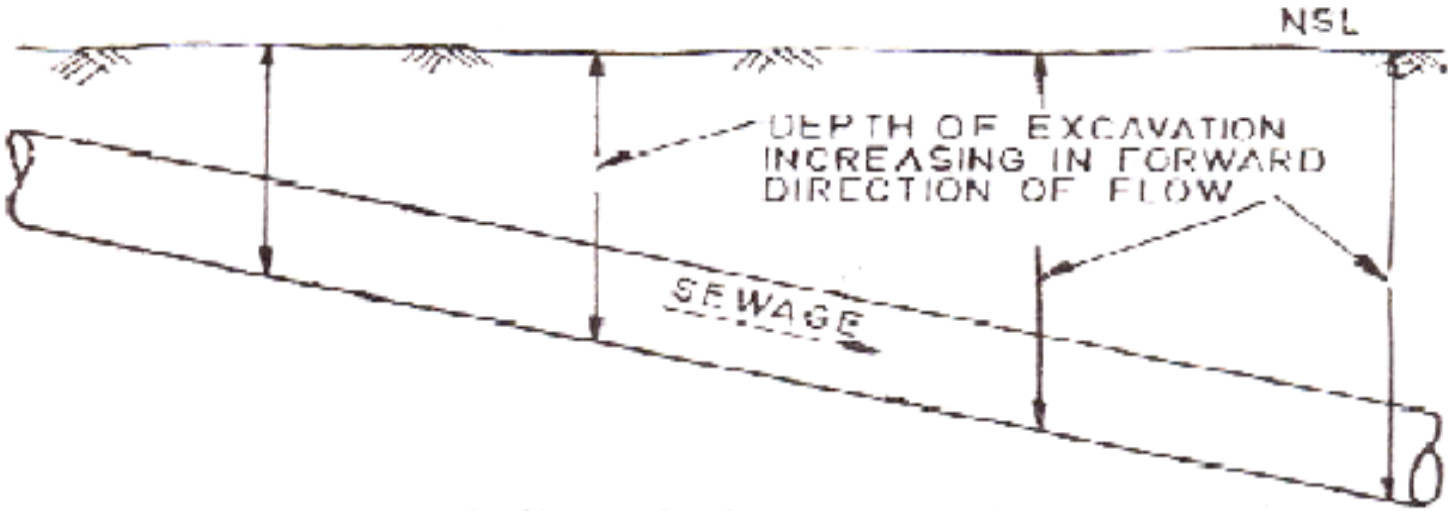
- Pump: is a mechanical device that used for lifting water or any fluid to a higher elevations.
- The operation of lifting water or any fluid is called pumping.

4.1 Necessity of pumping Sewage

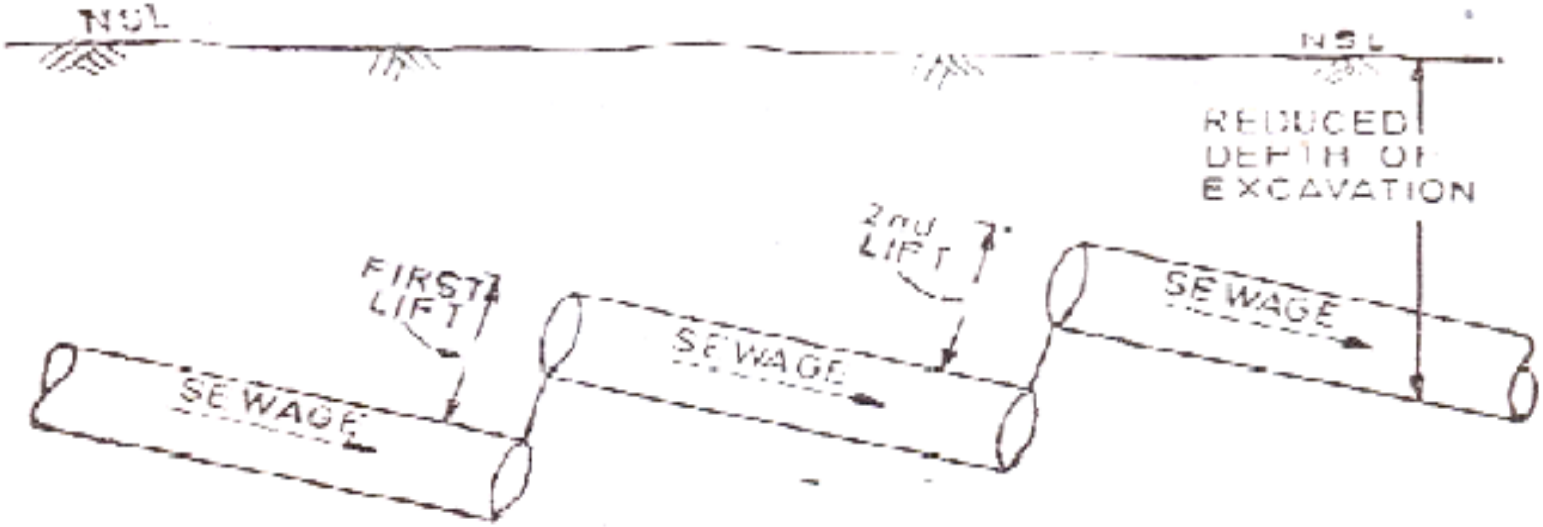
- ✓ Sewage is required to be lifted up from a lower level to a higher level at various places in a sewerage system.
- ❖ Sewage may have to be lifted by pumps under the following circumstances:
- ✓ The sewage from localized low laying pockets in city has to be pumped, so as to throw it up in to the city's sewer pipes flowing under gravity and running at higher
- ✓ elevation

continued

- When the area is flat, the laying of sewers at their designed gradients may involve deeper and deeper excavations to reduce such condition we use pump.
- When the level of outfall sewer is lower than the level of treatment plant, the sewage will have to be pumped up.
- Similarly, when level of the treated sewage coming out from the treatment lower than the level of the source of its disposal, it will have pumped before it can be disposed of.
- Recirculation of the effluent to achieve better purification, which is common in modern treatment plants.



(a) Ordinary laying of sewer line



Excavation for laying the sewer line

❖ Problems in Sewage Pumping

- ✓ Presence of a lot of suspended and floating solids causing very frequent clogging of pumps.
- ✓ Containing organic and inorganic wastes that can corrode pumping equipment and reduce their life time.
- ✓ Fluctuation of incoming flow of sewage requiring of adjustment of pumping from time to time.
- ✓ Smaller size of wet or sump wells to avoid longer detention time, otherwise deposited grit and organic solids start putrefying and cause nuisance for the operating staff.
- ✓ Smaller well requires continuous adjustment of pumping.
- ✓ It need to be highly reliable, otherwise, it will cause flooding and nuisance- public health hazard

4.2 Pumping Stations

- ✓ Is the building where pumps and other accessories are installed for lifting sewage.
- ✓ It should be located near a natural disposal unit, such as, a stream, a lake, or a river, etc., so that in case of breakdown of pumping, the accumulated sewage can overflow into this natural source of disposal.
- ✓ But at the same time, the site should be such that it is not liable to get flooded either due to seepage from the adjoining river stream or due to high floods in that river stream.

❖Component Parts of pumping station

Grit channel.

- ✓The sewage entering the pumping station generally contains a lot of indestructible solid matter, such as, grit, gravel, sand, etc., in addition to the solids in suspension like feces, papers, rags, etc.
- ✓The solid matter is, therefore, first of all, removed before the sewage enters the pump.

Screens.

- ✓which help in extracting other matter, such as excess of rags, sticks, etc.
- ✓Such matters, if not removed, may also cause the choking of pump impellers.
- ✓Two types of screens are commonly used course screens and fine screens.

Motor room

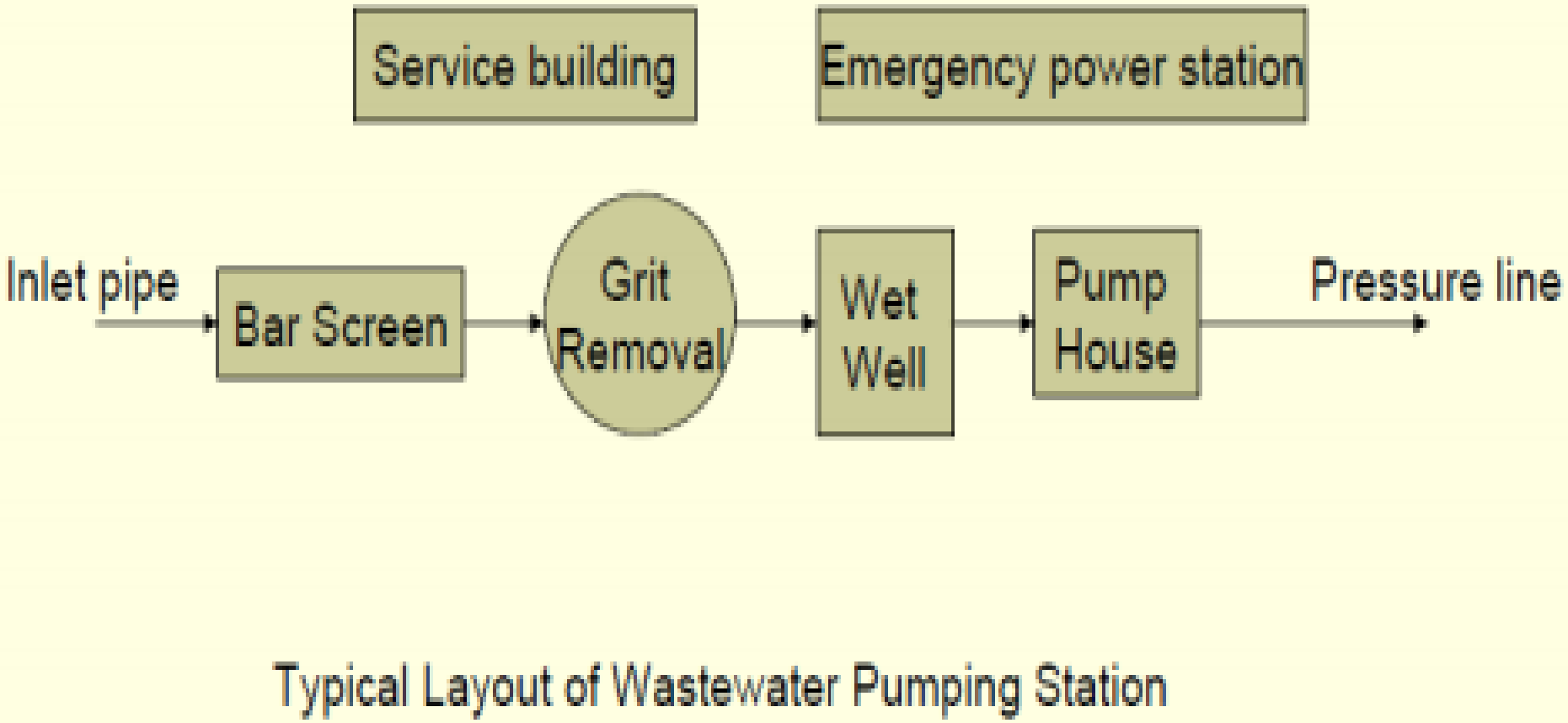
- ✓ Accommodates the electric motor which drives the pumps.
- ✓ The appurtenances like automatic starters, flow recorders, etc. are also installed in this room.

Rising mains

- ✓ The sewage, after being pumped, is taken to high leveled gravity sewer through the raising mains.

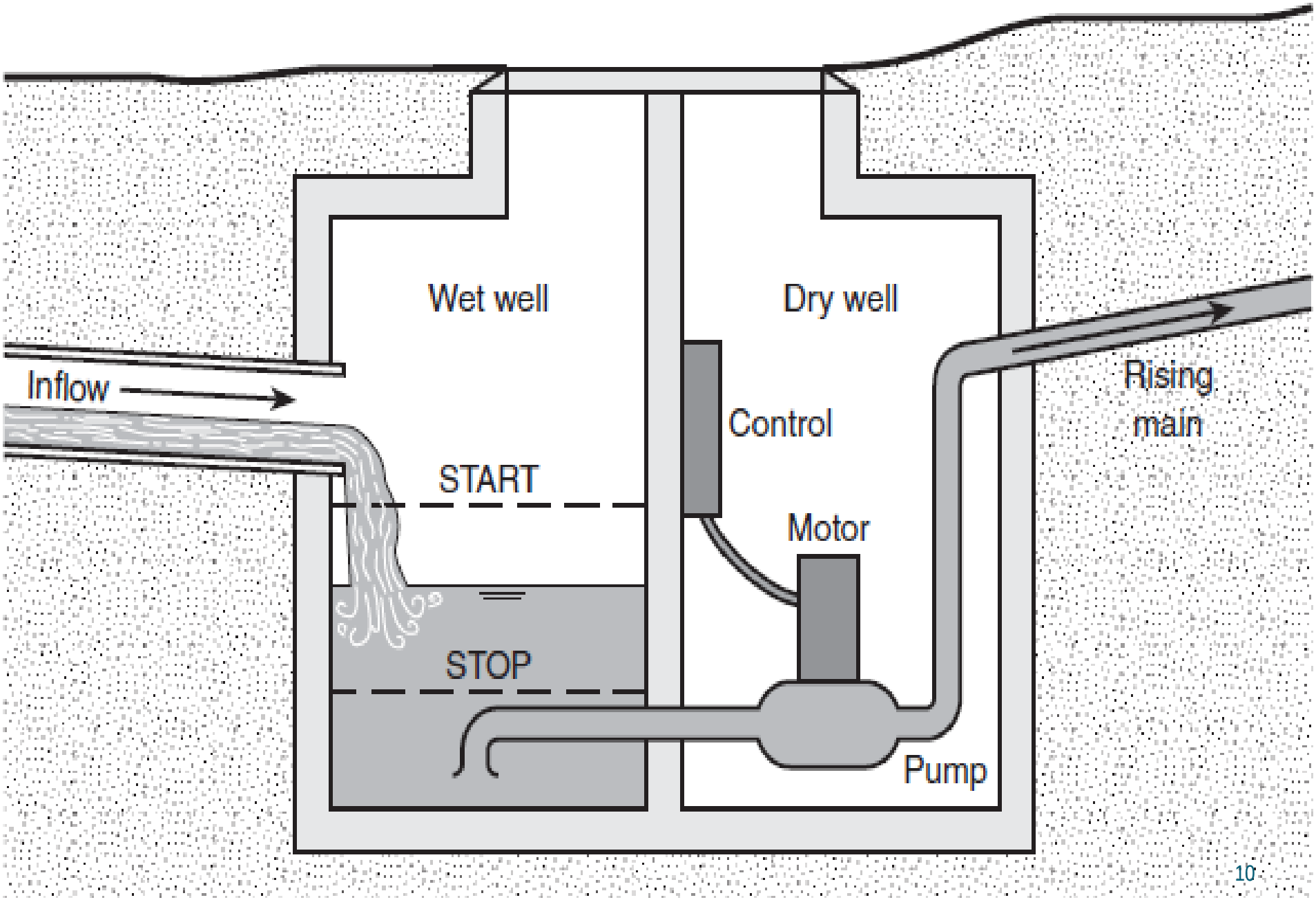
Emergency exit pipe.

- ✓ An emergency exit pipe, connecting the sump well with a natural stream or river, is preferably provided at all major pumping stations.
- ✓ Hence, when the sump well overflows due to any reason, the excess sewage can be easily directed through this exit pipe.



Typical Layout of Wastewater Pumping Station

Wetwell and pump houese



4.3 Types of pumps

- ✓ Various types of pumps that are commonly employed for pumping sewage are:

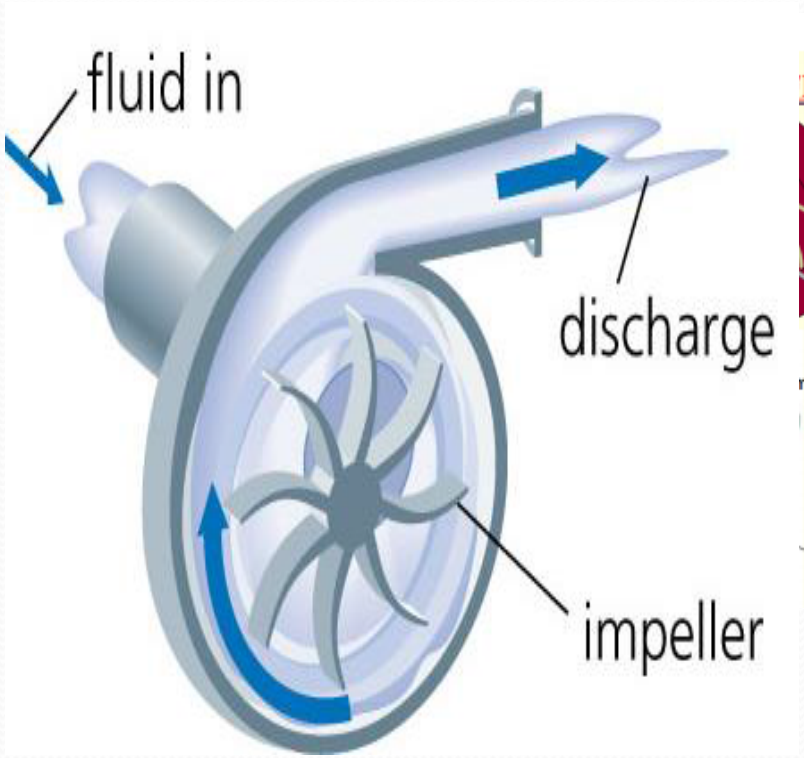
1. **Centrifugal Pumps.**

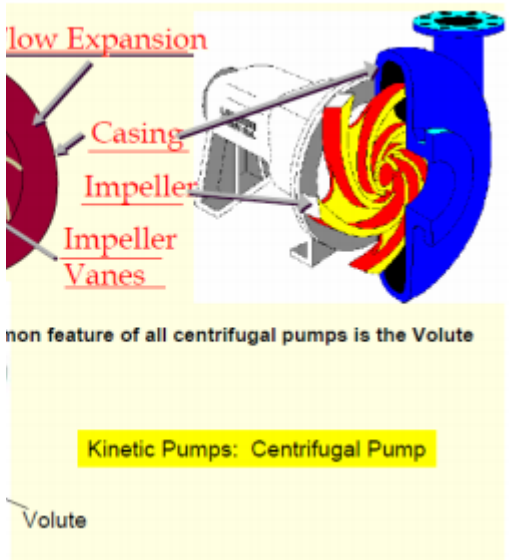
- ✓ Which lifts the sewage by centripetal force when the impeller rotates the sewage is pumped up.

Are two types:

- ✓ **Non clog pumps**: with large enough clearance to allow any solid matters entering the pump to pass out with the liquid sewage. This helps in preventing the clogging of pumps and damage of the rotor (impeller)

- **Disintegrating pumps**: in which the solid matters present in sewage are broken up (i.e. disintegrated) as they pass through the pump impeller.
  The use of centrifugal pumps, avoid installing pre screens or communtor.





2. Reciprocating pumps

- In the reciprocating pump a piston sucks the fluid into a cylinder then pushes it up causing the water to rise. Are two types:
  - Ram type: a piston or a plunger moves inside a closed cylinder, the liquid enters the cylinder through the intake suction valve. The delivery valve remaining close during intake stroke on the discharge stroke, the suction valve closes, and the liquid is forced into the delivery pipe through the delivery valve, which opens during the discharge stroke.
  - Propeller type: a multiple blade screw rotor or propeller moves vertically inside a pump casing, causing the sewage to lift up.

The main components are:

- ✓Cylinder with suitable valves at inlet and delivery.
- ✓Plunger or piston with piston rings.
- ✓Connecting rod and crank mechanism.
- ✓Suction pipe with one way valve.
- ✓Delivery pipe.
- ✓Supporting frame.
- ✓Air vessels to reduce flow fluctuation and reduction of acceleration head and friction head.

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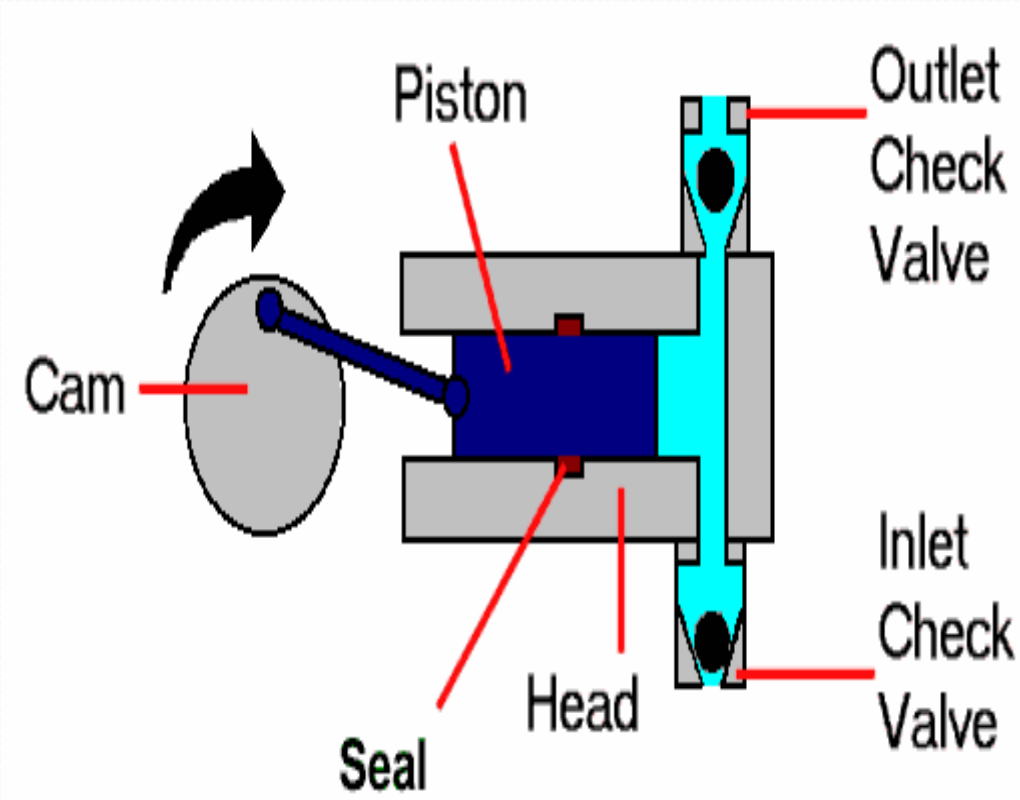
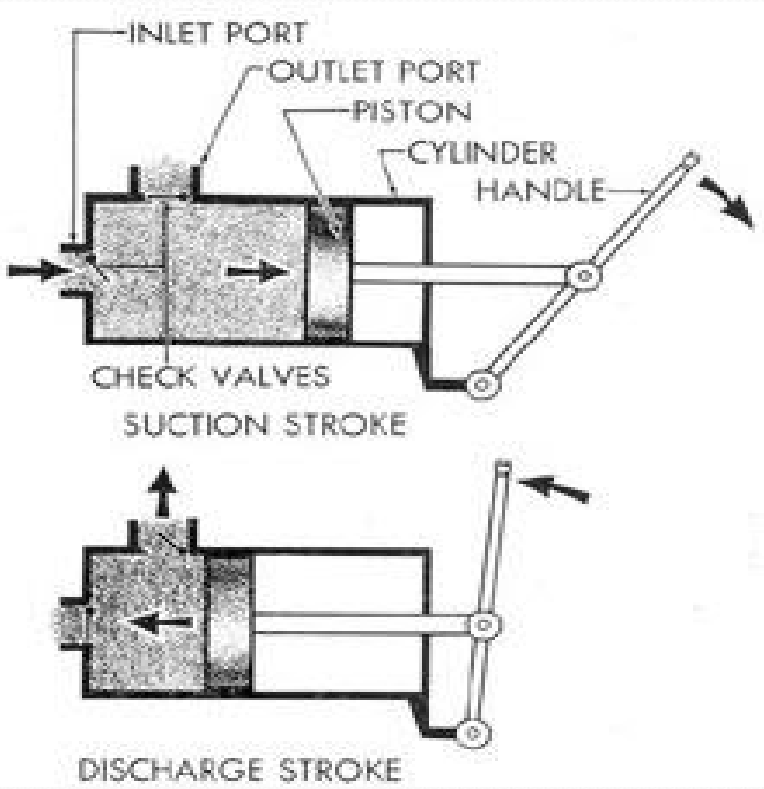
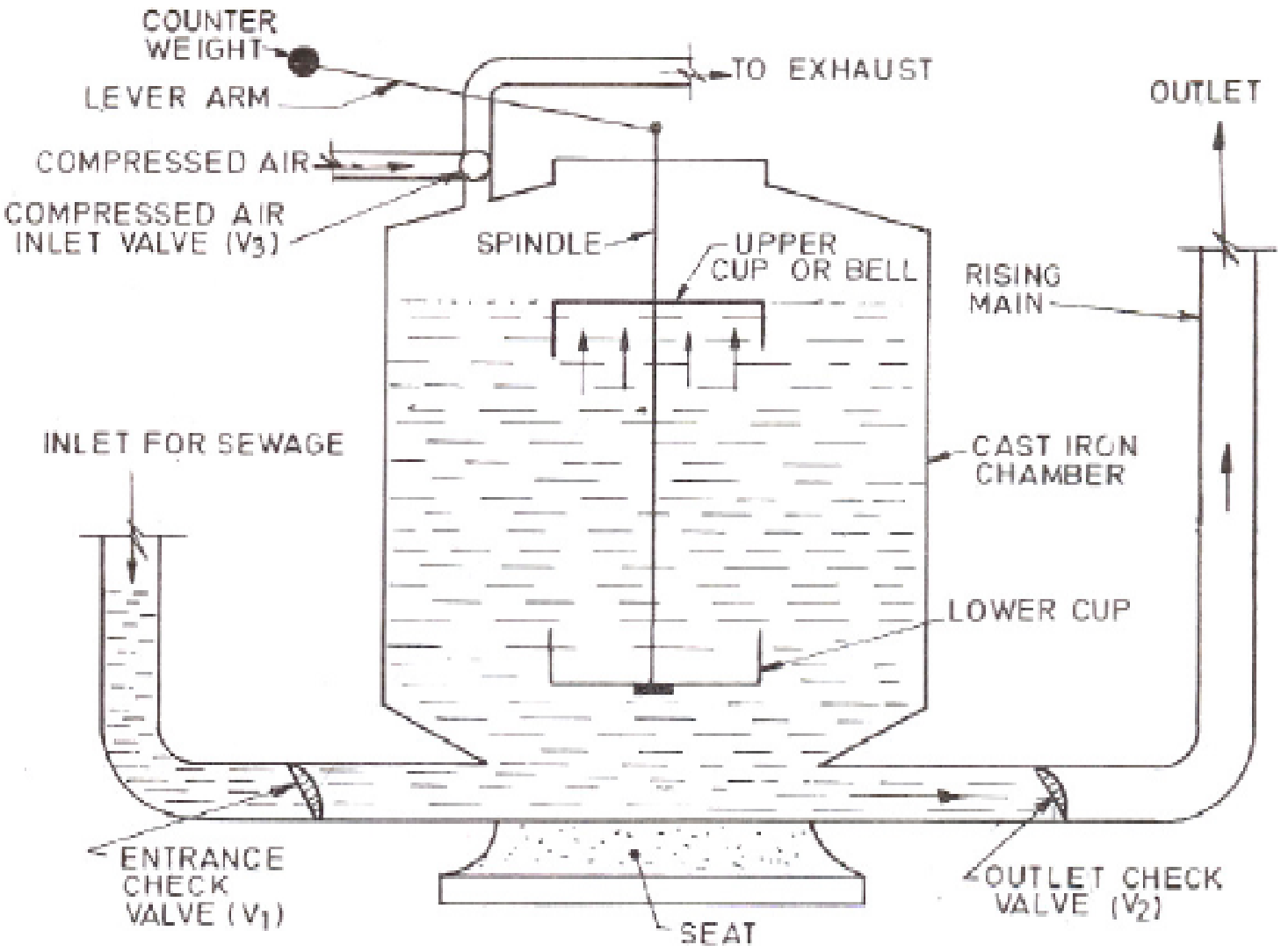

Piston
Outlet
Check
Valve
Cam
Inlet
Check
Valve
Head
Seal


INLET PORT
OUTLET PORT
PISTON
CYLINDER
HANDLE
CHECK VALVES
SUCTION STROKE
DISCHARGE STROKE

continued

3. **Pneumatic ejectors or Air pressure pumps.**

- ✓ Are sometime called air ejectors or air pressure pumps
- ✓ Consists of an air- tight tank in to which the waste water flows by gravity, and out of which, the waste water is forced automatically whenever sufficient waste water has accumulated to raise a float, and thus opening the compressed air inlet valve.



Shone's Air – Ejector.

continued

- The air under pressure entering the chamber from valve (V3) forces the wastewater from inside the chamber to rise up. In the outlet pipe by opening the exit valve (V2).
- At this stage, the valvesV2 and V3 remain open, but valve V1 is closed. The wastewater is thus lifted up and discharged from the outlet, till the level of the wastewater falls below the bottom of the upper cup. At this stage, the entrapped air from the upper cup escapes, and the lever arrangement opens the exhaust and closes the compressed air inlet valve (V3). The exit valve (V2) also closes, and the entrance valve (VI) opens to again admit the wastewater. The process goes on repeating.

Example 1:

- A low lying residential colony is having a population of 3000 persons. The colony gets a per capita supply of water at the rate of 140 liters per day. A separate sewerage system for the colony is installed. It is further required to lift the entire sewage of the colony by installing an air-ejector or air pressure pump . Assuming the velocity in the main sewer as 0.9 m/sec, and velocity of compressed air as 5 m/sec. Design the ejector or air pressure pump. Assume the entire water supplies totally appear as sewage.

Solutions

We have the average sewage flow

$$= \frac{3000 * 140}{1000 * 24 * 60 * 60} cumecs$$

$$= 0.00486 \text{ cumecs.}$$

Assuming the peak flow to be three times the average flow, have

The peak sewage discharge to be lifted

$$= 3 \text{ x } 0.00486$$

$$= 0.0146 \text{ cumecs.}$$

Design of the Ejector Chamber

Assuming that the ejector fills after every ten minutes, we have the required capacity of the ejector

= 0.0146 x 10 x 60 cu-m.

= 8.75 cumecs

Assuming the height of the ejector as 2 m, we have the cross-sectional area of ejector chamber

$$= \frac{8.75}{2} m^2$$

$$= 4.375 \text{ m2.}$$

Diameter of the circular ejector chamber

$$= \sqrt{\frac{4.375 * 4}{\pi}}$$

$$= 2.36m; say\ 2.5m$$

Hence use 2.5m diameter ejector chamber with 2m height

Design of main sewer

Since the peak flow of 0.0146 cumecs flows with the velocity of 0.9m/sec., we have

Area of x-section of the main

$$= \frac{0.0146}{0.9}$$

$$= 0.016m^2$$

Diameter of the main

$$= \sqrt{\frac{0.016*4}{\pi}}$$

$$= 0.143$$

$$= 14.3 \text{ cm; say15cm diameter}$$

Design of the Compressed Air-pipe

Velocity of the compressed air = 5 m/sec.

Area of the pipe required 0.0146

$$= \frac{0.0146}{5}$$

$$= 0.0029 \text{ m2.}$$

Diameter of air pipe

$$= \sqrt{\frac{0.0029 * 4}{\pi}}$$

$$= 0.06 \text{ m.}$$

$$= 6 \text{ cm. Ans.}$$

End of chapter four