BULE HORA UNIVERSITY

CHAPTER – four

MISCELLANEOUS HYDRAULIC MACHINES

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General out line of the topic

- Introduction
- Hydraulic accumulator
- Hydraulic intensifier
- Hydraulic press
- Hydraulic crane
- Hydraulic lift
- Hydraulic ram

4.1. Introduction

- A fluid system is a device in which force and power are transmitted through a fluid medium, generally oil or water.

- There are various types of fluid machines which are employed for storing or magnifying many fold the hydraulic energy.

- The stored(magnified) energy is later transmitted to the required machine.

- Most of these fluid machines work on the principles of either fluid statics or fluid kinematics.

Introduction(con’td…)

- In fluid statics or hydraulic system, the power or force is transmitted to the required machine by the change in pressure.

- In fluid kinematics or hydro-kinematics system the effect is obtained primarily by virtue of the change in velocity of flow of the working, i.e. liquid and changes in pressure are avoided as far as possible.

- Some of these machines are described here in under.

4.2. Hydraulic Accumulator

- Hydraulic accumulator is a device which is used for **storing or accumulating** the water under pressure (hydraulic energy) temporarily and **transmitting** it either as it is or after magnifying it several times to the machine (hydraulic press, lift, etc.) wherever required.

- Several hydraulic machines such as hydraulic lift, hydraulic press or hydraulic crane etc. are required to do a large amount of work during a small interval of time, which is followed by an idle period.

- The need of these machine is not at uniform rate through out its stroke. Whereas, the pumps supply water (liquid) at uniform rate.

Hydraulic Accumulator(con’td…)

- For example, a lift or a crane requires the energy to be supplied **during its up ward motion** of the load only. Practically, no energy is used during its downward motion.

- But the pumps supply water (liquid) under pressure (hydraulic energy) continuously more or less at uniform rate.

- Hence, this water under pressure **(hydraulic energy) is stored in an accumulator during the idle period** of the machine when the machine doesn’t need this energy.

Hydraulic Accumulator(con’td…)

- There are two types of hydraulic accumulator. These are:
  1. Simple hydraulic accumulator and
  2. Differential hydraulic accumulator

I. Simple hydraulic accumulator:

- An accumulator consists of a vertical cylinder containing a sliding ram.
- The ram is loaded with heavy loads which may consists of slag or dead weights.
- The accumulator is introduced in between the pump and the machine.

Hydraulic Accumulator(con’td…)

- Initially the ram is at its lowest position and the water from the pump is delivered into cylinder when not required by the machine.
- The pressure of water lifts up the heavy ram until the cylinder is full and the accumulator has stored its maximum amount of energy.
- Later on when the machine does maximum amount of work, it draws the energy from the accumulator and the ram descends down.
- This is one cycle of the hydraulic accumulator.

Hydraulic Accumulator(con'td…)

- The maximum amount of energy which it can store, is known as the **capacity of the accumulator**.
- Let D be the diameter of the ram , L its lift (length of the stroke) and pump supply the liquid (water) under pressure P.

- Weight of the ram including the dead weight being supported by it.
- That is, **W=P*A** and the work done in lifting the ram is

Work = weight *length =W_{done}= W_{weight}

Hydraulic Accumulator(con’td…)

- The work done in lifting the ram is equal to the energy stored and hence, it is the capacity of the accumulator.

Volume of accumulator = A*L

Capacity of accumulator = p*volume =P*A*L

Hydraulic Accumulator(con’td…)

II. Differential accumulator (Twedell’s):

- Its main advantage is that, it can store water at high pressure by comparatively small load on the ram.
- It consists of a vertical fixed ram, the lower portion of which is made larger than the upper portion by closely fitting a brass bush around it.
- The fixed ram is surrounded by an inverted cylinder with the collar at the base projecting outward.
- The loads are being supported over these collars.

Hydraulic Accumulator(con’td…)

- The fixed ram is being provided at its centre with a small diameter vertical hole throughout its length.
- The water under pressure (supplied by the pump) enters the accumulator through this hole.
- This causes the cylinder to ascend upward and store water under pressure (hydraulic energy).
- The liquid entering the cylinder exerts pressure on the internal annual area of the cylinder which is equal to the horizontal area of the brass bush.

Hydraulic Accumulator(con’td…)

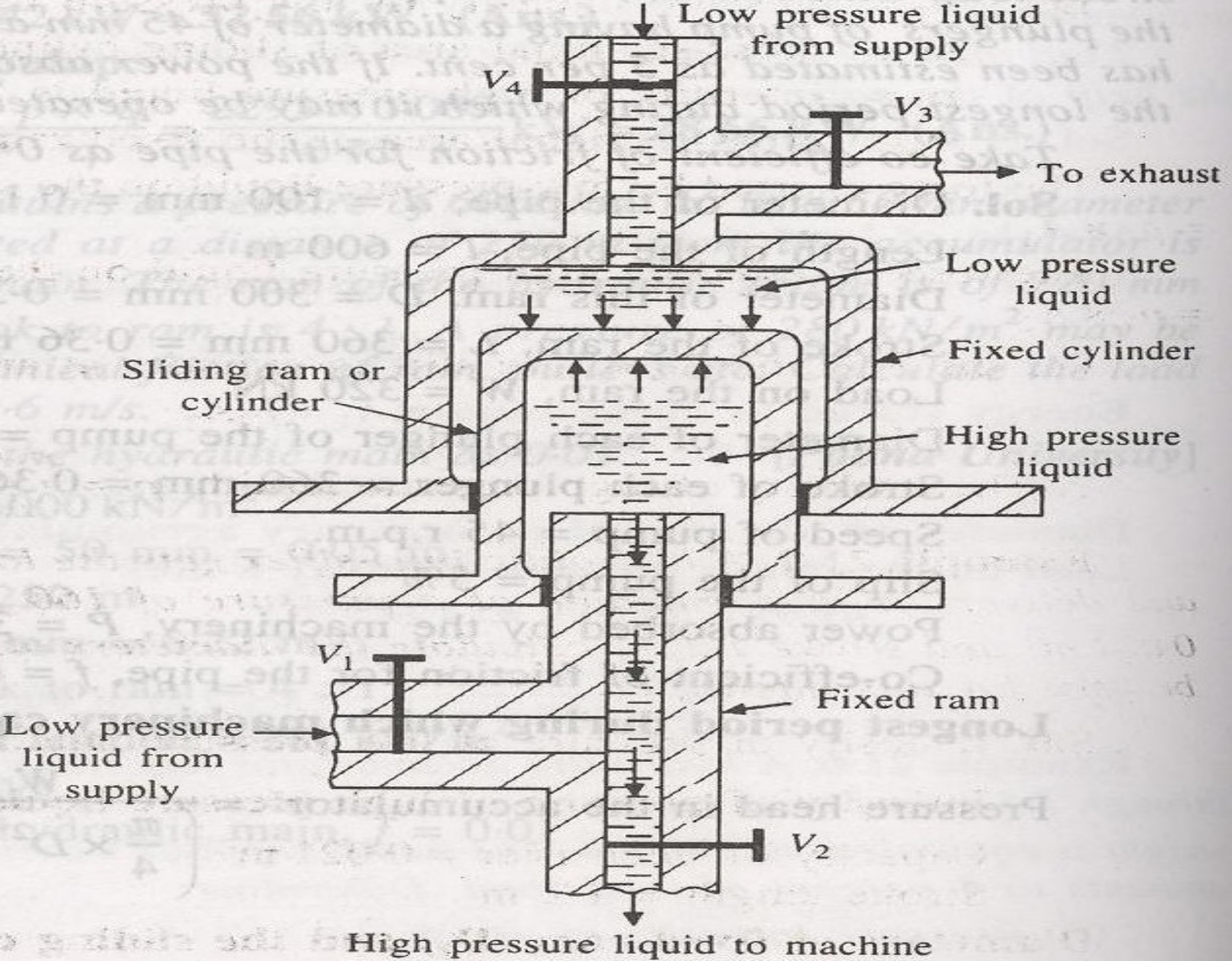
- When the machine is working, the liquid under pressure (hydraulic energy) is supplied by the accumulator and the cylinder descends downward.

$$W = P*A, \text{ from this equation } P=W/A$$

- It is clear that pressure intensity can be increased with a small load ‘W’ by making the area ‘A’ small.

4.3. Hydraulic Intensifier

- Hydraulic intensifier is a device which is **used to increase intensity of the pressure** of the given liquid with the help of low pressure liquid of large quantity.
- Applicable at a place where liquid of higher pressure is to be developed from available low pressure.
- It is located between pump and machine(i.e. press, crane, lift) that needs high pressure liquid for its operation.


Low pressure liquid from supply
V_4
V_3
To exhaust
Low pressure liquid
Fixed cylinder
Sliding ram or cylinder
High pressure liquid
V_1
Fixed ram
Low pressure liquid from supply
V_2
High pressure liquid to machine

4.4 Hydraulic Press

- It is a device **used to lift heavy load** by application of much smaller force.
- It is based on Pascal's law which states that intensity of pressure is transmitted equally in all direction through a mass of fluid at rest.

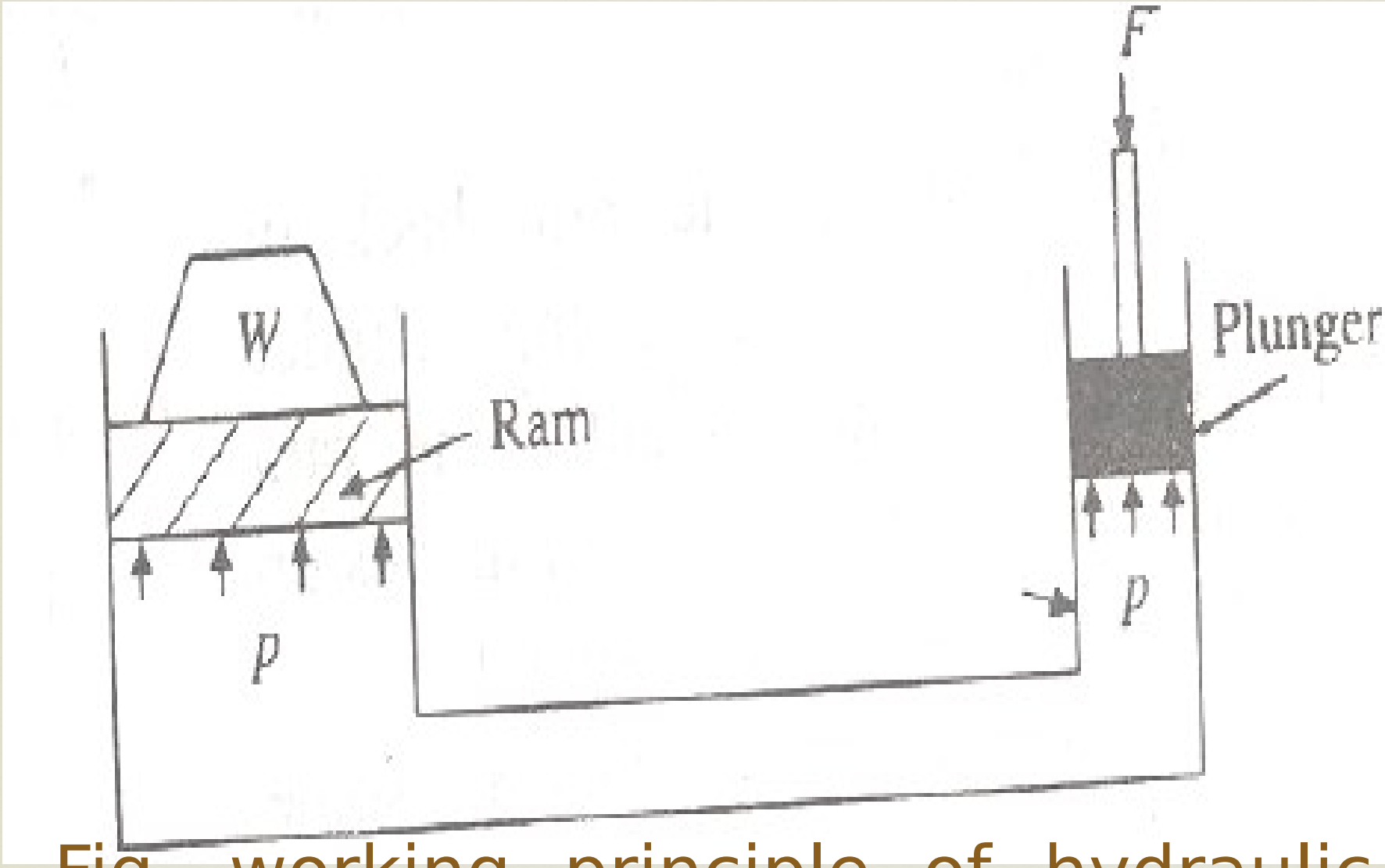


Fig. working principle of hydraulic press

- Consider a ram and plunger, operation in two cylinder of different diameter, which are inter connected at bottom through a chambers which is filled with some liquid.

Let,

W = weight to be lifted

F = force applied on the plunger

A = area of ram, and

a = area of plunger

Pressure intensity produced by the force F, is

$$p = \frac{Force}{area\ of\ plunger} = \frac{F}{a}$$

As per Pascal's law, the above pressure intensity, p will be equally transmitted in all directions.

Therefore, the pressure intensity on ram, P will be

$$p = \frac{F}{a} = \frac{W}{A}$$

$$\boldsymbol{W = F\frac{A}{a}} \ldots\ldots\ldots\ldots . equation\ 1$$

Equation 1 above, indicates that, by applying a small force F on the plunger, a large force W may be developed by the ram.

4.5 Hydraulic Crane

- Hydraulic crane is a device **used to lift heavy load**, up to (25MN). it is widely used in docks for loading and un loading ships, warehouses, founder work shop and heavy industries.

- Construction of hydraulic crane consists of hydraulic crane and jigger

- The crane have central mast from which tie and a jib are fixed. The mast is fixed on a pedestal which can revolve the load can be lifted and moved around the crane area depending up on the length of the jib.

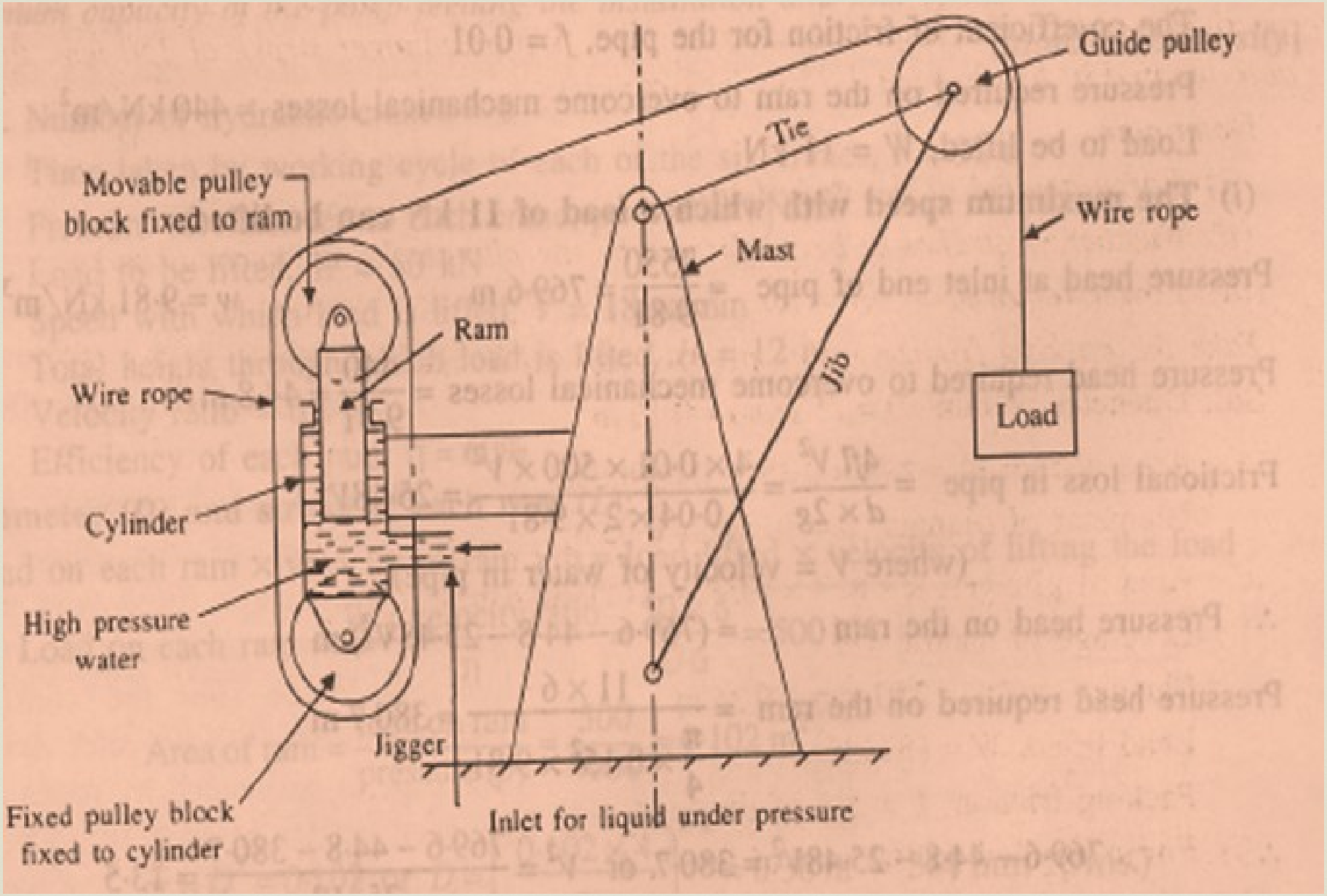


Fig. hydraulic crane

4.6 Hydraulic Lift

- It is a device **used to lift person and load from one floor to another**, in a multi-stage building.

There are two types of hydraulic lift those are:

- direct acting hydraulic lift and
- suspended hydraulic lift

1. Direct acting hydraulic lift

- consists of a ram sliding in a cylinder, as shown below
- A plat form or a cage is fitted to the top end of ram on which goods may be placed or person may be stand.
- As the liquid under pressure is admitted to the cylinder, the ram move up and cage is lifted. The lift of the cage is equal to the stroke of the ram. The cage moves in the down ward direction when the liquid from the fixed cylinder is removed.

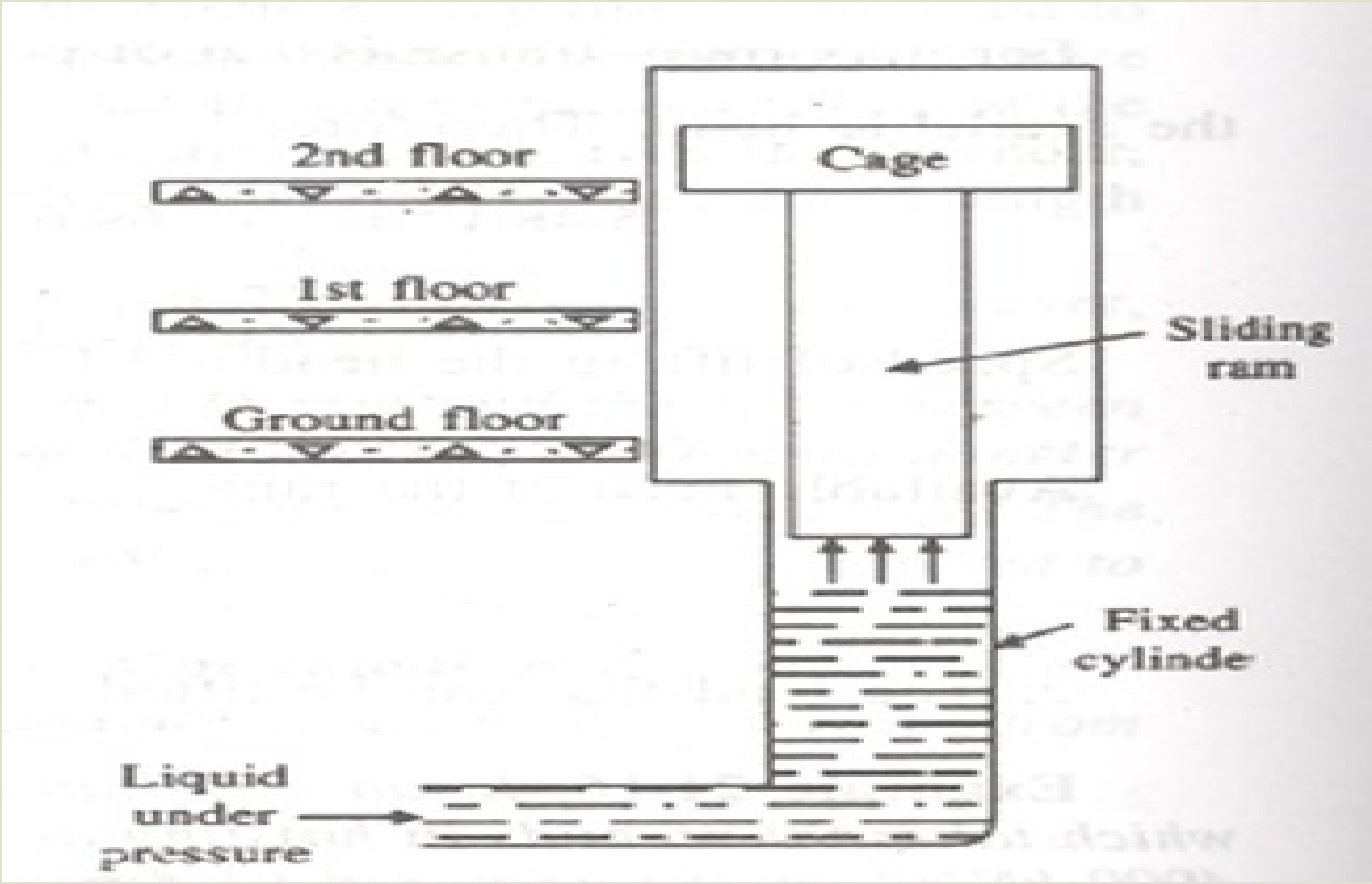


Fig. Direct acting hydraulic lift

2. Suspended hydraulic lift

- Suspended hydraulic lift is modified form of direct acting hydraulic lift.
- It is fitted with a jigger which is exactly the same as in case of hydraulic crane
- The cage is suspended by rope. It run in guides of hard wood or around steel. In order to balance the weight of the cage sliding weight balance are provided.

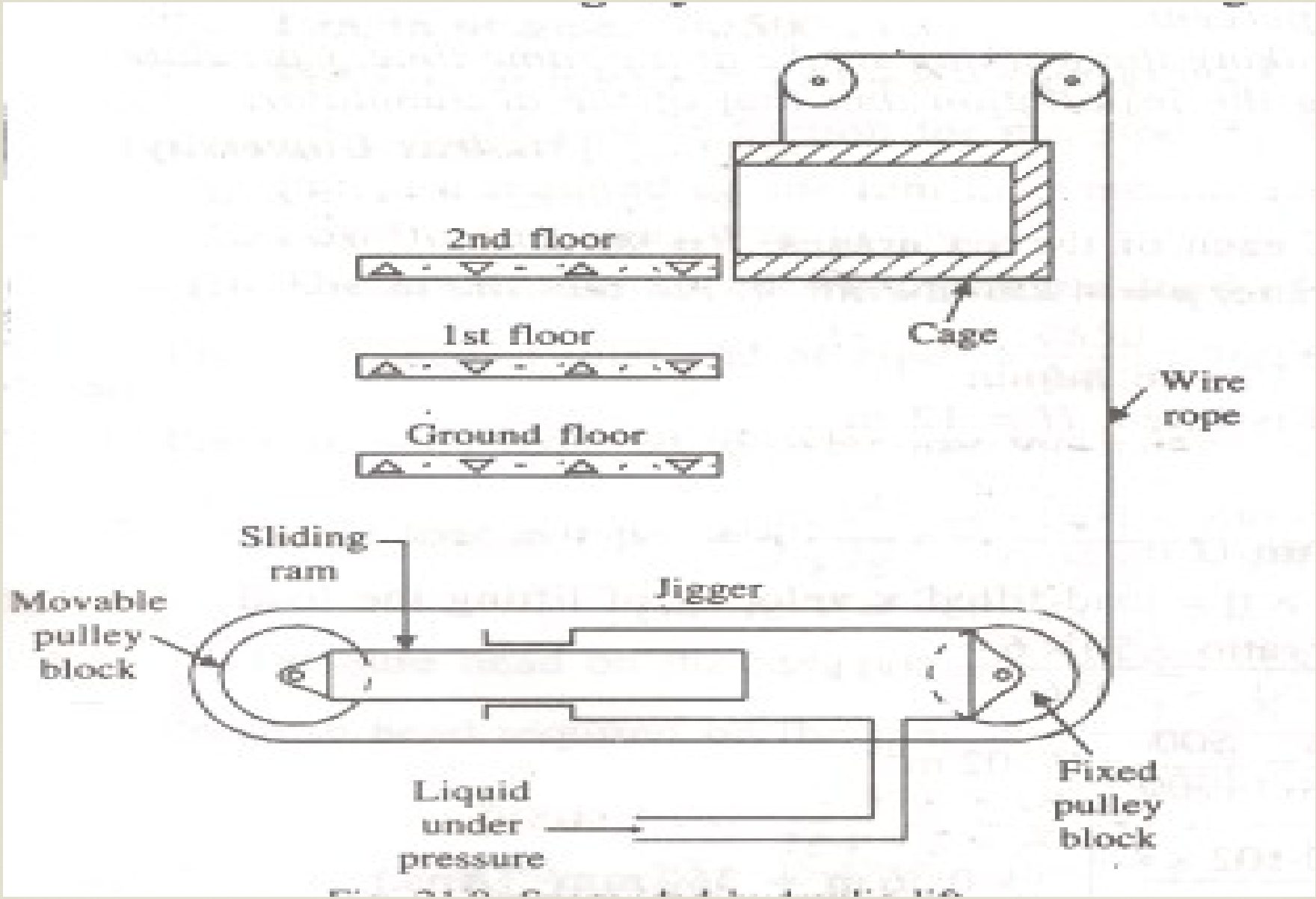


Fig. Suspended hydraulic lift

4.7 Hydraulic Ram

- The hydraulic Ram pump or hydram is a complete automatic device that uses the energy in the flowing water such as spring, stream or river **to pump part of the water to a height above that of the source** with a continuous flow of water.

- A hydram operates continuously with no external energy source.

- A hydram is a structurally simple unit consisting of two moving parts.
- These are the impulse valve (or waste valve) and the delivery (check) valve. The unit also consists of an air chamber and an air valve.

cont...

- The operation of a hydram is intermittent due to the cyclic opening and closing of the waste and delivery values.
- The closure of the waste valve creates a high pressure rise in the drive pipe.

- An air chamber is required to transform the high intermittent pumped flows into a continuous stream of flow.
- The air valves allow air into the hydram to replace the air absorbed by the water due to the high pressure and mixing in the air chamber.

Construction of the Hydram

- In designing an efficient hydraulic ram pump the most basic decision involves the choice of materials.
- Beside their **availability and cost** which are always of primary consideration, materials are also chosen on the basis of their properties.
- Materials that prolong the life of pumps are largely suitable. Galvanized metal plates and pipes were used for the construction.
- Figure below shows the fabricated hydram pump

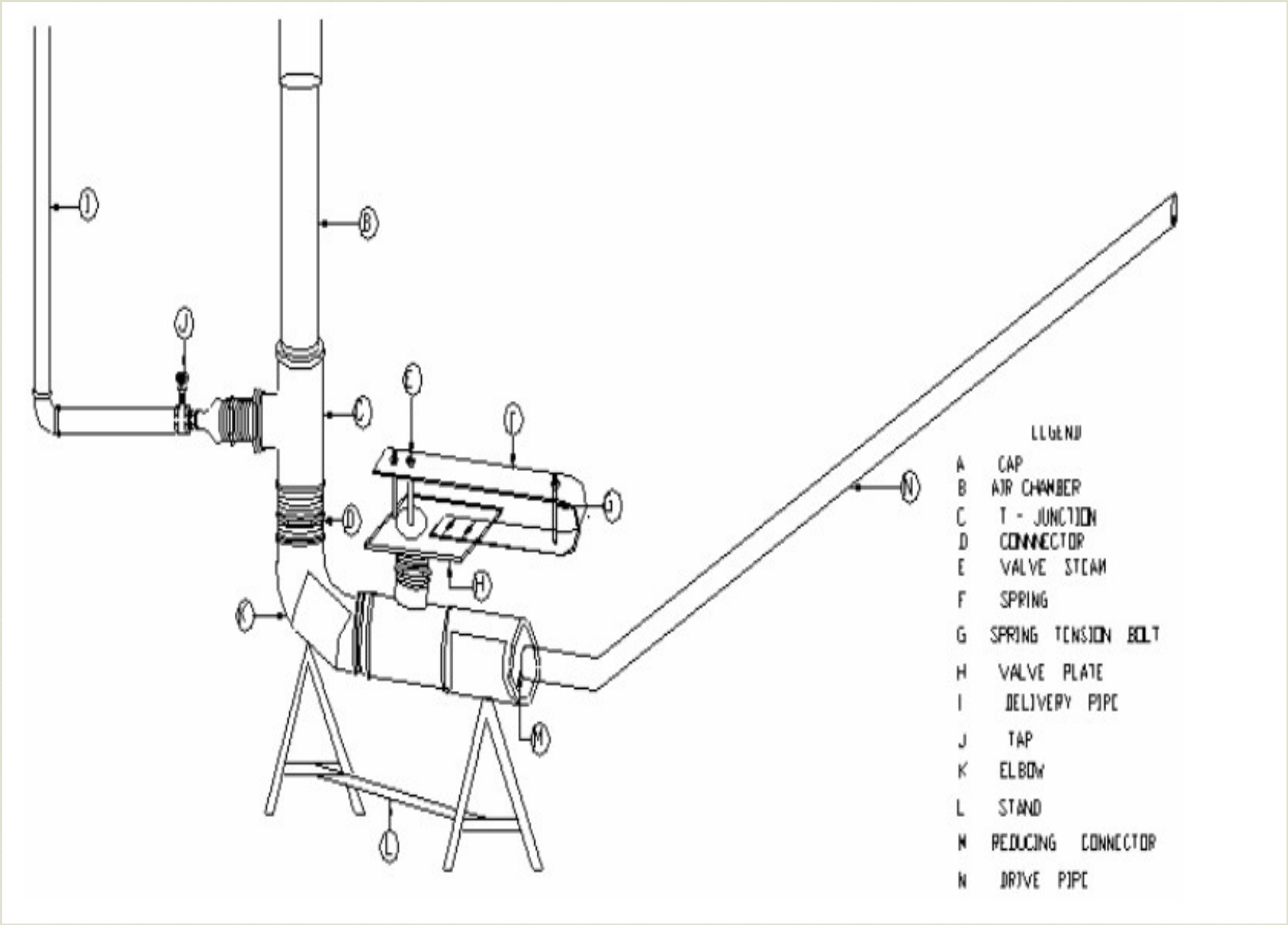


Fig. hydraulic ram

For more detail explanation please refer:

A TEXT BOOK OF FLUID MECHANICS AND HYDRAULIC MACHINES in SI UNITS
by R.K. RAJPUT

(Chapter 21: Miscellaneous Hydraulic Machines)

End of the course

