MECHANICAL BRAKING SYSTEM OF MINE WINDERS

WHAT IS A BRAKE ?

- Brake is a safety device which inhibits motion.

- Braking is the conversion of kinetic energy into other forms of energy.

Purpose of braking(in winders):

- Stopping the cage at various insets
- Holding the cage at rest at a desired location
- Speed control of hoists(affect retardation)
- Emergency stoppage of cage for safe hoisting
- Controlled slipping function

CLASSIFICATION OF BRAKING SYSTEM:

- **MECHANICAL BRAKING SYSTEM: It dissipates all the kinetic energy of the system by means of frictional forces to the atmosphere in the form of heat.**

- **ELECTRICAL BRAKING SYSTEM : It converts kinetic energy of a moving or rotating body into electrical energy which can be stored in batteries or lost in the form of heat.**

MECHANICAL BRAKING METHODS:

- Although due to the universal application of electrical braking systems like regenerative braking and dynamic braking the use of mechanical braking systems for normal service has reduced .
- However the regulations demand that all brakes should "FAIL TO SAFETY".

- Electrical systems are liable to failure in operation due to minor or major circuital defects or on the event of power failure.

MECHANICAL BRAKING METHODS:

- Hence the role of mechanical braking system as a critically reliable safety device comes into play.
- It is always the case that electrical braking systems are used in conjunction with mechanical braking units , their operations interlinked.

PURPOSE OF MECHANICAL BRAKING:

THREE PRIME FUNCTIONS:

- **Service braking** involves the retarding or restraining of the speed as required by the operator or by the automatic controls and to bring the conveyance to rest.

- **Parking braking** involves holding the load safely when the wind is completed, or when power is disconnected for servicing or standing idle.

PURPOSE OF MECHANICAL BRAKING:

Emergency braking results in automatic slowing(retardation) and stopping the winder before the conveyance or skip reaches the limits of travel without assistance from an external source of energy. It shall occur when:

(a) The controls malfunction or control is lost;

(b) Power is lost;

(c) An emergency stop is instigated by either personnel intervention or some protective device signalling an operating fault.

(d) drop in pressure of actuating hydraulic fluid

(e) Excessive speed of the conveyance indicated by an electronic over-speed limiter.

Purpose of mechanical braking:

Service brakes and Parking brakes are instigated by the same braking circuit while Emergency braking has a totally independent operational circuit so that it can be applied irrespective of the operation of service braking.

Types of mechanical brakes:

- **Pivoted Brakes:** These are the conventional brakes which actuate levers connected to the brake shoe frame through an adjustable tension or tie rod.

- **Non-Pivoted Brakes:** These have no levers or rods like the thruster type unit and disc brakes.

Design requirements of mechanical brakes:

The design requirements of hoist brakes are:

- Smooth , precise , reliable and fast in operation under all loading conditions.
- Low inertia of moving parts and minimum movement of brake shoes to eliminate shock loads when rapidly applied.
- Quick and simple means of adjusting the clearance of brake lining.
- Force of braking should be readily adjustable.
- Accurate and consistent performance over a long period.
- Negligible internal friction.

Design requirements of mechanical brakes:

- Consistent rate of deceleration anywhere in the shaft.
- Even wear of the brake lining.
- Good dissipation of heat to ensure cooling of brake shoes.
- Minimum linkages , freedom from slackness due to wear of pins and joints, no bending and stretch of components, elimination of 'SINGLE-LINE' components.
- Pivots fitted with non metallic brushes to eliminate need of lubrication

Design requirements of mechanical brakes:

- No tendency to vibrate.
- In case of emergency the cage should decelerate to stop in the minimum possible distance without harming men and preventing over-stress of conveyance attachments.
- Permissible accomodation for axial movement of host drum in their bearings.
- Simple and compatible design so that it can be readily tested for duty with safety.
- Easy to install and dismantle for inspection and maintainance.

Design requirements of mechanical brakes:

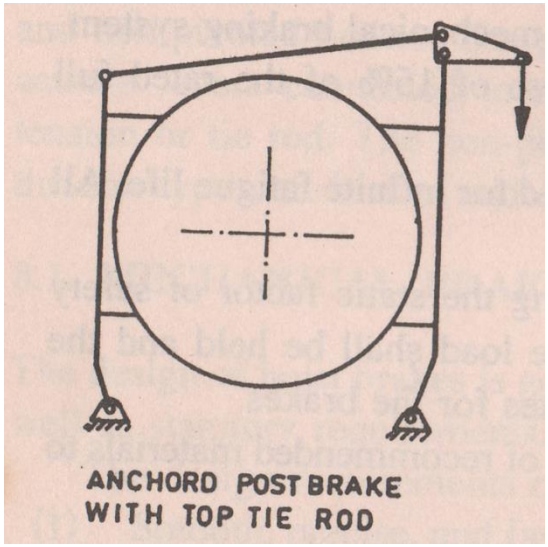
- In hydraulic and compressed air controls , failure of system pressure should cause full application of brakes.
- Even in the event of malfunctioning of mechanical braking system, it should provide atleast 50% of the normal braking torque.
- Safe stoppage of hoist at speeds 15% more than the rated full speed.
- All components should fail to safety.
- Manufactured upto a satisfactory standard.
- Atleast 2 independent braking systems when men are transported

Design requirements of mechanical brakes:

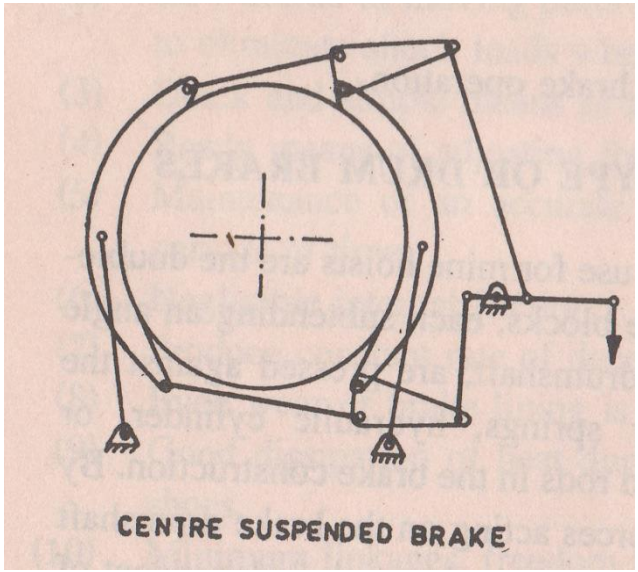
- Meet the statutory requirements regarding factor of safety with maximum out of balance load held and the minimum and maximum deceleration rates for the brakes.
- Means of automatic indicators of brake operation.

Different Designs for Pivoted Brakes:

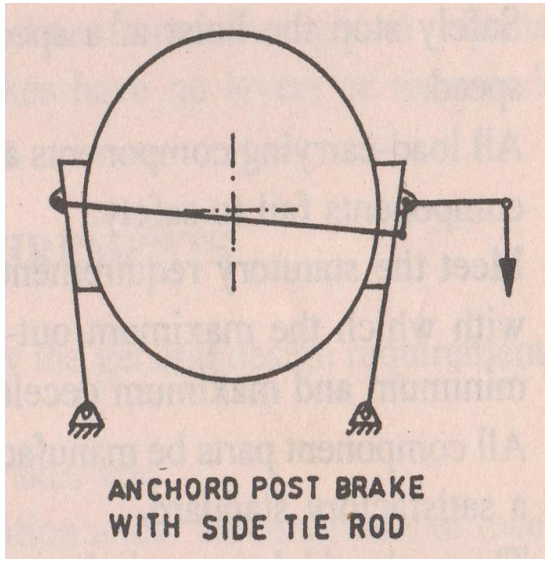
- Anchored Post Brake with Top Tie Rod
- Anchored Post Brake with Side Tie Rod
- Suspended Post Brake
- Parallel Motion Brake
- Caliper Brake



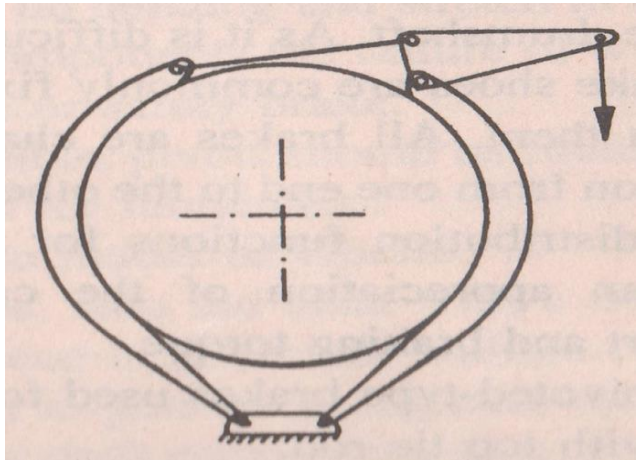
ANCHORD POST BRAKE
WITH TOP TIE ROD

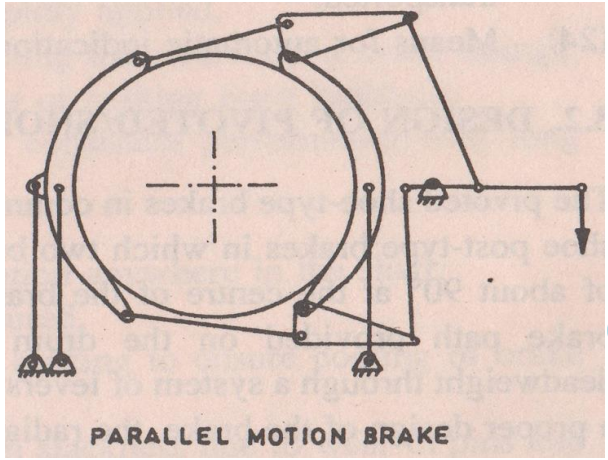


CENTRE SUSPENDED BRAKE



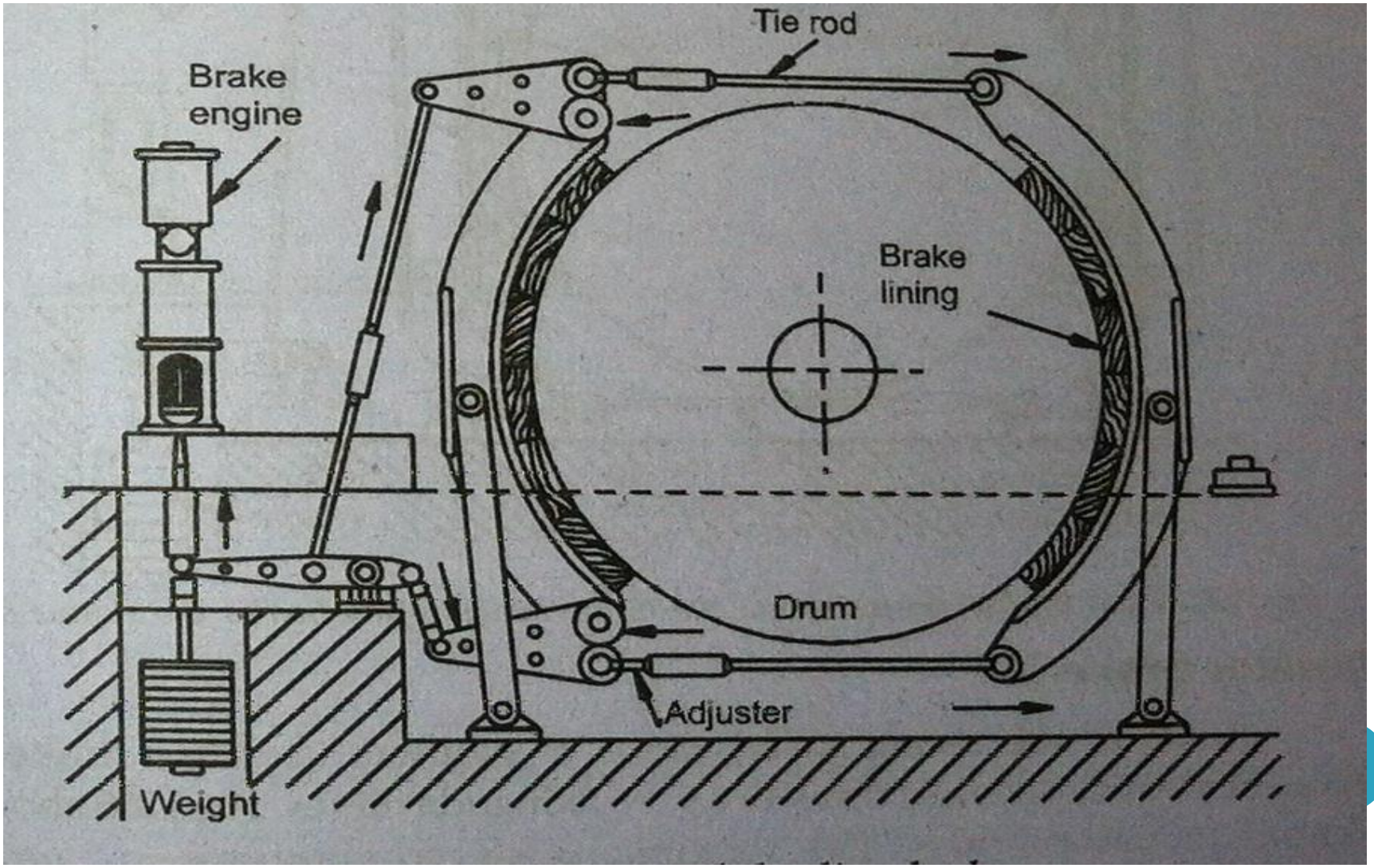
ANCHORD POST BRAKE
WITH SIDE TIE ROD





PARALLEL MOTION BRAKE

Working of Pivoted Brakes:



Working of Pivoted Brakes:

- There are Brake shoes or blocks which are lined with bonded asbestos or fibre like “Ferrodo” brake lining.
- The coefficient of friction should be such that it takes into consideration the decrease in its value due to presence of oil and water on the brake path.So, it is maintained nearly 0.4 .
- The brakes are ‘ON’ Type i.e. They hold the drum when stationary and when it is not required to be rotated with the help of dead weights suspended from the brake levers.

Working of Pivoted Brakes:

- An adjuster on the tie rod is used to adjust the position of the brake blocks relative to the drum as the brake lining wears in due course of time.
- The dead weight is lifted by a brake engine operated by steam, oil pressure or compressed air with the help of a system of rods.
- The control valve is designed such that in case the supply of steam , oil or air fails then the brake is automatically applied by the falling weight.

BRAKE OPERATING SYSTEMS:

Salient Features of an Ideal operating System:

- It should assure fast, sensitive and precise control of the braking effort.
- The hoist operator should be able to perform braking operations under all conditions easily by small movements of the brake lever with maximum safety.
- It should provide easy switching from manual to automatic operation.

TYPES OF BRAKE CONTROL SYSTEMS:

The various types of brake operating and control systems are:-

- Weight-applied and Pressure(air or oil)-released
- Fluid pressure-applied and Fluid pressure-released
- Spring-applied and Fluid pressure-released

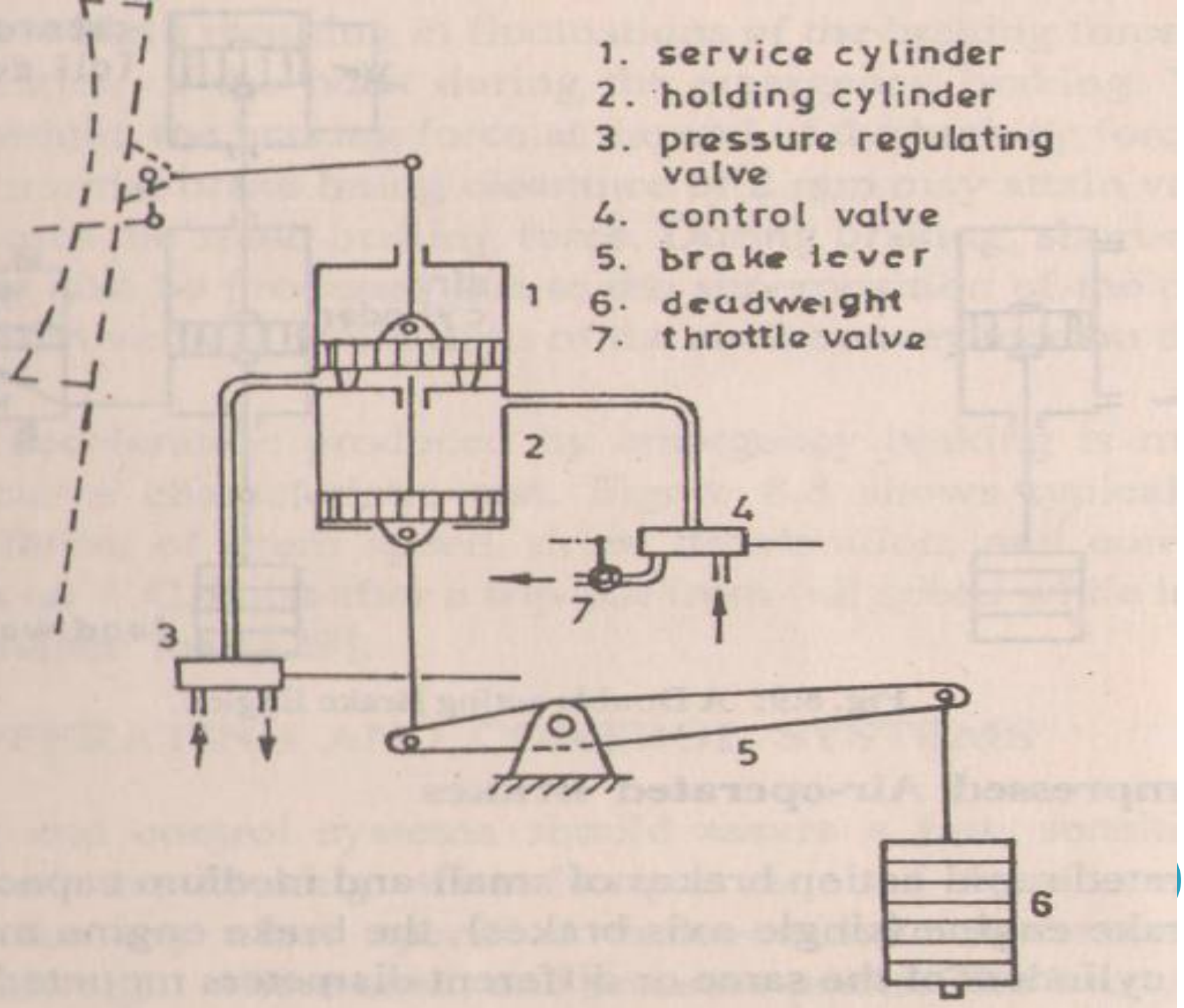
COMPRESSED-AIR OPERATED BRAKES:

Single Axis Brakes:-

- consists of a pair of vertical cylinders of same or different diameters mounted on a common centre line.
- Upper-service cylinder, lower- holding cylinder
- To actuate braking, through a linkwork the 'brake pressure regulator' is operated which causes compressed air to fill the service cylinder.
- The piston rises causing brake shoe to exert pressure on the brake paths.
- The dead weight does not move as holding cylinder is filled with air during service braking.

COMPRESSED-AIR OPERATED BRAKES:

- In case of emergency the line air immediately enters the service cylinder via the regulator while the air in the holding cylinder is evacuated by the throttle valve .
- Hence the piston of the holding cylinder moves quickly upwards to press against the piston of the service cylinder, thereby causing the brake shoes to exert pressure on the brake paths.
- Braking takes place.


1. service cylinder
2. holding cylinder
3. pressure regulating valve
4. control valve
5. brake lever
6. deadweight
7. throttle valve
1
2
3
4
5
6
7

COMPRESSED-AIR OPERATED BRAKES:

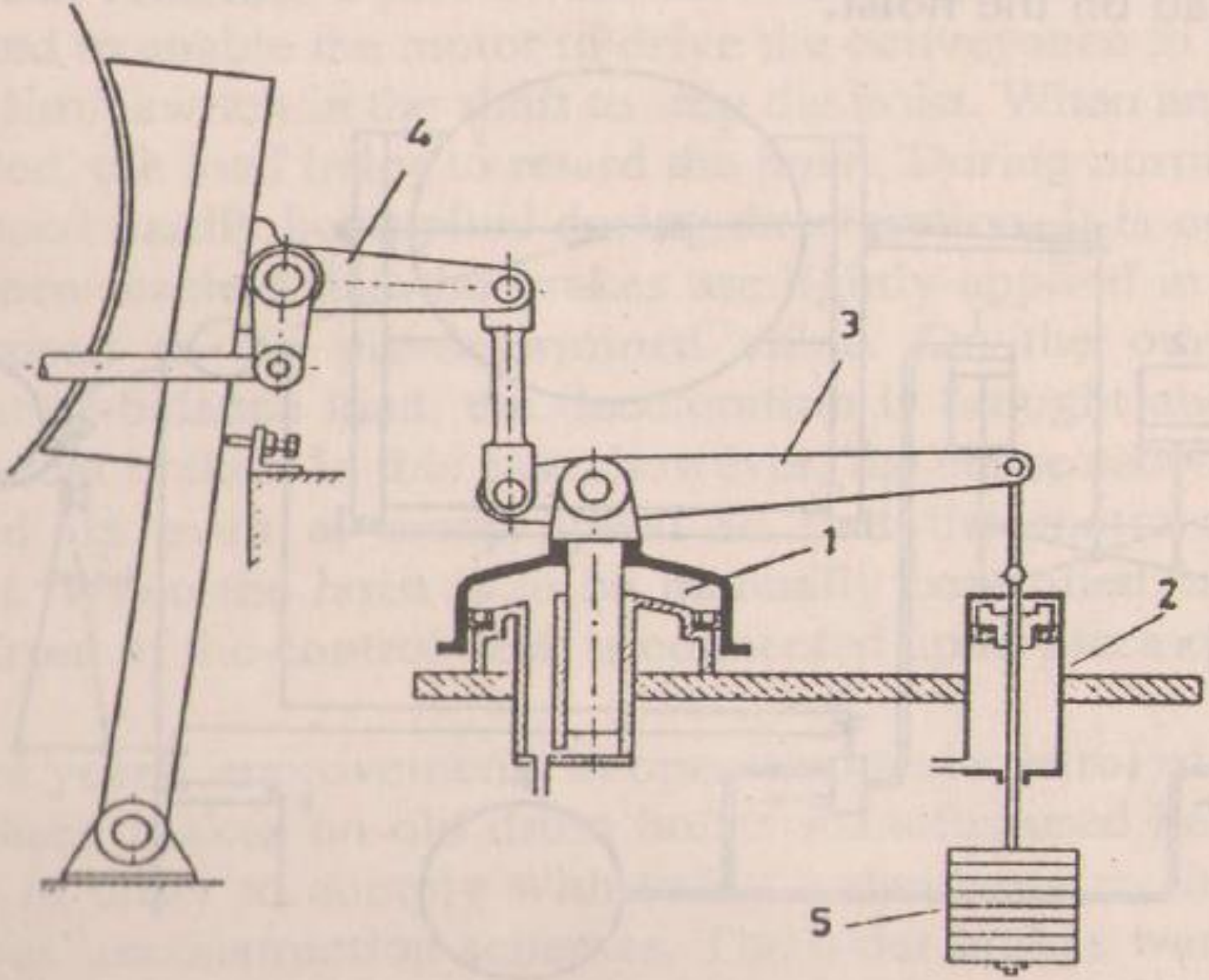
Double-Axis Brakes:-

- There are 2 cylinders for service and emergency braking.
- A differential lever connects through a pressure rod, and pistons of service and holding cylinders.
- During service braking the bell is pushed up by the compressed air,the differential lever turning about the pin connecting it to the piston of holding cylinder.
- In case of emergency , air at maximum permissible pressure is forced in to the service cylinder so that braking effort is applied rapidly in a short time interval and short travel of the service piston while the air in the holding piston is evacuated by the throttle valve.

COMPRESSED-AIR OPERATED BRAKES:

- Then the differential lever begins to turn about the pin connecting it to the pressure rod , lowering the bell to its seat as the deadweight begins to apply the braking effort.

- Used in high capacity hoists and is more compact than single axis brakes.



Basic Design of Siemens Rapid-Action Brake. 1. Brake Cylinder, 2. Holding Cylinder, 3. Differential Lever, 4. Brake Lever, 5. Deadweight

Advantages of Air-operated Brakes:

- The supply of air is unlimited, so the brake system can never run out of its operating fluid, as hydraulic brakes can. Minor leaks do not result in brake failures.
- Air line couplings are easier to attach and detach than hydraulic lines; there is no danger of letting air into the hydraulic fluid. So air brake circuits of trailers can be attached and removed easily by operators with no training.
- Air not only serves as a fluid for transmission of force, but also stores potential energy. So it can serve to control the force applied .Air brake systems include an air tank that stores sufficient energy to stop the vehicle if the compressor fails.
- Air brakes are effective even with considerable leakage, so an air brake system can be designed with sufficient "fail-safe" capacity to stop the vehicle safely even when leaking.

HYDRAULIC BRAKES:

Reasons for their popularity over air operated brakes:-

- Difficulty to maintain compressed air pressure, requirement of clean and dry air.
- Compressibility of air leads to slow brake operation
- Hydraulic brakes require only electric current for operation
- Instantaneous response and good control with high-pressure brakes.
- The braking effort can be quickly and easily changed to suit the operating conditions

HYDRAULIC BRAKES:

- Braking is smooth, accurate, reliable under all braking conditions.
- No deadweight is necessary with spring power brakes
- Hydraulic power pack is compact
- Easy erection
- Initial cost is less

HYDRAULIC BRAKES:

- Depending on pressure of oil used, hydraulic brakes system are designed as:

low-pressure system (0.5-1.0 MPa)

medium-pressure system (10-21 MPa)

high-pressure system (24-27 MPa)

- The volume of fluid to be moved, the dead time, reaction time and size of hydraulic components decreases with increase in oil pressure.

- High pressure system have a high speed of operation with fast response and high accuracy of control.

Types of hydraulic brakes:

- **Shoe-type Hydraulic Brakes:** These are generally

  a. ”Fluid pressure applied and fluid pressure released” type with weight application in case of power failure

  b. “Spring pressure applied” type, sometimes reinforced by weight for emergency application
- **Disc Brakes:** They consists of multiple brake unit arranged to work on a brake disc fitted on one or both sides of the hoist drum.

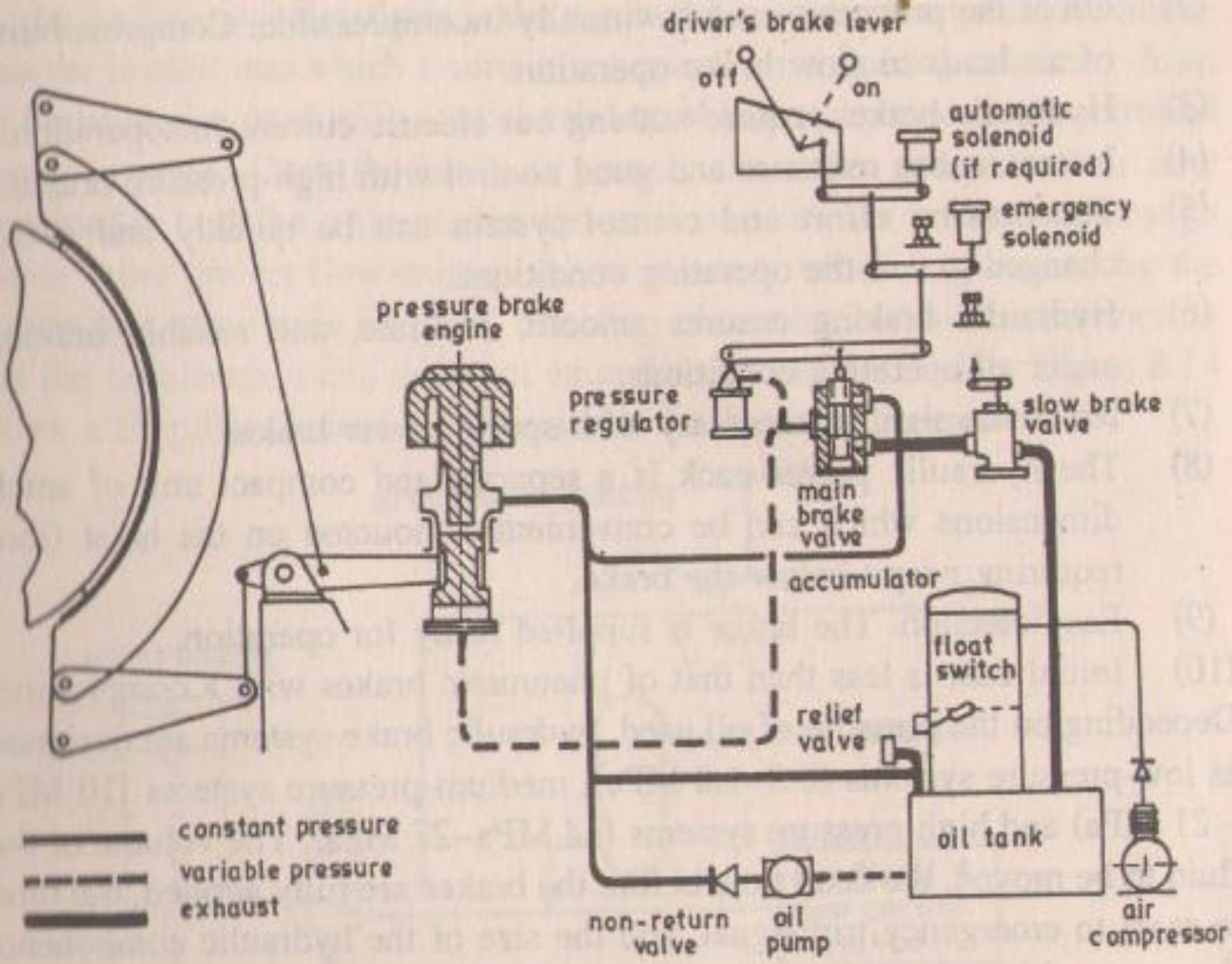
Shoe-type Hydraulic Brake:

Fluid Pressure-Applied and Released Brakes:

- Consists of a double acting service brake engine
- Service engine is a 2 diameter cylinder with a 2 diameter differential piston with the larger diameter at the lower end.
- Oil at constant pressure is supplied to the top of the cylinder while pressure in the bottom is controlled by a main brake valve and brake pressure regulator.
- In the ‘off’ position, pressure on both side of cylinder is maintained same and since base is larger hence the piston is in lifted condition.

Shoe-type Hydraulic Brake:

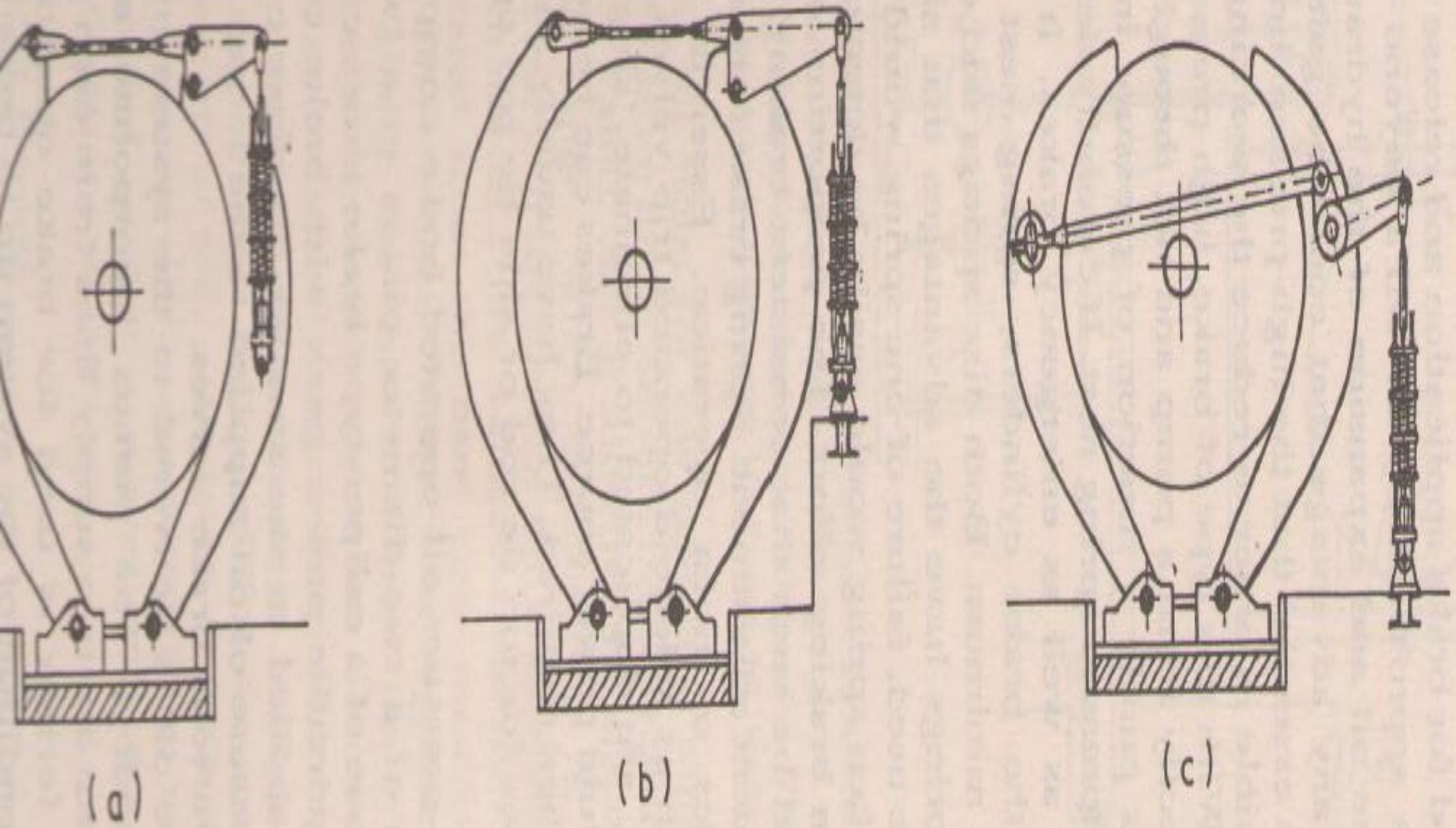
- In the ‘on’ condition , the main valve opens and exhausts the oil from below the piston which is forced down by the constant pressure above.
- In the event of emergency trip, emergency solenoid is de-energised causing main valve to open there by applying the brakes in about 0.2 seconds.
- An adjustable relief valve controls the working pressure of the hydraulic system.


driver's brake lever
off
on
automatic solenoid (if required)
emergency solenoid
pressure brake engine
pressure regulator
slow brake valve
main brake valve
accumulator
float switch
relief valve
oil tank
air compressor
non-return valve
oil pump
constant pressure
variable pressure
exhaust

Shoe-type Hydraulic Brake:

Spring Power Brakes:

- Suitable for automatic mode of hoist operation
- Braking torque can be adjusted instantaneously
- High pressure braking system have gained wider acceptance
- If carefully designed, the brake will act as good manual as well as emergency brakes



Arrangements of Spring Power Brakes.
(a) Caliper shoe brake with shoe-mounted spring nests and top tie rod, (b) Caliper shoe brake with floor-mounted spring nests and top tie rod
(c) Caliper shoe brake with floor-mounted spring nests and side tie rod

DISC BRAKES:

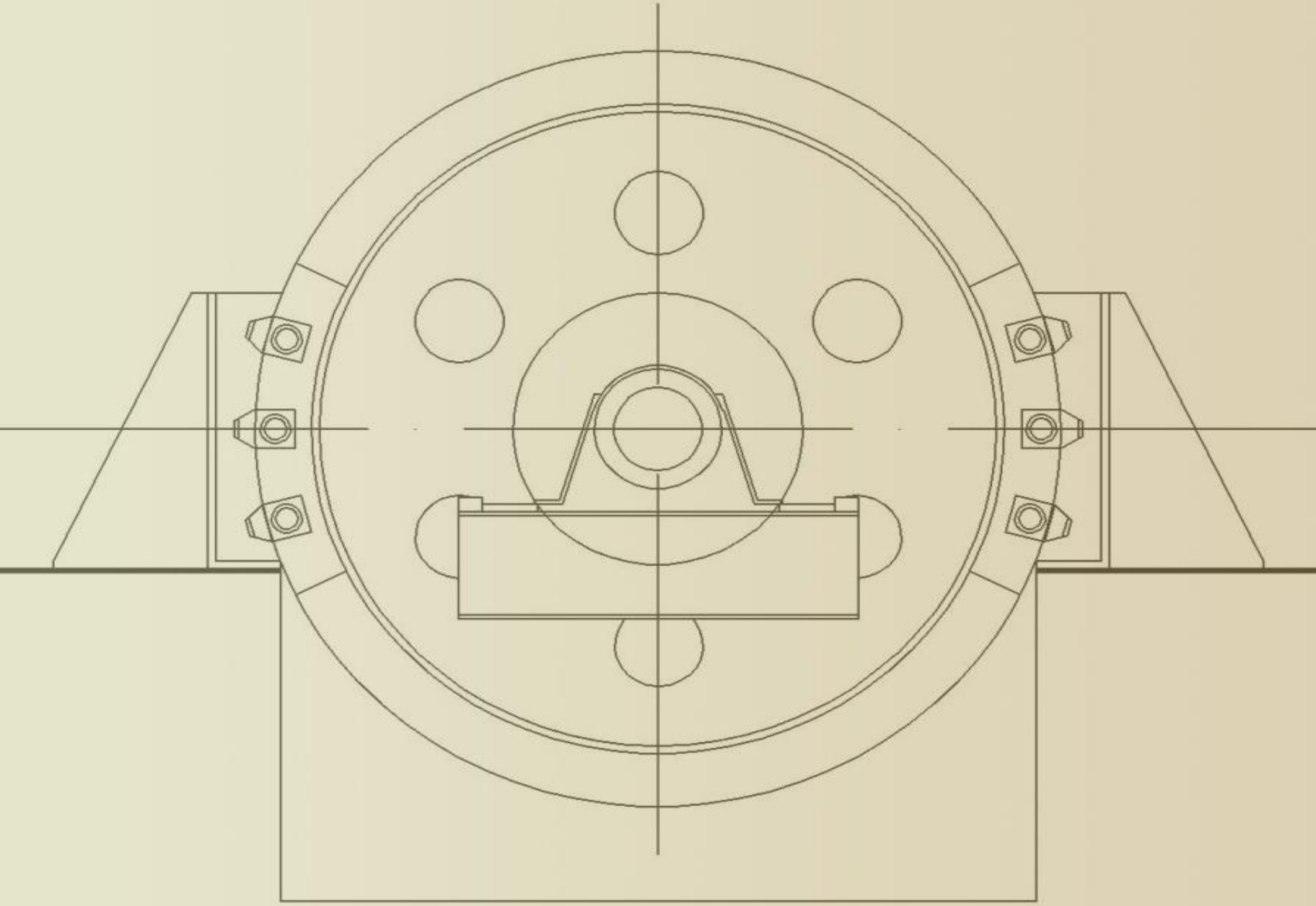
- Increasingly used for friction hoist replacing the conventional drum brakes
- They combine into a single unit- the hydraulically operated service brake and bellevelle spring operated emergency brakes.
- A disc brake unit consist of 2 similar halves mounted on a yoke which in turn is mounted on a common frame.
- To ensure that the brake lining is worn out uniformly, braking power is done over the entire area of contact uniformly.

DISC BRAKES:

- Each brake half consists of a hydraulic brake cylinder with a piston and a powerful spring assembly with the no. of bellevelle to produce the braking pressure.
- The brake pressure is transmitted on to a brake pad which presses against the friction disc to produce braking effect.
- The spring force presses the brake shoe onto the friction disc.
- During operation, a hydraulic oil pump pushes the oil into the braking unit at a pressure of around 16-24 Mpa.

DISC BRAKES:

- The oil pressure overcomes the spring force to lift off the brake shoes.
- The pressure of the oil is regulated by a pressure valve and the brake is operated by the use of a solenoid valve which energises and de-energises to control the flow of hydraulic liquid.
  - Energising -> pumping into the system, release of brake effort
  - De-energising-> liquid exhausted by pressure release, braking effort re-established
- In case of a power failure, the solenoid de-energises causing the brakes to “fail to safety”.



DISC BRAKES:

- Though disc brakes rely on the same basic principles to slow a vehicle (friction and heat), their design is far superior to that of drum brakes.
- Instead of housing the major components within a metal drum, disc brakes use a slim rotor and small caliper to halt wheel movement. Within the caliper are two brake pads, one on each side of the rotor, that clamp together when the brake pedal is pressed.
- Once again, fluid is used to transfer the movement of the brake pedal into the movement of the brake pads.
- But unlike drum brakes, which allow heat to build up inside the drum during heavy braking, the rotor used in disc brakes is fully exposed to outside air. This exposure works to constantly cool the rotor, greatly reducing its tendency to overheat or cause fading.

DISC BRAKES:

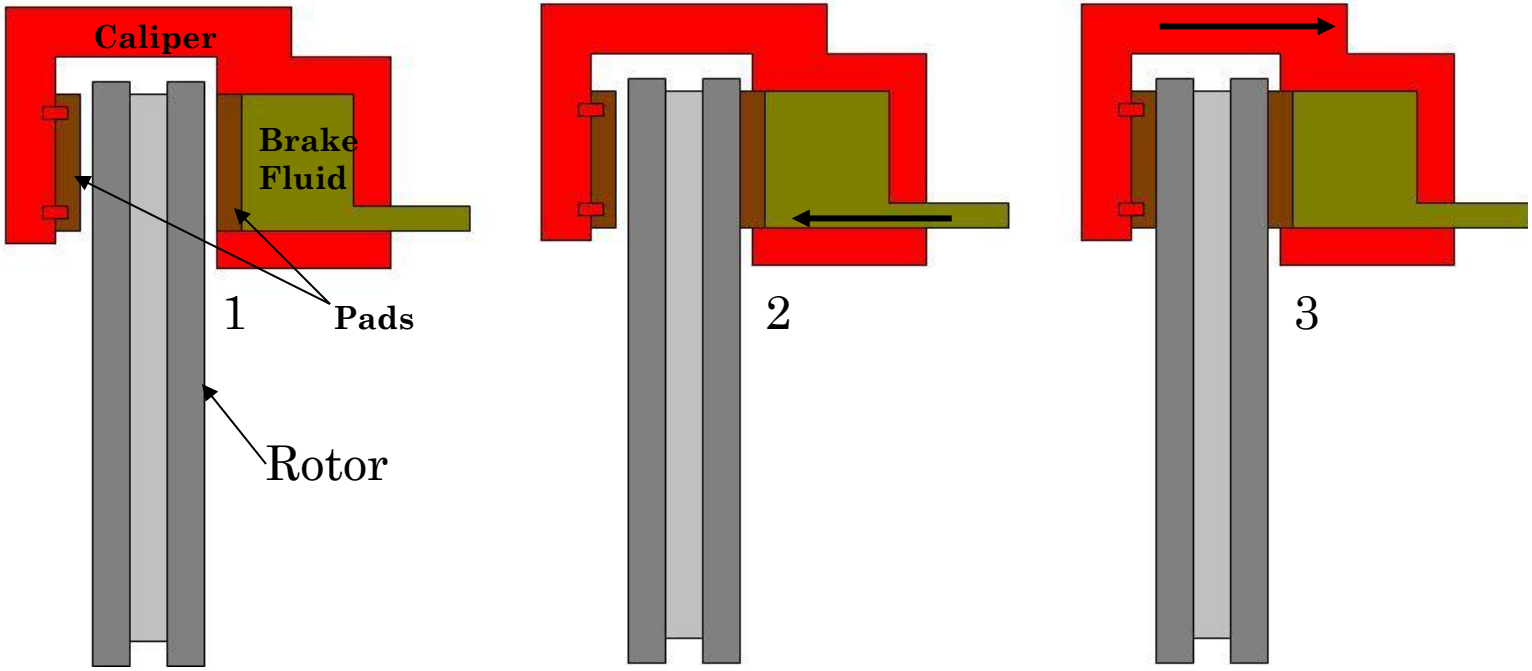
- The disc brake is designed to enable a large number of brake unit to be installed instead of fitting around the surface of the conventional drum brake ring, the new brakes grip on the either side of disc flanges mounted radically at the ends of the main drum right angle to it.
- The brake units are extremely compact and thus a relatively large number can be installed on each disk flange.
- The disc brake can be applied more rapidly than the conventional brakes and it is smoother in operation.

DISC BRAKES:

- A very interesting feature of disc brakes is that the pads automatically adjust the clearance between the friction disc and the pads as they are worn out by regular use. As the shoes are worn out the fluid in the caliper hydraulic cylinder increases thereby maintaining a fixed clearance.

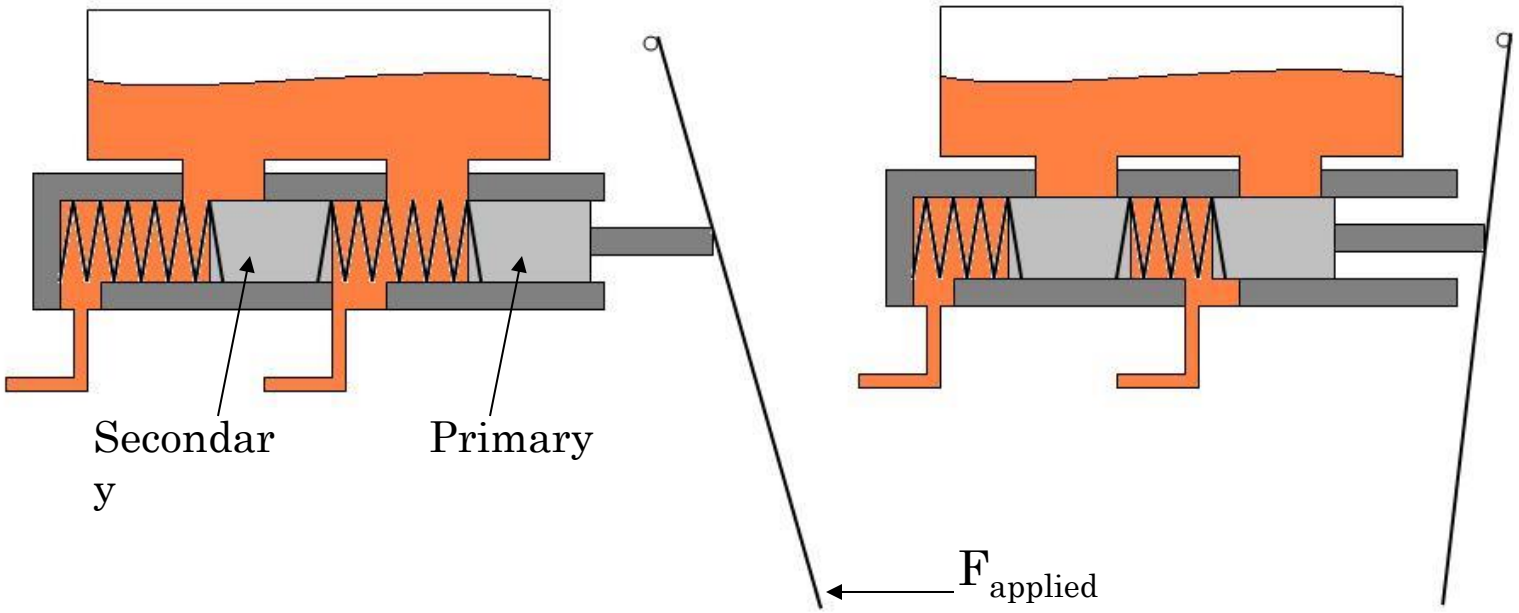
- Hence drastic decrease in the level of oil in the tank is an indication that the brake shoes need replacement.

Caliper Operation:



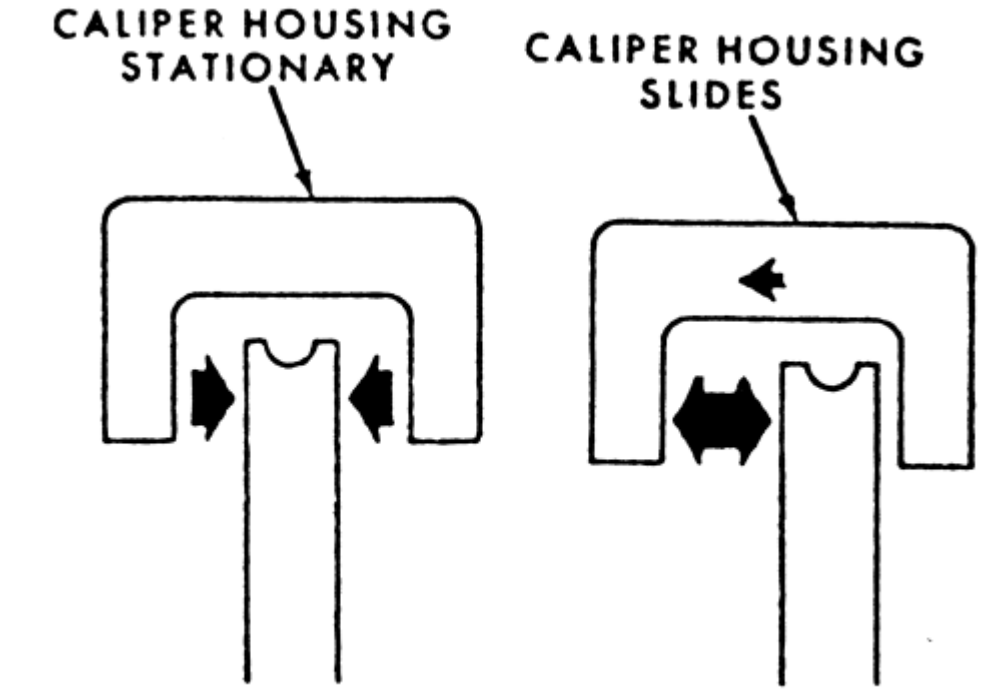
- Step 1: Force is applied to by driver to the master cylinder
- Step 2: Pressure from the master cylinder causes one brake pad to contact rotor
- Step 3: The caliper then self-centers, causing second pad to contact rotor

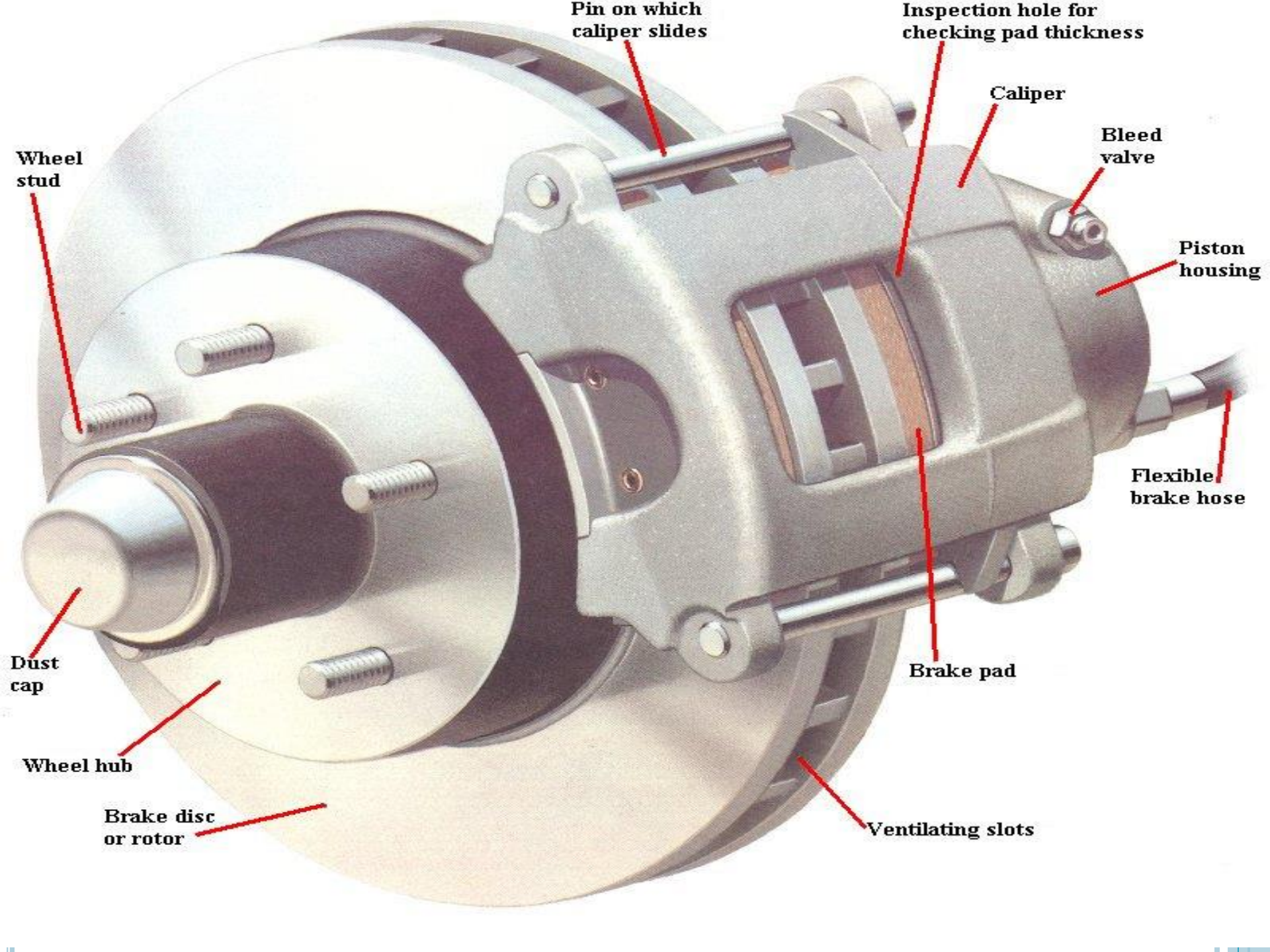
Master Cylinder:

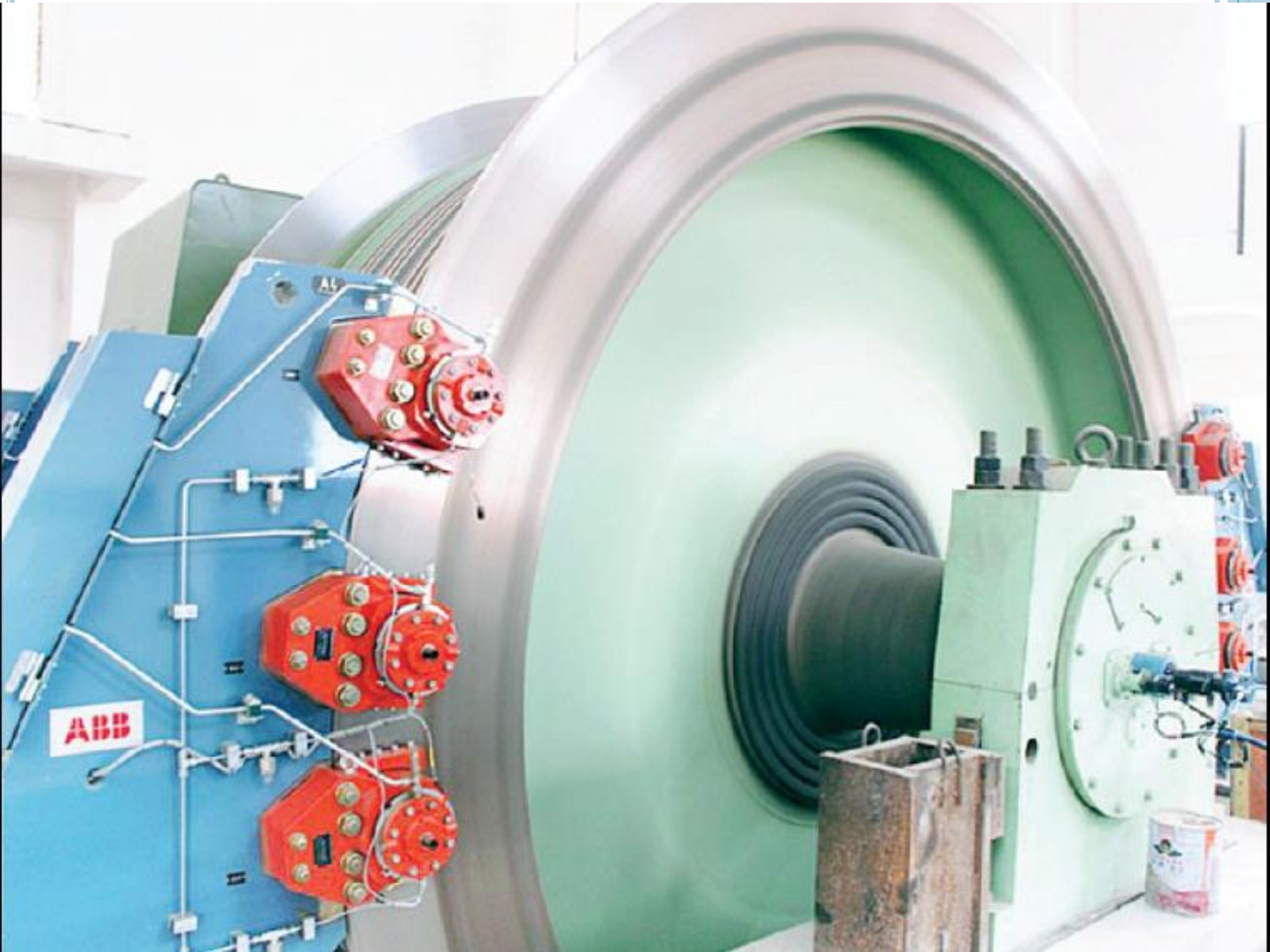


- Force is applied to brake pedal by driver
- Primary piston moves, which in turn pressurizes fluid in front of the first piston. The secondary piston and primary piston are connected through a spring. As the primary piston moves, it causes the secondary piston to move and pressurize fluid in front of it.
- The pressurized fluid in the brake lines then causes the brake pads to move into contact with the rotor.

TYPES OF CALIPERS:




Pin on which caliper slides
Inspection hole for checking pad thickness
Caliper
Bleed valve
Wheel stud
Piston housing
Flexible brake hose
Dust cap
Brake pad
Wheel hub
Brake disc or rotor
Ventilating slots



ABB

Advantages of Disc Brake over the conventional brakes:

- Low inertia, fast response and extremely smooth and precise in operation.
- High braking capacity, 2-3 times that of double shoe suspended brake of same diameter.
- Easy to maintain and install with high reliability in service.
- Apply equal braking in both direction of rotation.
- Large cooling area since disc pad covering only small part of the disc.
- Being compact, since mounted on hoist bed plate itself requires, less space.
- Economical manufacture due to large number of units.

Coal Mines Regulations:

According to **Coal Mine Regulation 2011:**

- There shall be provided **one or more brakes on the** drum or the drum-shaft.
- At least one of the brake shall be so designed that the **brake remains at the ON position except when** operated.
- Where the brakes are Power-operated at least one of them shall be arranged to be **applied automatically at all** times, if the power supply fails.
- The brake on the drum shall be used only for the purpose of keeping the drum stationary and **not for lowering the cage or any other means of conveyance.**

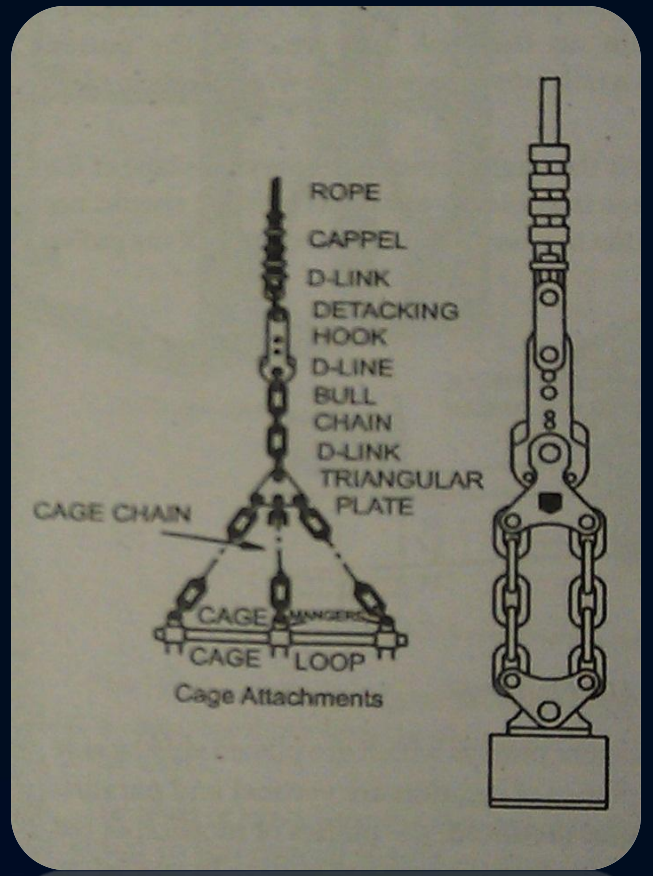
Detaching Safety Hook

- Before starting any discussion about detaching safety hook, a brief discussion about the setup of which the detaching Safety hook is part of, is necessary i.e.

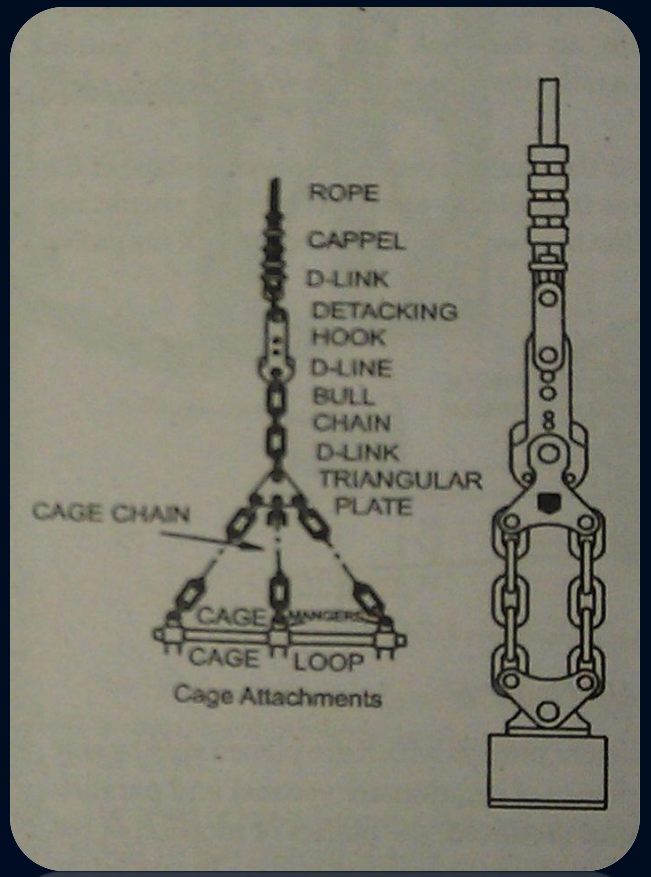
- How the cage is attached to the winding rope?

Cage Attachment To Winding Rope:

- In a typical arrangement four cage chains in the case of single cage and six chains in case of tendem cage are used
- These chains attach the cage to a triangular distribution plate which is connected to a safety detaching hook through D-links or bull chains.
- The detaching hook is attached to the rope capel which may be a cone type capel or reliance capel.
- The triangular distribution plate is wrought iron or mild steel. The cage chains and all the D links or shackles and bolts are of wrought iron or mild steel.



- As an alternative to wrought iron or mild steel , the various chains, links and shackles, the distribution plate of 1.5% manganese steel which is exempted from periodical heat treatment.



Detaching Hook

- Detaching hook is a safety device which acts when an overwind takes place.
- It refers to the hoisting of the cage above the normal banking level due to failure of brakes or any technical or manual error.
- Overwind is an event which can lead to serious accident if any safeguard is not present.
- The purpose of Detaching Hook is to suspend the cage/skip in the headgear if an overwind occurs, at the same time to release the rope to go over the pulley.

Detaching Hook

- Detaching hooks are only used in vertical shafts served by drum winders but they are not used on koepe winders.

Detaching Hook & Friction Winder

- Detaching hooks must not be fitted in friction winding systems, (where the rope(s) are not wound on the driving drum but only pass over the top part of the driving drum or sheave)
- as detaching the ascending cage would cause both cages and winding rope(s) to fall down the shaft.
- In friction winding systems, protection for the ascending cage in the event of an overwind is provided by a cage 'receiver' fitted with tapering guides to slow down the cage and a 'bumper beam' at the top of the receiver to finally stop the retarded cage.
- The drum or sheave will then be able to turn against the friction grip of the ropes.
- If the worst case happens i.e., the rope(s) break then spring loaded catches in the receiver prevent the cage from falling down the shaft.

TYPES OF DETACHING SAFETY HOOK:

- ORMEROD DETACHING SAFETY HOOK

TYPES OF DETACHING SAFETY HOOK:

- KING DETACHING SAFETY HOOK

ORMEROD DETACHING HOOK

It consists of three mild steel plates i.e. one inner plate and two outer plates.

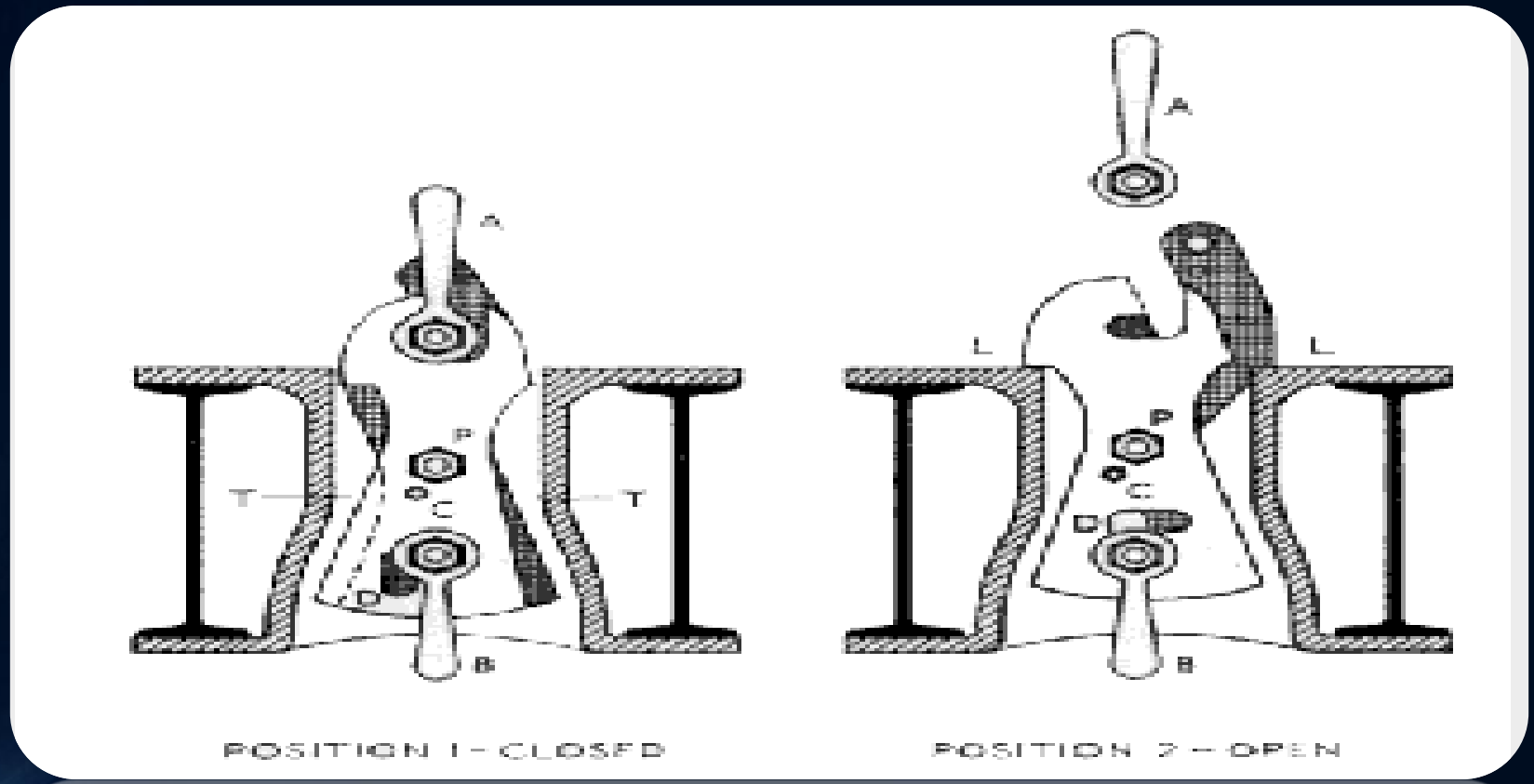
The plates are pivoted on a central bolt P.

Held in position by a copper pin C passing through the three plates.

Slots are cut in the plates to enclose the pin in shackle A to which the winding rope is attached.

The cage or skip is suspended from shackle B, the pin being passed through a shaped slot in the lower part of the plate.

ORMEROD DETACHING HOOK



ORMEROD DETACHING HOOK

IN CASE OF OVERWIND

- If there is an overwind, the hook is drawn up into the bell (position 1)
- The narrow throat TT, forces the lower parts of the plates together
- Shearing the copper pin C and open the slot in the top of the hook to release shackle A (position 2)
- The projections L on the plates are also forced outwards
- And engage with the top of the bell to retain the hook
- At the same time the pin in shackle B drops into vertical slot D, securely locking the three plates in position
- The cage or skip is then suspended in the bell.

ORMEROD DETACHING HOOK

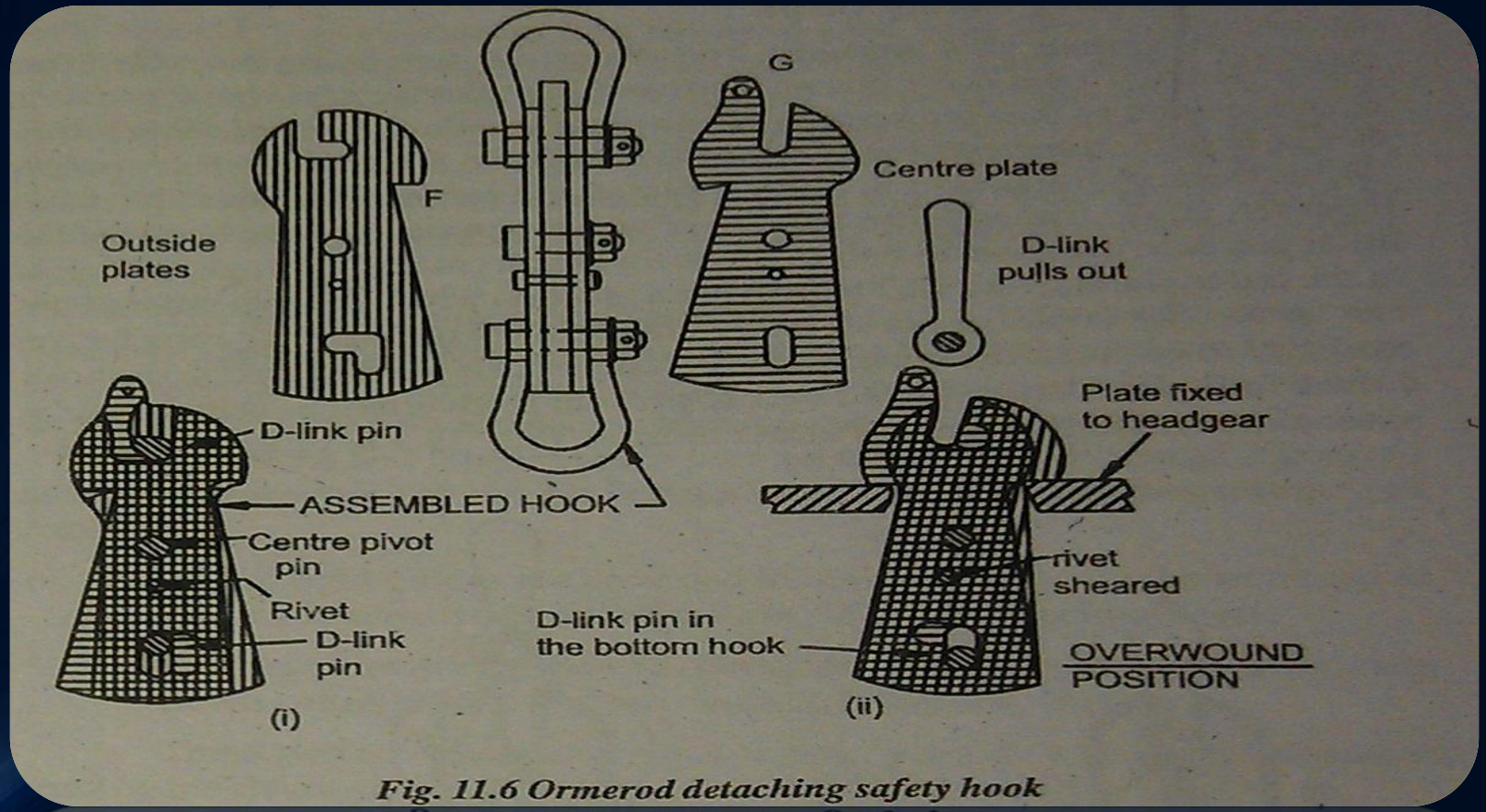


Fig. 11.6 Ormerod detaching safety hook

KING DETACHING SAFETY HOOK

- It consists of 4 plates, i.e. two being movable inner plates and the two fixed outer plates.
- These are made up of wrought iron or of 1.5% manganese steel or of good quality mild steel.
- A main bolt or center-pin passes the hole carved in the center of all the four plates and serves to bind them, to provide a pivot on which the two inner plates can move and also to transmit the tension in the winding rope from the hooks of the inner plates to the shackle-bolt of the main D-link.
- A pin, made of ductile copper, is placed through the hole just below the center hole I all the 4 plates and riveted over to prevent inadvertent movement of the inner plates when they are not in tension.

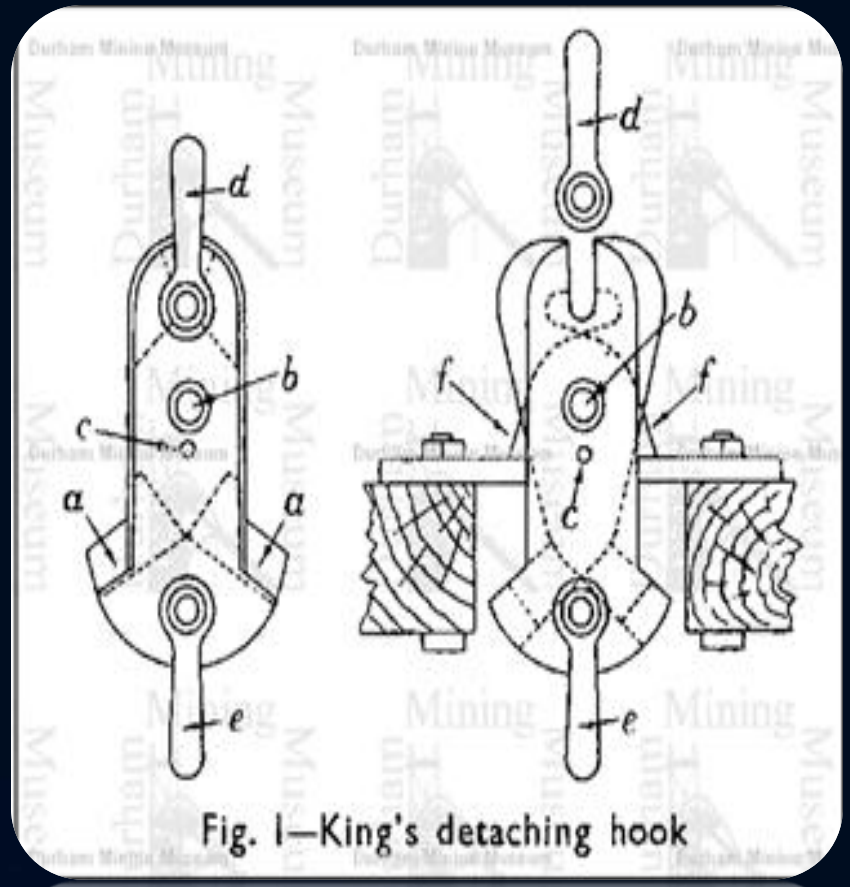


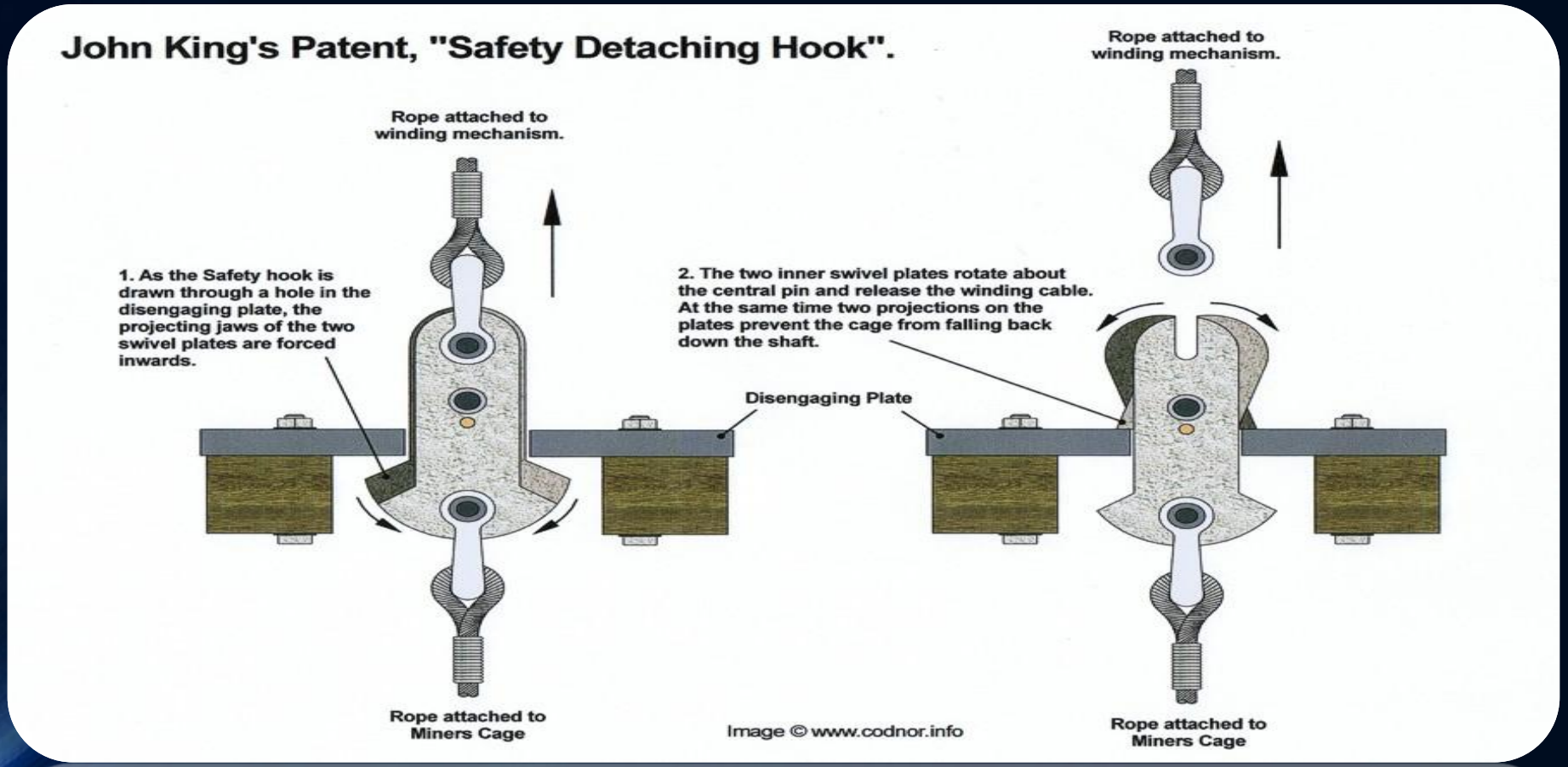
Fig. 1—King's detaching hook

KING DETACHING SAFETY HOOK

Functioning of king detaching hook

- During an overwind as the ascending cage rises, the hook is partially drawn through the circular hole in the catch plate e, securely attached to the horizontal member of the headgear and the lower wing d of each inner plate is forced inwards. The copper pin is thus sheared and the hooks m are forcibly separated, thus releasing the D-link attached to the rope capel
- The catches gg on the inner plate are forced outwards so that they rest on the upper side of the catch plate and the cage is thus safely held.

Functioning of king detaching hook



KING DETACHING SAFETY HOOK

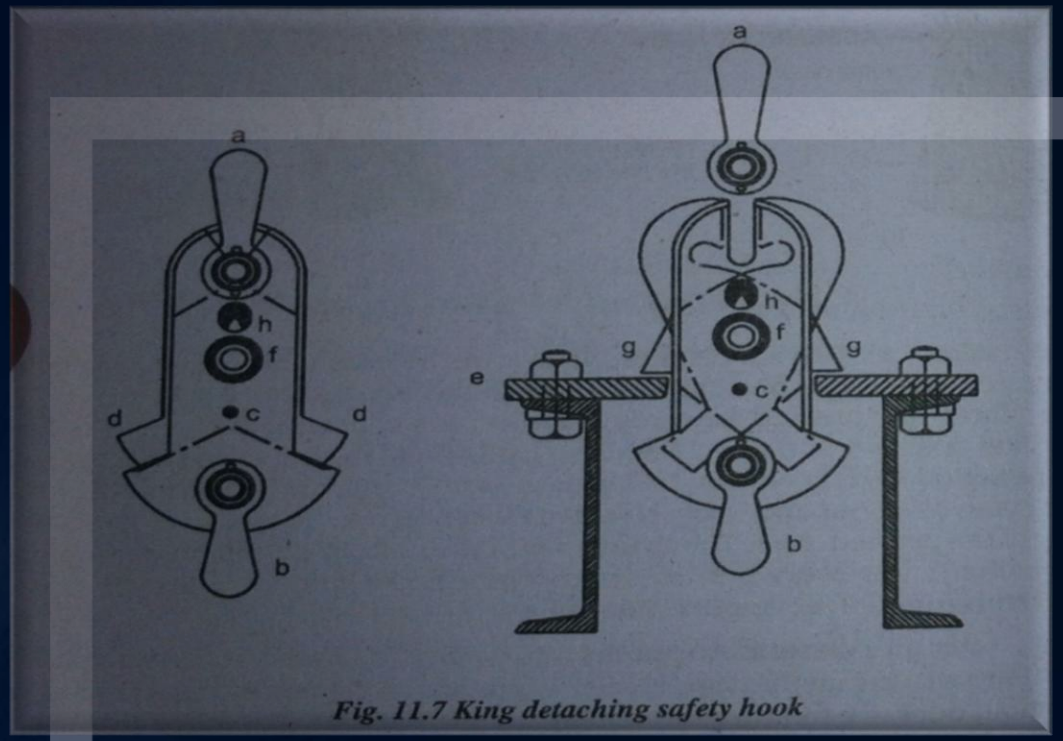
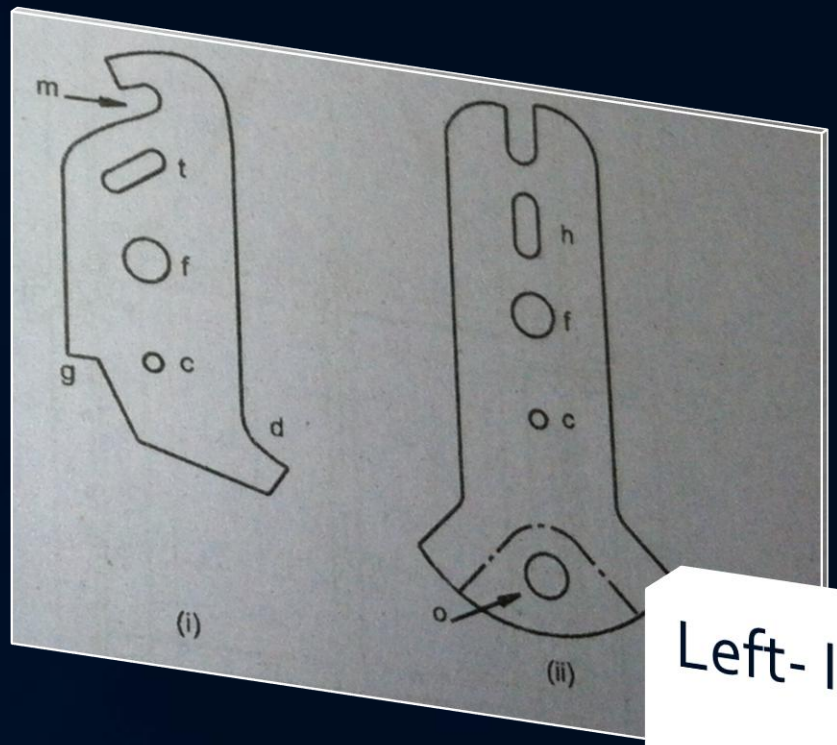


Fig. 11.7 King detaching safety hook

Left - Hook assembled and in working order

Right - Hook detached and cage suspended during overwind

KING DETACHING SAFETY HOOK



Left- Inner plate; Right- Outer plate

KING DETACHING SAFETY HOOK

What to do after overwind?

- For lowering the cage after an overwind, a vertical slot h is provided in each outer plate and an inclined slot in each inner plate. The cage being suspended, the slots in the outer plates remain vertical but those in the inner plates take different positions so that a clear, almost circular hole is still maintained through all four plates.
- To restore the cage, place a few rails across the shaft top, bring the winding rope capel back over the pulley and attach it to the plates by special D-Link whose pin should pass clear through the hole at h.
- Raise the cage slightly and the pull of the rope on new D-link pin causes the latter to rise along the inclined faces of the inner slots. This forces the hooks m and catches g inwards to their normal positions.
- Now lower the cage to the banking level. Replace the hook and fit it with a new shearing pin. The catch plate e also should be changed.

Regulations related to Safety Hook

- The safety detaching hook shall be installed such that its centre line matches that of the catch plate or bell.
- The alignment of the safety detaching hook to the catch plate or bell should be checked weekly.
- Detachment Test On commissioning, the conveyance and winding rope will be supported in the headgear and the safety detaching hook will be pulled through the catch plate or bell until full detachment of the winding rope occurs. (The copper shear pin shall be removed during this test.)
- Modifications No site modifications to any component of a safety detaching hook will be permitted, unless approved by a Professional Engineer.
- Installed safety detaching hooks should be protected against corrosion by applying grease or another suitable coating to all surfaces.
- Every detaching bell or plate used in connection a safety-hook shall be examined, and the Opening therein checked by callipers or gauges, once at least in every 30 days.
- End Attachments Ninety degree (90 °) chase blocks, which offers flexibility in both directions, are preferred as end connections to both ends of safety detaching hooks.
- Traceability of all components must be maintained throughout the life of the hook.

9. Repeat the process for the pair, strand of left hand rope and corresponding meshing strand of right hand rope.
10. Bend the splice back and forth until all strands rest firmly in their places. This also puts them under nearly equal tension.
11. Straighten each tail by removing any spiral formation.
12. With a vice and clamps untwist and open the rope at the end crossing, cut the fibre core at the centre, pull ir out and tuck in its place the tail of the strand. Cut off the fibre core at the end of the strand tail.
13. Tuck in the other strand tail of the same crossing in a similar manner.
14. Shift the vice and clamps to the next crossing and hammer the strands with a wooden mallet to fix them securely in their place.
15. Repeat the operations at the other five crossings and the splicing job is complete.

2.8 Calculate the size of wire ropes for winding & haulages.

The size of a wire rope is usually quoted in mm, but the centimeter (cm) leads to more convenient constants. If it is considered necessary to work with the rope diameter in mm all the time, the two formulate can be written as.

Mass=k $(d/10)^2$ in kg/m, d being in mm

And breaking strength = $s(d/10)^2$ in kN, d being in mm.

2.9 Describe rope capel for haulage winding & recapping.

The end of a rope where the load is to be attached should be a good portion of the rope, free from worn, rusted, bent or broken wires and free from effects of bending and corrosion. The simplest and easiest way to make the rope end suitable for attachment of load is to use a grooved thimble and bend back the rope end on it and part of the rope before finally tightening 4-6 rope lips at intervals on. The method needs little skill. Such attachment is permissible for haulage ropes and skips ropes hoisting on inclined planes but not permitted for winding ropes. Rope length under clips is nearly 30 times rope dia.

Different way of attaching capels :

1. Split capel with rivets : This is normally used on haulage ropes in mines but not permitted on winding ropes. Conical portion of capel fits the rope. Near the end of the rope mark two points, one point one cone length away and another point, two cone lengths away from the end. On the rope between points, wrap a number of turns of binding wire tightly to form a layer. Near give several wrappings of the wire to make it thick and slightly conical. Open out wires between rope end and point and clean them with petrol, kerosene oil or diesel oil to remove grease, oil or rust. After fanning out the wires cut $1/3^{rd}$ of them to $1/3^{rd}$ length and another $1/3^{rd}$ to $2/3^{rd}$ length. Turn back all the wires on the rope portion to give a cone and tie them on that rope portion with binding wire. Cut the exposed fibre core. Hammer a thin wooden wedge into the cone at the end. Push a split capel with its mouth slightly widened on to the cone and hammer the widened arms in position to grip the coned portion of the rope. Rivets are then hammered into the capel and through the rope at 3-4 points nearly 200mm apart.
2. Coned-socket type capel : The coned socket type capel is probably the most compact type of rope capping. This can be fitted on the rope used for practically every purpose, including winding. Near the rope end where the coned socket is to be used on the rope, wrap a few turns of binding wire tightly at a point equal to 1.1/4 times the length of conical portion of the capel. Thread the rope end through the capel. Open out the end

wires beyond the binding wire lashing, clean then with a suitable solvent like kerosene or diesel oil and cut the exposed fibre core. Reassemble the wires so that the rope end resembles a brush with the ends of the wires even. Pull the rope through the capel so that the brush remains inside its conical portion. Clamp the capel, complete with the rope in place, in a vertical position with the large end of capel pointing up, in readiness to receive molten white metal.

3. Interlocking wedge type capel (reliance capel) : In this capel there are 2 tapered iron wedges which grip the rope. The end of the rope is embedded in a block of white metal and the wedges are placed in a U-shaped steel strap on which 4-5 wrought iron hoops or clamps are fitted by hammering. The wedges have a machined groove curved to fit the rope surface and a taper of approximately 1 in 20 upon which the u-shaped strap is held. The jaws of the capel are about 24 times rope diameter in length.

3.0 Headgear :

The headgear is a steel or concrete frame work on the shaft mouth. Its purpose is (i) to support the headgear pulleys, the weight of the hoisting ropes, cages and the rope guides, and (ii) to guide the cage to the banking level. It should withstand dead and live loads ans wind pressure.

3.1 State function of head gear .

To support the headgear pulleys, the weight of the hoisting ropes, cages and the rope guides, and to guide the cage to the banking level. It should withstand dead and live loads ans wind pressure. The dead loads on the headgear are reasonably constant and calculate but the live load due to winding is a variable one depending on the length of ropes in the shaft, the contents of the cages and the rate of acceleration or deceleration. Headgears used for tower mounted Koepe winders are designed to carry in addition the load of motors, winding pulley and other equipment for winding.

3.2 Calculate height of headgear.

The height of the headgear is decided by considerations of number of decks on a cage, banking level or skip discharging point, pit-top layout, and depth of the shaft.

The level of joists carrying the detaching plate or bell above the decking level is equal to the overall height of cage/skip, plus length of cage chains and suspension gear plus a margin of 3-7 m. this margin of 3-7 m allows a cage to be lifted for materials to be slung beneath it.

The headgear pulleys should be at such a height above the detaching plate that the rope capel is released before it comes into contact with headgear pulley. The distance is about 3m.

A derrick is fitted on some headgears to facilitate lifting of the headgear pulleys at the time od replacement or repairs.

Headgears of wood are prohibited by Law.

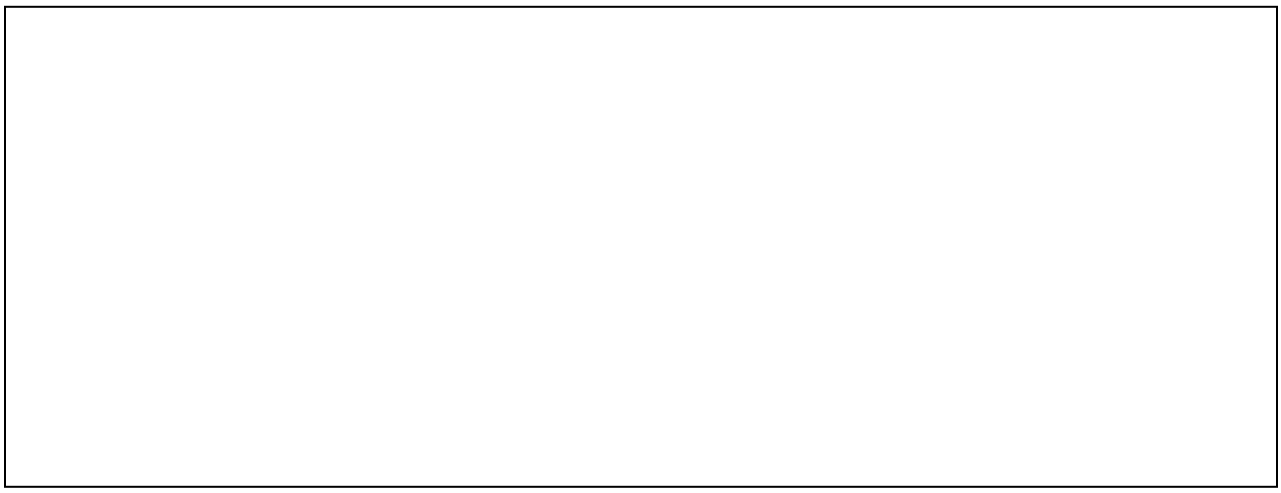
3.3 Describe constructional features of headgear pulley.

The headgear pulley should have as large a diameter as possible to minimize bending stresses in the winding rope. Its diameter should be at least 100 times the rope diameter. Pulleys of over 2.5 m diameter are generally constructed in two halves and bolted together. Normally the diameter of the groove of the headgear pulley should be 110% of the rope diameter for stranded ropes and 105% for locked coil ropes. This ensured that 1/3rd of the circumference of the rope is in contact with the groove. A lesser angle of contact causes excessive strain on the rope and wear on the pulley. The headgear pulley is keyed to a mild steel forged shaft which rests in plain bushed journal bearings.

The angle of fleet which is the angle between the vertical plane of the pulley and the rope when the cage is a the pit-top or pit bottom, should not exceed 1.5°. More fleet angle results in wear of the rope and wear of the pulley also.
The shaft of the two headgear pulleys which are placed side by side are in a horizontal line and their planes of rotation are vertical and parallel. In the case of Koepe winders, ground mounted, the planes of rotation of the two headgear pulleys are one below another (though not vertically one below another). There is therefore no fleet angle in the case od Koepe winder pulley. If a drum winder is used for a deep shaft, it may be necessary to consider double layer coiling of rope in order to accommodate all the rope on the drum and keep the fleet angle limited to 1.5°.

3.4 Define angle of fleet.

The angle of fleet which is the angle between the vertical plane of the pulley and the rope when the cage is a the pit-top or pit bottom, should not exceed 1.5°. More fleet angle results in wear of the rope and wear of the pulley also.



4.0 Cage and shaft fitting .

4.1 Describe cage, cage suspension gear, detaching hooks & its fanction, safety catch at headgear & keps.

Cage: The cage is lift suspended from the winding rope, open at both ends where gates can be positioned during man riding and it has rails fitted to the floor for mine cars or tubs. To prevent the mine cars/tubs from falling outside the cages, catches are provided on the floor which act against the axles of the mine car/tub, in addition, a long bar, turned at both ends and hinged at one side of the cage, prevents movement of the tubs during travel up or down the shaft. Cages used for man riding have a hand bar near the roof for the men to hold and at both ends collapsible gates are provided which can be closed or opened manually or by compressed air. The roof has a hinged or removable door for accommodating long timber or rails whenever necessary. A cage which can accommodate only a single tub is called a **single cage;** a cage which can accommodate two tubs is called a **tandem cage**.

Detaching Hook : Detaching hook which is always placed just below the rope capel, is a safety device which acts when an overwind takes place. Its purpose is to suspend the cage/skip in the headgear if an overwind occurs, and at the same time to release the rope

(along with the capel) to go over the headgear pulley. Detaching hooks are used only for vertical shafts served by drum winders but they are not used on koepe winders.

The two types of detaching hooks are in common use :

1. Ormerod detaching safety hook : The ormerod detaching hook consists of three mild steel plates i.e one centre plate and two outer plates. The plates are assembled on a common centre pivot and a copper rivet, 16 mm dia. Passes through a small hole of all the plates when assembled.
2. King detaching safety hook : It consists of 4 wrought iron plates i.e two being movable inner plates and two fixed outer ways so that the hook of one plate and that of the other jointly form a secure hole for the reception of the rope capel bolt.

Safety catches : As a safeguard against the failure of the detaching plate to hold the cage, safety catches may be fitted in the headgear. These safety catches consist basically of short levers mounted in the headgear at intervals that very from 0.3 to 1m. These are located above the normal running position of the cage. The catches are free to turn on a pivot. In the event of an overwind the catches are lifted allowing the cage to pass up into the headgear. They then fall back to the normal position and so prevent the cage falling back down the shaft. A mechanical linkage is provided so that all the catches may be withdrawn simultaneously in order to lower the cage after an overwind, or when the apparatus is to be checked/tested. This operation is performed by a single hand lever for each set of catches. The safety catches should be inspected regularly to prevent accumulation of dirt or coal dust and to ensure their free movements.

The detaching safety hook provides safety for the ascending cage and arrests its ascent, the safety catches also provide for safety of the ascending cage but no safety device is employed for the descending cage which in the event of overwind strikes the pit bottom joists with full speed and the consequent damage to the installations and injuries to the persons traveling in the cage.

Keps : Keps are retractable supports for cages and have to be used at the pit top under our mining regulations. Their use is not necessary at the pit bottom as the cages rest on the rigid platform of steel girders and wooden planks. Keps are not required at the mid set landing and in a shaft served by koepe winding system. Keps ensure not only support to the cage but their use results in proper alignment of the cage-floor and decking level so that the stretch of the winding rope creates no difficulties arise and are overcome by the use of tilted or hinged platforms. Keps are manually operated by the banksman at the pit top. The ascending cage pushes the keps back and as it is raised slightly higher than the decking level, the keps fall back in position by gravity as the banksman releases the operating lever. The cage after it has come to a halt, is lowered by the winding engineman to rest on the keps. When the top cage is to start on its downward journey, the winding engineman raises the cage only slightly to make it clear of the keps, the banksman withdraws the latter by manual operation of a lever which is held by him till the cage is lowered past the keps.

4.2 State & describe the types of guide.

The guides in mine shafts are :

(i) Rigid guides.
(ii) Flexible guides or rope guides.

Rigid guides : Rigid guides are of hard wood or steel (rail section). They are of rectangular cross-section, usually 10cm X 20xm, and are fixed by countersunk bolts to the buntons placed across the shaft at intervals of 1.8m – 3m. They suffer from the risk of fire.
Steel rigid guides are installed in some deep shafts in this country. They are made of flat-bottomed or T-section rails weighing from 20-55 kgf/m length, in lengths of upto 13 m. Owing to their shape and the manner in which the shoes embrance them, they need only be placed at one side of each cage. Only one line of buntons, in the middle of the shaft, is required for fixation of guides if the guide shoes are on inner sides of the cages but on either side of the bunton.

Flexble guides : Flexible guides consist of wire ropes which may be of locked coil construction of of 1 X6 construction with thick wires. They are suspended in a vertical shaft from a secure attachment placed on the top cross member of the headgear while at the shaft bottom they are given the requisite amount of tensioning by placing cheese weights on them. These weights ensure correct verticality and also eliminate to a great extent oscillations of the guide ropes during a wind. In shafts which are not deep, 2 or 3 guides per cage suffice but for deep shafts 4 guides per cage is the standard practice and the guides are arranged near the corners of the cages. If the clearance between the cages and shaft sides is limited “buffer” ropes are arranged between the cages and outside of the cages-sides. These buffer ropes are not attached to the cages through shoes but are hung freely with proper tension. The minimum space between the 2 cages is generally 40 cms to prevent collision of the cages as the guide ropes oscillate during the wind, the maximum oscillation being at the mid-run of the cages. The tensioning weights are about 10kN per 100 m depth in shallow shafts and about 5 kN per 100 m depth in deep shafts.

5.0 Winding Drum

Drum winding employing a cylindrical drum is the earliest and simplest system of winding adopted in mines. One end of the winding rope is secured to the hoisting drum and from the other end the conveyance (cage, skip or bucket) is suspended. Practically all the mine winders are balanced winders in that the drum accommodates two ropes, one for the hoisting cage and the other for the down-going cage, and the travel of the two cages is simultaneous – loaded cage, and coming up and the empty cage going down.

5.2 Describe different types of winding brake.

The different types of winding brakes are described below :

1. Mechanical brakes : It acting on the winding drum must be provides of all winding engines. For a winder with two cages the brakes must hold the maximum torque of the engine. The brakes shoes are connected by rods and levers to the operating pedal of the winding engineman. The brake lever is connected by a system of rods to the brake engine control. The control valve must be designed to move to the brakes on position.
2. Electrical braking of winders : The method of braking to be adopted in a particular case will depend upon the energy to be absorbed in the retardation period. This is the only method possible on steam winders. The types of electrical braking for winders are :
   (a) Counter current braking, (b) Dynamic braking, (c) Regenerative braking, (d) Eddy current braking.

Of these the first three are commonly adopted.

(a) Counter current braking : This is effected by reversing the electric supply to the starter. The amount of braking depends upon the position of the lever. This nethod of braking is simply and commonly adopted in mines.

Advantages :

1. A large amount of electrical energy converted into heat.
2. It involves a high line current and cables to carry such high line current have to be provided.
3. The reversing switch is subject to severe wear and tear.
4. The method has been proved to be bad for the winding ropes.

(b) Dynamic braking : The principle of dynamic braking for AC winders is perhaps the must important development of economical braking which has yet been employed. This system is particularly useful for heavy lowering winds and for slow speed shaft inspection. A survey of dynamic braking system used for A.C winder motor indicated that they broadly fall into four categories. (1) Coordinated control, (2) Compensated control, (3) Torque control, (4) Coordinated and compensated control.

(c) Regenerative braking : The net effect is that the winder motor receives less effective power and this amounts to in braking action on the winding drum. This is known as regenerative braking. It can take place at any speed in the case of Ward Leonard system. In case of A.C winders, however, regenerative braking can occur only beyond the synchronous speed of A.C motor.

5.3 Describe various types of safety devices on winding system.

The safety devices used for winding system are the following :

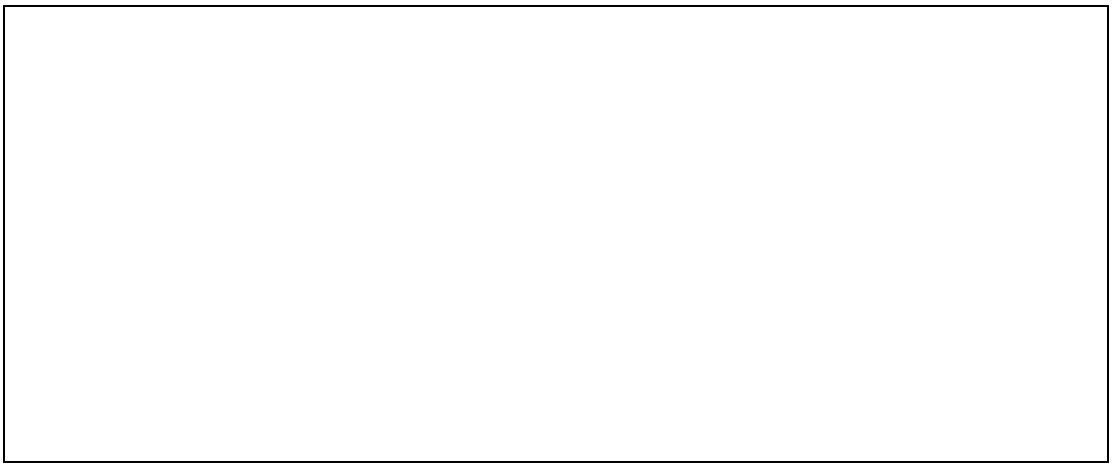
1. Mechanical brake or friction brake : When considering safety devices this is the first device that comes to mind and its required by mining regulations.
2. Additional mechanical brake : This acting or the brake rim of the flexible coupling between the motor and the gear box.
3. Automatic contrivance : It prevents over speeding, over winding and ensures slow banking at a speed not exceeding 1.5 m/s. Usually the speed during slow banking is 0.5 m/s.
4. Reverse direction prevention switch : It trips power if the winding engineman through mistake operates the motor is wrong direction.
5. Time limit switches at the pit top : It mounted on the headgear which trips electric supply to the motor if ascending cage over shots decking level.
6. rope deviation limit switch : It used as multi-koepe winder.
7. Limit switch for tail rope loop on koepe windes. It length of pit rope is reduced for any reason or if the loop is abstracted for any reason, a limit switch actuates the power trip switch.
8. Tachometer generator on the gear box : If the gear box is faulty and the winding drum shaft does not run at its normal speed the tachometer generator will not generate sufficient direct current.
9. Wedge arresters for down going cage.
10. Safety catches mounted on the wedge gear for the ascending cage.
11. Safety detaching hook for ascending cage.

6.0 Friction winding / Koepe Winding :

The friction winder, which is also called Koepe winder after its inventor, Fredrick Koepe, consists of a steam or electrically driven sheave fitted with renewable friction lining which is grooved to suit the main winding rope whose are of contact varies between 185° and 230° according to the design of the winder.

6.1 State & describe principle & constructional features of ground mounted koepe & tower mounted moepe.

The ground Koepe : In the ground Koepe the winding engine is installed at the ground level and the head gear pulleys are situated one above the other on the head gear as shown on figure below. The rope operates in the plane of the Koepe driving wheel without any angle of fleet.



The tower Koepe : In the tower Koepe the winding engine is erected on a tower over the shaft. This type of Koepe winder possesses many advantages over the ground Koepe, these being:

1. A large angle of rope contact on the ground driving pulley can be obtained, normally 200 degrees to 230 degrees.
2. The winding rope is protected against adverse weather conditions.
3. The head gear structure need to no stronger for a given duty than some of the head gears that are in existence today for normal drum winding.
4. It eliminates any obstruction by a winding engine house in the neighborhood of the pithead.
5. The rope is subjected to less number of bends on a tower mounted Koepe.

6.2 State advantages & disadvantages of Koepe winding.

Advantages of Koepe winding :

1. Koepe system is most suitable for winding heavy payloads from larger depths.
2. Koepe winder is simple for manufacture, compact and lighter than the drum winder. Initial cost is therefore, less for similar duties.
3. Less costly engine foundations are required for koepe winder due to lighter weight and compactness.
4. In koepe system the inertia of rotating parts that have to be set in motion is less compared to a drum winder. This is however partly offset by greater inertia of ropes.
5. there is no fleet angle in koepe system and wear on the winding pulley is reduced.
6. Koepe system lends itself to adoption of multi-rope winding which has important advantages listed.
7. It is very suitable for horizon mining system where both cages wind from one level.
8. The cage does not rest on the keps and therefore, to startit, no shock loads are transmitted to the rope.
9. A smaller length of main rope is required compared with drum hoisting using a balance rope, as there are no extra coils.
10. Operating costs are less to the smaller rated output of motor.

Disadvantages of Koepe sinding :

1. Winding is possible from one level only if the two cages are nearly balanced.
2. Koepe system can be used for only vertical shafts and not for inclined shafts as guiding and tensioning of balance rope poses problems,
3. Koepe system cannot be used during shaft sinking.
4. Koepe system is not suitable for shallow shaft as the cylindrical drum size, if drum winding is adopted, would be nearly the same as the Koepe sheave size.
5. A deeper shaft sump is required to accommodate the tail rope loop.
6. The rope changing equipment costs more and the balance rope requires heavier suspension gear and stronger shaft conveyance.
7. Separate run with one cage is impossible.
8. If the rope breaks, both cages fall in the shaft.

6.3 Describe multirope system of koepe winding:

Multirope system of winding :

The multirope koepe winder is an improvement over the single rope koepe winder and is essentially a friction winder with a drum replacing the pulley. The friction drum has as many parallel grooves as the number of ropes. These roves are 30 cm apart, centre to centre, and are as deep as the radius of the rope. The tread material, in which the grooves are made, is wood or a kind of plastic and it is attached to the drum plate by countersunk bolts. The number of ropes for the cage is even, usually 2 or 4. The reason for these even number of ropes is that adjacent ropes on the drum are of opposite lays i.e one rope of right hand lay and the other of left hand lay, as such arrangement avoids the rope tendency to untwist. In Russia *-rope hoists are in use for 50-te net payload. On the European continent 4-rope friction winders are popular though there are isolated installations of even ten-rope friction winders. In India, Jaduguda mine is equipped with a multi rope friction winder (2 ropes) with a payload of 5 te in the skip. The tension in all the ropes should be equal, as far as practicable.

Advantages of multi rope winders :

1. Each rope has to be of small diameter compared to one large diameter rope which is difficult to manufacture and handle.
2. It results in better safety.
3. There is saving in space at the pit top.
4. The capital cost of the installation is less.
5. No defection sheaves will be required.
6. The ropes are protected from the atmosphere.

7.0 Skip winding :

The term skip is sometimes used for a cage of larger size which accommodates mine cars but very often the term is restricted to a lift which does not accommodate mine cars but can be filled with mineral through its top opening. Skips traveling in a vertical plane have a discharge opening at the bottom for unloading the mineral content but skips traveling on rails along an inclined haulage plane are so tilted, during travel, near the unloading end that their contents are discharged from the top end. Skips moving in a vertical plane are sometimes partitioned for accommodating men at the upper half and material/mineral at the lower half.

7.2 Compare skip winding cage winding.

Skip winding v/s Cage winding :

Skip winding is best suited for deep shafts where high output is desirable in view of the large investment on deep sinking and the need for early return on such large outlay. The ratio (pay load : gross load of loaded skip) is high, nearly 0.6, in the case of skip winding but with cage winding of mine cars used underground is less as they are not to be raised to the surface, moreover such mine cars are independent of the size of the shaft or skip. Skip lends itself to automatic loading, unloading and decking operations, thereby providing a quicker cycle of operations of winding of mineral. This also means less manpower required for skip installation. Trackless mining is possible from the working face right upto the surface.

Skip winding has, however, the disadvantage that separate arrangements have to be made for winding of men and material, tough some recent installations have modified the skips for manwinding. With skip winding it is difficult to import dirt, washery refuse or mill tailing for underground packing of goaf or stope. Degradation of mineral, particularly soft mineral like coal, takes place during loading and unloading of skip and to prevent coal dust from entering the mine it is essential to install the skip in U.C. shaft. Winding of coal or mineral from different levels is not as convenient as in cage winding and where coals of different seams are raised from the same level, the qualities get mixed up, necessitating a washery at the surface. Skip winding requires large excavations at the pit bottom to accommodate measuring pockets, tippler and small bunker to store the mineral. A higher headgear is essential and the shaft has also to be sunk deeper than the level of the mineral bed, as compared to cage winding.

8.0 Pit top & Pit bottom circuit layout :

State factor affecting pit top and pit bottom layout :

Factor affecting the design of pit bottoms. The choice of the type and design of pit bottom depends on certain factor which are describe below.

1. Yearly output or capacity of mine.
2. Shaft capacity.
3. Method of development.
4. Surface configuration.
5. Number of shafts in the area of pit bottom.
6. Method of shaft hoisting and distribution of conveyances in shaft section.
7. Underground main haulage system.
8. Size and types of car used.
9. Method of handling cars in the pit-bottom.
10. Number of decking levels.
11. Provision for bending and preliminary in under ground.
12. Amount of diet & supply handled.
13. Intial capital cost and operating cost.

Factor affecting design of pit-top car circuit :

The various factor affecting the design of a pit top car circuit are :

1. location and number of shaft.
2. Surface of shaft ventilation
3. location of banking level.
4. method of hoisting in shaft.
5. Number of cages in shaft.
6. Types of cages.

7. Shaft capacity.
8. Amount of dirt & supply handles.
9. Size of cars.

Minimum car circulation time :

The following point should be borne be mine, when pit-top car circuit to reduce the car circulation time.

1. The car should not be allowed to run speedily under gravity for long distance.
2. The circuit should be as such as practicable by using car control appliences.
3. The teeper should preferable located in the shut or in securely plant on order that the duration of car circulation.
4. The teeper capacity should be selected on the event of any breakdown or interruption the entire output can be handle by a single teeper only.
5. The operation of the teeper and entry of cars into them should be automatic.
6. To large a number of control appliance or control point should be avoided.

The design of pit top and pit bottom layout is done with the following objects in view :

1. Use of the shaft to its fully capacity.
2. Use of minimum number of tubs in the circuit.
3. Use of minimum number of operatives.
4. Maintaining steady flow of tubs.
5. Minimum decking time.
6. Lowering of materials.
7. Handling of ores or coals of different grades.
8. Avoiding large excavations near pit-bottom.

Pit bottom circuit :

The most important types of pit bottom circuit are :

1. Circular type circuit :

(i) The circular type pit bottom circuit in which cars move only in one direction.
(ii) It is commonly used in large capacity modern mines.
(iii) It is running of strain in opposite direction on different tracks in the same roadways can be avoided.

A great disadvantage of this type of circuit a large amount of excavation work will be necessary.

The circular type layout are soon further classify depending on the location of the shaft relative to the man haulage road and the direction in which the mine cars are pushed into the cages.

2. Non-circular type circuits : These are suitable for smaller output, the layout are not flexible. They are divided into

(i) Roadway pit-bottoms.
(ii) Blind or dead pit bottoms.
(iii) A serious dis-advantages of the former type of pit-bottom, it causes traffic consecution in the pit bottom.

3. Back shunt circuit : The back shunt is cheep and simple but a speed feed is essential to allow sufficient time for each car to clear the back shunt before the next one enters. The space feed may be provided by a creeper or a stop start ram placed before the back shunt car clearance by may accurate by making the back shunt on steep or installing in a ram stop on.

4. Turn table circuit : A turn table circuit ensures continues feed of cars which need not be delivered to the turn table at regular intervals unlike the back shunt. Two reversal of car is accomplished within a restricted space. The turn table for outputs exceeding 500te/day are usuable power operated. The length of pit top required for turn table circuit is smaller than that for back shunt circuit. Only three man are required on pit top.

Chapter No. 2 – Winding In Shaft

WINDING:-

The Purpose of Winding is to

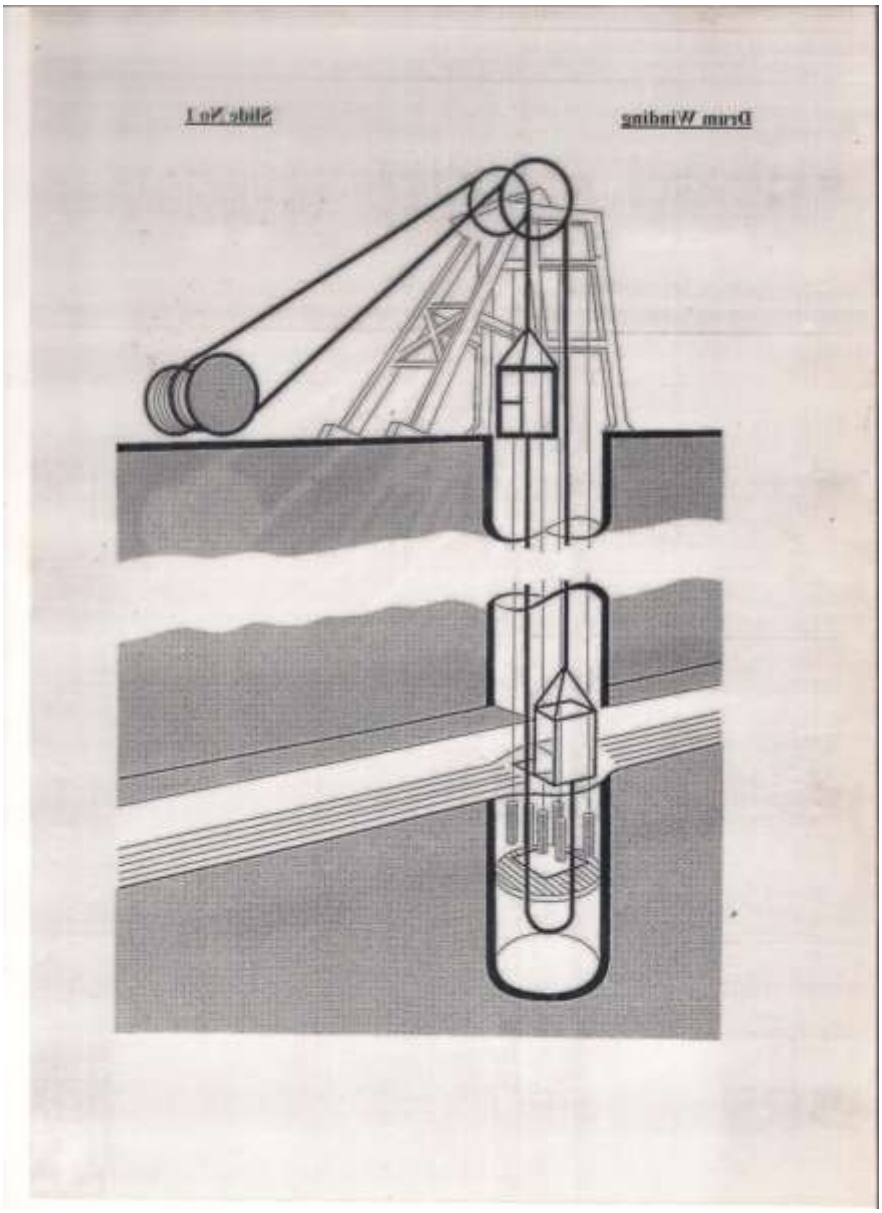
1) Hoist the coal or mineral from underground to surface.
2)
3) Lowering & rising of men.
4) Transport the material from surface to underground
5) Winding is a transport system from surface to underground through shaft when the mine is dip. It is more or less same as we see a lift in a multiplex building.

Main Equipments used for Winding

1) Headgear
2) Pulley (headgear pulley)
3) Cage
4) Skip
5) Winding rope
6) Winding drum
7) Guides
8) Keps
9) Suspension gear
10) Electrical motor

1) **Headgear:**It is a steel or concrete framework on the mouth of the shaft. The purpose of headgear is to:
   a) Support the headgear pulley, the weight of cage, ropes & rope guides.
   b) Guide the cage to banking level.

The headgear consists of four girders inclined towards the centre of the shaft at an inclination of 1 in 8 to 1 in 10. A network of steel girders joins these four girders to each other. Two real legs situated towards the winding engine room are connected to the headgear to prevent its building. This rear legs are also used as ladder way. Two headgear pulleys are installed at the tope of the headgear & a bell plate is installed below the headgear pulley.



c) These types of headgears are used in drum winding & are known as six legs tied headgear.
d) **Four-leg Headgear:** This type of headgear is used in friction winding. The construction is same as that of six-leg type headgear but only the difference is that it does not have two rear legs.
e) **Two-leg Headgear:** It consists of only two legs inclined towards the shaft. The headgear pulley is installed on a cross member mounted between two legs. This type of headgear is not used.

Design of Headgear depends on following parameters

1) **Total Static Loads:** Weight of cage, rope, pulley, guide rope, tub & mineral.
2) Rate of acceleration & retardation
3) Maximum velocity.
4) Depth of shaft
5) Diameter of shaft
6) Size of cage/Skip
7) Wind pressure.

Heights of Headgear depends on

1) Banking level
2) Height of the cage
3) Cage suspension gear
4) Diameter of headgear pulley
5) Inspection platform

Height of a Headgear

Sr. No.	Name of attachment	Cage in meter	Skip in meter
1.	Height of cage/skip	1.8 to 6	1.8 to6
2.	Suspension gear	3 to 4.5	3 to 4.5
3.	Height of banking level	4.5 to 6	6 to 8
4.	Over winding distance	1.8 to 7.2	1.8 to7.2
5.	Diameter of winding pulley	3.6 to 7.2	3.6 to7.2
6.	Inspection platform	3.6	3.6
		18.3 to 30.9	19.8 to 32.9

2) **Headgear Pulley:** It is made up of hard steel. Its construction should be such that its weight is less. Its diameter should be such that it should minimise the bending stresses in the rope. Generally its diameter is 100 to 120 times diameter of the rope. The large size pulleys are made in two parts& bolted together. The groove is made of renewable soft steel & its diameter should be 110% of the ropes diameter for stranded ropes & 105% for locked coil ropes.

3) **Cage:** It is a lift like structure suspended from winding rope by means of suspension gear arrangement. It is used for the transportation of men & materials. It is made up of steel & very strong in construction. A track is provided on the floor with catches to prevent the movement of the tubs. It is open with two sides & provided with collapsible door. Man travelling in the cage provides a hand bar on the sides for holding. The types of cage are as follows:
    a) Single deck single cage (only one tub).
    b) Tension cage – two tubs or more in one cage.
    c) Double deck single cage (one tub on each floor).
    d) Double deck tension cage (two or more tubs on each floor).

4) **Skip:** Skips are generally used for coal or mineral transport only, but, in new construction type; the men can also travel in the upper portion of the skip. It does not accommodate tubs but coal or mineral is directly filled in the skip from the roof& it is discharged from the bottom. Its capacity is very high but if the mineral is of different grade then mixing of the mineral & degradation of mineral is a problem.

5) **Winding Ropes**

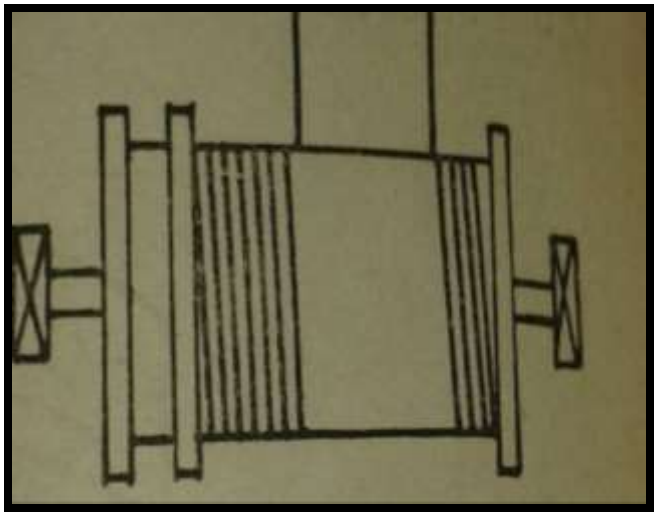
Type of Winding Ropes: A rope, which is used for winding, is generally a stranded rope, fibre core & Lang's lay construction. This type of rope is having more flexibility & smooth external surface this reduces the wear & tear of the rope.

Winding Drum

Drum profile: -The power required for winding resulted in the use of various drum profiles or shapes in order to afford the efficient design there are four different shapes of drum used in India these are

1. **Cylindrical drum.**
2. **Conical drum.**
3. **Cylindro-conical drum.**
4. **Bi-cylidro-conical drum**.

1.Cylindrical drum: - A cylindrical or parallel drum is a simple and robust in construction. The winding ropes are attached at each end of the drum barrel, and arrange to coil on the drum in the opposite direction, so that when the drum rotates one cage will be raised and the other lowered. The rope coiling underneath the drum is called under lap and the rope coiling over the top of the drum is the overlap. It may be either grooved or plain. Its serious drawback is that it can be used for shallow shaft only. In winding from deep shaft, the weight of one winding rope will exceed the weight of coal raised per wind. Thus there will an excessive load on engine when starting and negative load towards the end of the wind causing heavy brake wear. This unbalancing of load in cylindrical drums can be reduced by tail ropes.

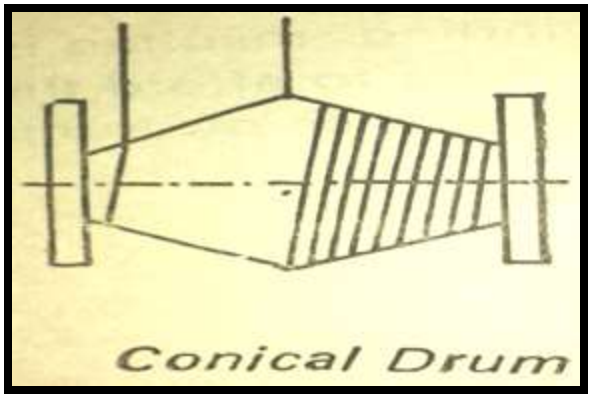


The **advantage** of using tail rope is that only load against the engine wil be the constant load of coal raised, resulting in better control of engine and reduce power consumption. But the use of tail rope has the following **disadvantages:**

a. The total masses to be accelerated and decelerated are increased.
b. Extra cost of tail rope is incurred.
c. Weight on cappel is increased.

2.Conical drum: - It is provided with flanges on two sides of the conical portion for even coiling of rope. Rope supporting the full cage is coil on the small radius

and that holding the empty cage on large radius at the commencement of the wind. These portions are reserved at the end of the wind.

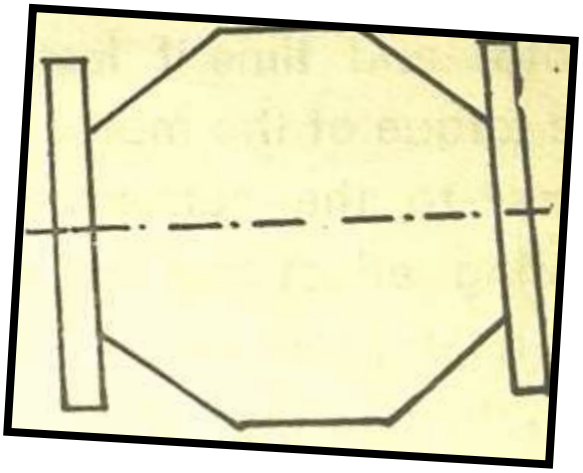


A conical drum has the following **advantages:-**

a. No tail rope is required.
b. At the commencement of wind, torque against engine, leaving the engine to accelerate the moving masses and to overcome friction.
c. At end of wind, instead of negative load there will be a positive load because the descending rope has now come on small diameter, reducing its toque while the ascending rope is on large diameter and its torque correspondingly increases.

The serious disadvantage of conical drum is that only the half width of drum can be used for coiling at each rope. Hence for deep shaft a huge size of drum will be required which may prove prohibitive proposition

3. **Cylindro-conical drum**:- This is an improvement upon the conical drum in which the apex of conical portion is provided with cylindrical drum. This is a combination of cone and a cylinder. The ascending rope is wound on the smaller diameter of the cone at first, and as the engine reaches full speed after the period of acceleration the rope is wound on the larger cylindrical part. For deep shaft the rope is wound back on itself for the last part of the hoisting period. The double winding materially reduces the total width of the drum.

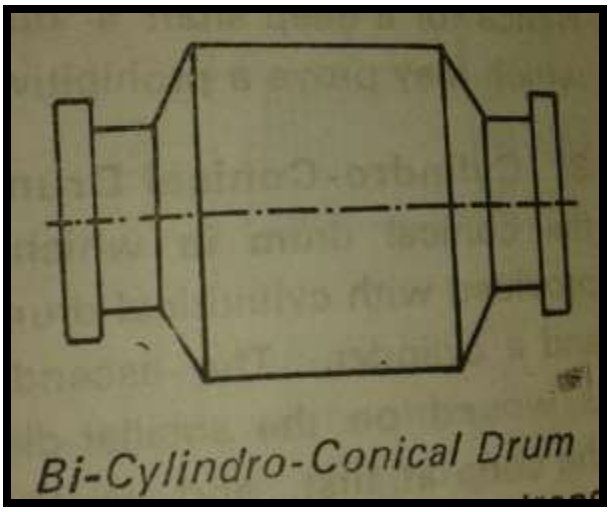


A cylindro-conical has the following **advantages**

a. The conical section improves the balance of the system at the beginning of the wind when the difference between the static torque due to suspended load is greatest.
b. The parallel or cylindrical section provides for additional space for coiling of ascending rope,provided that the fleet angle ratio is less than 1 in 40.if the condition is not obtained,additional capacity of ropes on parallel portion can be provided by fitting a centre plate to the drum and adopting double layer coiling

The main **disadvantages** are that the design is not so simple and the operation is not so smooth.

4. Bi-cylindro-conical drum: - It is composed of two cylindrical section, one of small diameter, the other of large diameter, joined by a conical section or scroll of uniform or variable pitch. At beginning of hoisting period the loaded rope is wound on the smaller cylinder until the full speed is attained, when the rope is transferred by the cone or scroll to the large diameter. Near the end of the hoist but just before the beginning of retardation, the descending rope is transferred from the large to the small cylinder.



The design of electric motors is largely controlled by the heating effect due to the hoisting cycle. Heating is proportional to the square of the current passing through the motor and time it lasts. Since the torque of the motor is proportional to the current, the high starting torque entails a strong heating effect and the motor must be large to properly dissipate the head produced. The bi-by-cylindro-conical drums serves to keep the heating effect of hoisting cycle below that of the cylindrical drum. It reduces the peak load on the motor and lands itself better than any other type of drum to a more definite control of torque especially during the starting torque.

A bi-cylindro-conical drum suffers from the following **Disadvantages:-**

a. It is heavier and more expensive than a cylindrical drum.
b. It cannot be used for multideck cages for simultaneous decking.
c. For deep winding the drum size becomes excessive.
d. Rope lying on conical portion may occupy more space than parallel sided drum and they may cause trouble due to angle of fleet.

Provisions of Winding Drums

1) Flanges.
2) Depth indicator.
3) Mechanical brakes.
4) Automatic contrivance.

1) **Flanges:** The flanges are provided on each side of the winding drum to prevent the rope from leaving the drum from the sides due to slip or slate in the rope. Its depth should be 10 to 15 cm.
2) **Depth Indicator:** A depth indicator is used to indicate the position of cage in the shaft. It is mounted on the drum winder through the gear arrangement as shown in figure. It consists of a dial & pointer moves in anticlockwise direction & during second half second the pointer moves in anticlockwise direction. When one cage is moves from bottom to top, the pointer moves from A to X1 to X2 to B. in this AX1 is the acceleration distance & X2B is the retardation distance. As soon as the pointer reaches the point X2, the power supply to ht engine should be cut off & brakes should be applied.

   When the cage moves from top to bottom the pointer move from B to X2 to X1 to A. in this BX2is the acceleration distance X2 X1 is the constant speed distance & X1A is the retardation distance. As soon as the pointer reaches the point X1, the power supply to the engine should be cut off & brakes should be applied.

3) **Mechanical Brakes:** Requirements of mechanical brakes are as under:
   1) When the cage is at rest, brakes should be in on position.
   2) When the cage in motion, brakes should be in off position.
   3) In case of power failure, the brakes should come in on position automatically.
   4) Brakes should not be used for speed control.
   5) Types of mechanical brakes
   6) Anchored post brakes.
   7) Centre suspended calliper post brakes

   a) **Anchored Post Brakes:** It is made of two 'H' section girder pivoted at P1 & P2. Each post carries its own curved brake block fitted with brake lining. The front post carries a triangular lever at its top. This lever is connected with rear post by a tie rod T2 & the main lever through tie rod T1. The main lever is pivoted at P & its anchor end carries a suspended weight. The main lever is also connected to a hydraulic cylinder through a piston rod.

   Working: When there is no rod to the brake engine, the main lever fails down under the suspended weight due to this tie rod T1 is pulled downward to operate a triangular lever in anticlockwise direction due to which the tie rod T2 is pulled. Force acting on a front post towards the brake path, applied the brakes & anchor force which is acting on the rear post by tie rod T2 applied the braking effect to the drum.

To operate a winding drum power is supplied to the brake engine to raise the piston rod which lifts the main lever upwards against the upward against the suspended weight. It will push the tie rod even upward to operate the triangular lever, which pulls the front post & at the same time pushes the rear post through tie rod T2. Thus the brakes are away from the brake path & the drum is free to rotate.

The main disadvantage of this brake is that the wear & tear of the brake lining is not uniform & it is more at top & minimum at the bottom.

b) **Centre Suspended Calliper Post Brake:** It consists of two-curved arm namely front & rear, front curved are consist of two triangular levers L1 & L2. These triangular levers are connected to the main lever at point A & B through tie rod T1 & T3 as shown in figure. Triangular lever L1 & L2 are also connected to rear curved arm to tie rod T2 & T4. Main lever, which is pivoted at P1, consists a suspended weight & a piston rod to another end.

Working: When there is no power to the brake engine the suspended weight falls so that main lever moves in anticlockwise direction about P1. Due to this tie rod T1 & T3 are pulled to operate the L1 & L2 in anticlockwise & clockwise direction respectively. These triangular levers pull the tie rod T2 & T4 so that rear curved arm is closed to the brake path & also pushes the front curved arm towards the brake path. In this way a uniform braking effect is obtained.

To operate the winding drum, power is supplied to the brake engine to raise the piston rod against the suspended load. Now the main lever rotates in clockwise direction around P1 in such a way that it pushes the tie rod T1 & T3 to operate the L1 & L2. L1 & L2 moves clockwise & anticlockwise direction respectively to release the front curved arm from the brake path & pushes the T2 & T4 to push the rear curved arm away from the brake path to release the brake.

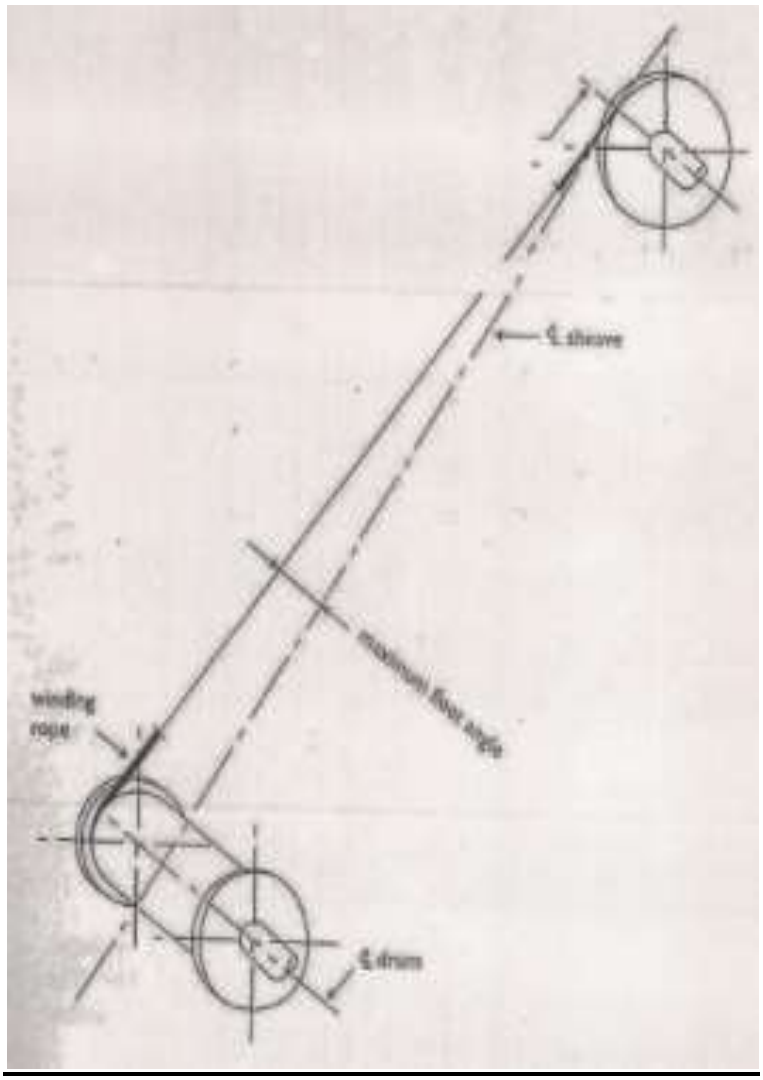
4) **Automatic Contrivance:** Its function is to prevent over winding, over speeding & to ensure slow banking.

Description: The winding drum is connected to two bevel gears, one bevel gear consist a stem, which consist of two governors pivoted at the top & connected with the sleeve. The sleeve carries a long floating lever, which consist a roller ball at the cam wheel side. The floating lever is pivoted at point 'K' which is situated & stem, 'A' which is having a knife-edge contact or an electrical contact.

The cam may indicate the position of the cage. During first half cycle cam wheel rotates in anticlockwise direction & during 2 1/2 cycles the cam wheel rotates in a clockwise direction. The cam plate is designed in such a way that there is always a hair gap between the roller & cam plate.

Working: When the winding cycle starts, the winding drum rotates which is then rotates the cam wheel & centrifugal governors through the bevel gears as shown in figure. As the winding speed increases the centrifugal governors go up to the centrifugal action. As a result to it the floating lever also moves upwards. If the speed exceeds a certain limit, roller touches the cam wheel. As well as roller touches the cam wheel; the cam plate exerts a thrust on it. These force acts at the point 'K', which either break the power, supply to the engine or apply the mechanical brake to the winding drum.

Angle of Fleet



It is the angle between the vertical plane of the pulley & the rope when the cage is at the pit top, angle is known as inside fleet angle & when the cage is at the pit bottom, the angle is known as outside fleet angle. As the angle of fleet increases, the wear & tear of the rope & pulley also increases. As per D.G.M.S. the fleet angle should not be more than 1.50.

Guides

Guides are used to give the direction to the cages in motion in the shaft to avoid collision between them.

Types of Guides

1) Rigid guides
2) Flexible guides (rope guides)

1) **Rigid Guide:** These guides are made of steel or wood. They are of rectangular cross section, usually 10 X 20 cm. & are fixed by countersunk bolts to the bun tons of places across the shaft of the intervals of 1.8 to 3 meter. The weight of the rail section varies from 20-to 55-kgf/m. lengths & length of the rail piece is up to 13 meter. Only one line of bun ton is required in the middle of the shaft for fixation of rigid guide. Generally one line of guide is enough but sometimes two guides /cages are used. These guides are used for dip shaft. But now day's wooden guides are not used.
2) **Flexible Guides:** These guides are made of steel wire ropes. The ropes used may be of locked coil construction or a guide rope itself. These guides are suspended in a vertical shaft from two headgears, by using a reliance rope capel which is a screwed on the on the cross member of the headgear as shown in figure. At the pit bottom the rope passes through the holes provided in the pit bottom deck & the required amount of tensioning weight is attached to the rope. In shallow shaft 2 or 3 rope guides or cage are sufficient but for dip shaft four guides or cages are used.

   The tensioning weights are about 10 KN per 100-meter depth in shallow shaft & about 5 KN per 100-meter depth in dip shaft.

Causes of Cage Oscillation in Rope Guide

1) **Depth:** If the depth of the winding increases, the length of the guide rope is also increases. Due to this more oscillation takes space as the cage travel.
2) **Winding Speed:** Oscillation of the cage increases as the winding speed increases its normal speed. To reduce this winding speed should not exceed its normal approved value or limit.
3) **Rate of Acceleration:** As the rate of acceleration increases the oscillation of the cage also increases. To reduce this rate of oscillation should not exceed its normal approved value or limit.
4) **Rate of Retardation:** As the rate of retardation increases the oscillation to the cage also increases. To reduce this rate of oscillation should exceed its normal approved value or limit.
5) **Tension in the Rope:** If the rope having less tension it will cause more oscillation to he cage, hence to reduce it correct tension in the rope should be used.

6) **Rubbing of guide shoe:** If there is more friction between guide shoe & rope it will cause more oscillation to the cage. To reduce this should the proper lubrication between rope & guide shoe.
7) **Sudden Power Failure:** Oscillation to the cage will increase suddenly if there is a sudden power failure.

Comparison between Rigid Guide & Rope Guide

Rigid Guide	Rope Guide
1) No oscillation. 2) Less space required. 3) Costly 4) Difficult installation 5) More maintenance 6) More resistance to fire 7) No load on headgear 8) Only damaged parts can be replaced 9) Bun tons are required through the shaft 10) More life	1) Oscillation of cage is there 2) More space required 3) Cheap 4) Easy installation 5) Less maintenance 6) Less resistance to fire 7) Complete load on headgear 8) Any damage causes full replacement 9) No bun tons are required 10) Less life

Cage Suspension Gear

When the steel wire rope is used for winding, it can't be directly attached to the cage. Hence the attachment used to attach the rope with cage is known as cage suspension gear.

It consist of a rope capel which is attached to one end of rope & it's another end is attached to a safety hook through 'D' link & bull chain. The another end of the safety hook is attached to a triangular plate to a 'D' link & bull chain & the triangular plate is further connected to the cage through four or six bridle chains.

The main parts of a Cage Suspension Gear are

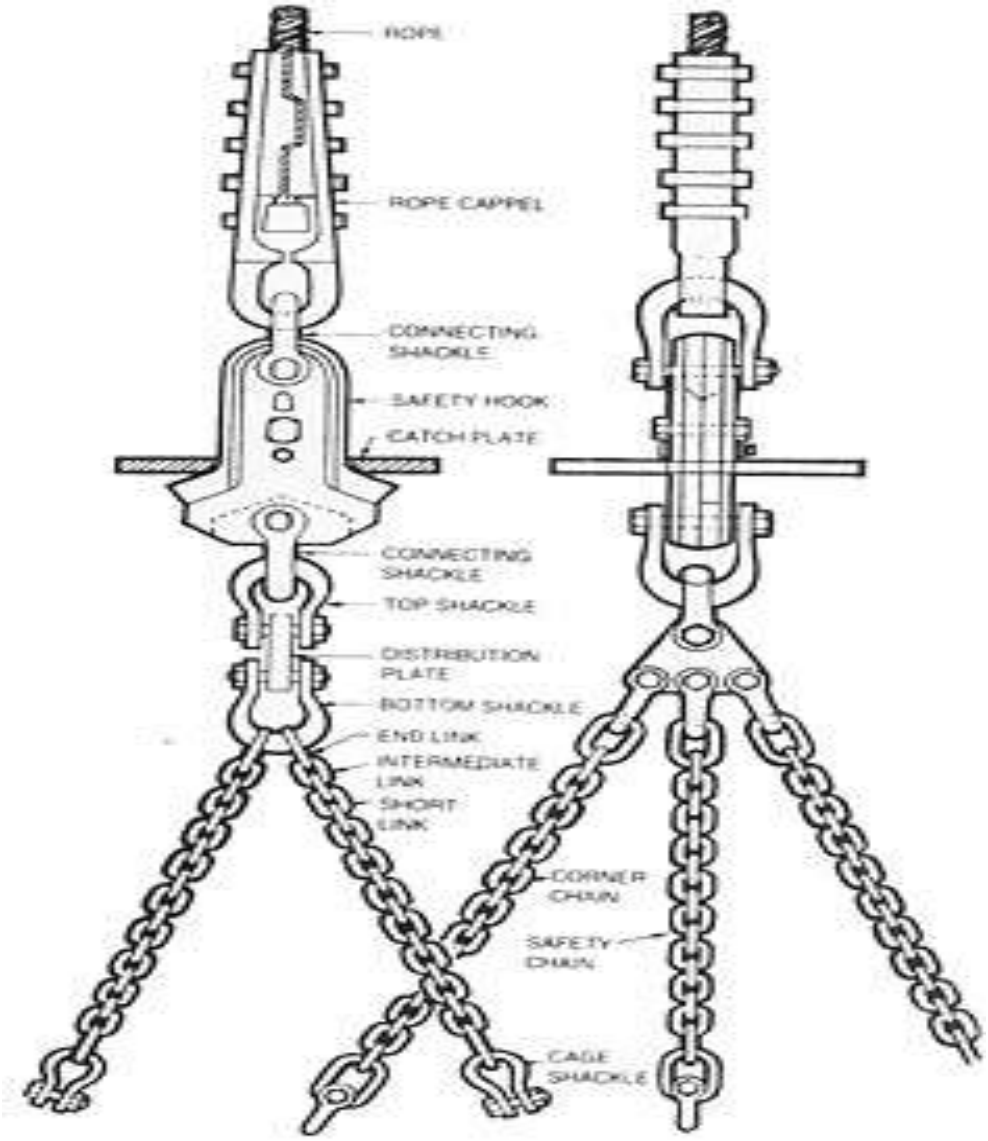
1) Rope capel (Reliance rope capel)
2) 'D' link & bull chain
3) Safety hook

4) Triangular plate
5) Bridle chain

CAGE SUSPENSION GEAR IN INDIAN COAL MINES

- Steel rope was introduced in our coal mines in the beginning of 20th century Prior to that Hemp rope or Flat
- Chains were used for winding.
- With the introduction of steel wire ropes, demand for rope end attachments arose.
- If required collaborative efforts of manufacturers, users, mining officials of statutory authorities to envolve
- Attachments which are safe and reliable.

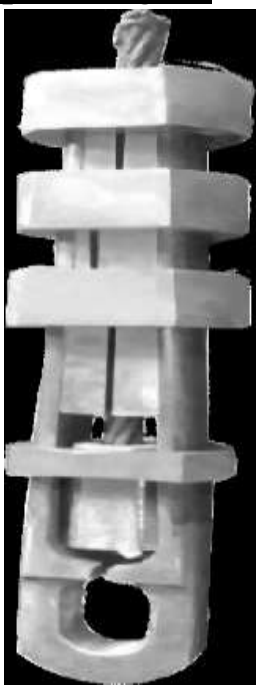
CAGE SUSPENSION FOR DRUM WINDING



In Drum Winding general requirements can be taken as follows :-

- method of connecting winding rope to suspension gear
- Incroporation of a safety device.
- Four-point suspension of the cage.
- Free movement of the gear in two planes.

Method of connecting winding rope to suspension gear.

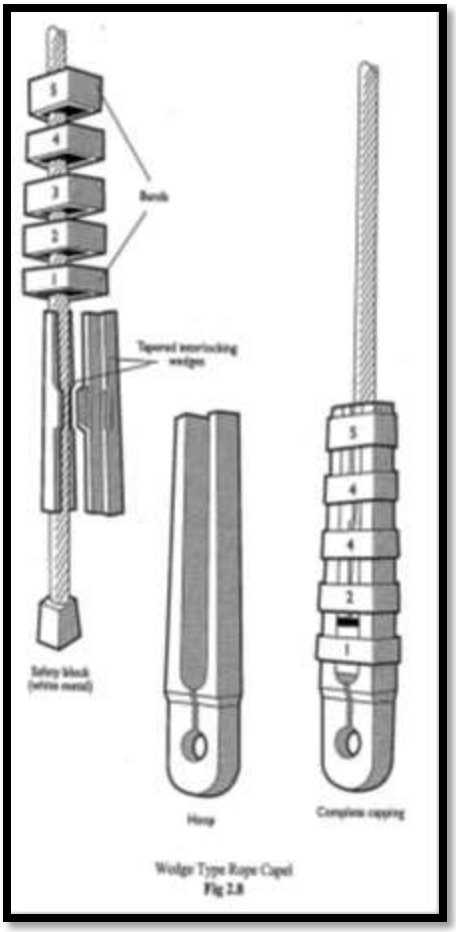


WhiteMetalSocket orFrictionWedgeRopecappel are usually used for this purpose.*White Metal Socket*-solid machined with open jaws are widely used forconnecting the winding rope to the suspension. The mouth of the socket isrounded to prevent the damage to the rope and short length of parallel bore is provided next to the mouth. After carefully preparing and securely binding the rope with soft iron, seizing wire, anti-friction bearing alloy is poured into thesocket (IS 3937 Part 2). A properly carried out capping of the rope in the socket will withstand the breaking strength of the rope.

The length of taper of the socket is usually not less than six times and not more than eight times the diameter of the rope. The angle of the taper is between 3^0 and 6^0.

Friction Wedge Rope Cappel was introduced by Mr. Becker in 1904. It was an interesting development. In this type of rope cappel, holding power of the cappel is more than the strength of the rope. A metal block is fitted at the end of the rope. If there is any movement of the rope between the two wedges, it can be checked by measuring the distance between the safety block and bottom of the wedges. It provides a warning to the operating supervisor and calls for remedial action.

B. ***Incorporation of a safety device. Safety Hook***



Wedge Type Rope Capel
Fig 2.8

The use of a detaching hook is a basic requirement for safety in winding practice is demanded by law. The intention is to provide a safety device which will come into operation if the other protective equipment fails to prevent an over wind and the winding engine fails to stop at the end of the normal wind. In the absence of such a

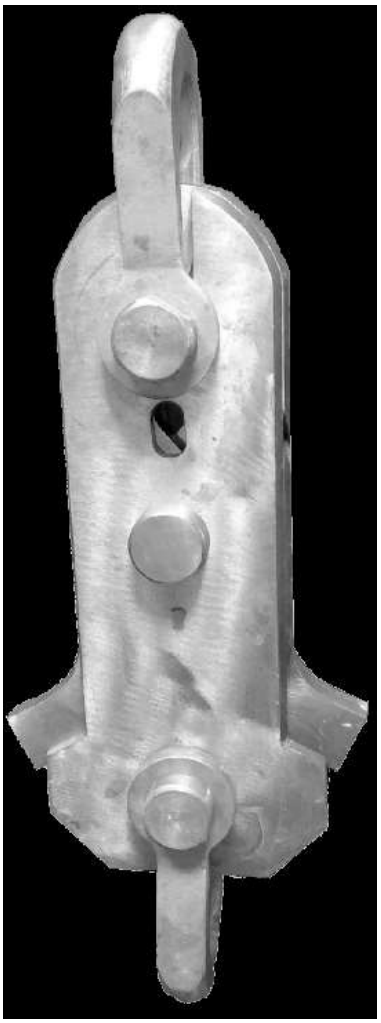
preventive device, the ascending cage would be taken up into the head frame to collide with the winding sheaves. This cage would then fall down the shaft with disastrous consequences. Detaching hooks must, therefore, be installed as part of the suspension of all cages and skips, except with the Koepe winding system.

The detaching hook operates in conjunction with a releasing device, the detaching plate, through which the winding rope travels and which is mounted some 1.8m to 3.6m below the winding sheaves. The equipment is designed to fulfill two functions, if the cage should be taken past the normal overwind trip position, first to release the winding rope from the cage and second to prevent the cage from falling back down the shaft when the rope is released. This is achieved by arranging the main members of the hook to rest on the detaching plate when thedevice is opened to release the rope and secure the cage.

There are several types of detaching hook in regular service, and the following description of humble safety hook, which is mostly used in our Indian coal mines, will serve to illustrate the general principles of the design and operation of these devices.

Safety detaching hook

The detaching hook consists of four plates; the two outer plates fixed together by rivets passing through a V-shaped spacing blocking at the lower and two inner plates shaped like a hook at their upper ends. The inner plates are connectedtogether scissor-wise and to the outer plates by the hinge pin at the centre. The lower end of each inner Plate is shaped to provide the striking horn and the notched projection for resting on catch plate in the event of an overwind. The inner plates have an extra thickness of material in the hook region. With this type of hook, both the inner (hook) plates and the outer (containing) plates are load bearing. The inner plate transmitthe load from the top connecting shackle pin to the hinge pin from which point the outer plates transmit the load to the lower shackle pin. The hook is prevented from opening during winding by a shear pin made of copper which is sheared as thehook is drawn through the catch plate.



C. Four point suspension of the cage.

To achieve even suspension of the cage, distribution plate is fitted below the adjusting device and from the platechains are attached by means of shackles. Four corner, chains, identical in length are fitted to the cage hangersby shackles and two safety chains are provided where safe working load is 8 tons or more. These being attachedvertically from the distribution plate to the top of the cage. Sufficient slack is allowed to ensure that they do notcarry the load.

D. Free movement of gear in two planes.

Free movement of the suspension gear in two planes is allowed by the connection used between the variouscomponent parts of the suspension gear.In our system, rope cappel in directly connected to the top shackle of the safety hook. Bottom shackle of the safetyhook is connected to the top shackle of the distribution plate.

By this type of connection we can have freemovement of cage suspension gears in two planes.

Steps for making White Metal Rope Cappel

1. Before cutting off the old cappel or rope end, fit sufficient temporary seizing or clamps to prevent the rope from ' kicking' when cut through. With locked coil ropes clamps are absolutely necessary and about four clamps for every 25mm of rope diameter should be used.

2. Thread the socket on to the rope and push it along out of way.

3.Seize the rope with soft iron wire for a length Xy equal to twice the diameter of the rope,leaving the rope end free of this seizing YZ equal to the length of the socket barrel less half a rope diameter.

4. Unlay the rope end beyond the seizing, separate all the wires out into a brush, but do not bend any of them too sharply at the seizing and do straighten the wires. Cut out the fibre core or cutas deep into the brush as possible

5. Clean all the wires carefully with petrol, emery cloth etc, and remove all dirt and grease before going any further. This cleaning is most important. Do not let the petrol run into the unopened rope or it will wash out the lubricant and allow corrosion to occur next to the cappel.

6. Pull the brush of opened wires into the socket and fix the socket upright in a soft jawed vice or clamps with the large end up, ready for pouring the metal. See that the rope hangs straight down under the socket for a length ofat least 36 rope diameter (Sketch 3).
7. Make a dry string binding round the rope at the small end of the socket to prevent the molten metal from escaping (Sketch 3). Do not use damp clay for this purpose as it will give off steam and may cause blow holes in the metal.

8. Heat the socket evenly with blow lamp to a temperature of 1000-2000c temperature more than boiling water. Atthis temperature drops of water placed on the socket will fly off.
9. Dust powdered rosin among the wires in the socket. This acts as a flux and help grip the wires.

10. Heat the standard white metal to a temperature of 3500C and pour it, in one ladleful if possible, while it is at this temperature or 130C above or below. The pouring temperature should be measured with a thermometer. If the metal is poured too hot it may affect the rope wires, whereas if it is poured too cold it may not flow or grip the wires properly. (See Coal Mines Regulation 1957:83 (5) (d). Metaliferous Mines Regulation 1961: 88(5) (d).

11. Allow the cappel to cool before using it. If there is not enough time for natural cooling, let the metal become solid and then apply wet sacking or direct a current of cold air on to the socket. Do not dip the socket in cold water or use it until it has cooled to air temperature.

12. Finally lubricate part of the rope which is near the socket.

White Metal Safety Block is fitted as detailed in W.M. Cappel Installation. After fitting the White Metal Block, the cappelshould now be fitted as follows:

Note: Prior to assembly, remove any portective paint, grease or backing strip from cappel limbs and wedges. Remove any trace of of rust which may have accumulated on the wedge back and grooves, and also on the inside of the limbs over the area on which the wedges operate. Emery cloth only should be used for this purpose. Remove any burrs or damage on wedges and limbsection particularly the area over which the wedges operate which may have occurred in handling, storage or transit, (if left they may interfere with the movement of the wedges.)
Thread cappel bands on rope in reverse number order i.e. No. 1 is threaded onlast. Make sure that the taper of the inner sides of the bands accords with the outside taper of the cappel limbs. This is shown by an arrow stamped on the limbs.
Thoroughly clean any grease and lubricant from that portion of the rope which will be gripped by the wedges and ensure that the rope is straight, clean and dry, Clean also the *Backs* of the wedges and the inner sides of the cappel limbs. Then apply alight smearing of grease to the *Backs (not The Grooves)* of the wedges and the inside of the limbs. *The Groove Of The WedgesMust Be Clean And Dry*. Place the wedges around the rope approximately in the position they will take up when in the cappel.

Fit the cappel limbs over the wedges and draw downwards until the ends of the limbs are flush with the thin end of the wedges. The rope should then be drawn through the wedges until the safety block is approximately 20mm from the bottom of the wedges. The bands should now be drawn over and tapped down on the

cappel limbs. The band numbered 1 should be fitted adjacent to and encircling the safety block.

Using drifts which should fit snugly on the edges of the bands adjacent to the cappel limbs (starting with No. 2) should be driven down until they sound tight and solid. The driving down should be on alternative bands so that all the bands are driven down progressively. Preferably two strikers should be employed tofacilitate uniform tightening. The sides of each band adjacent to the wedges should never be struck, as otherwise burrs can be caused which may foul the wedges and retard their movement.
Band No.1 is intended only as a protection for the safety block and need not be driven on to a very tight fit. It is not a "working" band and its position on the limbs is not critical. The top ("point") band at the cappel mouth (No. 4 in the illustration) being the last and easiest to drive on may receive the hardestblows.

This Must Be Avoided. It needs to be tight, but not excessively so.
The "Working" bands (Nos. 2, 3 and 4) in the illustration properly driven on, should be spaced about equally along the cappel limbs, the top ("point") band being slightly short of the end of the cappel.

Notes on Safety Hook:

Inspection: Coal Mines Regulation 1957 No. 81 (2) (a) requires inspection of all parts of Suspension Gear including safety hook every six months and if necessary at shorter interval.

<u>Maintenance:</u>

1. Check all nuts and split pins for wear of safety Hook and slackness. Renew split pins at regular intervals.

2. Check outer plates for wear and cracks around shackle eye positions. Do not weld up.

3. Check the copper pin for wear and partial shear which may be due to wear and slackness in platework and pivot pin. Pivot pin must be good fit in platework.

4. Check all plates for flatness by means of straight edge.

5. Ensure that hooks are always well lubricated and as clean aspossible. Avoid excessive accumulation of grease and coaldust. Ensure that the locking bolt slot is free from grease andother matter which may hinder the action of the bolt in an overwind.

6. Ensure that the Lifting shackle (for release of hook afteroverwind) is maintained in a clean and corrosion-free condition. Ensure that it is the correct one for the hooks in useand always ensure that several persons are certain where theshackle is located.

Precaution:

1. Ensure that the catch plate position is such that sufficientclearance exists to allow complete detachment of the hookbefore the cappel makes contact with the sheave in anoverwind.

2. Ensure that adequate clearance exists between catch plate hole and all attachments including rope cappel so that unrestricted passage through the catch plate is possible.
Humble Safety Hook

Step 4 for fitting F.W.R.C.
18
1. Check that the jaws of shackles are parallel.
2. Check that the safety chains are slack after installation incase of six-legged C.S. Gear.
3. Ensure that the length of the slings are 2230mm for fourlegged CS gear & 2725mm for corner chains and 2575mmfor safety chains in case of six-legged C.S. Gear.
4. Ensure that there is not much slackness between jaws forshackle and the cage hangers. DGMS (tech.) circular No.7 of 1987 has given the following guidelines to the industrywhich must be followed.

<u>Installation</u>

- Inspections of attachment of bridle chains to cage hangers have revealed that at some of the installations the fitment between D-shackle pins and cage hangers was not proper causing excessive wear. This happens mainly due to abnormal clearance between shackle pins and cage hanger hole as well as improper inclination, width and thickness of cage hangers.

- To deal with the above difficulties, guidelines given above must be followed.

Inspection

Coal mine regulation lays down following periodicity for inspection

Coal Mine Regulation 83-

1. Daily Inspection:
Every part of cage suspension gear shall be examined carefully for its proper and safe working.

2. Monthly Inspection:
Every detaching plate of safety hook shall be examined and its opening dimension shall be measured and recorded once in at least thirty days.

3. Half Yearly Inspection:
For proper maintenance, it is required that all cage chains in general use and other parts of suspension gear between rope and the cage including the detaching hook, shall be taken apart, cleaned and carefully examined as to wear and tear by gauging and for rust and cracks once atleast every six months or if necessary at shorter intervals.

4. It is suggested that where the conditions are severe, the present visual method of detection of cracks and flaws always does not indicate the correct health of Cage Suspension Gear or its components. In such case magnetic and ultrasonic tests or any other N.D. Test can be done, to detect any crack or flaw in the suspension gear or its components which are regular in service.

PROPER STORAGE OF CAGE SUSPENSION GEAR & ITS PARTS.

- C.S. Gears and it's components must be stored in shelves above floor level.
- They must not be exposed to direct sunlight.
- Proper labeling of components identifying the manufacturer must be done.
- If storage is likely to be more than one year then anti-rust lubricant must be used.
- Principal of first-in first-out must be implemented.

NORMS OF DISCARD OF CAGE SUSPENSION GEAR COMPONENTS.

-Rope Cappels (Wedge Cappels)

1. Tightening bands being damaged, becoming out of shape due to mishandling or any other reason.

2. Marked pitting/corrosion appearing on the bands and the body.

3. Deformation in the body or excessive were on the outer or inner surface.

4. Whether the last tightening band could be tightened up to 6mm or less measured from the bottom of thetapered wedge.

5. Wear to an extent of 5% to 6% or more on the eye portion of the cappel.

Safety Hook

1. Wear on the centre pin exceeding 10% in top and bottom shackles and pins.

2. Wear exceeding 1% in top and bottom shackles and pins.

3. In the top portion of the safety hook if slackness in the pin in more than 1.6mm.

4.(a) Wear on the outer plate shall to be not more than 0.3 mm.
(b) Pitting/corrosion on the inner/working plates.

5.(a) Obliquity in the hole for the copper pin.
(b) Obliquity of holes in the top and bottom shackles (outer) limited to 10%

6. Where the shackle eye has rubbed on the plates and the wear due to such rubbing exceeds 1.6mm.

7. Any deformation, pitting/corrosion or any other defect on the projected fins of the working plates as wellas the protion which rests on the catch plate.

Note: The detaching plate or safety hook is considered as a part of the hook. In case of any notch/groove due to rubbing of rope or otherwise on the circumference of the plate hole, the plate should be rejected. If there is no defect like corrosion, groove in the hole of the plate and obliquity in the holes of the tightening bolts,the plate can be allowed further use after proper heat treatment and tests for cracks etc.

Distribution Plates:

1. Marked pitting and corrosion.
2. Obliquity in the holes exceeding 10% of the original dia.

3. Where the shackle eye has rubbed on the distribution plate and wear due to rubbing exceeds 1.6mm.

Shackles and Pins:

1. Wear on shackle eye sides exceeds 1.6mm.
2. Wear on the shackle eye hole exceeds 10% of the original diameter.
3. Obliquity in the hole exceeds 10% of the original diameter.
4. Wear on pin exceeds 10% of the original diameter.

Suspension Chain Slings:

1. Marked pitting and corrosion.
2. The wear on the contact surface of the links exceeds 10% to 12% of the nominal diameter of the link.

POINTS TO PONDER

1. No rusting used to appear on the imported C.S. Gear, Humble safety hook or Reliance Friction Wedge Rope Cappel even after long storage & exposure to adverse environment.Indigenous C.S. Gear & Components gets rusted much earlier.

Suggestion: Grit Blasing of components is advocated to prevent earlier rusting.

2. During the installation of friction wedge rope cappel, bands get deformed and damaged due to sledge hammering. Availability of expert strikers is decreasing. Mining industry is not attractive to the present generation.

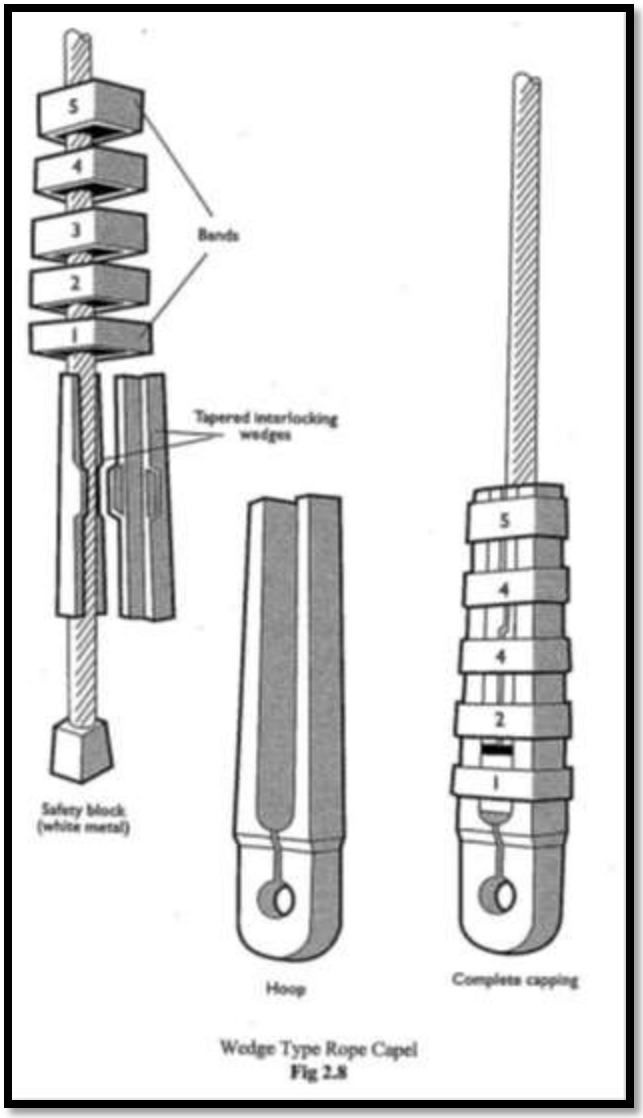
Suggestion: Adopt Hydraulic Rope Cappel Banding. Fig. 18
It ensures consistent and specified pressure on all bands.

3. Avoidance of repeat testing-CS Gear & components are tested 100% at CMFRI for proof load & NDTincluding magnetic particle test, ECL repeats these tests in their own work shop.Due to this procedure acceptance of material is delayed.

Suggestion: Testing may be carried out at either National testing house or at ECL Testing House.

4. DGMS has specified inspection of CS Gear & components every six months by the manufacturer. Thisobligation is for six years. As per the present purchase norms and porocedures the vendor is supposedto carry out these inspections without any further pecuniary benefits.

1) **Reliance Rope Capel**



Wedge Type Rope Capel
Fig 2.8

a) In this capel there are two iron wedges, which grip the rope near the required end where a white metal block is prepared. There is U-shaped steel strapped

which is placed over the two wedges & on which 4-5 iron clamps are fitted by hammering.

b) Prepare a white metal block at the required end of the rope.
c) Insert the iron clamps on to the rope in order of numbers (largest number first). The jaws of capel are about 24 times more diameters.
d) Properly clean any grease or lubricant from that portion of the rope which will be griped by the wedges.
e) Place the two wedges around the rope approximately in the position they will occupy when in capel.
f) Fit the U-shaped strip over the wedges such that the U-shaped strip & wedge top are in one line. Draw the iron clamps over the U-shaped strip.
g) Hammer the iron clamps for proper grip. The ring number 1 should not be hammered because it is only for the safety of the white metal block. With this capping operation is over.

2) **<u>'D' Link & Bull Chain</u>:** These are used to attach any two components of cage suspension gear & to adjust the height of cage suspension gear. The diameter of link rod should be 1.5 times the rope's diameter & should not be any join in the link.
3) **<u>Safety Hook/Detaching Hook/King Detaching Hook</u>:** It is a safety device which acts when an over wind takes place. Its purpose is to suspend the cage or skip in the headgear if an over winding occurs & at the same time to release the rope capel to go over the headgear pulley. It is always placed just below the rope capel.

It consists of two inner plates & two outer plates, which can rotate around a common point 'H'. The outer plate is fixed & inner can move. The inner plates are arranged face to face on each other between 'H' & through all the plates assemble the hook. A copper pin is placed through the hole 'C' in all the four plates.

In case of over winding, the hook passes through the detaching plate, which is fitted in the headgear, while pulling through detaching plate, the lower portion of the hook is pressed inside & the copper pin is sheared. The inner plate moves around 'H' so that rope capel release from the top & the catches of inner plates are fill apart. The cage rests on detaching plate with the help of catches. Thus the cage & the persons travelling in the cage are safe.

Recovery of over winding cage: Before starting the recovery operation, the shaft top is covered with rails. Now the winding rope is brought up to the hook & the rope capel is attached to the hole 'F' through the 'D' link, when the

winding rope is pulled slightly. The inner plate comes in their original position since the hole 'F' is inclined. The catches are now inside & the safety hook can freely pass down through the detaching plate. The cage is now slowly lowered on the rails placed over the pit top.

After the over wind, the safety hook is to be inspected & refitted with new copper pin & the rope is to be replaced after every over winding.

4) **Triangular Plate/Load Distributing Plate:** Its function is to distribute the load of the cage, hence it is known as load distribution plate. It consist of one hole at the top which is connected to the safety hook & at the lower end it consist of two or three holes which are connected to the cage through bridle chains.
5) **Bridle Chain:** These are used to attach the cage with the triangular plate, for a small cage only four chains are used at the four corners of the cage while in case of large cage total six chains are used. Out of these six chains two central chains doesn't carry any load & these are used in case of failure of corner chains.

Keps/Keps Gear

Keps are used to support the cage at the pit top for proper alignment of the cage floor & the decking level.

Type of Keps

1) Rigid keps
2) Davies improved keps gear

1) **Rigid Keps:** These are retractable supports for cages & have to be used at the pit top. Their use is not necessary at pit bottom as the cages rest on rigid platform of steel girders & wooden planks. Keps ensure not only support to the cage but their use results in proper alignment of cage floor & ducting level so that stretch of winding rope creates no difficulties during decking. The banks man at the pit top manually operates Keps. The ascending cage pushes the keps back & as it is raised slightly higher than the decking level, the keps fall back in position by gravity as the banks man release the operating lever. The cage after it has come to half is lowered by the winding engine man to rest on the keps. When the top cage is to starts on its downward journey, the winding engineman raises the cage only slightly to make it clear of keps, the banks man withdraws

the latter by manual operation of a lever which is held by him till the cage is lowered past the keps.

Disadvantages of Rigid Keps

1) Accumulation of slack rope on pit bottom cage when the top cage is raised a little for withdrawal of keps subjected to shock loads.
2) Loss of time & power in lifting the cage.

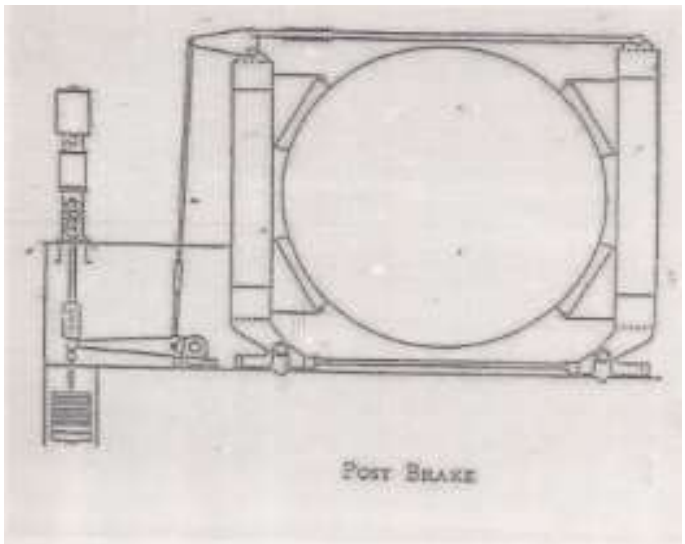
2) **Davies Improved Keps Gear:** Because of the defects of rigid keps, they have been devised which can be withdrawn from under the cage without lifting it, hence keps are stausskeps& the Davies improved keps gear has been designed.

The gear consists of shaft 'S' to which is keyed the hand lever & a pair of arms 'A' with a steel rollers 'R' mounted on a pin between the arms. The roller presses against a renewable roller path on a swing lever 'L' which is pivoted at 'P' & carries a pallet mounted on a steel pin at its other end. The pallet is free to move upward & around this pin as shown in dotted lines. Thus permitting the upward passage of the cage, but it is prevented from moving downwards by a projection on the lever 'L'. The cage is thus securely supported on the upper surface of the pallet. The gear may be withdrawn, however without first raising the cage, in the manner shown in figure. It will be seen that when the hand lever is moved to the left, the roller 'R' moves upward along the roller path on lever 'L', thus allowing the lever to rotate downwards by gravity around the pin 'P' until the pallet is clear of the cage.

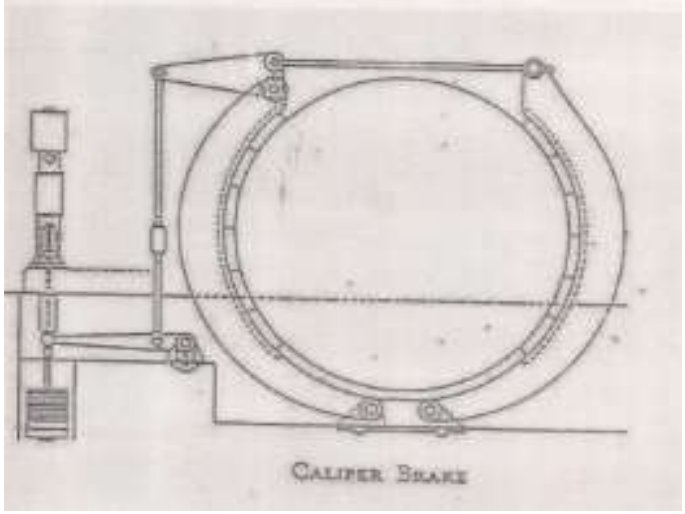
Safety Devices

1) **Electrical Brakes:** Electrical brakes are used to reduce the speed of the cage, as soon as the speed of the cage comes to near zero, the mechanical brakes should applied. Electrical brakes are also known as service brakes.

2) **Mechanical Brakes:**



Post Brake



Caliper Brake

Requirements of mechanical brakes are as under:

1) When the cage is at rest, brakes should be in on position.
2) When the cage in motion, brakes should be in off position.
3) In case of power failure, the brakes should come in on position automatically.
4) Brakes should not be used for speed control.
5) Types of mechanical brakes
6) Anchored post brakes.
7) Centre suspended calliper post brakes

a) **<u>Anchored Post Brakes</u>:** It is made of two 'H' section girder pivoted at P1 & P2. Each post carries its own curved brake block fitted with brake lining. The front post carries a triangular lever at its top. This lever is connected with rear post by a tie rod T2 & the main lever through tie rod T1. The main lever is

pivoted at P & its anchor end carries a suspended weight. The main lever is also connected to a hydraulic cylinder through a piston rod.

Working: When there is no rod to the brake engine, the main lever fails down under the suspended weight due to this tie rod T1 is pulled downward to operate a triangular lever in anticlockwise direction due to which the tie rod T2 is pulled. Force acting on a front post towards the brake path, applied the brakes & anchor force which is acting on the rear post by tie rod T2 applied the braking effect to the drum.

To operate a winding drum power is supplied to the brake engine to raise the piston rod which lifts the main lever upwards against the upward against the suspended weight. It will push the tie rod even upward to operate the triangular lever, which pulls the front post & at the same time pushes the rear post through tie rod T2. Thus the brakes are away from the brake path & the drum is free to rotate.

The main disadvantage of this brake is that the wear & tear of the brake lining is not uniform & it is more at top & minimum at the bottom.

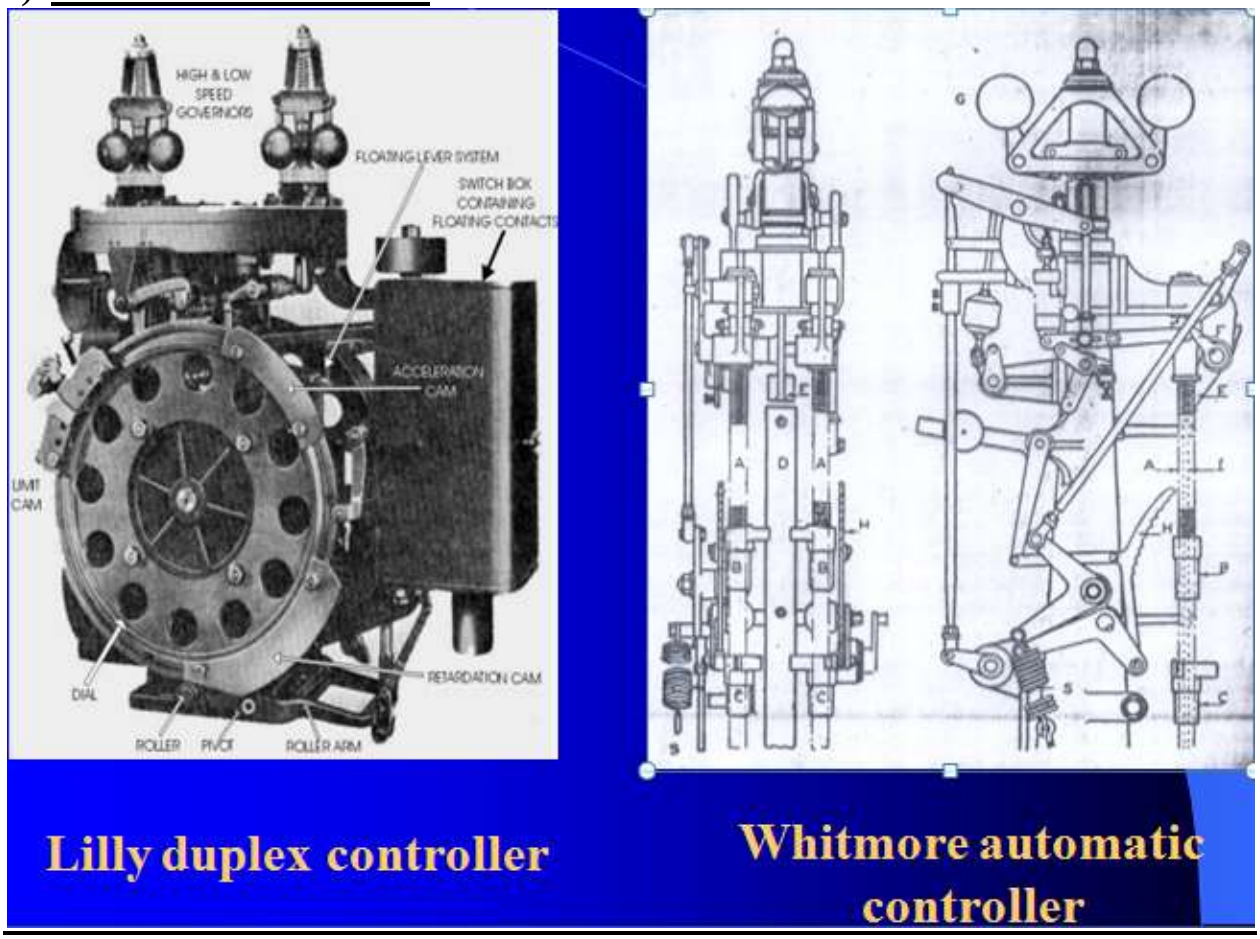
b) **Centre Suspended Calliper Post Brake:** It consists of two curved arm namely front & rear, front curved are consist of two triangular levers L1 & L2. These triangular levers are connected to the main lever at point A & B through tie rod T1 & T3 as shown in figure. Triangular lever L1 & L2 are also connected to rear curved arm to tie rod T2 & T4. Main lever, which is pivoted at P1, consists a suspended weight & a piston rod to another end.

Working: When there is no power to the brake engine the suspended weight falls so that main lever moves in anticlockwise direction about P1. Due to this tie rod T1 & T3 are pulled to operate the L1 & L2 in anticlockwise & clockwise direction respectively. These triangular levers pull the tie rod T2 & T4 so that rear curved arm is closed to the brake path & also pushes the front curved arm towards the brake path. In this way a uniform braking effect is obtained.

To operate the winding drum, power is supplied to the brake engine to raise the piston rod against the suspended load. Now the main lever rotates in clockwise direction around P1 in such a way that it pushes the tie rod T1 & T3 to operate the L1 & L2. L1 & L2 moves clockwise & anticlockwise direction respectively to release the front curved arm from the brake path & pushes the

T2 & T4 to push the rear-curved arm away from the brake path to release the brake.

3) **Automatic Contrivance:**



Its function is to prevent over winding, over speeding & to ensure slow banking.

Description: The winding drum is connected to two bevel gears, one bevel gear consist a stem, which consist of two governors pivoted at the top & connected with the sleeve. The sleeve carries a long floating lever, which consist a roller ball at the cam wheel side. The floating lever is pivoted at point 'K' which is situated & stem, 'A' which is having a knife-edge contact or an electrical contact.

The cam may indicate the position of the cage. During first half cycle cam wheel rotates in anticlockwise direction & during 2 1/2 cycles the cam wheel rotates in a clockwise direction. The cam plate is designed in such a way that there is always a hair gap between the roller & cam plate.

Working: When the winding cycle starts, the winding drum rotates which is then rotates the cam wheel & centrifugal governors through the bevel gears as shown in figure. As the winding speed increases the centrifugal governors go up to the centrifugal action. As a result to it the floating lever also moves upwards. If the speed exceeds a certain limit, roller touches the cam wheel. As well as roller touches the cam wheel, a thrust is exerted on it by the cam plate. These force acts at the point 'K' which either break the power supply to the engine or apply the mechanical brake to the winding drum.

4) **Safety Hook/Detaching Hook/King Detaching Hook:** It is a safety device which acts when an over wind takes place. Its purpose is to suspend the cage or skip in the headgear if an over winding occurs & at the same time to release the rope capel to go over the headgear pulley. It is always placed just below the rope capel.

   It consists of two inner plates & two outer plates which can rotate around a common point 'H'. The outer plate is fixed & inner can move. The inner plates are arranged face to face on each other between 'H' & through all the plates assemble the hook. A copper pin is placed through the hole 'C' in all the four plates.

   In case of over winding, the hook passes through the detaching plate, which is fitted in the headgear, while pulling through detaching plate, the lower portion of the hook is pressed inside & the copper pin is sheared. The inner plate moves around 'H' so that rope capel release from the top & the catches of inner plates are fill apart. The cage rests on detaching plate with the help of catches. Thus the cage & the persons travelling in the cage are safe.

5) **Recovery of Over Winding Cage:** Before starting the recovery operation, the shaft top is covered with rails. Now the winding rope is brought up to the hook & the rope capel is attached to the hole 'F' through the 'D' link, when the winding rope is pulled slightly. The inner plate comes in their original position since the hole 'F' is inclined. The catches are now inside & the safety hook can freely pass down through the detaching plate. The cage is now slowly lowered on the rails placed over the pit top.

   After the over wind, the safety hook is to be inspected & refitted with new copper pin & the rope is to be replaced after every over winding.

6) **Reverse Direction Prevention Switch:** It trips power if the winding engineman by mistake operates the motor in wrong direction.
7) **Time Limit Switch:** It is mounted on the headgear. It trips power if the ascending cage crosses decking level.
8) **Tachometer Generator:** It is connected to the winding drum for normal rpm it generates a normal amount of current, but if the gearbox is faulty, the tachometer generator will not generate the normal current & it will trip power to the motor.
9) **Safety Caches:** These are mounted on in the headgear at an interval of 0.3 to 1.0 meter above the normal decking level. In case of over winding, the cage presses the safety caches which are pivoted levers as shown in figure & it crosses it. In case of failure of the safety hook the cage falls downward over the safety caches. Hence the damage to the cage can be reduced. To clear the cage these safety catches can be removed from the cage path by operating a lever.
10) **Depth Indicator:** A depth indicator is used to indicate the position of cage in the shaft. It is mounted on the drum winder through the gear arrangement as shown in figure. It consists of a dial & pointer moves in anticlockwise direction & during second half second the pointer moves in anticlockwise direction. When one cage is moves from bottom to top, the pointer moves from A to X_1 to X_2 to B. in this AX1 is the acceleration distance & X2B is the retardation distance. As soon as the pointer reaches the point X_2, the power supply to ht engine should be cut off & brakes should be applied.

    When the cage moves from top to bottom the pointer move from B to X_2 to X_1 to A. in this BX_2 is the acceleration distance X_2 X_1 is the constant speed distance & X_1A is the retardation distance. As soon as the pointer reaches the point X_1, the power supply to the engine should be cut off & brakes should be applied.

11) **Warning Bell:** When the cage is at a distance of two revolutions before reaching the decking level, a warning bell warns the operator to remains alternative.

Characteristic Curves

These are the curves between torque & time during the complete winding cycle. Torque is of two types as follows

1) **Static Torque:** Unit of torque KNm. It is due to cage tub, mineral & weight of rope. During complete winding cycle the torque for the unbalanced coal

or mineral load. But the torque due to cage, tub suspension gear etc. is zero. It is constant throughout the winding cycle for the unbalanced coal or mineral load, but the torque due to unbalanced rope charges continuously & the total static torque reduces continuously as shown in figure. In the figure it is represented by O, A, B, C, D, 3.

In the graph 0-1 is the acceleration period, 1 - 2 is contact speed period & 2 - 3 is the retardation period & 3 - 4 is decking period.

2) **Dynamic Torque:** It is there during acceleration & retardation period only. It is due to the total masses moving in the linear direction i.e. cage, rope, mineral etc. & due to the rotating masses i.e. pulley & drum. As the sum of this total mass is constant, the dynamic torque due to their masses will also be constant but it is positive during acceleration period & negative during retardation period. In the figure O, A2, B2, 1, 2, C2, D2, 3, shows it.
3) **Total Torque:** it is the total torque on the drum at any moment. Total torque= Static torque + Dynamic torque. In figure total torque is represented by O, A, B, B_1, C_1, C, D, 3.

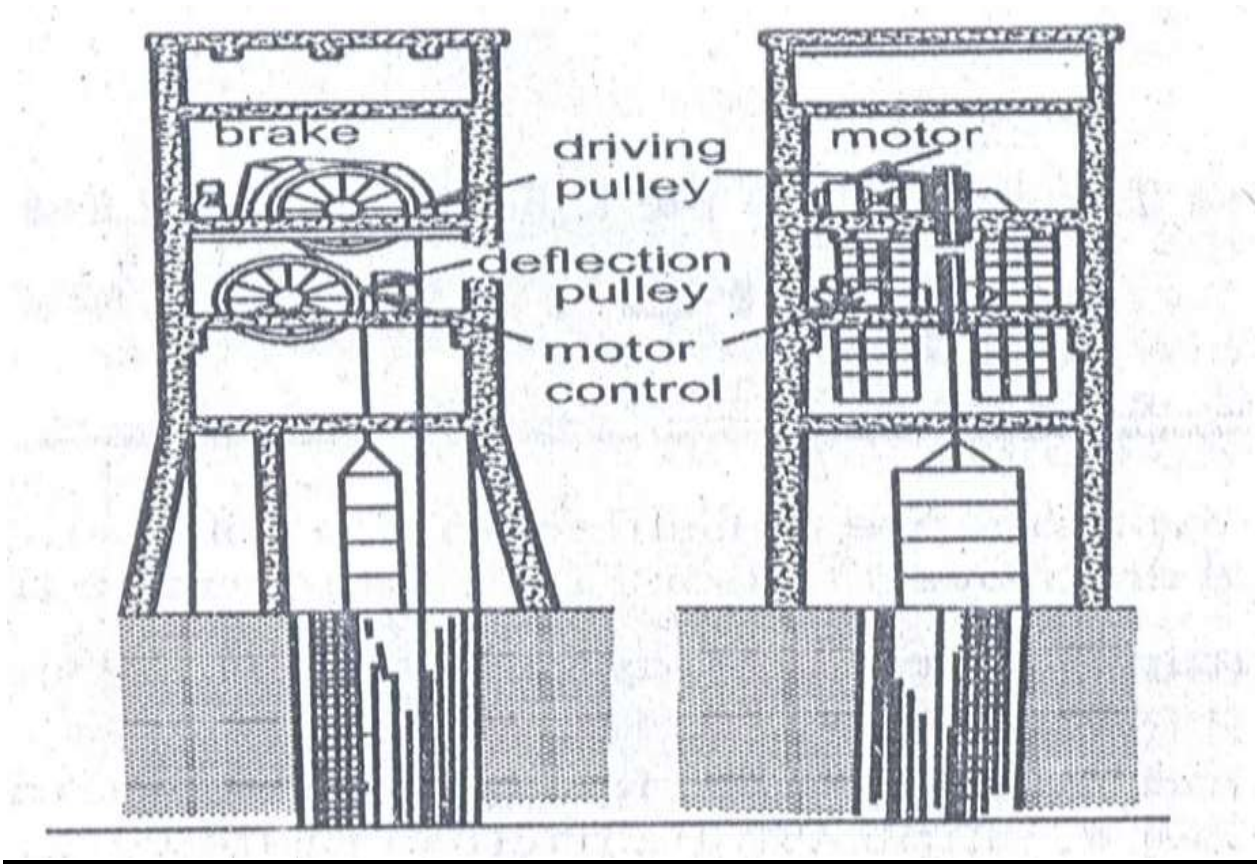
During decking period when the cage is resting on the keps, the static torque, the dynamic torque & the total torque are zero.

Smooth Winding cycle (Balancing System of Winding)

If the torque requirement during the complete winding cycle is more or less uniform is known as smooth winding cycle. In a winding system, using a tail rope or balancing rope may obtain a smooth winding cycle. It is of the some diameter & some weights as the winding rope. Its length is equal to the depth of the shaft & is attached to the bottom of the two cages.

Another method to obtain a smooth winding cycle is the use of conical or Cylindro conical drum which are preferred for dip shaft winding. A tail rope is not used with this type of drum.

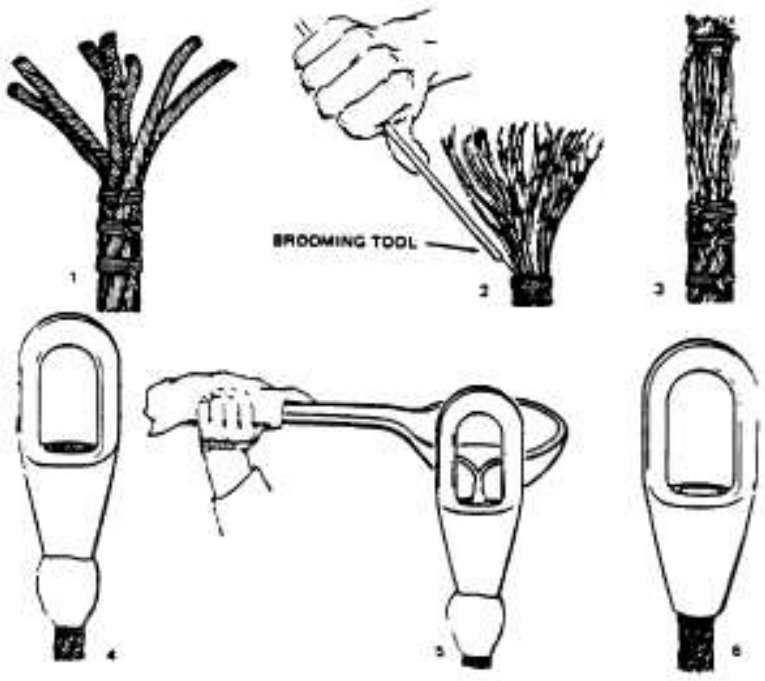
Friction Winding/Koepe Winding



It consist a single rope passing over a friction pulley which is electrically operated & installed at the top of the headgear. The two ends of the rope passes over the pulley & connected with the cages. A tail rope is always used in friction winding. It is connected to bottom to bottom of the two cages & hangs freely in the shaft. The winding rope along with the attached cages is raised or lowered by power transmitted to the friction between the winding rope & the friction pulley. The driving motor is installed at the top of the headgear to operate the system at a time 2 to 4 or 6 ropes can be used for the winding.

- **White Metal Capping (Cone socket type Capel)**

1) White metal= Lead 80% + Tin 5% + Antimony 15%, melting point: 260° C to 300° C, maximum temperature: 360° C.
2) Before cutting the extra length of rope or old capping, the rope should be tied properly to prevent any loosening of the rope.
3) Cut the rope by any suitable method & tie a thin wire up to a length 40d + L, where d is the diameter of rope & L is basket length.
4) Insert the cone in the rope & clamped the rope below cone & at a point F is shown in figure such that XL = L – 2d.
5) Open the rope between X & F & separate all the wires.
6) Cut the fibre core if it is there. Thoroughly clean each wire to ensure proper grip of white metal.
7) By means of a single turn of thin wire repair a brush at the required end of the rope.
8) Remove the clamp P & position the brush in the cone, & again clamp the rope just below the cone.
9) Heat the cone & brush up to a temperature of 100° C & pour the molten white metal in the cone.
10) As soon as white metal achieves the atmospheric temperature, the clamp & thin wire are removed. With this capping operation is over.



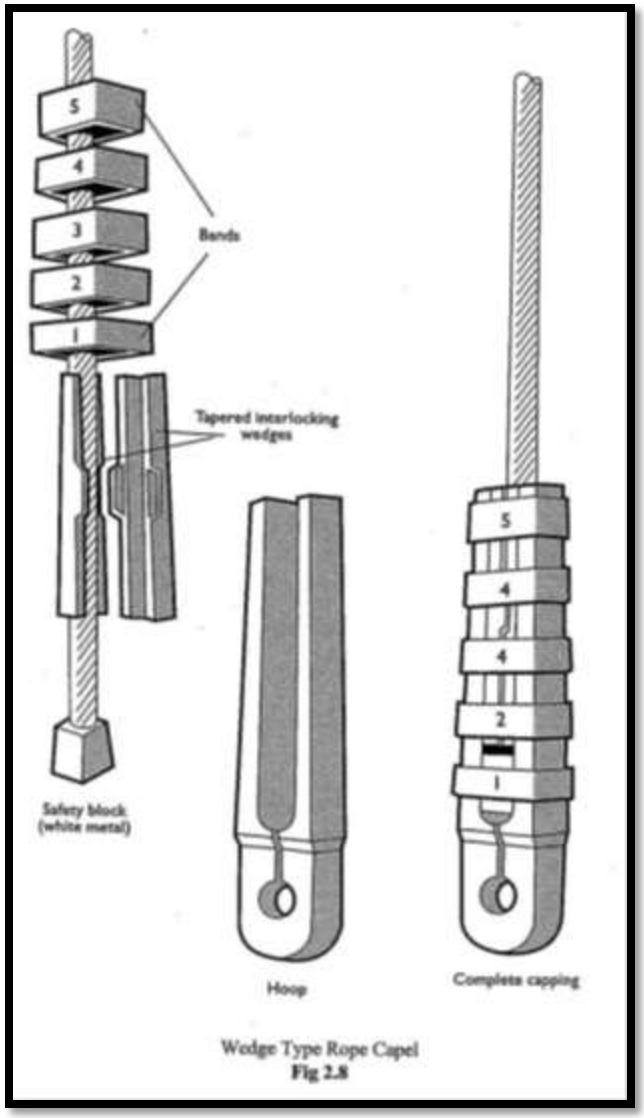
- **<u>Capping with Split & Rivets</u>**

1) Near the required end of the rope, mark these points A, B & C such that AB= BC = capel length. Between A & B wrap a number of turns of thin wire tightly to form a layer. Near b, give more turns of wire as shown in figure.
2) Open wire between B & C.
3) Cut 1/3rd wires to 2/3rd length & clean all the wires.
4) Turn back all the wires on the rope position B - A to give a cone & tie them on that rope position with a thin wire.
5) Cut the exposed core.
6) Lay a thin layer of white metal on the cone.
7) Hammer a thin wooden wedge into the cone at end B.
8) Push a split capel with its mouth slightly widened onto the cone & hammered the widened arms in position to grip the coned portion of rope.

9) Rivets are then hammered into the capel & through the rope at 3-4 points nearly 20 cm apart. With this capping operation is over.

Wedge Type Capping (Reliance Rope Capping):-

Reliance Rope Capel:-



Wedge Type Rope Capel
Fig 2.8

In this capel there are two iron wedges which grip the rope near the required end where a white metal block is prepared. There is U-shaped steel strapped which is placed over the two wedges & on which 4 - 5 iron clamps are fitted by hammering.

1) Prepare a white metal block at the required end of the rope.
2) Insert the iron clamps on to the rope in order of numbers (largest number first). The jaws of capel are about 24 times more diameters.
3) Properly clean any grease or lubricant from that portion of the rope, which will be griped by the wedges.
4) Place the two wedges around the rope approximately in the position they will occupy when in capel.
5) Fit the U-shaped strip over the wedges such that the U-shaped strip & wedge top are in one line. Draw the iron clamps over the U-shaped strip.
6) Hammer the iron clamps for proper grip. The ring number one should not be hammered because it is only for the safety of the white metal block. With this capping operation is over.

❖ Recapping

Every rope should be re-capped at least once in every six month or if necessary at shorten intervals & also after every over wind. Before every such re-capping, At least two meter of rope is cut off & examined properly so that condition of the rope can be judged. If it is found that rope can be used again, the normal capping operation should be done.

❖ Rope Splicing:-

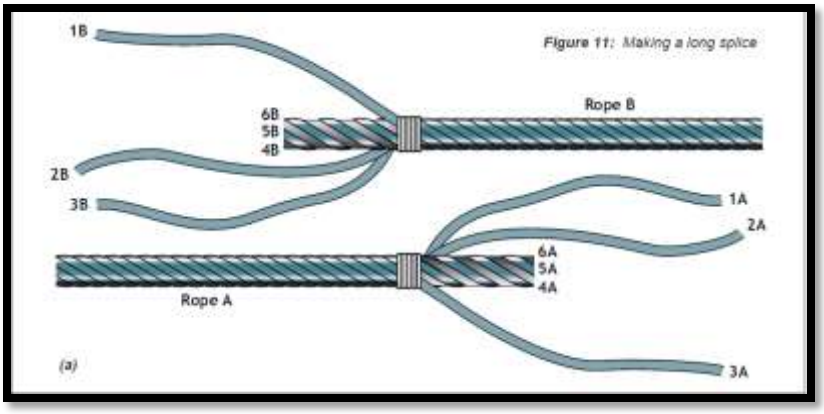


Figure 11: Making a long splice

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THE END

Coal Face Machinery

* Different types of drill machines used in mines :-

* The drill machines used in mines are broadly classified into the following types.

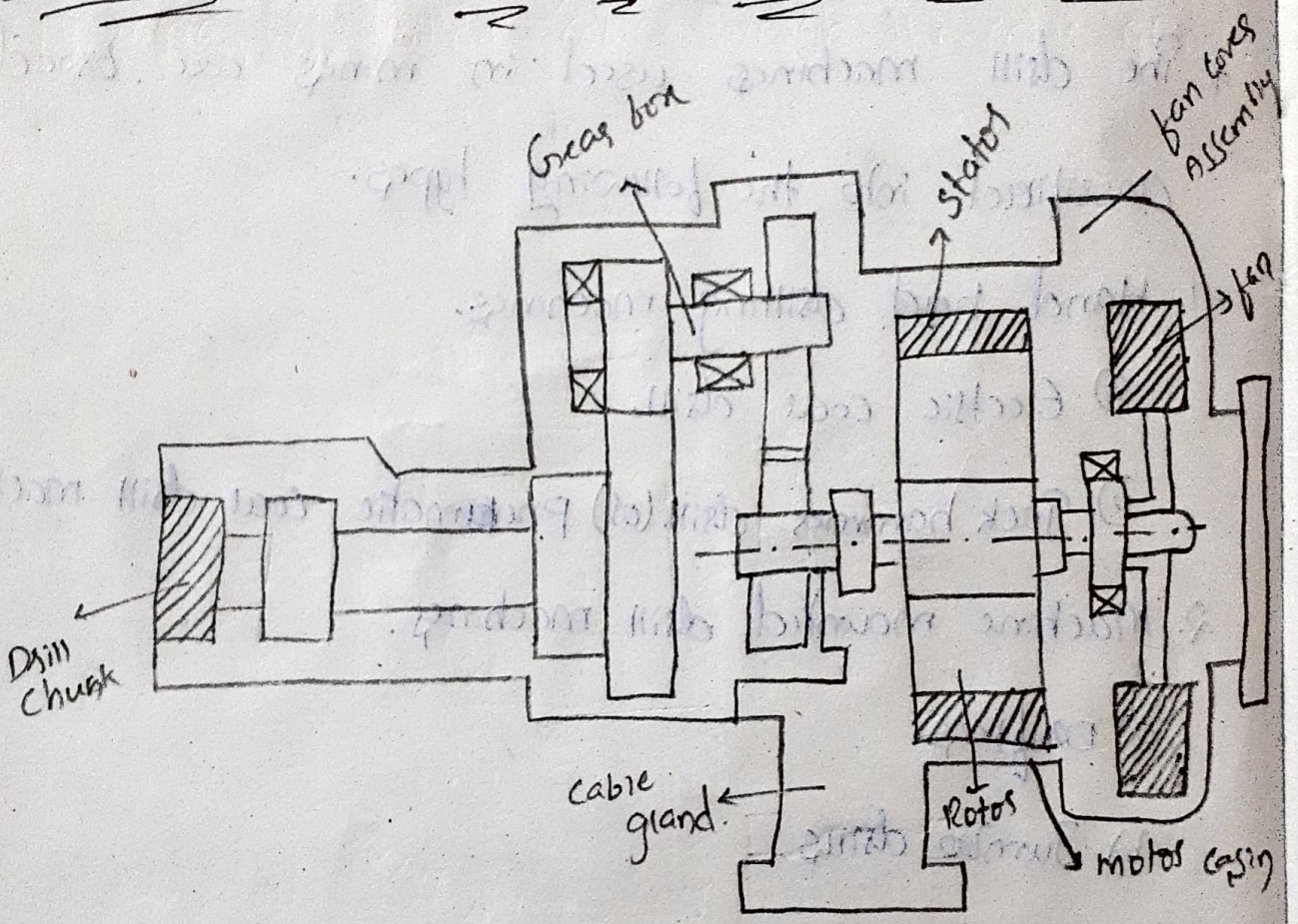
1. Hand held drilling machines.
   a) Electric coal drill.
   b) Jack hammer drill (or) Pneumatic coal drill machine.
2. Machine mounted drill machines.
   a) Drifters.
   b) Jumbo drills.

* Field application of drill machines :-

* The Electric coal drill is used to drill the holes into the coal deposits which is of soft to moderate hard-ness.
* The Jackhammer drills are used to drill the holes into the rocks.

* The machine mounted drill machines are used to drill the holes of long length.

* Constructional details of Electric coal drill :-



* The Electric coal drill is of flame proof construction containing Squirrel cage Induction motor.

* It will be operated at a voltage of 125volts 3-phase 50 cycle per second.

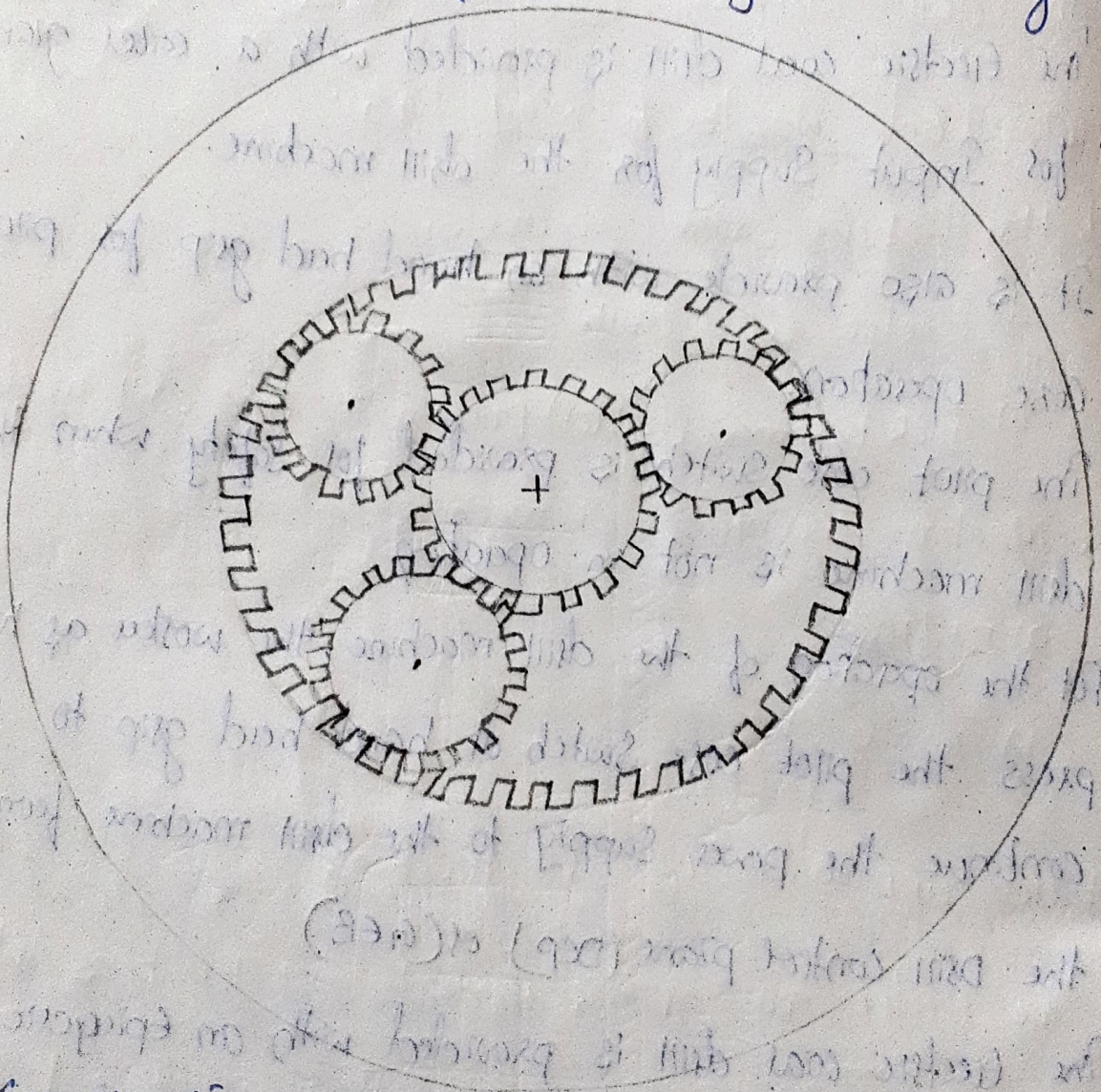
* The horse powes of the motor is 1 to 1.25 H.P

* The weight of the Electric coal drill varies from

13.5 to 19.5 kgs.

* The motor of electric coal drill is placed inside a light metal casing which doesnot produces any friction sparks.
* The Electric coal drill is provided with a cable gland for Input Supply for the drill machine.
* It is also provide with an hand held grip for pilot case operation.
* The pilot case switch is provided for safety when the drill machine is not in operation.
* For the operation of the drill machine, the worker as to press the pilot case switch at hand held grip to continue the power supply to the drill machine from the Drill control plane (DCP) or (GEB)
* The Electric coal drill is provided with an Epicycle gear (or) Sun and planet gear to operate the drill machine at various speed.
* The drill machine is usually operated at a speed of 600, 430, 500 rpm in coal and 200 rpm in stone.

* The Drill chuck of the electric coal drill is used to connect the drill rod into the machine.
* The Drill machine is connected to an electric supply by means of trailing cable through the cable gland.



* Generally, five core trailing cable is used with drill machine have cross-section of 6.5 mm^2 and 100m long. * The trailing cable receives power supply. *
* The electric coal drill is provided with a fan being

down the temperature of the drill machine during its operation.

* These are two types of drill rods are used along with electric coal drill are.
  a) Turbine section.
  b) Diamond section.

⇒ The diamond section drill rods are used for drill in coal. The turbine section drill rods are used for drill of hard rock.

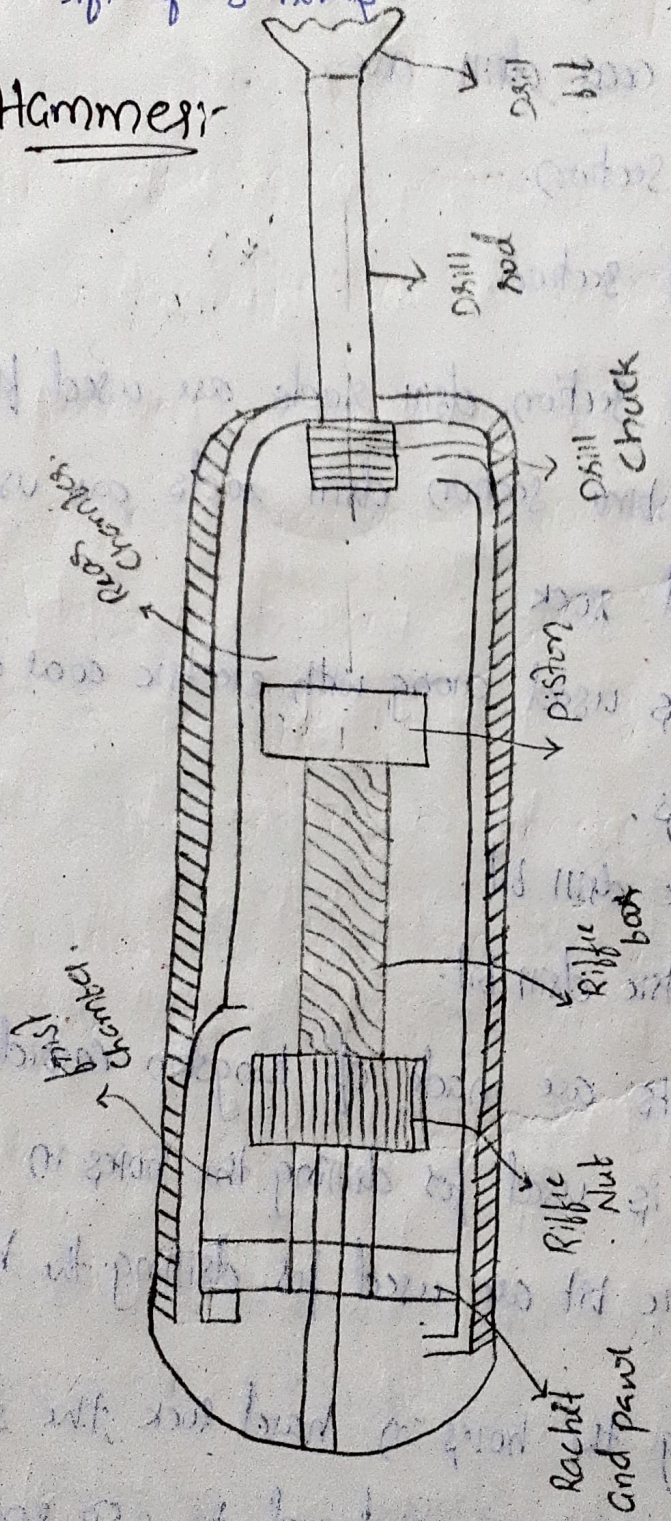
* The drill bits used along with electric coal drill are of two types.
  a) Eccentric drill bit.
  b) concentric drill bit.

* The drill bits are made of tungsten carbide and the eccentric bit is used for drilling the holes in coal and the concentric bit are used for drilling the holes in head rock.

* While drilling the holes in hard rock, the speed of the drill machine is reduced to 250 rpm.

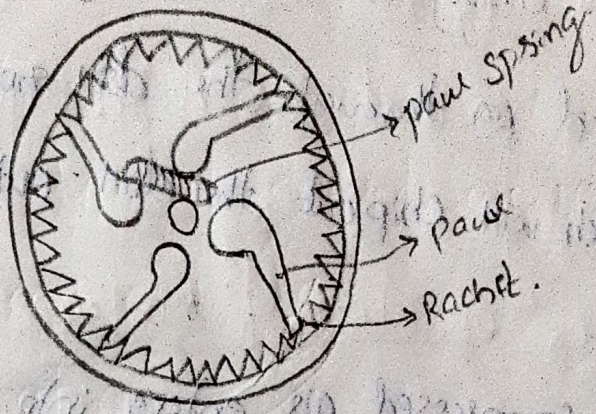
* The rate of penetration of drill bit in coal is generally 1.5 m/min and can capable to drill nearly 80 bores in a shift of 8 hours.

* Jack Hammer:-



last point

* The central line of jackhammer drill is connected through water pipe to cool the drill bit during its operation and also used to flush out drill cuts at th



* Jack hammer drill is also known as percussive drill, which will be operated by means of compressed Air.

* The Jack hammer consist the following components

a) Riffle bar
b) Piston
c) Riffle Nut or twist Nut
d) Drill rod
e) Drill bit
f) Ratchet and pawl
g) Air leg.
h) Drill Chuck.

* The compressed air enters into the first chamber and will pushes the Riffle bar connected to the piston inforward direction and gives a blow on the chuck.

→ bottom of the hole

* The blow energy or the intensity of the blow is transmitted on through the drill rod on to the drill bit. which will chip out the drill out the drill hole. material.

* Now, the compressed air enters into the rear chamber and push the piston bar in the backward direction.

* During backward movement of piston bar the splines of the piston bar may not be coincide with piston nut so as to pass through it.

* In order to pass the piston bar through the piston nut, the piston bar has to undergo slight rotation.

* For every blow of the piston the piston bar has to rotate 1/12th of one revolution.

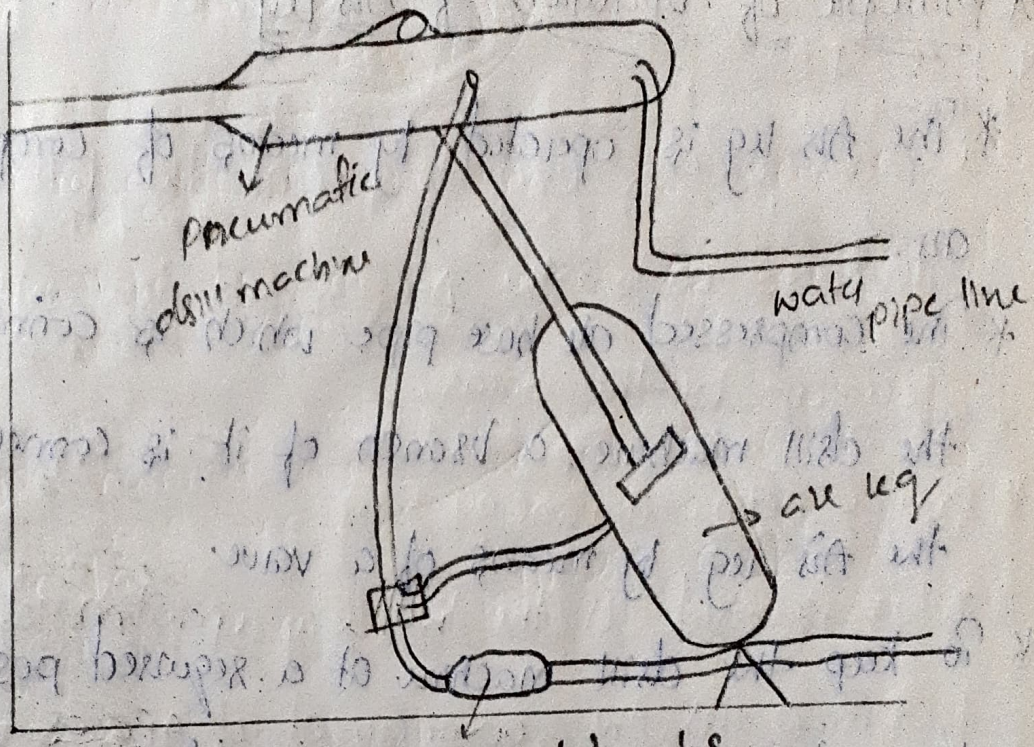
* The ratchet and paw arrangement is used for unidirectional of piston bar.

* It will not allow the piston bar to rotate in reverse direction.

* To place the jack hammer drill, at a required

height to drill the holes, Air leg is used.

* The Air leg is used to reduces the fatigue of the worker during its operation.



* Purpose of Air leg:-

* The Air leg is used to place the drill machine at any desired height to carry out the drilling operation.

* It is used to reduces the fatigue of the worker in holding the drill machine and keep the drill machine in forward direction

* The Air leg doesnot increase the rate of

Penetration of feed.

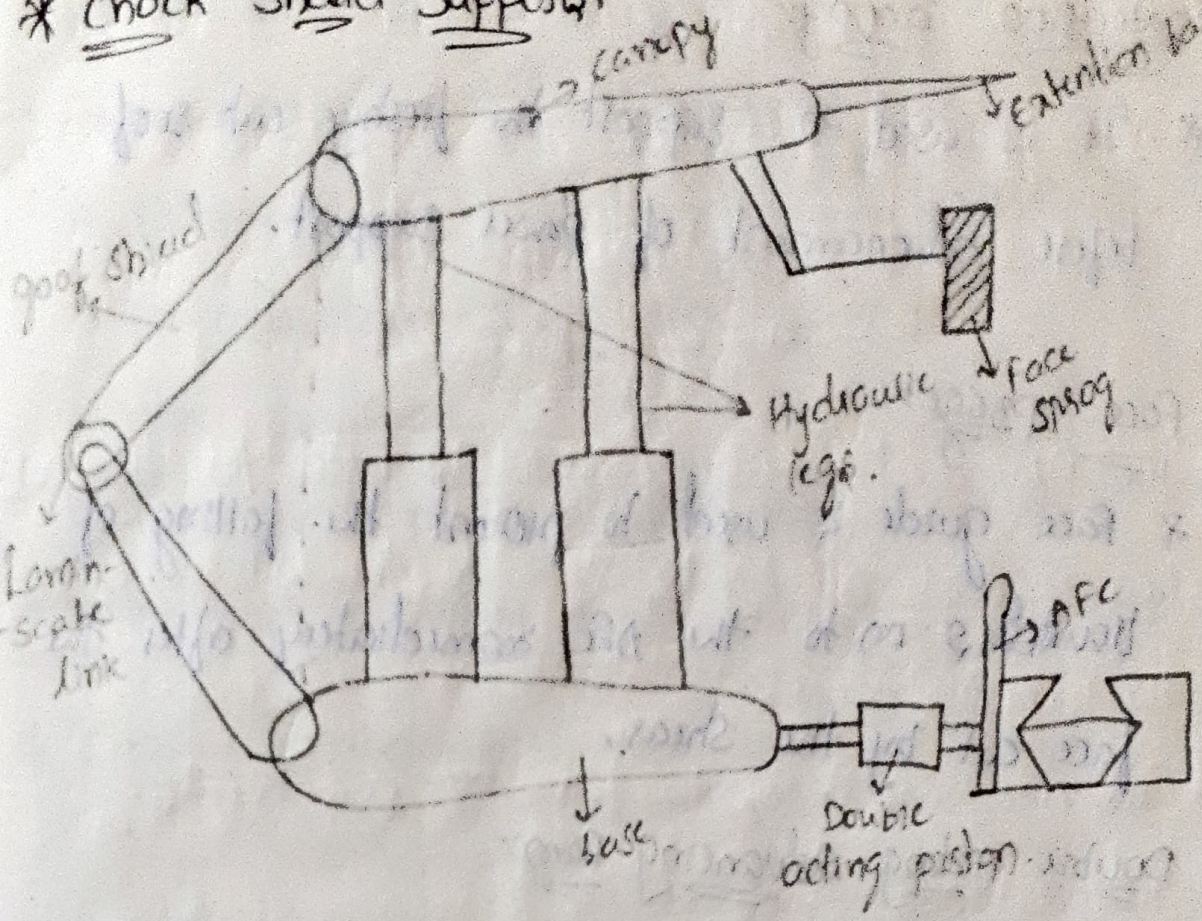
* The air leg is used for drifts upto a height of 2m.

* Principle of operation of Air leg:

* The Air leg is operated by means of compressed air.
* The compressed air hose pipe which is connected to the drill machine, a branch of it is connected to the Air leg by means of a valve.
* To keep the drill machine at a required position the piston of the Air leg is moved forward by operating the hose pipe connected to the air leg.
* The hose pipe of compressed air is also connected to the line lubricated which will inject the lubricating oil into the compressed air, which inturn lubricate the rotating parts of drill machine.

*

* Chock Shield Supports:-



* canopy:-

* Canopy can be is used to provided support along the longwall panel. It will bear the immediate roof pressure along the longwall pannel.

* Caving Shield:-

* It is used to shield the material falling from the goaf area towards workings.

* Laminscale Linkr

* The Laminscale Link is used for the vertical movement of power support.

* Extension canopy

* It is used to support the freshly cut roof before advancement of power support.

* Face sprage

* Face guide is used to prevent the falling of boulders on to the AFC immediately after the face cut by the Shears.

* Double Acting advancing Ram

* It is used for the two way operation of the piston for the advancement of AFC as well as advancement of chock shield support.

* Factors to be considered for the selection of Power Supports:-

* The following are the factors to be considered for selection of power supports.

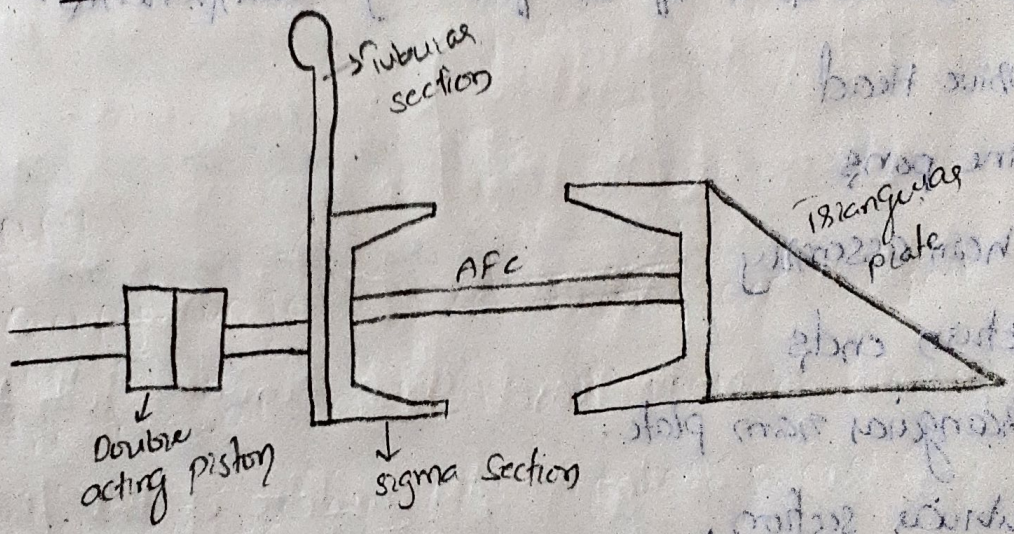
* The support setting load density

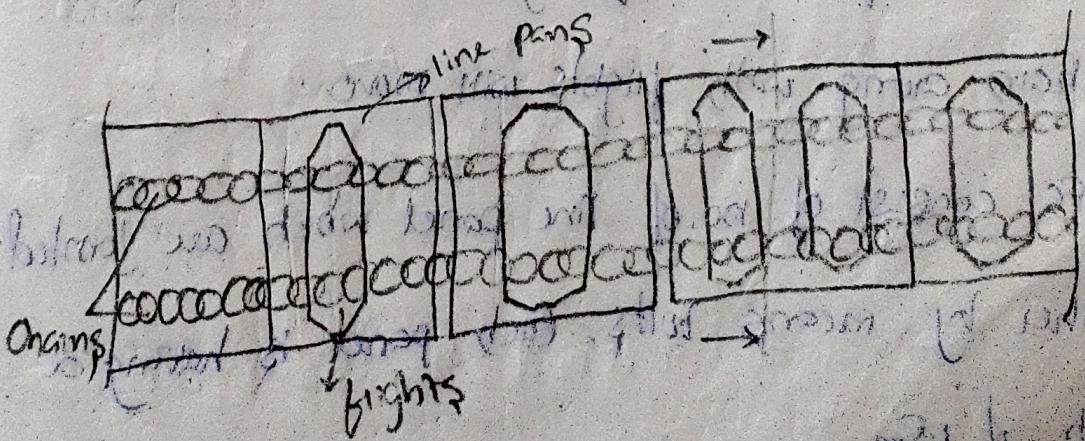
* Height of the Roadway.

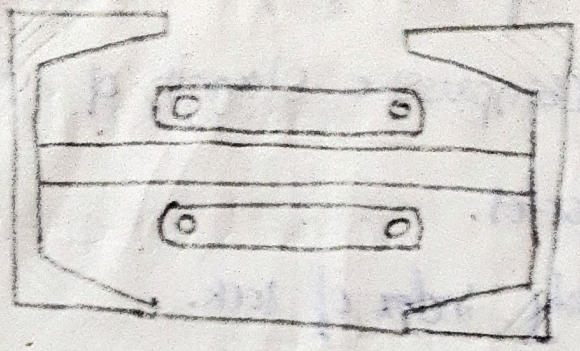
* Type of immediate roof and main roof.

* Thickness of the seam
* Uniaxial Compressive Strength of rock.
* Bulking factor. B.F. $= \frac{V_B}{V_0}$
* The caveability index of rock.
* Water conditions.
* Geological conditions / disturbances.
* The factor of safety of supports.

* Constructional details of AFC:







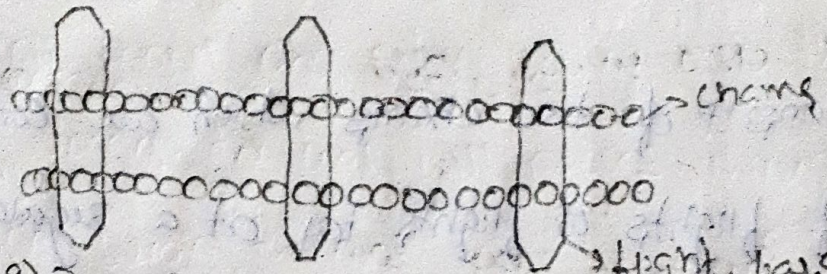
* The Armoured flexible Conveyor is used for transportation of coal cut by the Shears to the tail end of the longwall panel.
* The AFC consist of the following components.
  1. Drive Head
  2. Line pans
  3. Chain assembly
  4. Return ends
  5. Triangular ram plate.
  6. Tubular section.
* The pannel of AFC is of signal section in which the chain along with flights will move.
* The AFC consist of no. of line panel which are jointed together by means bolts. Each panel is having a length of 1.5m.

* The panes are joint together which will allow the flexibility of 6° in the horizontal and 4.5° in the vertical.
* Each line panel is pre-fabricated to form a sigma section.
* The AFC consist of two chains which are connected by means of flights or flights bar at a regular interval
* The flight bars will carry the coal cut by the shearer to the tail end.
* Based on the floor condition in which the AFC is used the line panel are two types. They are-
    a. Bottom opened AFC
    b Bottom closed AFC.
* The Bottom opened AFC is used if the floor of the longwall panel is not soft.
* The Bottom closed AFC is used if the floor of the longwall panel is soft and contains mud.
* Based on the connection of the chain to the flight bars moving in the panel, the AFC is categorised

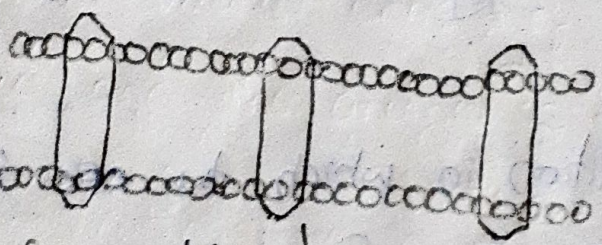
into two types. They are.

a) Twin In-board AFC

b) Twin out board AFC.



a) Twin In-board AFC



b) twin out-board AFC

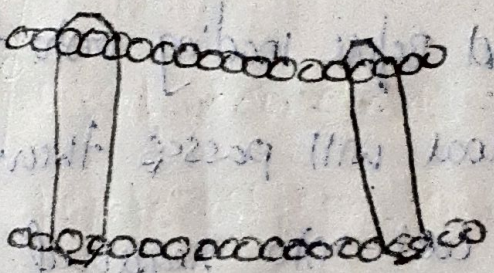
* In case of Twin-In-board chain conveyor both the chains are connected in the middle of the flight bars and will move in the middle of the pannel

* The limitation of twin In-board AFC if the big boulder fall on the AFC. both the chains are may get damaged.

* In case of Twin out-board, the chains are connected to the ends of flight bar and will move inside

the sigma section.

* In Twin-out board chain conveyor both the chains will carry uneven load and leads to tilting of flight bars.



tilting of AFC

* since, the both chains move inside the sigma section which is having limited space, the chains may get jammed easily due to presence of transporting coal.
* The ends of the AFC is connected to a driving motor which contain sprocket on which the AFC chains will move.
* The AFC contains tubular section to mounted the shearer. It is also contain separate cable section to accommodate all the cables connected to a shearer.
* The triangular ram connected to the AFC is used to load the coal present between the face and the AFC on to the AFC.

* principle of Lump Breaker:-

* The Lump Breaker is used to Break the big boulders cut by the Shearer.
* The boulders are transposted to the tail end of the longwall pannel and Before loading onto the Beam Stage loaders. the coal will passes thrught breakers which break the coal into required size.
* The lump breaker consist of two jaws, one is fixed and the another is movable one.
* The movable jaw will break the boulders into the pieces by hitting against the fixed jaws.

* Power packer

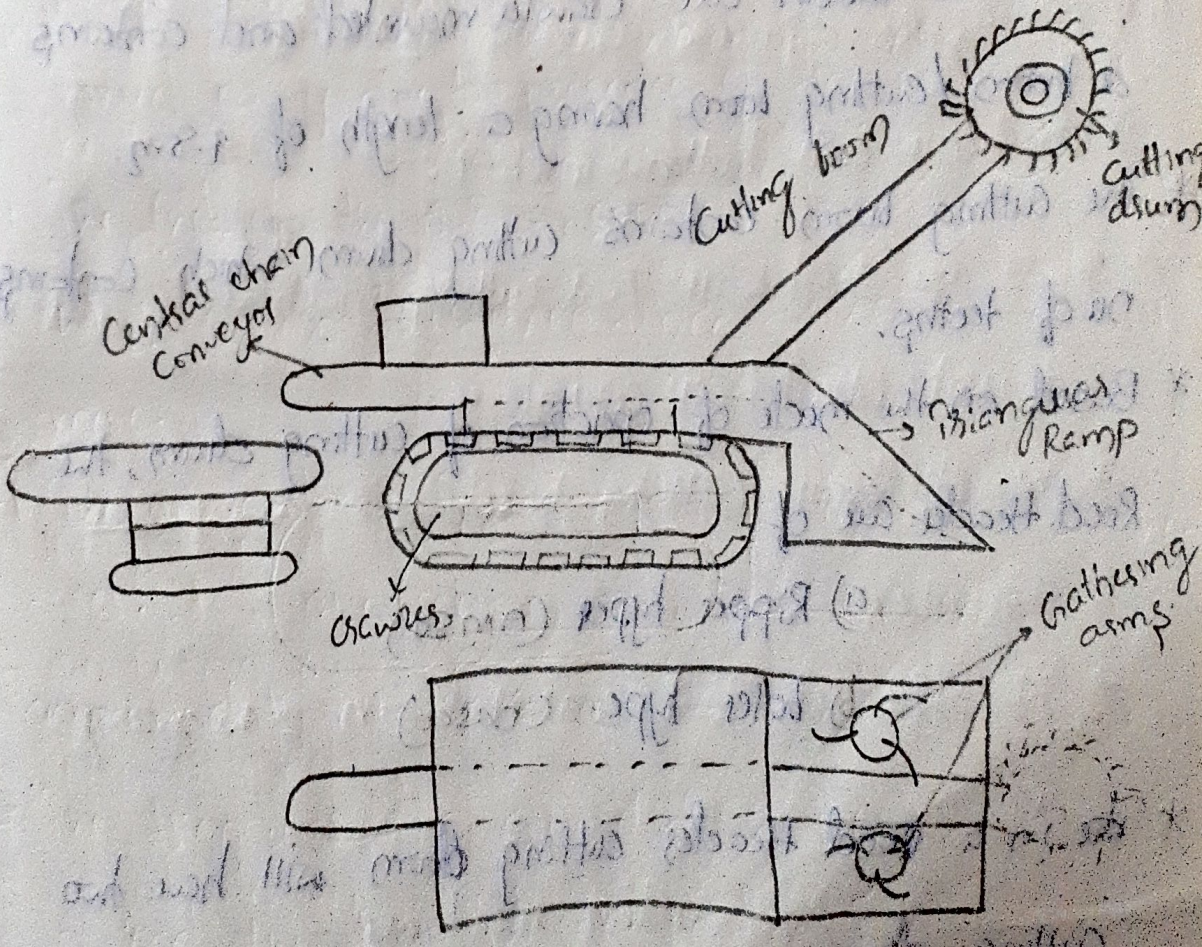
* The Hydraulic power pack is used to supply the hydraulic fluid at required pressure at the chock shield. Support
* using power pack the hydraulic chock shield can be set to the setting load.
* The Hydraulic fluid supplied thrugh the which power pack at the rate of 200 lit/m and ata pressure of 400 bars

* Composition of Hydraulic fluid:-

* The Hydraulic fluid used for power pack supports contains 5 to 10% of emulsion oil and 90-95% of water.

* The emulsion oil used in the Hydraulic fluid must be uninflammable, low viscous, cheap and Non-Susceptable to the formation fume.

* Principle of working of Road Headers AL-50



* The Road Headers are used to drive the roadways used for the longwall panel.

* The Road Headers consists of the following parts.

1. Cutting drum
2. Triangular Ramp
3. Cutting boom
4. Gathering arms
5. Central Chain conveyor

* The Road Headers are crawler mounted and contains a boom / cutting boom having a length of 9.8m.

* The cutting boom contains cutting drum which contains no of teeths.

* Based on the mode of operation of cutting drum, the Road Headers are of

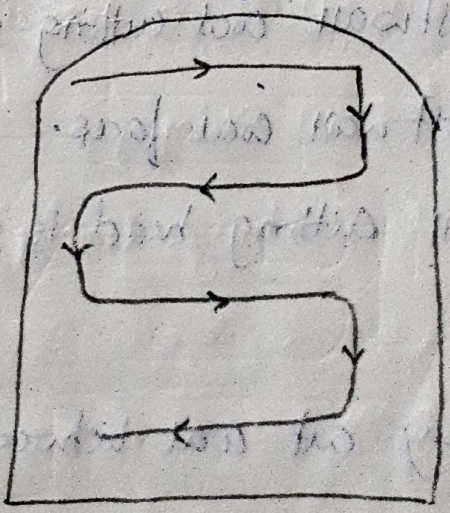
a) Ripper type (AM50)
b) Boter type. (Dasco)

* In a Road Headers cutting boom will have two cutting drums.

* The coal cut by the Road Headers after driving

the roadway, will be gathered by the Gathering arm loaders.

* The gathering arm are present on a triangular ram which contains an eccentric operated disc along with the arms.
* The gathering arm will gather the coal and will be placed onto a central chain conveyor.
* The central chain conveyor is present in a middle of the road headers and will carry the load to the another end.
* The coal from the central chain conveyor will be placed onto movable conveyor.



* Classification of coal cutting machines :-

The coal cutting machines are categorised into following types.

1. Shortwall coal cutting machine.
2. Longwall coal cutting machine.
3. Bent Jib coal cutting machine.
4. Arc wall coal cutting machine.
5. Arc shearer coal cutting machine.

* Applications of coal cutting machines :-

* Shortwall coal cutting machine :-

* The shortwall coal cutting machine is design to cut shortwall coal faces.
* The shortwall cutting head is normally over 9m wide.
* It effectively cut coal between 2 to 2.2m thickness.

* Longwall coal cutting machines :-

* The longwall coal cutting machine are

used for longwall face excavation

* The longwall coal cutting machine are two types.
  a) Single End Ranging Drum Shearers (SERDS)
  b) Double End Ranging Drum Shearers (DERDS)
* The SERDS are commonly used for seams having a thickness of 1.5 to 4mts and Inclination is upto 20° degrees.
* Strong floor and cavable roof, medium hardness seams.
* The DERDS are used for excavating the longwall panneis having more than 150m face length.
* The DERDS are used for excavating seams upto a thickness of 4.8mts.

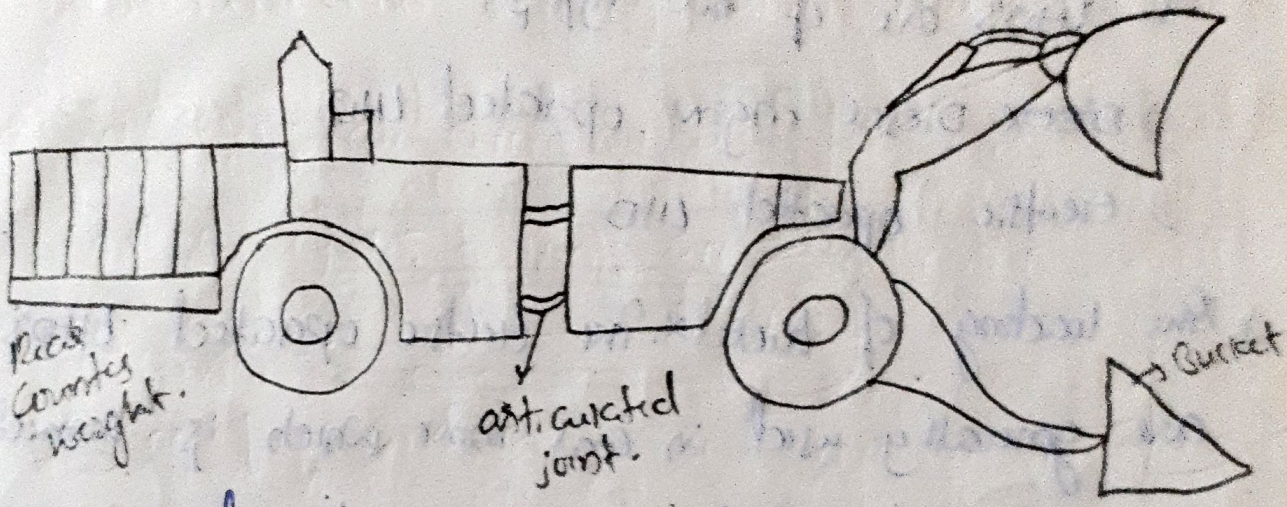
* **Best Jib coal cutting machine:**
* used in longwall face for giving undercut.
* It gives a cutting depth of 1.5m.

* **ASC wall coal cutting machine:-**
* It is used for development of roadways.

* In bord and pillar method, the Ase wall coal cutting machines are used.
* The Ase wall coal cutting machines are used for under cut, middle cut or top cut of the coal face to provide a free spaces.
* Ase Sheas coal cutting machines
* It is of crawler mounted and is used for manual working.
* It is used in bord and pillar method.
* It can cut the coal in any direction.

* Types of loaders used in underground mines.
1. LHD (Load Haul Dumper)
2. SDL (side discharge Loader)
3. Shuttle car
4. Scraper loaders
5. gathering arm loader.

* constructional details of LHD:-



* The load Haul dumper is used for loading, hauling (transporting) and dumping the blasted material in coal as well as metal mines.
* The LHD's usually of crawler or tyre mounted. generally the tyre mounted LHD's are used in coal mines.
* The construction of LHD consist of two frames
  a) front frame
  b) Rear frame
* The two frames are joint either by means of an articulated joint and it is used to negotiate curves.

* using a articulated joint the LHD can taken d turn of 100° to 120°.

* Based on the mode of operation or driving motor the LHD's are of two types.

a) ~~Diesel~~ Diesel engine operated LHD

b) Electric operated LHD.

* The loading of bucket. The Electric operated LHD's are generally used in coal mine which is connected to a Gate end panel by means of trailing cable.

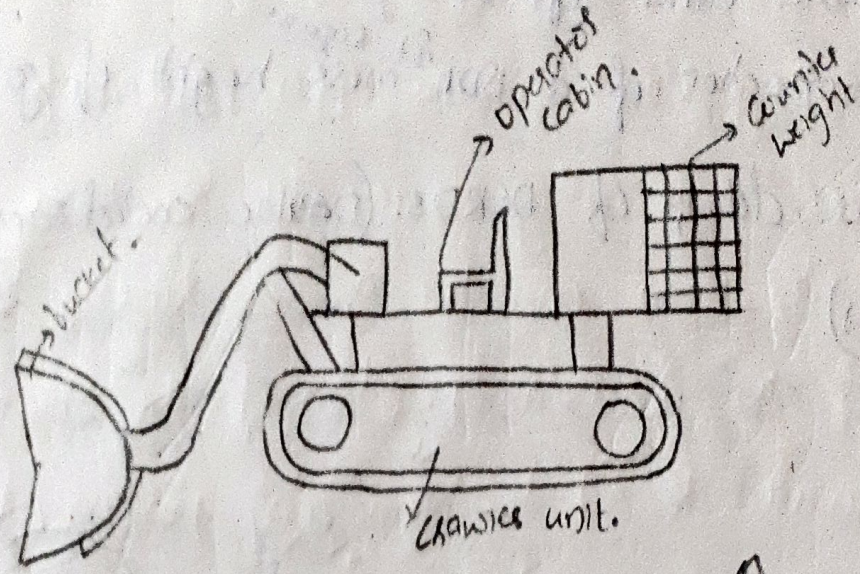
* During operation the trailing cable can be coiled or uncoiled to a drum.

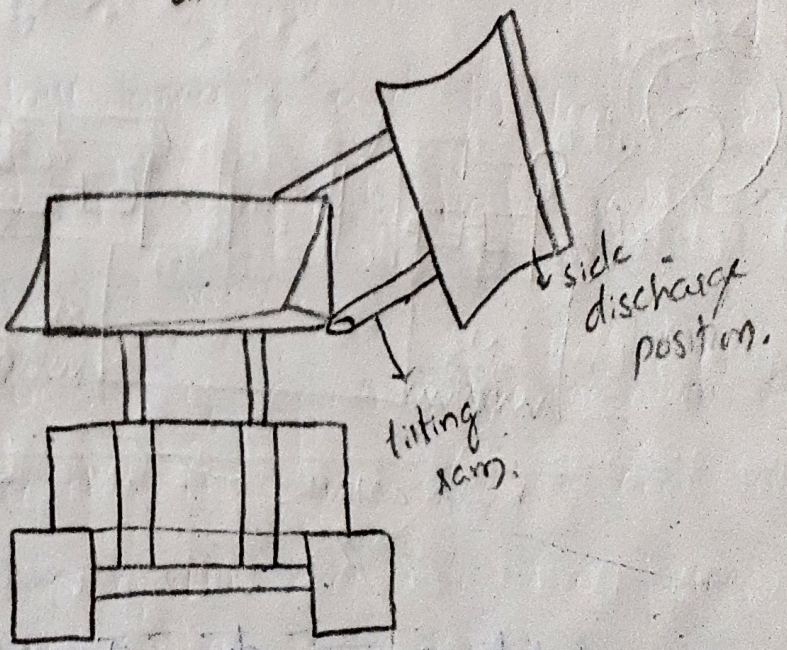
* The capacity of the LHD varies from 0.7 to 6 cum and it can negotiate a gradient of 1 in 7.

* The maximum operating speed of LHD is 8-10 Kmph during empty and its loaded speed is 3-5 kmph.

* During loading operation the bucket will scoop the material by means of hydraulic ram and it will be hauled upto the unloading point and discharge the material with the help of hydraulic ram.

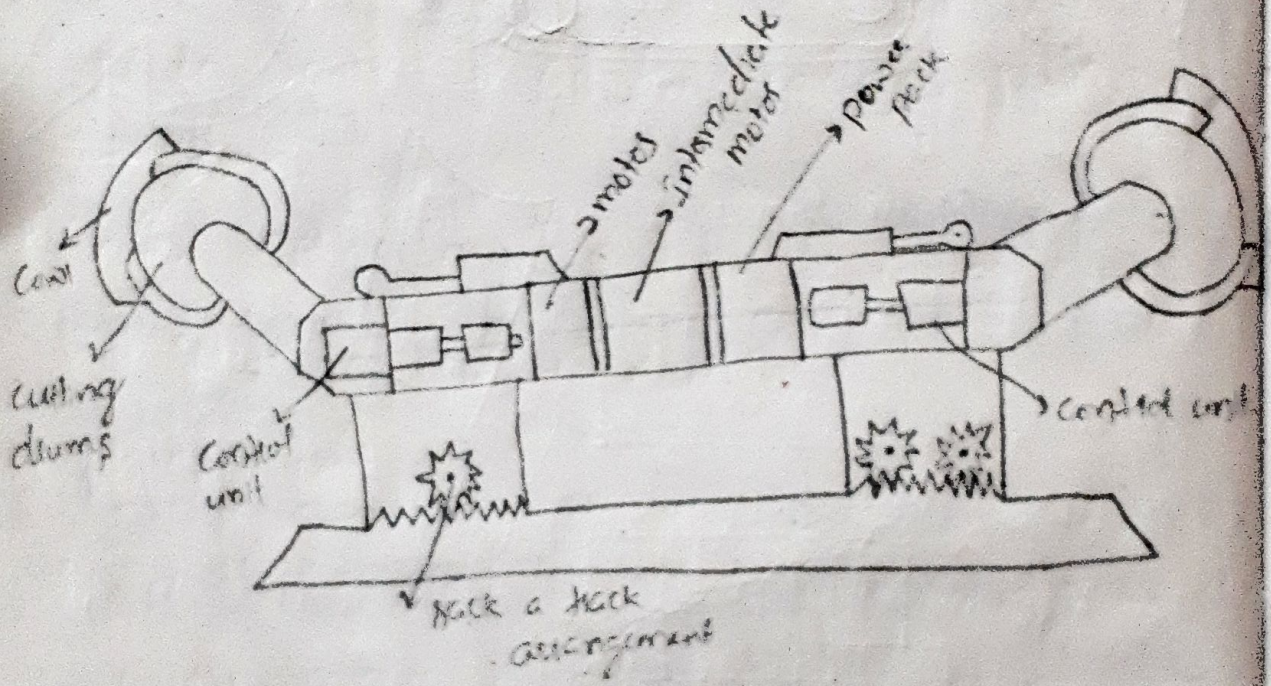
* Constructional details of SDL:





* The side discharge loader (SDL) are used in both coal and metal mines for loading operation.
* The SDL is mounted on a crawler and move with a speed of 0.7m/sec.
* The SDL is operated by electric or diesel motor.

* The SDL can negosiate a gradient of 18° of 1in3.
* Using SDL, the loaded material can be dump in side ward either left of right.
* For effective operation of a SDL it require more height of gallery
* Constructional details of DERDS. (Double ended ranging drum shearer)



* In Double Ended Ranging drum Shearer (DERDS) consist of the following main components.

1. Electric motors.
2. Cross Head of Control unit.
3. Haulage unit. (power pack)
4. Cutting drum

* Electric motors
  * The power of electric motors ranging from 150 kw to 1000 kw.
  * The electric motors supply the power to the Hydraulic unit present in the hauling unit, gear heads of the cutting drum.
  * Depending on the capacity of the Shearer, the high capacity Shearers equipped with two or more motors.

* Gear Heads
  * They are two Gear Head (control unit) present on the both sides of the Shearer.
  * The Gear Head is used to control the cutting and loading operation of cutting drum.

* Cutting drum
  * Each cutting drum on the both ends of the Shearer is of spiral vanes over which the cutting bits are mounted.
  * The Average diameter of cutting drum ranges from 0.86 mts - 2.8 mts.
  * The rotational speed of the cutting drum varies from 30 - 45 rpm.

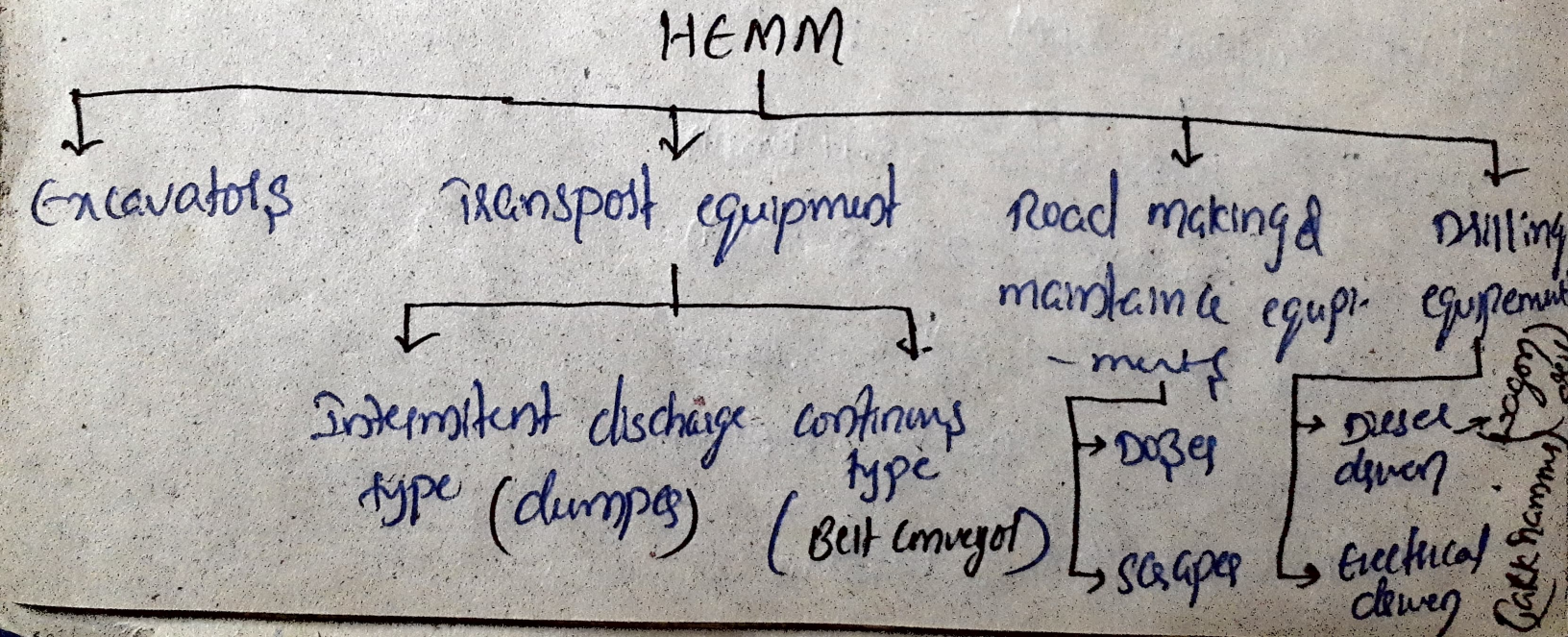
* During the operation of Shearer one cutting drum will cut the seam upward and the another forward downward.
* The upper cutting drum will the upper position of the seam and lower cutting drum will the lower position of the seam. once the shearer reaching the last end of the panel, the position of the shearer will be reversed to cut the remaining position of the seam.
* In the cutting operation both the cutting drums are will rotate in opposite direction

* Hauling unit:
  * The Hauling unit is used to move the shearer along the panner during cutting operation.
  * There are two types of Hauling units used with in the shearer
    a) Chain type Haulage System
    b) Rack & pinion Rack Haulage System

* For a high capacity shearer generally the

* The main parts, functions and place of application of Shovels.

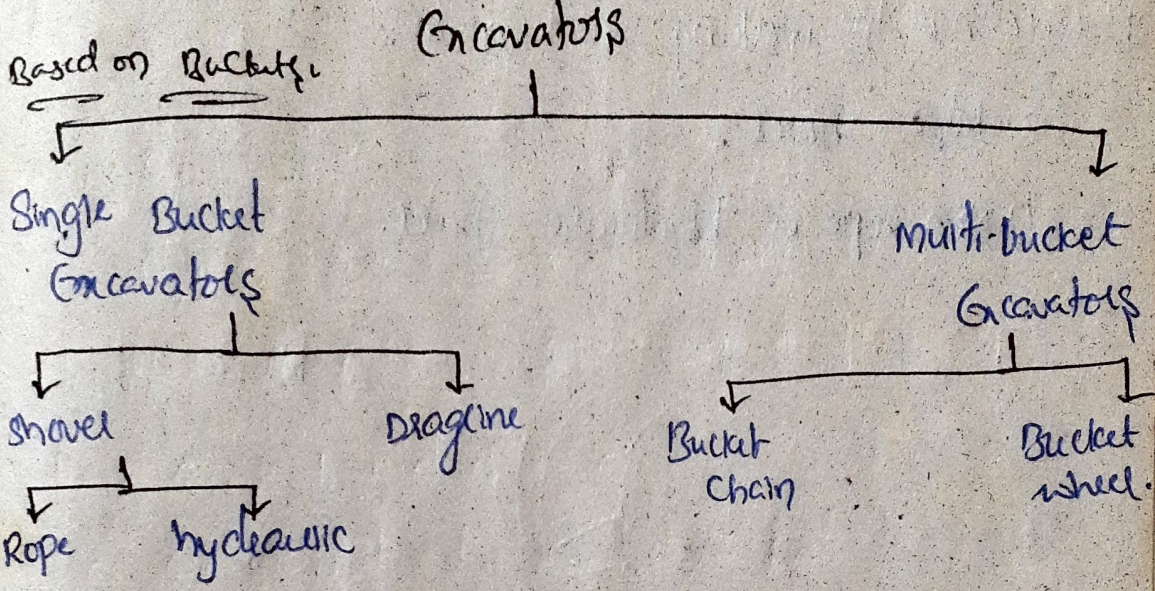
* classification of Heavy earth moving machinery:



Excavators:

Excavator is the one which is used for excavating or digging & removal of mud.

Classification of Excavators:



Based on operations:

a) cyclic → Shovel, Dragline
b) Continuous → Bucket wheel, Surface miners.

Shovel:

It is an equipment which excavator rock or ore by digging from its operation bas to upward and dump it into the dumper.

Classification of Shovel:

* According to working agent.
  a) Diesel
  b) electrical
  c) Hydraulic

* According to Bucket size.

a) Commercial type. ($0.275m^3$ – $1.8m^3$)

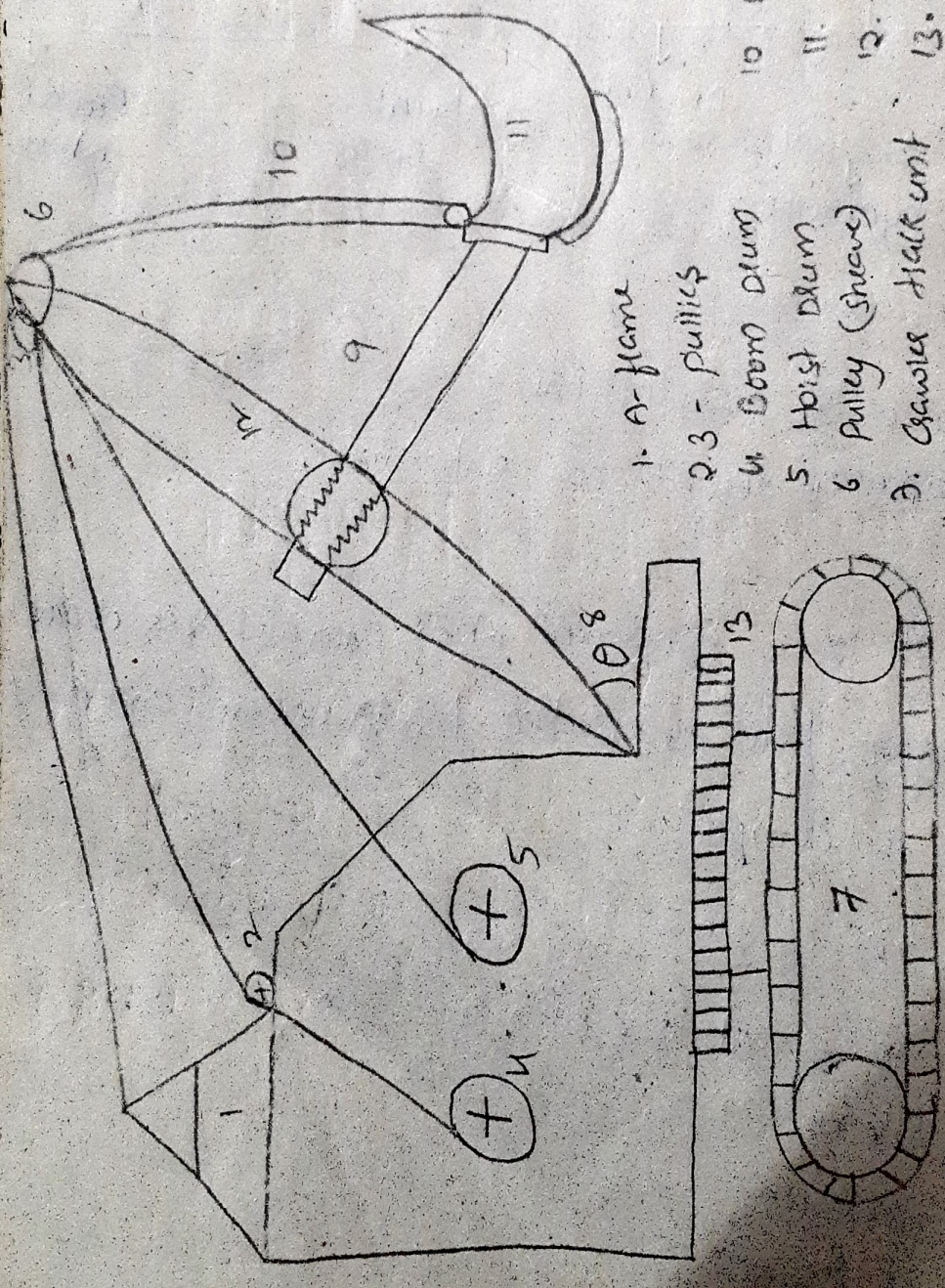
b) Quarry mine type. ($1.8m^3$ - $15m^3$)

c) Large quarry mine type. ($15m^3$ - $25m^3$)

* According to walking mechanism;

a) Rope Shovel

b) Non-Rope or Hydraulic Shovel.



* Structural division of Shovel:-

1. mounting of travelling unit. is legs
2. Revowing of top unit is Head
3. Arms and hands

* Rope shovel:-

In this type of shovel, the main function is carried out by rope. Hence it is called as Rope shovel.

* main components of Rope shovel

* under carriage unit:-

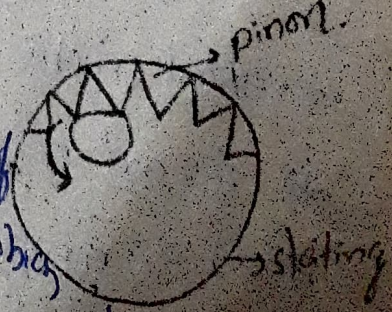
a) Two crawler track units or Assemblies fitted with

i) Driving sprocket
ii) Idle. sprocket.
iii) track rollers.
iv) Support rollers.

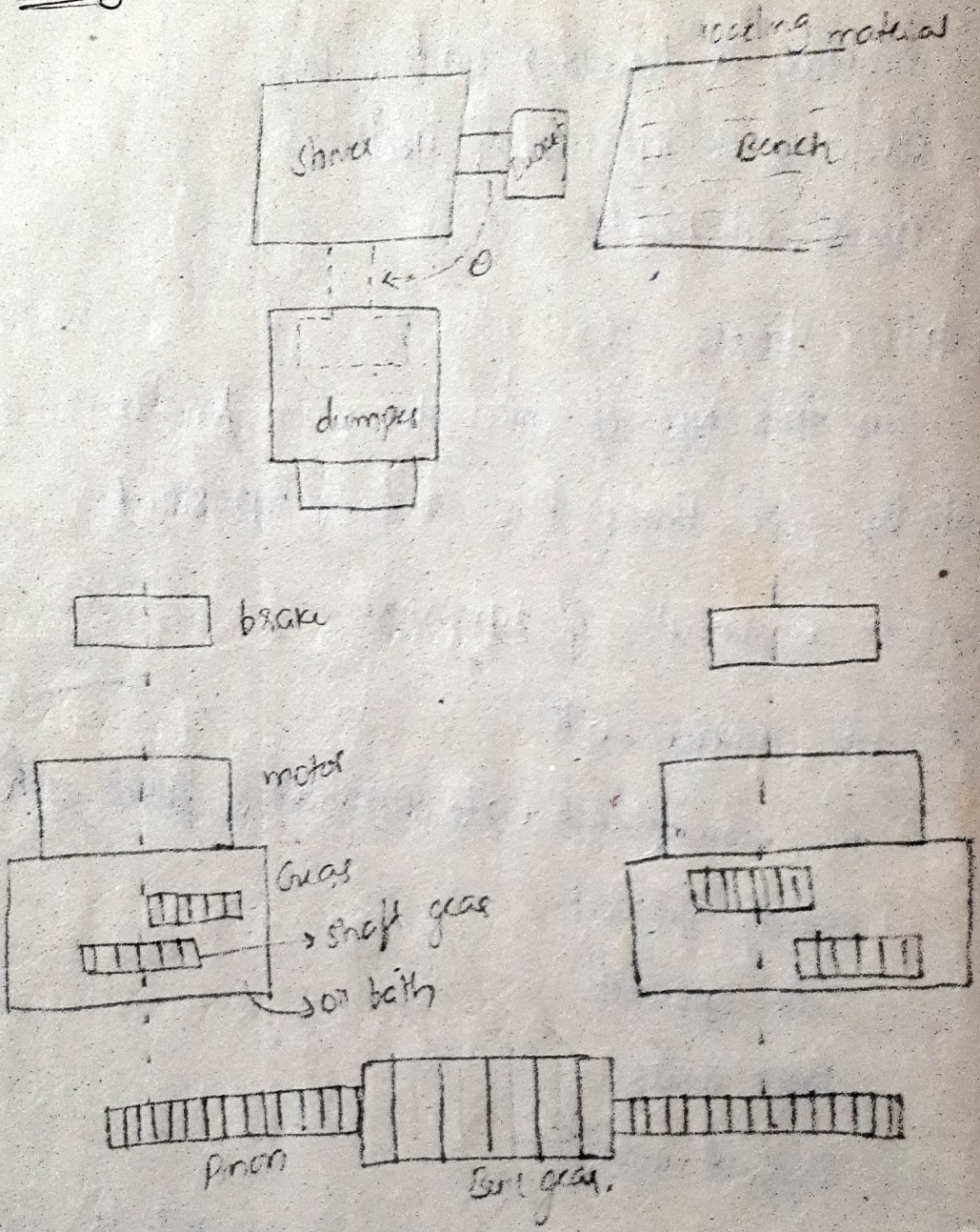
* The hallow of the assembly is mounted on the crawler track.

* Turn Table:-

It is mounted on the structure of the Bull Gear through a ball race which supports the turn table and at the same time permits rotational motion of the turn table over the bull Gear.



* Swing mechanism



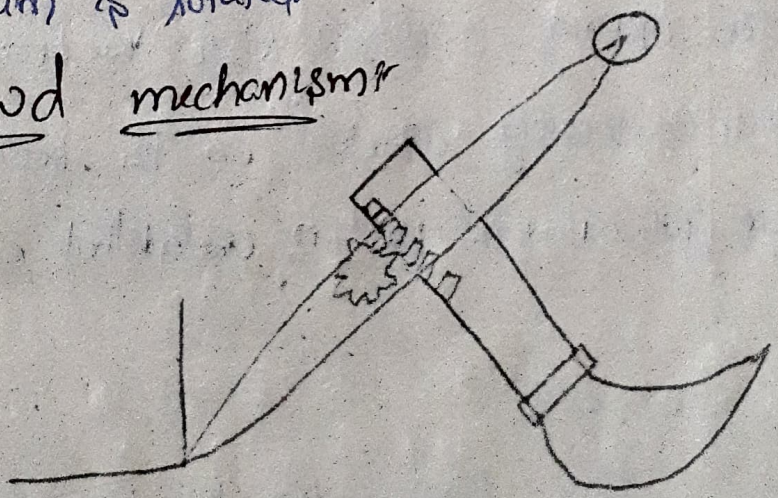
* A swing mechanism consist of two units each has a vertical motor with its flange resting on the housing. At the end of the vertical motor shaft there is a pinion in mesh with gear.

* Hoist mechanism

one end of the motor shaft is connect to a reduces theough a coupling. The reduces deriving the power in constant mesh with a hoist Gear. This provides movement to the horst drum which intern lifts the Bucket.

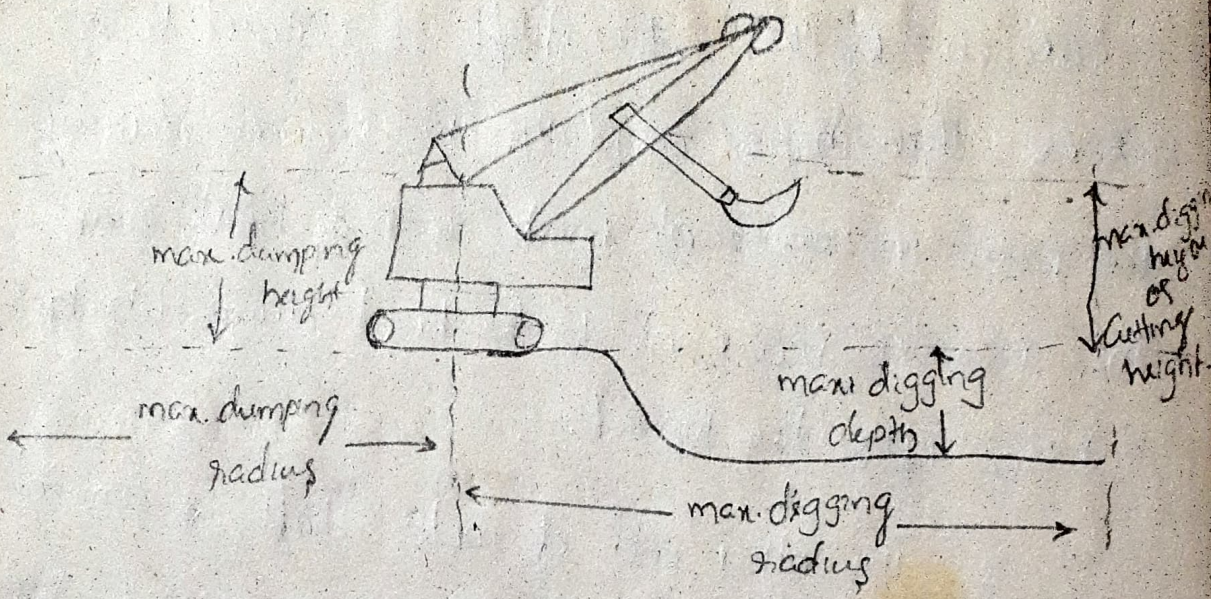
The other end of motor shaft is connect to the worm wheel theough the chain spocket. Syste the Boom hoist drum is mounted on the output shaft of the worm wheel combination. Thus, the Boom horst drum is rotated.

Crowd mechanism



If you want to lift the bucket horst drum should rotate anticlock wise as shown in fig and vise-visa

*Operating Ranges of Shovel :-



*maximum dumping height :-

* At a prakcular boom angle it is the vertical distance b/w the level and the bottom most point of the bucket under tipping condition while the boom and all other asscessory attached on the boom are at their full extended position under that condition.

* maximum digging height :-

It is the vertical distance b/w the level and the top most point of the bucket.

*maximum dumping radius :-

It is the horizontal distance b/w the vertical swing axis of the main body of the

Shovel and vertical centre of the bucket.

* maximum digging radius:

The maximum horizontal distance b/w the tip of the bucket and vertical swing axis of the shovel.

* maximum digging depth:

It is the vertical distance b/w the level and bottom most part of the bucket.

* Bucket fill factor:

$$B.F.F = \frac{\text{Actual volume of the material inside bucket}}{\text{volume of bucket}} \times 100$$

It depends on degree of fragmentation, physical characteristic of rock, and size and shape of the ore

* Swell factor:

$$SW = \frac{\text{weight per unit volume of solid rock in bench}}{\text{weight per unit volume of loose rock mass after blasting}} \times 100$$

* Bucket factor:

$$B.F = \frac{\text{Fillability}}{\text{swell factor.}}$$

*

* Swing factor

Standard cycle time of the shovel is based on the 90° swing for loading. this cycle time will increase or decrease depends on angle of swing.

* cycle time

It is the total time taken by a shovel to complete one full cycle of operation.

* Total cycle time

= digging time + loading time + hoisting time + swinging + dumping + swinging back.

* Effective overall percentage of utilisation:-

$$= \frac{\text{Actual working hrs}}{\text{total working hrs}} \times 100.$$

* Specifications of Shovel: (4.6 m³ Bucket cap.)

maximum digging height → 10m

maximum dumping height → 6.3m

boom height → 10.5m

maximum digging reaches → 14.3m

maximum dumping reaches → 6.3m

Boom angle → 45°

Travelling speed → 0.45 kmph.

maximum gradient → 12°.

* output Calculations of Shovel :-

No. of passes (cycle) per hour = $\frac{60 \times 60}{t}$ (t = cycle time)

Rock loaded in one pass = B x F x S

cycle time = digging = 10 sec
hoisting = 5 sec
swinging = 8 sec
dumping = 10 sec
swinging back = 7 sec
= 40 sec

Bucket capacity = 4.6 m^3
Fill factor = 0.8
swell factor = 0.6

Hourly output of Shovel =

$$= \frac{60 \times 60 \times 4.6 \times .8 \times .6}{40} \ m^3$$

$$= 198.72 m^3$$

$$\sim 200 \ m^3.$$

output per shift = 6 x 200 = 1200 m^3

output per day = 3 x 1200 = 3600 m^3 - 200 m^3 = 3400 m^3 (in night)

output per month = 3400 m^3 x 25 = 85000 m^3.

output per year = 85,000 x 12 = 1040,000 m^3

output per year = $85,000 \times 8 + \frac{85,000}{2} \times 4 \times 8$ m³

= 68,0,000 + 2,72,000 m³

= 9,52,000 m³

functions of Shovel :

* Digging, loading, swinging dumping.
* Digging, loading and hoisting is all together called as crowding.
* place of application of Shovel
* merits of Shovel
  * it is used to to excavate the blasted ore / coal / overburden deposits in opencast mines (coal / metal)
  * it is used to load the blasted materials into the trucks, dumps, Railway wagons.
  * it is also used for back filling of excavations
  * It can negotiate at gradient of 12°.
  * Used to removal of overburden in Quarry mines in hilly terrains.
* place of application of Shovel
  * It is capable of handle of all types of ores, rocks, ranging from fine to very hard lumps.

* It can work upto a gradient of 12°.
* It is appheable for bench height upto 50m in coal lo-B | metal mines.
* It is applicable for medium stripping ratios.
* It's performance is good even in tough and abbsestige rocks and also dusty condition.
* The main parts, functions and place of applicabilities of Dragline.
* A Dragline is an excavator which has a long boom, one of which is attached with a revolving unit of machine and the hanging end is the earth end side carries a large sheave/pulley for the cabel attached with the bucket.
* It is used for excavating earth, sand or soft rock.
* The bucket when it has to be loaded is lowered into the earth d loose rock by manipulation of cables and is dragged by them. As it is dragged it is loaded. Hence it is called a Dragline.
* Classification of Dragline:-

Dragline

- Self propelled
- propelled by external agent.

self propelled

- crawler track
- walking dragline

propelled by external agent.

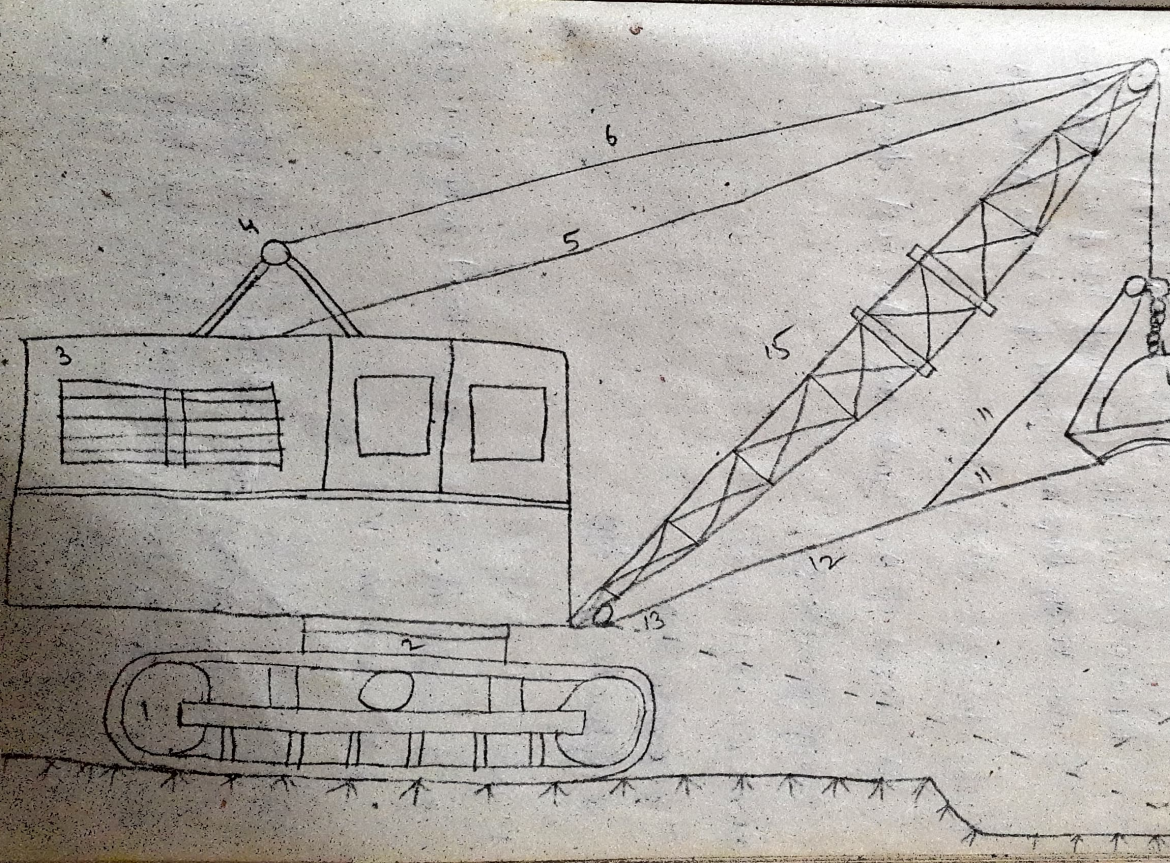
- wagon
- track

*Types of mounted/er

* Skid mounted
* Semi mounted
* Wheel mounted
* Track mounted
* Wagon mounted
* Tire mounted
* Crawler mounted.

*Main components of Dragliner

* Bucket
* Boom
* power transmitting system.
  a) Bucket operation
  b) boom hoisting.
  c) swing motion.
* walking mechanism
* Under Carriage system/unit.
* Lubrication system.



1. Crawler track assembly
2. Turn table
3. machinery House
4. A-frame
5. Hoist line
6. Boom hoist cable
7. Boom point sheave
8. Hoist cable
9. Hoist chain
10. Bucket
11. Dumping cables
12. Drag cable
13. Fair lead
14. Bucket position before digging.
15. Boom

*Bucket:-

Rectangular section, box type, opening on one side. Bucket attached to boom by hoist cable, front part attached to drag cable.

*Boom:-

1. short length [fabricated tubular structure depth at middle pointed towards ends.]
2. tubular column type. [made up of tube of low alloy steel]
3. long length truss boom [made of a tubular frame work.]

*Power transmission system:-

It consist of A.c Synchronous motor, hoist, drag, swing generators.

*walking mechanism:-

*Eccentric type

*Hydraulic ram type

*under carriage unit:-

* It consist of a tub (circular base), ring gear, central post, roller ball base.

*Lubrication System:-

Lubricates, walking drag machine, boom, head, walking drive gear, swing, hoist drag gear, hoist and drag ropes, swing gear boxes.

*merits of Dragliner

* It is used for excavation of loose material, sand, blasted over Burden in surface mining system
* where high production of is need in high mechanised mines.
* High ons is possible.
* Drag line can be effectively used where excavation and back filling is need in one cycle of simultaneously.

*~~Fault~~ functions of dragliner

* Draging, hoisting, swinging, dumping

*place of application of dragliner

* It is applicable where seam is almost flat.
* applicable for excavation of soft, loose material and applicatable for excavation of blasted rock in surface mining
* It is applicable for opencast mining upto stripping ratio of 1:7
* It is also applicable in watery conditions.

* specifications of dragline:

make :- marion
model :- 7820
Bucket size :- 25-45 yd^3

power :- 3000 HP

hoist motor Hp :- 3600 HP

drag motor HP :- 1500 HP

swing motor Hp :- 1500 HP

propelling motor HP :- 1300 HP

weight :- 3860000 lb

* for bucket size = 23 to 80 m^3 output per year 12-14 hour per day. it is 350 to 5 M.m^3

* Main parts, functions and place of application of Bucket wheel Excavators:

* Bucket wheel excavator is suitable for smooth O.B excavation rocks without blasting and also excavation of lignite in opencast mines.

* Bucket wheel excavator digges and discharge continously from bank to dumping point. since the series of buckets are attached to the pepheiry of the wheel which is rotated dusing cutting action, hence it is known as Bucket wheel excavator.

* It is suitable for long range stripping of soft O.B rocks at iron cast.

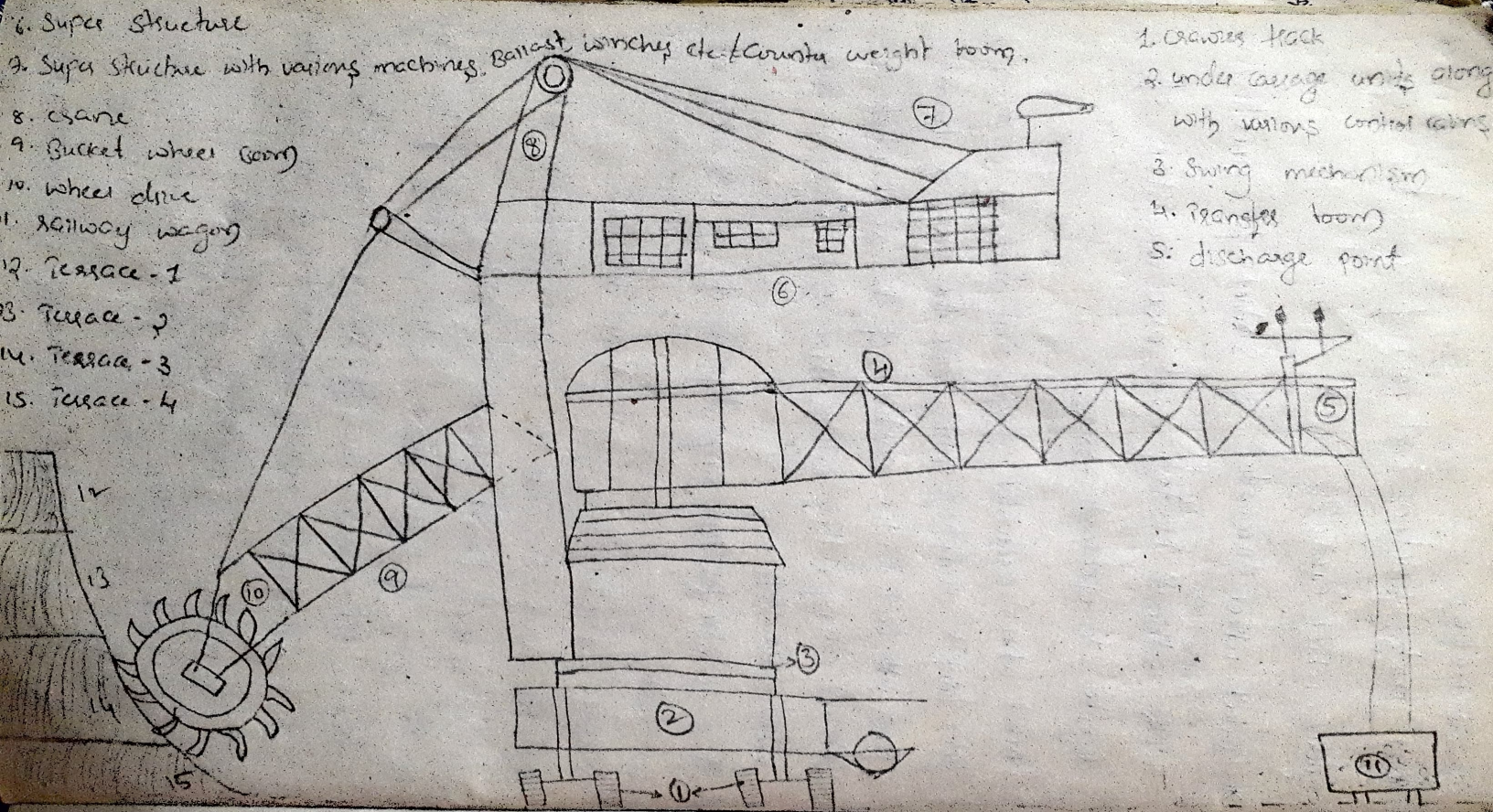
* Working / operation for Bucket wheel excavator

* Bucket wheel excavator has a wheel containing 6 to 8 no of every spaced bucket around its periphery.

* The series of bucket attached to the peripheey of the wheel digs into the mineral as softe rock mass and cuts the same when wheel wheel rotates from bottom to top in clockwise

* Cutting material is loaded by the bucket and discharge over the belt conveyor mounted on the movable boom via a hopper.

* The can type bucket discharges materials onto another


1. crawler track
2. under carriage units along with various control cabins
3. Swing mechanism
4. Transfer boom
5. discharge point
6. Super Structure
7. Super Structure with various machines, Ballast winches etc & Counter weight boom.
8. crane
9. Bucket wheel boom
10. wheel drive
11. Railway wagons
12. Terrace - 1
13. Terrace - 2
14. Terrace - 3
15. Terrace - 4

common chute permitted free falling of material with
higher wheel RPM and has higher capacity.

* The excavated material from the bucket flows onto the conveyor unit via slope chute or some feeder or disc feeder.
* To increase the digging effectiveness & in hardness formation cutting bows are attached in b/w the buckets.
* in addition to the teeth of cutting bow on the bucket top.
* Power from the motor to the multi-speed drive/wheel drive unit is transmitted either via hydraulical operated multiple disc clutch or fluid coupling or by magnetic power clutch to compact the over loads.
* The digging depth of B.W.E is around 25 mts below and the cutting height of 70 mts above its level. The cutting width is of 100 mts
* vertical movement of the cutting boom is done by hoist rope connected with a structural infront of the excavator.
* Main components:

* Bucket wheel.
* wheel boom and conveyor.
* Transfer boom and conveyor.
* counter boom and equalizer boom
* Swinging System.

* Luffing arrangement.
* Travel mechanism
* Lubrication system.

* Luffing arrangement:

The lowering and raising of the boom along the bucket wheel is terms as luffing. This is achieved by a) Hydraulic system
b) Rope with winch arrangment
c) Combination of above.

* Method of working:

1. Full block method
2. Lateral block method

* Place of Application:

* It is applicable to excavate lignite mine of soft to medium hard coals without blasting.
* It is applicable to hard and tight will fragmented blasted rock.
* It is can be used for thin seam and selective mining
* for easy disposal of OB as OB to a considerable distance above or below of its working level.
* for reclamation of land.

Merits of B.W.E :-

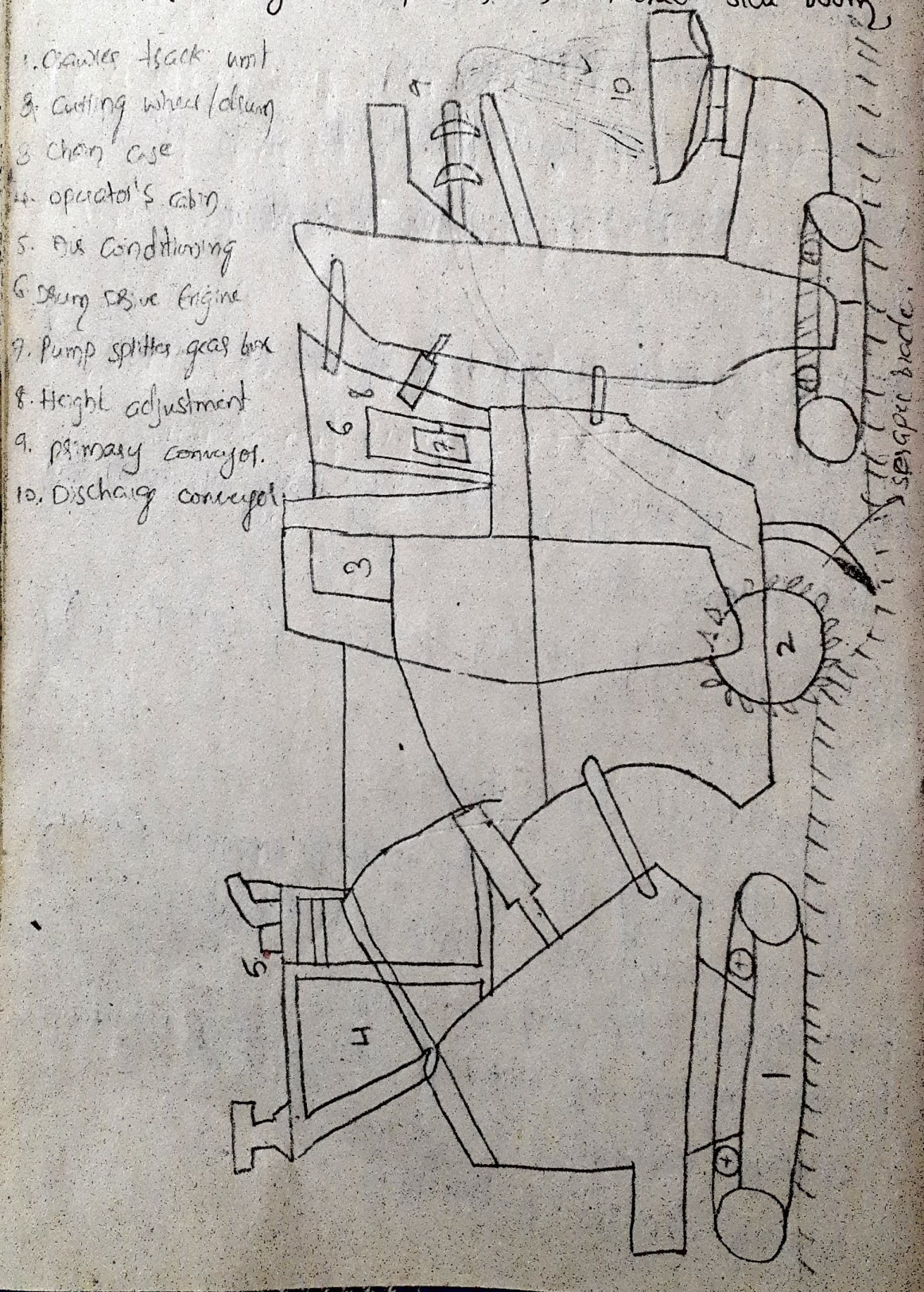
* It an efficient excavator for hgnite, soft Alluvium without blasting.
* used to excate hard and taught with fragmented blasted rocks.
* Used for wide range of excavation (10 to 30 mts) with high deep cut.
* It can be used for selective and thin seam and reclamation of land.
* Disposes of OB or O-B to a considered distance.
* Demerits of B.W.E
* High Investement cost.

* List the main parts, functions and area of applications of Surface miner:

* Applicabilities of Surface miner

* open pit mining of hardes minerals example : limestone, bauxite, coal, Lignite, Gypsum without blasting.
* mining of thin seam deposites.
* Selective mining of materials with varying minerals.
* Creating Channels.
* Digging exploratory trenches.

* Removal of partings.
* mining of residual minerals.
* Removal of consolidated O-B layers.
* Road construction and maintenance.
* digging drainage ditches.
* Moving conveyor units with an attached side boom.



Method of working:

* Like Shearers in ung mine the surface mines have the duty to cut the coal or other soft mineral deposits in open pit mining.
* It is usually crawler mounted machine having a cutting drum centrally mounted beneath the machine at the front joint end of the seam.
* The cutting drum has helical vanes over which tungsten carbide picked cutting picked are mounted.
* A shield (crown) is fitted behind the cutting drum.
* By virtue of rotation of cutting drum the material is cut crushed by the helix and the coal and then they are conveyed from the two sides of the drum to the centre of the same, from which the material is passed through an inter channel in the coal into the primary conveyor behind it.
* Then the material intern transfer on to a discharge belt conveyor which is swivable 90° on its
* The height of the discharge conveyor is adjustable.
* The cutting drum is operated by pole changing squirrel cage induction motor and can be raised up, lowered down and tilted in the transverse direction by the hydraulic rams, to negotiate greater cutting heights and dipped pole seam or ore body across the motor.
* In the central position of cutting drum, the seat crawlers travels at lower level than the front crawlers which equal to the cutting depth during mining.

* The latest version of C.S.M 4200 SM. with an operating weight of 180 m.t and an output of 1200 kw by two engine has cutting width of 4.2m and max. cutting depth of 0.6m.
* The machine can easily cut, load the coal/lignite /o.B @ at the rate of 3000 tonnes/hr.

* Advantages

* lower mining losses, better exploitation of available deposits.
* saving of transportation cost, lower processing cost
* It eliminates blasting, Reduces quality of auxiliary machine

* Disadvantages

* Initial Investement is more and skilled workers are required
* when break down of any unit, the whole system will be in standstill

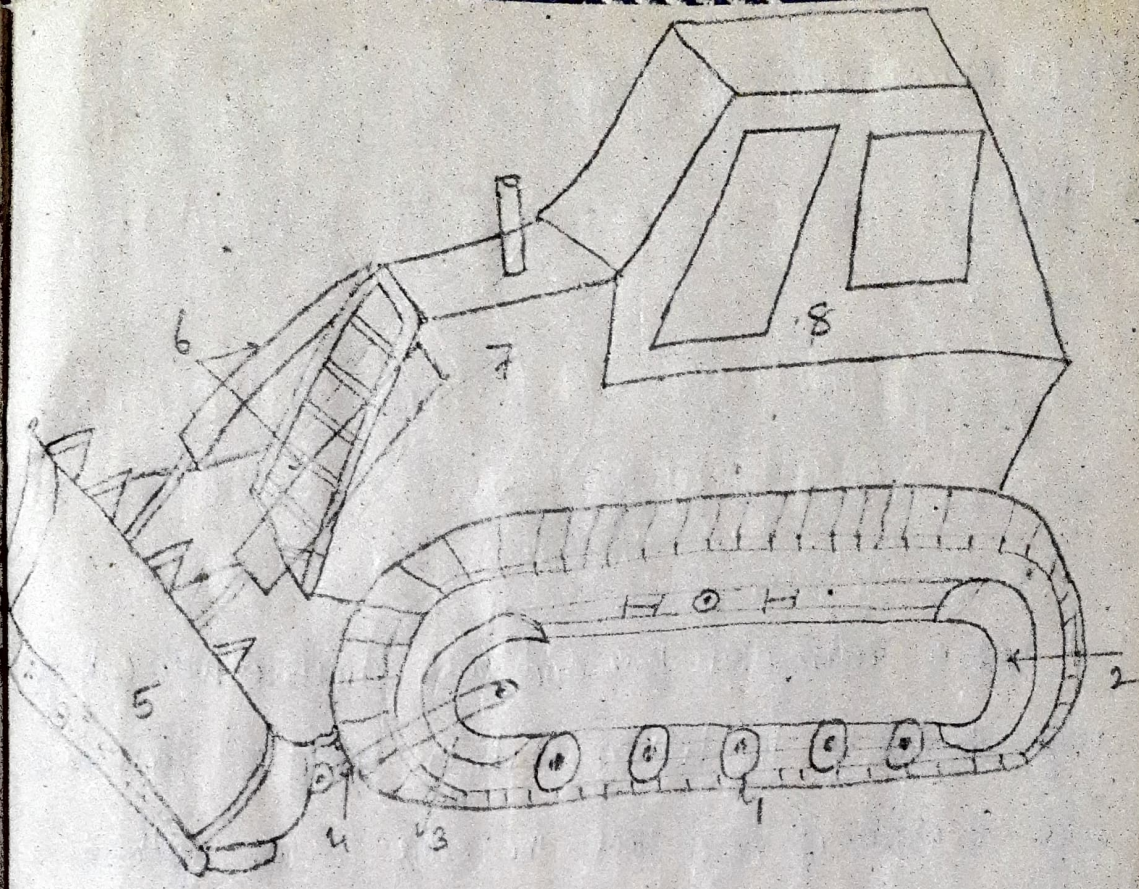
Machinery Employed in Surface Mining

Different machinery for preparing the ground for mining operation:-

* Dozer / tractor.
* Scraper
* Ripper
* Road Grader
* Rollers
* Cranes
* Crane Shell

* List the main parts, functions and place of application of Dozer.

* A Dozer consist of large vertical curve steel blade mounted at a fixed distance infront of a tractor. Secured by arms on a pivot or shaft near the horizontal centre of the crawler or wheel of the tractor.
* The blade itself can be raised or lowered or fitted vertically by means of control cables or hydraulic rams



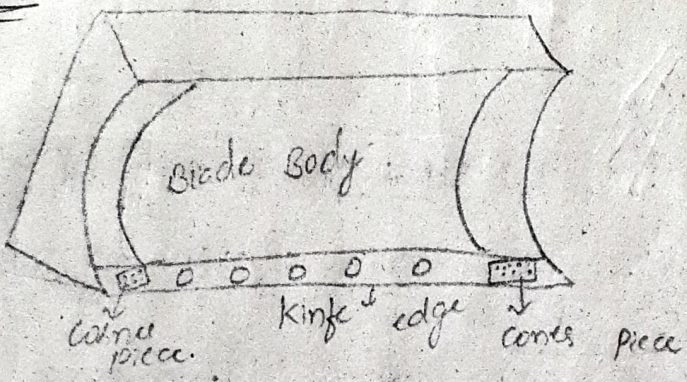
1. Crawler track assembly
2. Driving sprocket
3. Idler sprocket
4. Arm
5. Blades
6. Lifting cylinder
7. Engine
8. operators cabin
9. cutting edge.

* classification of Dozer

* Stright or Bull dozes.
* Angle dozes.
* Tilt dozes.
* push dozes.
* "U" shaped dozes
* Brush or rock ~~graders~~ / rakes

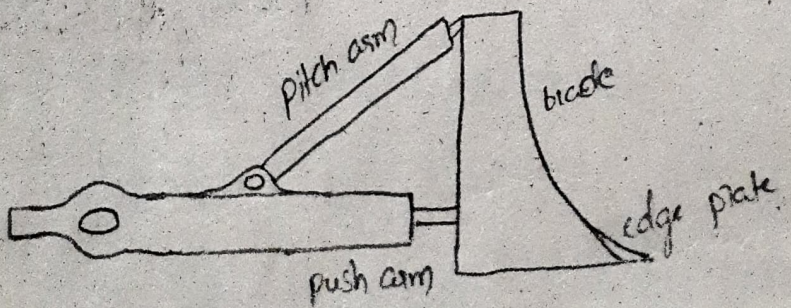
main Components of dozers:

* Blade:



* It has a rectangular base and back structure with a knife edge rivested to the bottom part. The Body is steel structure edge is made of hard steel. The edge is usually three pieces a wide centre and two ends which are bolted or Rivested.

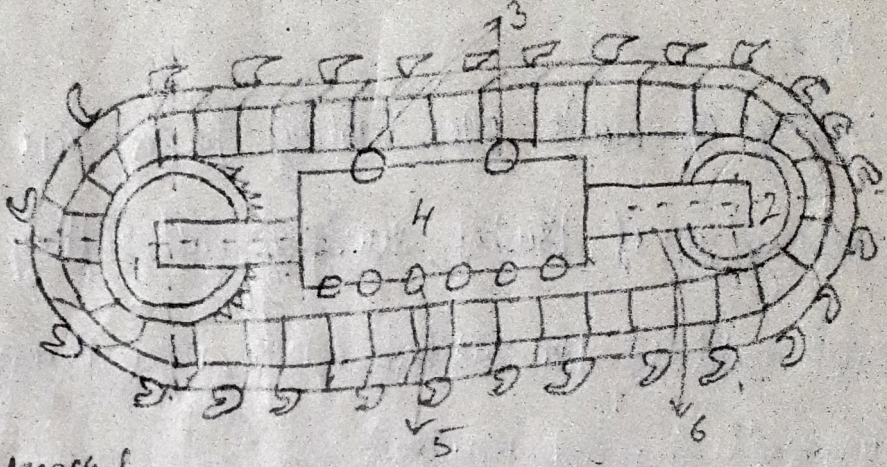
* Arms:



* There are two types of arm. They are 1. pitch arm 2. push arm. These are heavy narrow beams connected from hinge points of the body to the bottom of the blade.

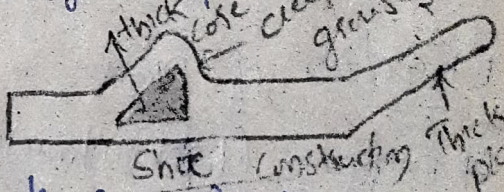
Pitch arm: These are diagonal Bracing members placed b/w the push arm of the top of the blade and a carriage unit

Under Carriage unit:



1. Driving sprocket
2. Idler wheel
3. carrier rollers
4. Carrier frame
5. Track rollers
6. Tensioning arrangement.

* There are two type of under carriage units.
  * wheel mounted
  * crawler mounted.



* The driving sprocket is hinged at the rear wheel.

* Transmission systems
  * cable control
  * hydraulic control

* cable control
  a) front mounted
  b) Rear mounted.

* Uses of Dozer
* Land preparation, cleaning, construction and maintance of haul roads, benches.

* It is used as auxiliary backup service machinery for piling of the blasted rock mass for Shovel and Dragline.
* Dozing of waste pile, making proper slope of bench, cleaning up of brushes, salvaging and shifting of machine and materials like switches, cables, pipes, pumps, steel mounts various auxiliary machines
* pulling heavy vechines into work shop when breakdown
* pushing of coal into bunkers.
* Reclamation of land, spreading and compacting.
* Function of Dozer
  * Digging. (light cutting).
  * Breaking piles.
  * Transporting.
  * Spreading.
* place of application of Dozers:
  * It is applicable for ground preparation during initial stage of opencast / quarrying.
* It is applicable in surface mining for leading cleaning construction. maintena of haulroads, benches
* It is applicable to work within the operating leading of 150 metres. It is applicable for all ground conditions

* It is applicable for gradient of haul roads upto 13-14°

* List the main parts, functions and place of application of road scrapers.

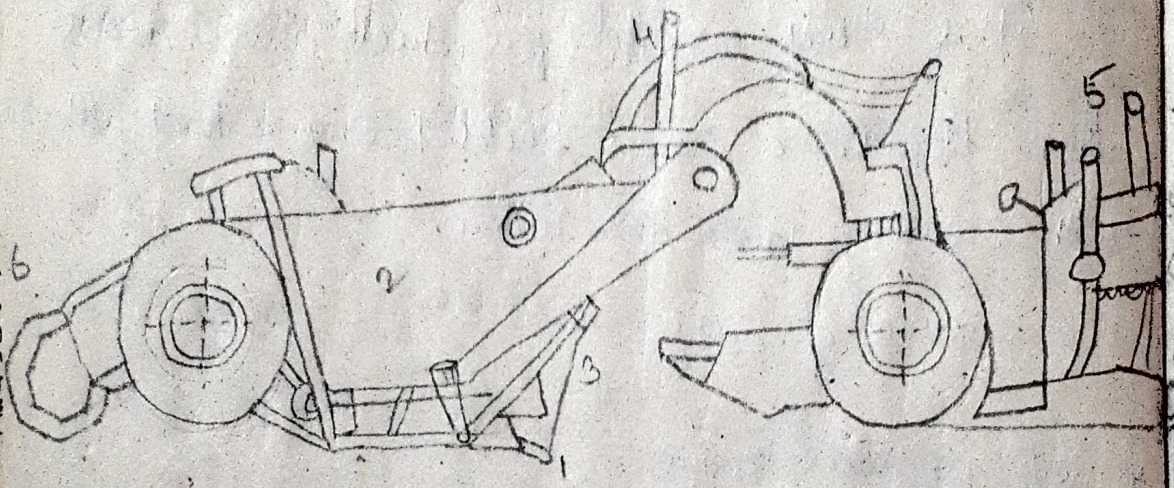
It is Diesel operated four wheel drive rubber tired tractors or a crawler tractor having a bowl attached with a cutting blade at a bottom.

Classification of Scrapers

* self propelled scrapes
* towed scrapers.

Both of them can either cable control or hydraulic control.

These are also classified as ① free
② Half forced } discharge type
③ forced



1. cutting edge
2. Bowl.
3. Apron
4. Lifting cylinder
5. Engine transmission.
6) push block.

* main components of scraper:

* **Bowl:** It holds the materials cut by the cutting edge during its operation. The bowl may be a hinged type and tips forward to load the material out. In some scraper a tail gate which is a wall in the bowl.

* The bowl is held in position by two lifting cylinder.

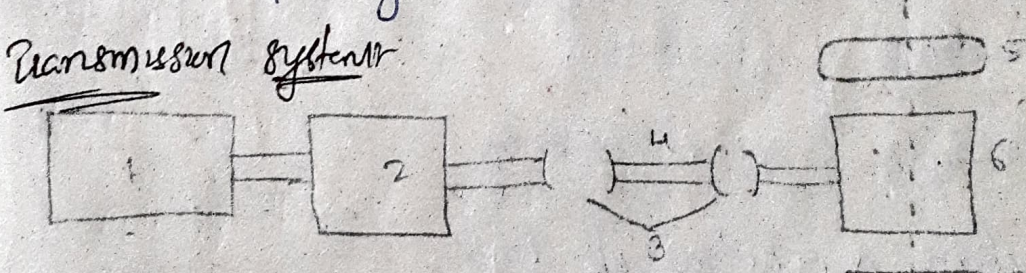
* Apron:

It may be a straight or curved wall which opens and closes to regulate the flow of the earth in and out of the bowl. It is also controlled by separated piston cylinder arrangement.

Cutting edge:

It is forced into the earth surface to make a shallow cut. This is made of wear resistant steel bolted onto the bowl bottom. It is made of three pieces. The middle one is long and two side are short in length

* Transmission system:



1. Engine
2. Hydraulic transmission
3. universal joints
4. propeller shaft
5. front wheel
6. differential.

* There are five forward gears and one reverse
* The machine is steared by Hydraulic system.

Control system: They are two system

a) Cable control system
b) Hydraulic control system

* Specification of Scraper

make :- Caterpillar

Model :- 261

Fly wheel power :- 246 kW

operating weight :- 80.479 tonnes

Scrapes struck :- 10.7 m^3

Heaped capacity :- 15.3 m^3

Top speed :- 51 kmph

width of cut :- 3.02m

max. depth of cut :- 0.33m

max depth of spread :- 0.522m

* Functions & operation of Scraper

* Digging/loading :-

* The gate is retracted to its extreme position the apron is opened partly and bowl is lowered until the cutting edge rests & penetrates into the ground. The push tractor is run in a suitable gear by regulating the depth of the cut (5cm - 20cm) & fed into the bowl

* Hauling :-

Transporting of the loaded material from the face to dumping pit. During the hauling the bowl is raised sufficient

above the ground.

*Dumping and Spreading:-

* The bowl is lowered until the cutting edge touches to the ground, the apron is raised enough for the material from the bowl to start flowing, the material will spread in a layers.

*Merits of uses of Scraper

* cutting, to cut a thin slice (70mm - 250mm) soft of unconsolidated material of soil.
* It is also used for hauling cast of fragmented very hard rocks of mineral.
* It is used for removal of top soil of thickness 2 to 3m
* It is also used for levelling purpose.

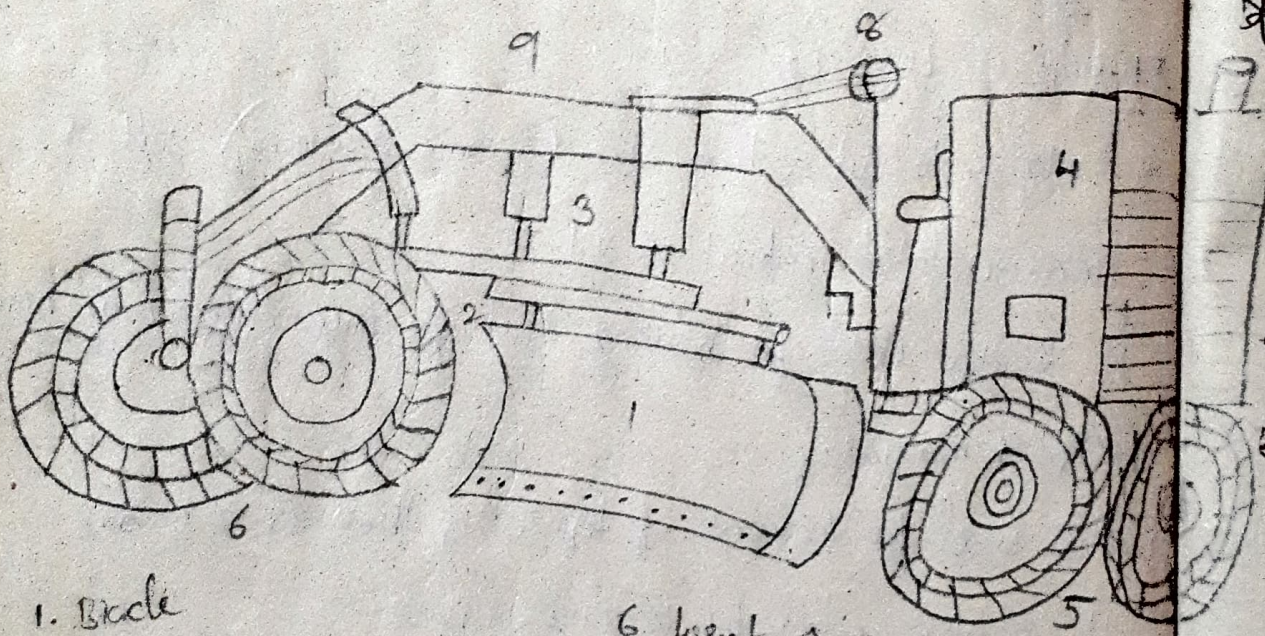
*Place of application of scraper

* Applicable is to cut a stress of soft rock, soil in surface mining during preparation.
* Applicable to extract the top soil or material of thickness 2 to 3m during initial stage of open cast mining.
* It is Applicable to work in open cast mines within a lead varying from 150 m to 600 m.
* It is most suitable for flat gradients and applicable

upto a gradient of 15°.

* Road Graders:-

* It is a pneumatic wheel driven equipment used mostly for grading and levelling the surface land.



1. Blade
2. Circle
3. Lifting cylinder
4. Engine
5. Rear driving wheels
6. front wheel
7. Exhaust
8. steering wheel
9. frame

* Classification of Graders

1. Self powered Graders.
2. Towed Graders.

1. Self powered Graders they are two

a) mechanically controlled and.
b) hydraulically controlled machine

* major component of the grader

1. Blade and circle
2. Transmission
3. Steering system
4. blade control unit
5. braking system.

* Blader

* Blade is curved with cutting edge at the bottom and has two coarse pieces at the side.
* circle is a machined with gear teeth on Inner surface
* Approximate dimension of blade 3710 x 620 x 19 mm.
* The blade movement are of three types 1. up and down 2. Sideways 3. Rotational

* power transmission

It is transmitted through a multiple disk clutch coupling to the crear box. power from the gear box is taken in a differential through universal joints and propeller shaft

* Steering system

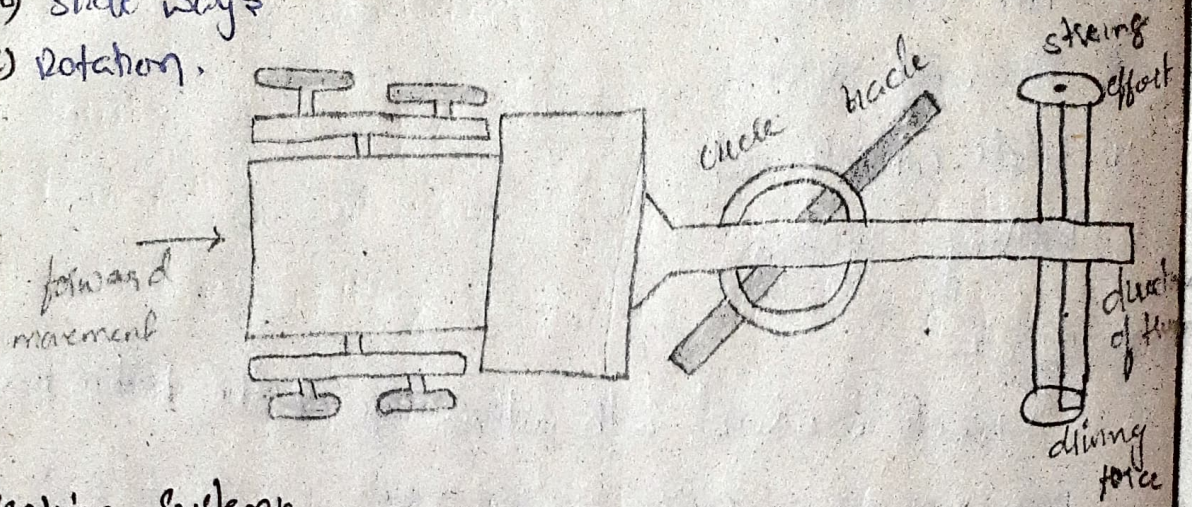
a) mechanically operated
b) power operated

4. Blade control unit:-

a) up and down

b) Side ways

c) Rotation.



Braking System:

* parking Brake:
  mechanical break
* Service Brake:
  operated by hydraulic system.

* Function and operating of Grader

* Bulldozing
* side casting.
* planing.
* Ripping.

*Bulldozing:

* For spreading piles of loose material.
* It can be achieved by extending the blade side ways during the front wheel are the piles.

* Side casting:
  The blade is set an angle such that the material being

pushed infront of it. is thrown of to one side.

*Planing:

It is also used for plane of irregular surface. This is done by lower the blade sufficiently below the original level of the material. the material is cut and stored in proper places.

*Crowning:

The road material is bacled inward from sides and the top of the crown is cut by adjusting the blade accordingly.

1. ~~Hence~~ ends can be lowered or raised
2. Blade can be positioned across the one of the frame parallel or at any angle.
3. It can be shifted to one side and to vertical position.

*Specifications:

*make: caterpillar

fly wheel power: 93 kw

Basic operating weight: 12 tonnes

Rotated Engine RPM: 2000

Top speed: Forward: 35.4 kmph

Reverse: 23.8 kmph

Standard blade: length: 3.66 m

height: 0.61 m.

lift above ground: 0.381 m

*Merits

* Grading :- To Grade the roadways in designed position while making haul roads in surface mining.
* levelling the surface land.
* Light cutting and planing of bench, berm and Haul roads.
* cleaning of spilling rocks & ores boulders on haul roads.

*Application of grader

* It is applicable in open cast mining for making haul roads.
* To make the required gradient of the roads in surface mining.
* applicable to maintance the haul roads during the excavation of coal, ore and O.B

* Inpit crushing Technology and conveying

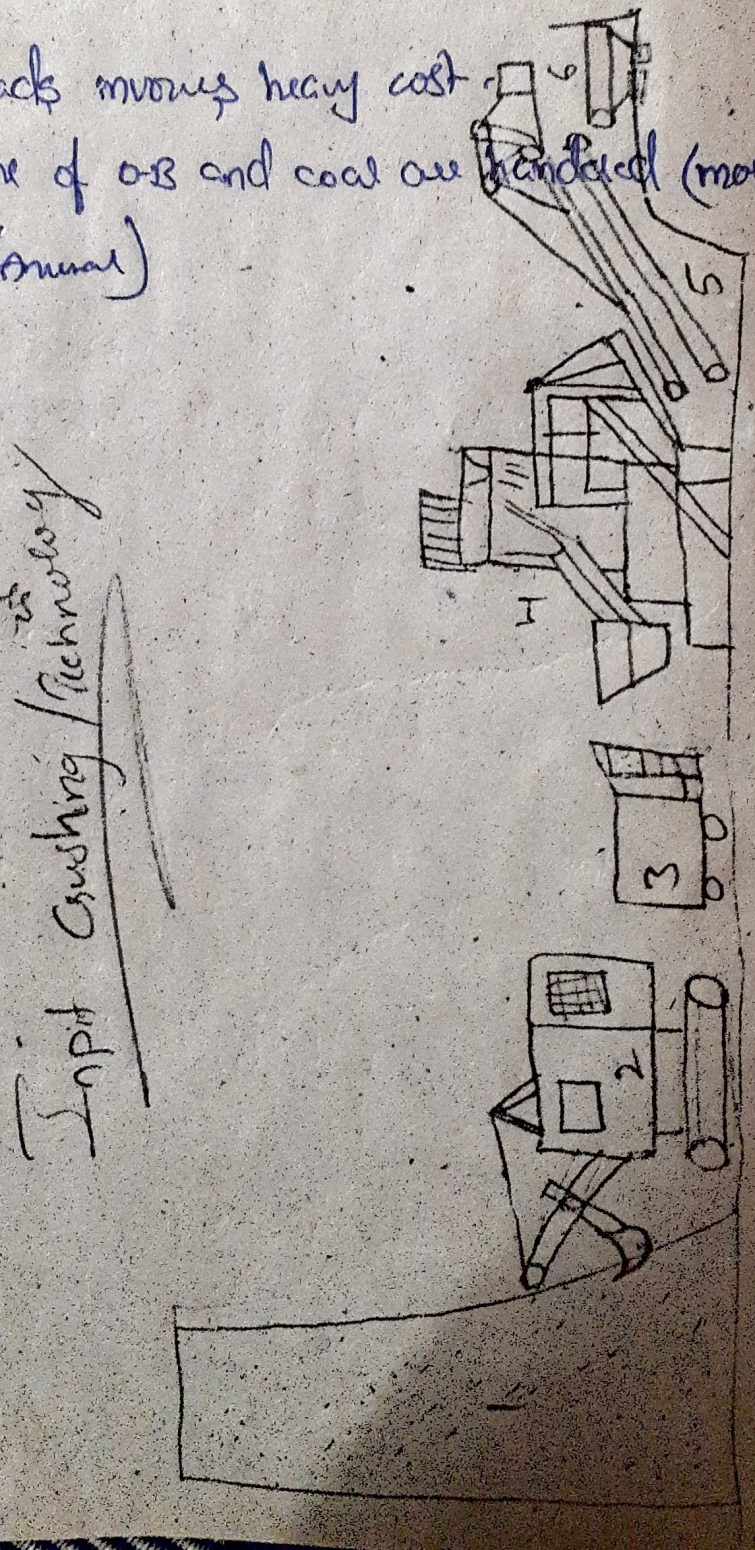
* applicability:

* In case of Stripy dipping massive deposits occur at great depth.

=> * Reserves smaller lateral extend when conventional methods are not suitable.

* where approach roads involves heavy cost.
* where large volume of OB and coal are handled (more than 10 millions m^3/annual)

1. Blasted ore
2. Shovel
3. Dumpers
4. mobile crushers
5. High angled belt conveyors
6. Belt wagons



Method of working:

* In this system, the following operations are involved.
  1. Drilling & blasting
  2. loading
  3. Transportation / conveying before crushing
     a) from bench to crushers
     b) from crushers to surface CHP.
  4. spreading

* The blasted ore of rock is loaded into the back of dumpers or sometimes directly into the crushers.
* In the crushers, the ore of rock is primary crushed to the required size.
* The crushed material is discharged on to a high angled belt conveyor which discharges material intern on to a long belt conveyor.
* The belt conveyor discharges the material on to a secondary crusher plant and finally, the ore of rock is conveyed required dump yard through spreaders.
* The mobile crushers generally contains gyratory crushers sometimes (jaw crushers) are employed.

* The mobile crushers are generally crawler track mounted or skid mounted or as walking mechanism.

a) The crusher used for this purpose may be near-pit crusher and adjacent to the opencast.

b) Inpit crushers: crushers located with in the future influences of the ore body.

c) mobile crusher system.

d) portable crusher system.

e) ~~conveyor~~ conventional crusher system.

1) crusher and feeder.

2) Reinforced concrete structure which is typically located in large that arc of the pit.

* Advantages of Inpit crusher:-

* As the depth of working increases the system offers the cheaper means of transportation system compared to truck haulage system.

* High production capacity and high energy utilization efficiency.

* control of dust is very easily and can not very much effected by the climate conditions compared to the truck haulage system.

* This system requires less excavation for transport route. Hence, Construction and Transportation, maintenance cost is very less in this system.
* Man power requirement, operating and maintaining fuel cost are less compared to Truck haulage system.
* ~~Initial cost is more.~~

*Demerits of Inpit crusher

* Initial cost is more.
* It has incapable to carry large size ore.
* It has less flexibility.

*Applicabilities of G.P.S in open cast mining:-

* control of bucket wheels and dozers.
* Drill guidance.
* Road grading and maintance.
* Fleet management system for haul trucks and other vechiles tracking and dispatching, Asset other vechi tracking Eg:- lighting plant and mobile generations.
* Guidances and control for drill (bit) rigs and explosive trucks.
* Access and zone control for visiting vehicles