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MATERIAL HANDLING & LOGISTICS (THEORY 4)

HAULAGE TRANSPORT SYSTEMS

One of the most important considerations in the efficient operation system. of an underground mine is the transport or haulage Often the determining factor between the profit and working loss is the quick removal of coal or ore and waste from the places to the secondary and main-line haulage areas can and not so on be to the outside. The underground haulage system winning considered in isolation of the method of mining or coal at the face.

Coal mining still resolves itself into
Three distinct operation

(i) Production of coal,
(ii) Transport of coal, men, and materials including stowing materials, and
(ii) Maintenance of track, machineries and other equipment. It should is thus obvious be that underground haulage or transport system geo mining compatible with coal getting operation and the conditions of the mine under consideration. transport
(iii) The transport systems utilized in mines, excluding the through shafts, may be divided under the following heads
(iv) 1. Track-mounted Haulage (a) Rope haulage: Direct rope haulage, (ii) Main-and-tail rope haulage, (ii) Endless rope haulage, (iv) Gravity rope haulage, and (v) Mono rail. (6) Locomotive haulage (i) Diesel locomotive, (ii) Battery locomotive, (iii) Trolley wire locomotive, (iv) Cable reel 1ocomotive, locomotive. (v) Compressed air locomotive, (v) Steam 2.Trackless Haulage (a)
(v)
(vi)
(vii) **Conveyors** : (i) Belt conveyors, (i) Chain conveyors ii) Shaker conveyor. 98 Mine Pumps, Haulage And Winding (b) Spiral chutes (Gravity transportation). (c) Hydraulic transportation. (d) Pneumatic transportation. (e) Wheel mounted equipment: Shuttle cars, Load, Has Dumpers. (f) Aerial rope war: (i) Monocable, (ii) Bicable. (g) Scrapers or slushers.

TRENDs IN UNDERGROUND TRANSPORT

Rope Haulage: This is the most common system of haulage in majority of coal mines in india,' both for coal transport and for auxiliary purposes such as material supply and even for man riding purposes. A rope haulage system is highly flexible and is not capital intensive and can deal with any gradient o the seam, thus covering most geo-mining conditions. It is the most suitable system for low to medium outputs, say less than about 1200 tonnes per day. The large endless haulages as main haulages are now gradually being replaced by locomotive systems, belt systems and spiral chutes. High speed main-and-tail haulage has, as yet, found little favor, although it can be used successfully Rope haulage of the small "direct" type are still being used very widely in haulage materials in long wall face tailgates, drifts and headings. For man-riding purposes, endless ropes are used and the persons travelling have a hook attached to their belts which can be put on and off the upward travelling rope, thus puling the persons travelling. Endless ropes are also used in cane fit system for both upward and downward journeys. A haulage system with specially designed trolleys. A direct haulage system with specially designed trolleys attached the haulage rope is used for man-riding.

Rope haulage being used to drive mono-rails. are Conveyors: These are being used to an ever increasing In modern haulage systems. The use of the cabie reinforced belt have allowed longer hauls and high 99 economically tackled. The nylon-cord belt has been of immense improvement. It has allowed increased length of haul, and reduced belt costs. It has allowed belts to operate with smaller diameter pulleys (solving installation problems), deep Haulage in Mines the conveying

equipment as it will allow smoother flow and prevent minor stoppages. The use of a conveyor feeding into a spiral chute can also be extremely useful. The spiral chute can serve two purposes: (1) It can serve as a normal coal lowering medium between levels, and (2) It can feed into a staple which can act as bunker storage. Conveyors and chutes, now ever, still cause an excessive amount of dust and this is a serious disadvantage. is also possible. The bunker storage conveyor is also a useful addition to Locomotive Haulage: On fairly level hauls locomotive methods are cheaper C than other methods but roadway drivage preparation costs may require adding some extra cost per ne output. Though capital of transport intesive, it is an efficient means coal, men and material, the conditions required in only a few mines are equipped with key wire locomotives) are currently in use in India. Only in approached from surface by audits. Forgivable use of this system of haulage are not commonly met T e haulage to the trunk route either by belt conveyor or rope haulage wire locomotive. These mines are in a hilly terrain and are an ever increasing extent in horizon mining. Since the combative haulage Trough system. All the three types, (Battery, Diesel and wire mines in India, the entire transport system is by trolley two an ever Locomotives are being used in many countries to High speed to Cars (o system is capital intensive, it is usually used with locomotive mine sys cars(get the sing the so that more coal can be hauled at a time thus Wheel-who -arms (generally 2.5 tone cap one capacity) creasin9 rather than tubs f 1 the effective capacity capacity of the transport system. provides themes Amounted Equipment oust flexible system of transport in underground Ailment: Wheel-mounted equipment Mine Pumps, Haulage mine for material And Winding handling as well as transport at 100 from the production panel. It required very five in 7 anta editions, such as, flat gradients undisturbed ground, (1 beg self-supporting roofs and wide and loader shuttle car combination has given gather high ray ideal, gathering Continuous miner-shuttle far combination wide or pillaring production. In recent years, LHD have become r parts of the world as they combine two functions-that is diesel and and transporting by one machine. Both diesel of models of LHDs are available. L in Indian coal mind (cable) LHDs are in use at present.

(viii) **TRANSPORT ARRANGEMENTS BELOWGROUND**.

(ix) The various transport arrangements that are for material Han the available in underground mines, may be divided following heads - 1. Gathering haulage. 2. Secondary haulage. 3. Main haulage. Gathering Haulage: let is placed in the immediate vicinity the face, and ‘operates between the working faces and intermediate loading points. Secondary Haulage: It operates between the gaur haulage delivery points and-the main loading point. That Main Haulage why: The main haulage arrangement 0perates or between the main loading points and ten w incline. The gathering, secondary. Or main haulage may DE a ropes, conveyors, combination locomotives, ‘shuttle cars or of them. In any haulage system underground economical safety aspects predominated. The cost undergo Haulage in Mines 101 transport system can be sub-divided into. (a) Capital, capital depreciation and interest charges on all equipment installed. (b) Maintenance costs. (c) Energy costs. Operational labor costs. (d) The choice of any haulage system must take into consideration hose costs together with such factors as (1) Tonnage. (2) Inclination, (3) Length, (4) Capital or plant available, (5) expected life, (6) Simplicity, or complexity. (7) General method forking. Some items are measurable in terms of costs and generally the items tend to overlap one another.

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(xii) SCOPE OF ROPE TRANSPORT

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(xiv) it may be tackled under the following heads:

(xv) (1) Tonnage: High tonnages in relation to capacity are essential for economical running. Rope haulages are the most datable to conditions of variable tonnage or low utilization.

(xvi) (2) Inclination: Rope haulages are usually the most inimical system within the range 1 in 3 to 1 in 20. At the steepest inclinations but at limited distances able drum direct ropes and belts are as economical as less rope.

(xvii) () Length the limits below which very high cost values tinier 600 meters for rope haulage. (4) Capital and Plant Available In many instances viable plant is utilized or modified with varying economical us. If cars are available the use of rope haulages generality cues capital charges. Where there is limitation on capita there may be rapid development of working places with actively short

life. Under these conditions and especially variations in gradient endless rope haulages are suitable.) Life Rope haulages can operate economically fora number of years. Rope haulage can also be easily ended 102 Mine Pumps, Haulage and winding (6) Complexity: Series and series-parallel arranger I are usually unsuitable for rope haulage. (7) Method of Working This chiefly dictates they secondary haulage and the type of material transport, this turn can restrict the choice of the main transport systerm.Ro haulage may be used to move in bye materials and.in sir cases debris for solid stowing. (8) Safety: A rigid system of inspection and minter" is necessary especially for systems operating at gradient this case rope methods are more susceptible to accident personnel than conveying. (S) Costs: Costs are reduced if the tonnages inner and with rope haulages cost per ton kilometer are the length is increased. Cress educe Gradient only slightly increases the Conan haulages, on steep gradients (1 in 4) the balance IS cheaper than conveyors, but the capacity as the length exceeds 1000 meters. The power item on rope haulages. costs of aim ism The highest items of cost with rope haul (1) Supplementary Labor: The cost of the to point, landing, etc.; this accounts for about are the tot (2) Direct about Costs: Drivers, rope rope attendants (3) Depreciation and Maintenance oral P ants costs can be reduced to that taken modern locomotive systems by mocha attaching and detaching, the endless should be competitive with locomotive system on gradient of 1 in 40 or steeper. all plants: practice nor n loading.9J very Would-be once Ms. It shoo continuous stream of coal throughout though as

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(xix) We ROPE HAULAGE The main roads feeding ng tether shaft must working shot so rope haulage can be successfully o plied as main 103 Haulage in Mines condor or gathering haulage in both long wall methods and pillar installations of working. And especially Rope haulage is applicable to all existing where the roadways are driven in a seam of varying gradients or in shallow mines where coal has to be hauled up an inclined drift to the surface. The rope haulage maybe classified under the following heads (1) direct rope haulage. (2) Main-and-tail rope haulage. (3) Endless rope haulage. (4) Gravity haulage. Direct Rope Haulage This is a very popular and simplest form of rope haulage and has several variations. It has very special application in mines which communicate with the surface. And product by means of drifts or inclined shafts. The equipment for this type of haulage consists of a Single drum mounted on a shaft, a jaw clutch being used to 2 Started tartan(6)Controlled Lever: (7) Brake lever; (8) Reversing able the (1)Worm gear; (2) Drum; (3) Rope; (4) Brake path; Direct Rope Haulage Fie switch handle; (9) Liquid controller; (10) Motto, Liquid controller; (10) Motor, drum to either run freely Flexible Coupling Coupling; (12) Bearing drum to either run freely 104 Mine Pumps, Haulage And Winding en a full set is being or to be "clutched" to the shaft when a full set i.e. up. Power is supplied by a motor which drives thing h road, plus a few extra coils on the drum, is required fog the shafts. A length of rope, equal to raster the length of the haul type of haulage. The common practice consists in having the ha engine placed at the top of the incline. The tubs are altar. To one end of the ‘rope, the other end being fixed to the ha drum. When an empty set is being lowered down the ink the speed of the set is controlled by means of a brake reconnected to a brake on the drum, the latter is allowed torch freely on the drum shaft and when full set of tubs has t hauled up the clutch is put in so as to rotate the drum w= the motor rotates the shafts. The supply of tubs or cars intermittent with this type of haulage since only one set tubs can be run on the haulage incline at a time. This suits conditions in this case since single track working in Nat galleries is possible. The gradient must be sufficient for the empty set tor down in declutched position of the drum, overcoming Trico both tubs and rope, and to enable them to gravitate in bye inure any power from the haulage engine. However it IS a precaution when lowering heavy or bulky materials to KE engine in gear which allows of better and more sensitive co* than when the engine is declutched and sole reliance lisp not places upon the brake. With ordinary tubs having ordinary o Dearing’s, the gradient may be 1 in 12 or steeper. VI l cars having ball or roller bearings, the gradient maybeas15K15K as 1 in 20. The haulage speeds may range up to ab per hour, or ever more the system gives an intermittent supply to bank e as ply to bank and n speeds are essential for large Outputs. The chief dangers aids from heavy loads being hauled at high speed up stee1aced gradient with the result that severe stresses are liable to be plateau cedes ropes, couplings, drawbars and the haulage gear. h his efficiency and to prevent dangers, wide gauge track hark tails are necessary, careful starting, accelerating Ana

with heavy sec. Mine Pumps 105 ential A backstay to the last tubs of a set of tubs should edto prevent runaway of tubs in case of breakage ofrone ubcouplings ble-rope, double-drum, balancedhaulage This is a modified form of the direct rope haulage that many advantages especially for drifts and surface mines. His method, the haulage gears tatted with two drums so whilst a train of fulltubsis being hauled out bye, a train of pity tubs is being lowered in bye, the tubs being therefore aced. The tubs are in sets and separate rope is attached each set and wound in or out of its own drum. The motor is continuously rated and there are suspended or caliper type brake's two to each drum. Each drum is separately clutched when working the plane both drums are normally clutched. His one rope is wound on and off at the top of its drum and heather rope is wound on and off at the bottom. high standard of maintenance of both trams and tracks 2Clutch Brake Over-rope levers levers drum D Under-rope drum Claw clutches Brakes Double-drum haulages compared with single-drum Double-Drum Balanced Haulage ES which with could work the same plane, will handle Equip a reduction in power and at a much reduced speed hunch greater outputs over longer distances than is posada Advantages The advantages of this type of haulage may unbalanced haulages. Slate as Mine Pumps, Haulage. And Winding 106

(xx) (a) The average power demand, and peak horse-no very much less than that of a main rope haulage of the output and it approaches that of an endless rope haul

(b) Fewer tubs are required per train, and theses ropes of smaller diameter. These smaller ropes mea reduction in the diameter of drums and the weight of caps etc.

(c) The delivery of tubs is more .regular than wit unbalanced system.

(d) Higher output capacity with given load portray set of tubs and a given speed, or smaller train and lower s3 for a given output.

Disadvantages: The main disadvantages of Double balanced system are –

(a) the haulage engine is larger and more expensive and the inertia of the rotating parts etc., is greater than that for the direct or, main rope haulage.

(b) The system requires wider road-way with double this may tracks. Reduced be partly by providing three-rail a pass-bye system with usual which the arrangement surface for installations is.

(c) Starting trams over the top of slope presents the certain difficulties mechanical devices to over come these difficulties must be provided unless a shunt and Tracks for Balanced Hua back yester used. Haulage in Mines 107

(d) Owing to the irregular booking of the rope on the two drums, it is impossible to guarantee exact landing of the Fu more and empty sets. Thus the operation of the system is rather complicated. The clutch arrangement is necessary for the readjustment of the ropes and for the shunt back type of landing is most common. Main-and-Tail Rope Haulage This system is employed when the gradient.is insufficient to ways permit are the use of main or direct rope haulage or where road- undulating and it is impossible to have a double track. Branch may be lines applied to almost any condition of roadway and can be worked easily from the main system. As the name implies tall rope, the haulage has a main rope and a one tor the engine being provided with two separate drums, each rope. The main rope, which is coiled on a drum, tacked to the front end of a set of loaded tubs to haul men out bye. The tail rope from a second drum, passing over a . Main-and Tail Rope Haulage e aring;

(2) Double Helical aearing;

(3) Drum spur; (4) Coups arena (6) Brake paths; (7) Trafford plate; (8) Controller: (9) 5) Frame, (10) Brake levers: (11) Clutch lever: (12) Motor 108 Mine Pumps, Haulage And Winding return sheave in bye, is attached to the rear an. tubs. The rail rope hauls the empty tubs inbye.bBrakafitted to each drum and the drums are arranged so that. May be driven independently through.clytches. When is in gear, the other revolves freely on the shaft but coca when necessary, by the brake to keep the ropes taut. Thereof the rope needed is more than three times the length e haulage road the main rope is approximately equal length of the plane, and the tail rope twice this length system can operate 12 to 18 Km or even up to 20 Km pert This system needs only a single track except in landings and pass-byes, and can be employed in Nar roadways. The engineman has complete control of the t= right through-out its journey.

Motive power is used only wt. = the train is making its journey. Special shackles are uses attach the tubs or set to the rope. Endless Rope Haulage In this system an endless rope, made up to see lengths spliced

together, passes out bye from the driving pulley pulley, end also of known the haulage plane to a return pulley. The din motivated by electric power as surge wheel or fleeting pulley of gear wheels from the motor through a name turning on substantial pass round: the driving pulley shafts. The rope only21/, and 3/, times an, times ant: Surface prefer return. The friction between the rope and pulley surfacepre Cite C3ifton puller outdo t: abs Eauti0o Tensions Endless Rope Haulage might allow slip. Again to manta of the fasten itself on the pulley. Accepts high Pea the rope slipping. But two few turns of age the rope on the P s might cause the rope eve. Except on very short haulages Haulage in Mines 109 r to have rope tensioning arrangements, This is a rope will extend by a small amount when a load is bent and thus stretch might result in the rope slipping on necessary to ha he rope to drop free from guide or return pulley, with disseat. A sequences, the tensioning device keeps the rope taut continuously. The endless haulage speeds range about 2 to 5 Km per hour. The system is ideal for roadways flat to 1 in in 6 gradients. Turn Sets of rails are required for endless haulage system, one for the empties going in bye, and one for the full tubs being drawn out bye. The tubs are attached to the rope at regular intervals either singly or in sets. Attachment of tubs with the rope many be made by a lashing chain or goose neck clip or cam clip for over-rope haulage (when the rope is placed over the tubs) and by means of screw clip or small man clip for under Tope haulage (rope is along the floor). It is possible to have automatic detachment of small man clip and goose-neck clip rom the endless rope at prefixed points, the driving pulley especially when starting. It might also cause Under-rope haulage has the advantages that there is a more direct pull on the drawbars, the tubs may be fully loaded, Tuvesare more easily worked, automatic detachment of clips De readily arranged and the moving rope, being near the O,1s less liable to personal injury. The method is suitable steep roadways of uniform gradient. Overs-rope haulage requires fewer rollers the rope is not cited by wet floor and there is less friction and wear of rope Peers. The rope is not liable to corrosion. The rope is term working height for persons engaged in attaching anddetachin tubs. The method is suitable for roadways or Ong instances, the tonnages normally collected from a number aryinggradients. Endless haulage is simple to work, effective on uptotheir final destination. It is capable of hauling over subsidiary haulages or conveyor loading points. Further The aryinggradients, oats, and can negotiate curves usually at the cost to power; getup it can be readily extended and the tubs taken 110 Mine Pumps, Haulage And Winding advantages claimed for this method of haulage are with larger outputs than other types of rope haulage,sim layout and operation; low speed, lowered risk of acid other damage; reduced liability to airborne and roads less wear and tear to track and rolling stock; apple level, undulating and inclined roadways, while negotiating of moderate nature, constant load imposed on motor, re and even flow of tubs and coal into and out of the mine maintenance on the hauler due to'alimination of high. Revolving parts and simplified layout. Moreover, the svstwell balanced and power costs are smaller than other sys At the same time it is slow, it is liable to breakdowns bring the whole haulage system a standstill; its sum encourages a multiplicity of subsidiary haulages; wide required with double track; employs large number of tubs it is extravagant in manpower; the rope requires splicing; grew= obstruction to airflow; liable to excessive coal spillage in c rope method; a tension carriage has generally to be prove to keep the rope taut; unless a secondary road is avail journey of materials in bye is slow and definite setback emergency. Driving pulleys: Pulleys or wheels which are use driving purposes on haulages must have its throat so she as to give the necessary grip to the rope and prevent jar shock. Different forms of driving pulleys for endless rope= 1. Clifton Pulley, 2. V-grooved Pulley. 3. Flower's clip pulley. 1. Clifton Pulley The Clifton pulley is the type generally used in endless rope system. The pulley has a taper throat lining of renewable cast iron or soft steel segments having a taper of about 1 in 8. These segments are secured to the rim by counter-sunk bolts and have Changing the liners is effected very quickly and the cost of passes rope on to it at the larger diameter, gradually slipping towards Haulage in Mines 111 c to protect the main pulley flanges from wear side flanges to rope such pulling loads is coiled 2-3 times around the pulley and such liner is but a fraction of the pulley cost. The incoming the smaller diameter before leaving the pulled. 2 V-grooved Pulley: A V-grooved pulley or olio pulley is suitable for light haulages. A good grip of the rope is obtained, thereby preventing slip. Both sides of the throat are made in segments and bolted to the rim of the wheel. These pulleys have a tendency to flatten the rope by wedging and greater the load the greater the wedging. 3. Fowler's Clip Pulley: Thesis a form a clip pulley, the throat of which is made in several segments. This is an improvement designed to on the V-groove type and is overcome the friction the entrance resisting throat of to the resisting from the taper onto the the pulley. When the rope passes open groove of the pulley, segments are the about their pivots, passed down and rotated on the rope. Thus increasing the grip allow

the segments are adjustable for wear and ropes of different diameter. Rope Clips: The Special endless rope moves at a slow speed over Clips are ravels used for attaching tubs or cars to the moving under the tubs, or over the tubs. (a)The clips used for under-rope haulage are - pulleys or S or rollers rollers situated between the rails in the haulage way. To the moving travel. The design of such clips depends on whether the rope Screw 2. Small man clip or Hadfield clip clip. Mine Pumps, Haulage and Jinxing 112 rope by hang Screw Clip the clip is tightened on the rune screw. It is coupled to the tub drawbar bay long hang hinged to the clip. Set Screw Clip Small man Clip A mailman clip consists of a pair of= cheeks or side plates, loosely held together by an adjust central bolt which has a spring surrounding it, to keep.thed apart. The top of the clip is expanded by means of a speed designed lever - operated wedge. When the lever is depressed, the wedge entersthenorrower part of the space between the plates, so forcing them apart at the top, and at the same time causing bottom the rope. When jaws to grip the the lever is SIOE raised, the Small man Clip wedge moves towards the wider part often* between the plates so releasing the .rope from the Jab clip is provided with a coupling Mailman hook to attach ach with win tubs. Clip can be automatically aeenienthe rope by fixing a trip bar to a sleeper at some cone the somatically detached from at some convenient he: so that the lever of the clip strikes against it to ineffective. S (bi Clips gains it to make the used forever-rope haulage are - 1. Lashing chain 2. Goose-neck 3. Cam clip. Clip. are molest means of attach me Lashing Chain:Thisis the tubs to haulage ropes whichsim is used for means over-rope an pen haulage 113 Haulage in Mines m to 4 m long and has a hook at each end. One hook is attached to the tub drawbar and the other end of the chain is twisted a steed gradients, they provide reliable attachment, but ne are better for passing round pulleys. The chain is about 3 two or three times around the rope and the second hook is linked to the chain. Gradients one chain in front may be used, but on undulating roads one chain should be used at each end, one chain in the front and another chain behind the set pubs. On uniform

Lashing Chain ooze-neck Clip: This is an S-shaped hook or fork slotted position two holders on the end of the tub. When the rope is in through the hook turns about 300, so pro- using a pen local bend in the and thereby automatic gripping it. Dbtaineddetachment may by DE through passing the pair of guide tames placed gather near enough to prevent the clip enough sing Goose-neck Clip between MP them. Clip this consists of a ate and a cam shaped levee hitch enacted by a shaped lever pivoted and is be hauled. The pull anthem lever around Cody a chain to the tub pail of the tub pie around the pivot the grip of the clip on the suit provided at each end of news proportion to the load. Adulating roadway ng roadways. Clip Cam Clip 114 Mine Pumps, Haulage and Winding the tub. Tension Arrangement for Endless Rope: To ensure unison, it is the endless rope is always kept at a suitable tension essential to take up any slack rope that occurs due stretching of the rope. Numerous methods are employer applying the necessary tension in an endless rope haul the methods commonly used are lager 1. Fixed Tension. 2. Mobile Tension 3. Gradient operated Mobile Tension. Fixed Tension this arrangements is very useful on short haulage planes up to about 750 m. It take up less room. The endless rope return sheave is mounted on a special tension bogie or carriage running on rails. The bogie is attached to a set of strong girders vertically pieced being though a short length of chain. A wire rope attached to the sheave is connected Fixed Tension with the girder which can be made shortened by special screwing arrangement thus tensioning the slack rope. Mobile Tension: These are used for extensive endless haulage system. The purpose ofthistype of extension arrangement is to take up the slack rope created by variable loads on ropes. These varying loads would cause the rope, taipan the surge pulley. To take up the slack rope, the endless ‘rope is passe0 assed Haulage in Mines 115 cheese mounted on the special tension bogie or helfarounda running on rails. The bogie itself is controlled by heavy cerriageruni carries required in a manner as shown in the figure. Where the gradients allowing the vicinity of the haulage engine a Wane bogies heave can be placed on an inclined roadway which move backwards and forwards in accordance with necessity. Weights asrequ ENT Operated Tension: This is also a mobile tension. a bonneted with loaded tubs with sufficient weights to maybe connected Where reverse gradients are met with it might be necessary to install a take up tension at each end of the haulage plane since slack rope would have to be taken up on Gradient Operated Tension both sides of the engine. The correct place for the tension device is at the point where slack rope is most likely to occur. Changing the Endless Homage Rope: Replacement of old endless rope is done on a rest day to avoid hampering the normal output of the mine. The entire track should be cleared of tubs before such

operation. The length of new rope, equal to the length of old rope plus some extra length for splicing, etc. should be in one piece unless the section is heavy in which case additional splicing might be required. The reel of the new rope mounted on a tram is taken Delos ground at suitable place and two persons are engaged nod brakes on the reel, generally by means of timber poles motor holding the old scrap rope should be placed near the before cutting the rope, the cut being on the tension side of Connected with the old rope by splicing (towing splice). Driving pulley. The the haulage gene, and on their coming off the surge pulley the old rope is taken off simultaneously. The moving old rope the new open is ten connected with the old rope is then ne tension in the existing rope should be slacked off the new rope is towed round the haulage system and Mine Pumps, Haulage and Winding 116 carries the new pulley. Continue rope towards the return pellet emulate slack tension rope must is be turned maintained into the at collecting the pulley trams while the until a towing nu splice reach around the driving pulley. The towing split then cut out. The reel end or the new rope is properly ankh. Leaving adequate length for splicing (a rule sometimesfol is that he length of the splice should be 3.6 m per c circumference of the rope). The new rope now overlaps other end of itself ready for splicing. A lashing should be attached.to the rope a short distance away from the splicing point on the hauling side of the rope - enable the haulage engine to strain the rope. Before straining the rope a Sylvester should be attached to the opposite side splicing section of the rope. This has the effect of tightening the whole rope except that where the splice will be made. That=engine hauls quietly on the chained rope whilst the slyest= takes in the slack until the whole rope tightens.

Endless Rope Haulage in Mines The splicing is then done with two loose ends of the new After splicing the new rope, the Sylvester, etc. for tensioning the new rope is removed and the rope is made taut at the tension end of the haulage as usual. Rope overlapping each other. A trial run with the new rope is given and if necessary adjustments at the balance bogie end is made. The new rope is then ready for use. Personnel Required Haulage Driver Fitter Splicer Helper, Assistants 9 Total = .12 Gravity Haulage he gravity haulage or Self-acting incline is adopted to Steer loaded tubs from one elevation to a lower one in mines. E System does not require any motor or any source of power e the roadways are sufficiently steep and gradient uniform in favor of the load. The gravity of the full load is the power plied to overcome the gravity load of the empty set and nape, empty together with friction of fully tubs running downwards tubs moving up. Usual to work the self-acting incline with a single time e end Wheel an attached to the full set. The rope passes 12 cast iron pulley, known as Jig Pulley or Brake around a pulley there on, and so back uphill to a holding-up safety prop and the surplus prop rope is heel 1.3 m to 2 m diameter, w strap-brake, firmly secure incline near the advancin9 CC n diameter, with a Frodo-lined lever-operated incline ne only secured in an anchor prop in the top or runt ten of the pulley. The other e g coal face. A safety prop is placed in prop end of the rope passes to a bogie, where trimly secured by a clam. It is also secured to rope rope is coiled on a drum Tor or when the face advances. By operating in readiness for 117 Haulage in Mines rope overlapping the splicing is then done with two loose ends of the new each other. After splicing the new rope, the Sylvester, etc. for tensioning the new rope is removed and the rope at is made taut the tension end of the haulage as usual. A trial run with the new rope is given and if necessary adjustments at the balance bogie end is made. The new rope is then ready for use. Personnel Required: Haulage Driver 1 Fitter 1 1 Splicer Helper, Assistants 9 Total .12 Gravity Haulage he gravity haulage or Self-acting incline is adopted to Steer loaded tubs from one elevation to a lower one in mines. System does not require any motor or any source of power ne n favor roadways are sufficiently steep and gradient uniform of the load. The gravity of the full load is the power n d Supplied to overcome the gravity load of the empty set and empty Pea, together with friction of full tubs running downwards tubs moving up. Ties. Usual to work the self-acting incline with a single times rope one en Wheel1 attached to the full set. The rope passes 1/ times around a cast iron pulley, known as Jig Pulley or Brake rap-bra diameter, with a Frodo-lined lever-operated not of their the advancing coal face. A safety prop is placed in incline near front then of around the up where a pulley there on, and so back uphill to a holding-up Wheel 1.3 m to strap-brake, firmly secured in an anchor prop in the top of the the prop pulley. The other ended of the rope passes to a bogey, where safety nearby prop in my secured by a clam. It is also secured to the surplus prop rope is coiled on a drum SS tor when the face advances. By operating 118 Mine Pumps, Haulage And Winding lee, hang the brake wheel, controlling the lever (or alternatively. wheel acting through a screw) the loaded balance tubs

automatically moved downwards bogie puling the balance h b= on its track. It is possible to maintain an ordinary double track in the pulled double gateway, the bogie may be dispensed with empty tubs up by each descending full tubs. The system having a d track for the full length of the incline for a set or train of. Full tubs, in descending, pulling an equal number of empty tubs is known, as train incline. Such inclines 4 call for a well-laid track, good rope and 8 (1) Anchor prop; (2) Safety prop; (3) Level landing; (4) Safety props; (5) Holding-up prop; (6) Balance bogie; (7) Bumping chock or Buffer; (8) Full tub; (9) Tub track; (10) Dip direction Gravity Haulage roller, and a strong brake wheel. Three rails may also be U in above 'meetings' or pass-byes having four rails or duo track and an ordinary single track -below. bile The least gradient tor a gravity haulage depends on- (a) The length of the plane (b) he size, apacity, weight and conditions of tubs and their numbers. 119 Haulage in Mines (c) The state of the roadway in regard both to layout and maintenance. Some authorities suggest 1 in 20 is being the least gradient, but eaçh case requires its own diagnosis.

Safety Precautions: The safety measures to be taken for the gravity haulage include- (1) Large roadways, adequate lighting, welI-Iaid tracks with proper maintenance, strong and reliable coupling, chains, etc. (2) Backstays behind ascending tubs, and back catches or spring catches to prevent empty tubs running backwards down the incline. (3) Safety prop in the front of jig wheel to hold the rope in the event of pulley anchorage failure. (4) Drop Warrick near the top of incline and at bottom to arrest tubs in case of forward runaway. Runaway Switch to derail tubs and arrest them for the same reason.)A second brake on the brake wheel should be provided which acts directly on the rope itself to prevent runaway of full tubs if they should be lowered into the incline without an empty set having been attached to the rope at the bottom. (D) To The brake wheel securely fenced and a guard erected prevent men running into the handle of the brake.

HAULAGE ENG! NES

The following electrically driven rope haulage engine consists of essential parts.

(1) Drums: Drums for direct and main-and-tail rope haulage are seaware cylindrical, with cheeks or flanges, arrange usually and to run ace Ooze on the shaft and controlled by clutches 0SSes in one construction the drum center including bosses, arm brakes. In one arum side’s side’s sand or tread is one casting of iron. The mild steel needs are bolted to the flanges on the casting 120 Mine Pumps, Haulage and Winding within the circle of the drum tread. The sides must widths bursting stress set up by the coiled rope, and should adequate thickness and ad. firmly secured to the drum trees brake path which may be of cast iron in sections, with turn" path and ledge should be bolted tether to one side, concentric with shaft. T is best to have a separate brake path because is unequal expansion caused by friction heat when the brake. In use. In another construction there may see be two cast iron bosses bored and bushed to seat loosely. On the shaft, the bosses joined by a shaft for rigidity. The bosses have seats formed to receive radial arms of channel section to form a spider. Drums may be in halves for convenience in transport and an opening must be formed in the tread at one side forth rope and to pass through to the inside where it is secured. The opening must be shaped to give an ‘easy lead through for the rope so as not to bend it too sharply. The drum should be large enough, at least 80 rope diameters, to keep the bending stress in the wires down to a legible value and to give sufficient bearing to the rope, In case of double drum hauler, both drums are arranged to run loose on the drum shaft and are gun-metal bushed and grease-lubricated. They are driven by cast steel jaw-clutches sliding on squares formed on the shaft and controlled by hand levers. The Jaw Clutch, also known as Claw or Dog Clutch, simple, positive and strong and can be engaged when the drive members are nearly stationary or running at same speed. Widely is used on direct and main-and-tail rope haulages. in endless rope haulage system, a driving wheel, a a/so called a surge wheel or fleeting pulley, is used in lieu Of a mms The pulley may be keyed to the shaft, or it may run loo on the shaft, being hen operated by Friction Clutch as rebut The friction clutch Is to disengaged with shock enable the clutch to be engaging when the driving shaft is nagged rev of the clutch slips if the load becomes excessive, tnu in ng shaft is redo atfullspeed. Also enables the load on the driving end of motor to be increased gradually from zero to full load, w age of some important part of the plant. Skive, thus avoid breakage of so 12 Haulage in Mines (21 Brakes: Brakes are used to regulate the speed of = haulage or to stop its motion absorbing the moving the kinetic energy o parts. A set of post brakes, caliper-brakes is used sometimes called the in haulage engines. It has two curved arms or posts made of lined brake-blocks steel girders

and provided with Frodo they are anchored shaped to fit the bake-path on the drum. Close together beneath the center-line of the drum, and connected by an adjustable tie-rod and a bent lever. Or quadrant at the top. The bent lever is connected in its turn by a When rod to a lever which may be operated by a pedal. the pedal is depressed, so pulling down the road, the Dent lever, in conjunction with the rod, pulls the two brake arms closer together 3) Motors: at the top and so applies the brake. The most usual drive of haulages is by means Of an electric motor which may be - D.C. Ct. Shunt Motor: For small endless rope haulages. Compound Motor, with a light Suitable for series winding: It is larger endless haulages, applied the load being through a friction clutch. haulages where a heavy starting torque must be (d) D.C. compound motor, with heavy series winding: For (e) 3-phase A.C. Squirrel cage induction motor: For small D.C. series motor: For direct rope or main-and-tail rope developed. Direct rope or main-and-rope haulages. E clutch. in and started through the medium of a friction less rope haulages, being switched straight on to phase A.C. slip-ring induction motor: For all the arguer were haulages where the starting torque is heavy, Ana there is frequent starting and stopping and speed (3-phase control is desired. ample, a 100 HP. Direct haulages requires induction slip-ring m or example hehehigh hi motor with a controller in the rotor circuit because of form start Slating torque required, and the need for speed control creeping to full speed. 122 Mine Pumps, Haulage And Winding breaker to give supply to the motor fitted within ,(i1)cont. automatic over-current and under-voltagereleasa t The control gear for the motor consists of() manic. with ammeter for starting up the motor and for speed control. inch Other equipment in. a haulage motor room fire-extinguishers, flame safely lamps, notices regard procedure in case of fire or electric shock. signaling system, telephone, visual indicator, code ofsigm as regarding (4) Gearing: The muse relatively high speed of motor m pen reduced usually by toothed gearing to lower the drum son Drum haulages are. usually fitted with double reduce gears and endless rope haulages with treble reduction nor with one reduction in toothed gears and one reduction worm and worm-wheel gearing. Toothed gears may have striper teeth or double helical vie-shaped teeth. (5) Bed Plate The bed plate is usually of mild steel, built sections convenient for transporting. The parts for each section can be welded or riveted together but bolts and nuts are us for joining the sections. The bed plate is mounted on a concern" foundation. Holding down bolts usually rag type with, boot ends spread out to grip the cement which is poured around them after placing them in position in oversized holes in bed. The rectangular bedframe receives the bearings tor shafts of drums and gears, the brakes and clutch gear and ns electric motor. MINE TRACK The successful operation of rope haulage depends on the prouiope haulage haulage orlocomo locomotive the provision system capable of carrying the of a good o a good haulage race carrying the loads greater safety and security imposed for a longer period. Rails: The weight of the rail must be sufficient upon it with load, to allow the wear and to ensure be good maintained. The weight of align raileSure ascent to carry the the mint rails being depends on the axle axle load5ads, 123 anlage speeds, the danger of corrosion in wet mine, the need cru Haulage in Mines Oland the capital cost. Economy might be obtained by using an Ollie heavier section that theta theoretically necessary. The stiffness t a rail orbits ability to support a rail with the minimum adequate cross-section to resist wear, longevity required hall perfection varies as the square of the weight. The strength or ability carry a load without breaking varies as the power of the the weight. The resistance to wear depends on the weight or due Quantity of metal in the rail. The rails should have 42% of the weight in May the head, 21% in the-web and 37% in the flange. It be practicable to wear away about half the metal in thee era before it is necessary to discard the rail. eyed A Simple rule to determine the minimum weight of the Xin Enters (or of a pair of wheels), provided the distance between two adjacent Ds sleepers does not exceed 0.85 m. m 1.1 weight cubic m capacity the rail section should have of 16 kg per meter length. Forget the Wight locomotive one of rail lies between 18 kg err meter length and 28 kg perimeter length for the larger sizes. N is 5 kg per meter, plus 2.5 kg for each tone of weight on it SE Deter rail track of 0.6 m gauge and tubs 1 oil tone (1.1 cubic meter) capacity is most commonly used in Indian mines for 2m ort. For locomotive haulage it is usually 1 m to Jan coal transport loading chain conveyors by SDLs and then using tubs in ten 2m. De 0.9 m rail Use m rail track and 2.5 ton capacity mine cars may Use for system. Increase Long Stem. Capacity asking the efficiency and capacity of haulage prefer paucity nerd, wider but lower in height tubs of 1 acing early tone ever with 0.7 to 0.75 m gauge may be used for a Kingman or mechanized loading easier. Many mines " now ding ding of tubs at etransport the face by SDLs during development Rall system. Jolnts 9.1mdepet rt system. 1 m The length of rails used in normally

r 5.4 m, 7.3 m ion in may be possible to use longer rails with a ndsofthe ra oul Case on the conditions of each particular mine. Clal cases it may ails mus be sawn off square and the rail joints duction inthe the he number of joints and maintenance cost. The 124 Mine Pumps, Haulage And Windina should have as nearby as possible the same strengtha ion byleavi is allowe for stiffness as the solid rail. Expansion is allowedforh bars slotted bolts holes, and drilling the rail holes 0.32 up t to20 Sleepers and Ballast: These are used to distribut a sufficie spaces between rail ends, using fish-plates orsnli lea sh-plates or splice wrere larger than the bolts. Flat bars is used for railsn64 the and for rails over 20 kg the angle-bar is better he ma reates thetr e intens bearing prèssureof the wheeis on the rails' over nen area of the floorso that the sage bearing pressure ofthe ails o is not exceeded. In wet condition the floor on which the. floor on which thet with rests should be cross graded to drain to one side of the ra. and clips (or both sides in a double track system), and a channel ong sh t be cut at the low side to conduct. the water away alana dip of the raodway. The slope of the grade should be 1 inh 1 in 45 depending on.the amount of water and nature of floor. The depth of the channel should be such that the wa level should be belowthe.levelof ballast. Wiltn bein 20 req gres Uns tha ste Sleepers of the adequate length and cross-sectiona placed below the rails at intervals to give rigidity and maintai the gauge. Sleepers may be of wood, steel or concrete. Timb se sleepers are the most common and should be of sound clea timber, free from bark, dead wood, large knots and other defect C likely to affect their strength in use. They should be straigh well sawn and cut square at the ends and bottom parallel.T length of sleepers should be the minimum gauge plus 0.0 The thickness 12.5 cm and the width 20 cm. The averagel of treated sleepers ranges from 7 years to 15 years depena upon the natural conditions of the mine. Dog spikes are most commonly used for securing towooden sleeper. The length of the spike should be 1. th less than the thickness of the sleeper. A satisfactoryme 1.27 is to use three spikes, one inside the rail and two ouside rail. Footplates are inserted between the rails and and thee s slee The sleepers may be countersunk to hold the footpid footplates a the rails are then fastened by special clamps and bo bolts run through the full length of the sleepers. 1ni me Haulage in Mines 125 ole for locomotive haulage and high speed haulage mine cars are employed. The footplates between wherelarge mine whered sleeper providing a cant inwards the rails, giving ismost suitable therailand sle maximum amount of bearing for the wheels. With specially ted sleepers, impregnated with creosote or zink chloride, the track may last for many years Various types of steel sleepers are used to fasten the als by bolts or clips and wedges, e.g. (a) two movable clips h1.6Cm bolts, one on each side of the rail; (b) both fixed andmovable clips fasten the rail to the sleepers, the fixed ins being reveted or welded and the movable ones bolted wth1.6 cm bolts; (c) sleepers are. specialy made, no bolts being used, the sleepers merely slide along the rails to the required position. Steel sleepers are not a fire hazard, give greater headroom and are lighter, stronger and more durable unless the mine water is acid. Another marked advantage Is that they hold the track rigidly to gauge. At some mines two steel sleepers to maintain the gauge. Concrete sleepers have been with locomotive haulage in Several mines and where they are in use the rail is laid on a chair plate and between this and the sleeper is placed a felt or Tubber pad. The rails and pads are held in place by clips and bolts through the sleepers. Concrete sleepers have not proved $atisfactory in mines where considerable floor lift is encountered. Ballast may consist of crushed rock, gravel, crushed slag Tused boiler clinker. Well-rammed ballast provide a custioned ng surface for the haulage. The procedure in ballasting is ay and align the track, using if necessary, a dial or ulte. The track is then ballasted 4 cm to 5 cm and brougnt proper level, The ballast must be well tamped with blunt- ended SuSTETpicks or su air-driven tampering tools. When ballasting, it anto tamp firmly under the rails simultaneously to ensure evenbearing. operation isto fill the spaces between the sleepers with ballast thetotalthicknes of ballast being of the order of 25 to 30 cm. and to tamp the centre very lightly. The final 126 Mine Pumps, Haulage And Winding At On curves, the inner s rail is graded and tamped first, At. points, the level of the ballast must be kept belowthesle Curves:The determination ofthe minimum radiusfor mine ras vehicle such as a tub or mine carjs Simple, but the determ uch of the minimum radius for a train of. vehicles is a muo complicated problem and involvesconsideration of the following factor (a) length of rigid wheel-base : (b). wheel diameter; (c) wheel gauge; (d) rail gauge; (e) overhang of vehicles beyond wheel base; (f) speed; (g) super-elevation; (h) design of coupling and buffing gear Sharp curves cause increased tractive resistance excessive rail and wheel wear, derailments and possible breakage of locomotive axles. It has been suggested that for speeds up to 13 km per hour, the radius of any curve in a main haulage road should be not less than 20 times the

longest rigid wheel-base of any vehicle in the train; and for speeds over 13 km per Curve For Endiess Haulage hour the radius should be greater than this, it has been fou from experience that satisfactory operation of trains on Curve with 30.5 m -60 m radius; and 16 to 24 km per hour O Cure with 61 m - 91.5 mradius.Thesefigures assume that n elivation appropiate to the speed is applied. The gauge on curved track must be widened to pre wheel binding onthe rails and thereby increasing resistance. It should be increased by 0.64 cm. Tne formula may be followed to work out the increas required on curves. ollow, Additional width in cms = 15.25 X wheel bsein Radius of curve in mis Haulage in Mines 127 relevation : On a curve, centrifugal action creates a ency for the train to leave the track and proceed along a ressing hard against the inner edge of the outer rail and lessening that on the inner rails. If the speed is sufficiently hich, and the rails be laid truely horizontal, the train' may become derailed. To counteract this the outer rail should be raised by amount which is called 'cant or super-elevation. cours irse tangetial to curve. This throws the wheel flanges The amountofsuper-elevation required is dependent on theradius of curve, speed of train and the gauge of the track. If rail, for a any reason it is impracticable to super-elevate the outside Curve check for rail should be provided along the inside rail of the its full length. The amount by which the outer rail, must be raised is given by the formula Super-elevation in metres = Gauge in metres XgR wherem v = velocity of train, metres per second g 9.81 metres persecond2 R = radius of curve in metres. faras possible the design of turnoutsshould be standardised n no circumstances should be super-elevatioexceed gauge. Crossings ings and ad Turnouts : Different crossings and turnouts usedinn haulage haulage track belowground are shown in the figures. As F GEHET 7wITCH STRr.naL C.RCS SINC CROESNa SIRALHT EILLER wITCn BA HCEL DISTANwCE rT O0 CADSSIt Points or Split Switch 128 Mine Pumps, Haulage And Winding and its installation should be purely a matter of assemblin the component parts in the cofreat manner. Standard point and stub switches and many other devica are used in minesto transfer carsor tubs from one track another. The point or split switch consists of 2 points or latches lead and follower turnout rails, and frog with guard or chec rails opposite frog. On blunt switches the toes of the frog an heels of the point rails meet, otherwise feeler rail lengths ar inserted. Facing a switch, it is passed from the point end. The finger or single latch switch, a modified point switch omits one point rail and the frog. The turnoutis an angle instead of a curve, but it is cheap and a good switoh for light, narrow work. Its application is found in a 3-way switch. Double Turnout 1. Three-way Finger Switch Fixed switch is suitble for hand tramming. All ralls fixed, but with liberal flange clearances at the points, andcars are or tubs are crowded towards the turnout or against the u main rail to take or pass the switch. Lowering the outer broke slightly at the turnout helps to protect main ln traflia 129 Haulage in Mines the shaft bottoms. The figure shows the case.where distance between track is greater than the gauge. Double cross over or diamond switch is the standard for Diamond Crossing (Fixed switch)

SAFETY DEVICES ON HAULAGE ROADWAYS

Part from the falls of ground, haulage and transport operation been responsible for a greater number of accidents or vying deaths and injuries than any other single cause. The Ewes. Proportion of haulage and transport accidents result from airways the various safety devices used on haulages are as follows.

(1) Stop-blocks, Jointer plate, (5) Drop Warrick, (6) Age croft device Pointer plate, (2) Buffers, (3) Back catch, is, Back (10) stays or drags, (8) Runaway switches, (9) Jazz Oppress, Retarders and arming (11) Approach devices, galling (12) (12) arrangements etc. emends Stop- blocks : A stop- block is management a placed near the common ofliclines. It consists of stout beam or block lying the rails end pivoted at one and held against aunts a Stop block 130 Mine Pumps, Haulage And Winding best pivoted side-block at the other. The side-block maybe or bent. When it is desired to open the blocks, side-b first opened and then the as shown stop-block is turned as sh. arrows in the sketch. (2) Buffers when any roadway or face is in direct line with a haulage track and persons may be BUFFER exposed to danger from run-away tubs, strong buffer is provided and maintained on haulage road to prevent such danger. Buffers may be horizontal vertical. (3) Back catches these are made: different forms. It ma *** consist of a pivoted: piece of steel Back Catch paced between the rails as shown in the figure (monkey catch). Tubs can move over it only in one direction. In case of backward runaway it will catch the tub axis thus arresting the tubs. A stout wooden block pivoted at one end and passed over the rail by a strong spring a Spring Catch tubs in one direction only and prevents runaway (back ward) case of spring catch. Haulage in Mines 131 late: This is fitted on the main haulage track to 4) Pointer Plate 4) Backward runaway into the prepared side of the

defile railway. The derailed tubs may be automatically re-railed when drawn forward. Rick: It consists of a girder (heavy type) hinged at 5) Drop Warrick one end to a special enemy-bolt and emergency by a haulage worker pulling the wire to withdraw the one to a specially set roof girder and, held up at the other by ENT and pin. The Warrick is released when required in panama also be operated automatically when the ant rolled movement of tubs give a long swing to an operating handle. An obvious disadvantage is that excessive impact.

. Drop Warrick into the Warrick may displace the roof support thus causing an OOT fall if the Warrick post (drop girder) is hinged to a roof bar. Essential therefore, to anchor the Warrick to a girder not forming part of the roof support but firmly set into the side of Toad way. Thought must also be given to the siting or the neck 10 persons between refuge holes, avoiding possibility of accidents sheltering therein. Are the auto closing type of Warrick's are also used which than the the y weights. The drop girder is slightly heavier the weigh e distance. Such Warrick's may be operated by means of which eight rod suspended from the roof or (ii) a side Warrick itself itself string rod attachment in this case. The moving tub strikes weight the rod to cause dropping of the girder a in which either a side arm by de arm is balanced to return to the closed position amity or by a set of weights after a last tram has Mine Pumps, Haulage And Winding 132 mint Dossed, controller. The type has the swinging movement co balance weights and pulleys. Where it is desirable to have the roadway closed, against runaways when tubs are passing under a Warrick possible to connect two Warrick's In series so that when tram opens.one the other is automatically closed. This Susie can on. Only be installed where the trams run in one direction Warrick's can be arranged to have an automatic trine device incorporated which comes in to operation when t normal speed is exceeded. This works on the principles the the trams travelling at normal speed move a pendulum without disconnecting the slip link which is holding a drop girder means of a chain and cable. Lf a certain speed is exceeded the pendulum is struck a harder blow and sufficient to release the pin slip link and thus causing the girder to drop to the closed position. (6) Age croft Device: This is designed to arrest forward runaways automatically. These work on the principle that the first axle of the tubs depresses the higher end of a catch raising the forked end to axle height. It the tub is passing at normal speed, the forked end drops before the back axle reaches it. If the tub is moving too fast, the back axle is held by fork and the tub is stopped. Age croft Devices Haulage in Mines 133 endless (7) D rope) shall have a drag or backstay attached to the rear (7) Backstays: Any train of tube ascending an incline (except as to prevent the train from running back. These may be attached to the tub axle or to the tub drawbar according to their types. Backstay (8) Runaway Switches: The basic principle of these is that the open tubs braking loose from a rope are diverted by means of a wheels track switch. The runaway points are closed by the tub opened as the train ascends the incline but they are immediately tubs are again automatically by the action of a spring. Runaway them. The then guided into the side to a place prepared to receive descending points are held in the closed position, for tubs designed the incline, by a light rope attached to a specially haulage hand catch when 29-30 m up the incline, which is released by a them in safety the train has gone over the point, leaving position with the light rope slack. 1LEVER Box SPRING LEVER Spring Operated Runaway Switch 134 Mine Pumps, Haulage And Winding A way form of interconnected stop block and run au is used at the brow of the direct rope haulage plan constructed that at one time either the stop block or there. Run Nava away oafs switch is effective in the event of a backward runaway | B1ock & Either on Inter-connected Stop Block and Runaway Switch tubs. It is manually operated by the haulage attendant when the set of tubs has to pass clear of the stop block. The distant between the stop block and the safety switch is sufficient accommodate the full length of the train. (9) Jazz Rails The principle of this device is that tubs travelling at normal speeds pass over a section of the jazz track Q: 6« ROPE S7EED 3 KM/HOUR RADIUS DIUS Jazz Rail negotiating the bend readily. If the tubs travel at an excessive speed, as in the case of runaway, they will fail to get round ten bend and a derailment occurs. Rails should be bent to co radius. (10) Retarders: Slowing down and stopping tubs are integer parts of haulage operations. A hand operated retarder consists of two plank, lined on the top with belting and mounted on ca as An end cover plank fastened to the inside faces of planks 135 Haulage in Mines serves to to hold the plank in position. They are operated by a le lever. When the

cams are fully raised, the tub wheels lifted clear to the rails and a braking action is provided on the tub retarders represent waste of energy and should he avoided in planning. However, the speedy movement of tubs required for quick turnover and higher raisings may make its application essential at pit tops, pit bottoms, haul bowheads, etc. There are many types of elaborate designs and manually controlled. Smooth braking may be effected by air or hydraulic braking cylinders, fully automatic retarders, which are released by pneumatic are widely used. The device Consists of two pairs of hinged bars faced with renewable skid plates and braking effected action by movements of two opposing in a pistons cylinder containing air. The above bars are raised rail level the wheels. And grip the axle. RALS -Pave WEAR7a Rye. When desired, no braking releasing the valve atmosphere to is open-air Compressed eructing is Kid PLATs 5PRNS the off air Aspiring nor draws malposition. Ask... the braking bars. N automatic hid relic tub retarder is suitable tor PLAN Tub Retarder he locomotive is haulage or ordinary rope haulages. The hydraulic from a 1-2 KW electrically driven pump. Coming tram is assure he is supplied attuning am is retarded by the tread of the leading whicetween which fixed skids and and an inclined hinged acts as wedges. 136 Mine Pumps, Haulage and winding (11) Approach Warning Device: essay It is sometimes near warn men working or travelling in a haulage roadwava way of operating a warning device in rope haulage r arm protruding into the path of oncoming trams why oats deflected closes an electric circuit connected to a sin betray or bell. The device is operated by a lever depressed axle.

SIGNALLING FOR ROPE HAULAGES

Continuous are ringing type electro-magneto bells. Generally favored for underground haulages signaling pun since most haulage roadways are of a considerable Len pose end nowadays. an In this system two bare galvanized iron wires used on one side of the track throughout the haulage roadway The wires are supported on insulators fitted on long iron De fixed into the pillars at suitable heights for convenience. When the two bare wires are connected by a small piece of wire thus closing the bell circuit, the bell fixed in the haulage room w give audible signal. The voltage used in any one bell circus shall not exceed 30 volts in terms of IER and this may be available from an approved Laclanche cell or approved Drivel having built-in non-resistor or from a transformer on the power mains. Bell $Allery Spiting Contact *.° Sew Line artery Bell Map'ne3 F. Way Li1ne housed The in bell a mechanism most commonly used in mines cast iron case to with stand a small intern flame-proof explosion. The joint flanges in the case are machined to make with the cover plate. The hammer rod en Haulage in Mines 137 the case via a grease-filled sleeve which also makes a flame proof entrances. An electrical signaling system used in mines must be aide intrinsically safe so that the circuit is inherently incapable of creating a spark or sufficient intensity to ignite firedamp. It is well known that when an electric circuit is broken, the flow of electrons cannot be stopped instantly and they tend to jump the gap thus formed. This causes a spark or a flash to be generated, and if large enough, and of sufficient duration, could lead to the ignition of gas in the mine. To make a bell intrinsically safe is to modify the design so. As to avoid sparking at the 'make and break' points in the bell circuit. This can be done by (a) absorbing the spark energy by an addition to the design and (b) by keeping the voltage across the 'make and break' as low as possible. Bell In the first method if the electromagnet bobbins or solenoids have an auxiliary coil, wound in the opposite direction in order to endure different y of them and the terminals short circuited by a piece of UT copper wire, the self-induced currents pass through the Side New short-circuited coils where their energy is absorbed harmlessly. Very weak sparking may occur which is incapable of igniting firedamp. In a long haulage road signaling System, where the combined resistance of circuit, bell, battery, joints, and the leakage Oases on a wet and damp road would be too high for a 30 Volt battery to operate the Dell, the maximum voltage being restricted Non-Inductive Resistance 138 Mine Pumps, Haulage And Winding both in terms of 1.E.R. The difficulties may be overborne installation of a relay. A relay, as used in connector electric bells is essentially an electro-magnet eerie. A battery, separate from the bell battery, and is installed the resistance of the bell circuit is such as to produce inept signaling with the statutory 30 Volts. Here a magnetic cut b a relay circuit. It is possible, of a long haulage roadway, d two or three relays could be. Employed. A non-induct t the electrical connection is used between the bell cries resistance if connected across the terminals of the bell u w make the system intrinsically 135 safe. The figure in Nan illustrates the principle action of the relay and shows its canners to the belt circuit. Mono-Rail The mono-rail system is used for transporting supplies and materials form the end terminus of the main haulage system. With mechanization or semi-

mechanization of mines. The the maintenance ofsufficientsupplies at all of the heading faces in berm and pillar system of working and at all times, is a serious problem. The mono-rail can be successfully applied in such cases if roadways of adequate heights are available. It does not require ground rails to the face which Sup TRAC BELT Kori is an advantage where extensive floor lift is apt to occur. The system consists of a single rail BE MONO RAIL AMONO RALS suspended from roof on which special carriage can run through a rope by a direct haulage. 139 Haulage in Mines the supplies for the headings are brought in to the landing point tithe with the empty mine cars. From here a district rope the headings from this point by mono rails. M The rails of the system are of H-section 50 mm X 127 and 2.7 m long. They are attached to roof gardens at each ND by bolted clamps. The rails are joined by a single bolt by parallel plates at the Opposite side end of each rail. A Special carriage attached to a carrying pulley being driven to the dip, since the gravity provides the hauling power. In rise headings, a direct rope haulage is used. The mono-rail is independent of ground railing. It is suitable for roadways of adequate heights, at least 1.8 m, having moderate gradients and free from obstructions at crossings and haulage, with a ground track running into direct, delivers les toe storage point at B. Ice the supplier are then sent to Junctions. The disadvantages of this system are: (a) The loads vet to be lifted up to the height of the mon0-rail: (b) The nave difficulties of pass the height of the mono-rail: (b) the resulting from runaway offloads. Sultana sing brattice sheets; and (c) The dangers and (c) The dangers in a way of Trackless loads. Which is clamped to the roof girders. The materials a tensioned used for supplying materials to the roof rope is used (instead which is girders. The materials suspended from a pulley Coalface mono-rails also used for supplying materials rails) coalface. In this method a tensioned rope is used (instead recon hitch eyed by a sling which is suspended tromp which run haulage sort us or by on h the rope. The sling can be hauled by an owning small device (usually Sylvester), fix clamp to girders, Nan. It is easy to extend the rope as coiledattheface. Rope as extra rope tensioning ace. To extend, slacken the rope by taking slacken the rope by taking 140 Mine Pumps, Haulage And Winding put required length of rope on clamps and re-tighten the. By Sylvester at the end of end of clamps. For the capacity of the sling is relatively small, there more odes journeys will be needed for a given task. Ice method cheaper and the floor have does affect the system.

LOCOMOTIVE HAULAGE

The locomotive haulage is most efficient and simple’s method of underground transport especially in mines where the reserves of coal in a given area is large enough to justice the huge capital expenditure involved. The essential requirement for this system is that the roadways are approximately levee and this limits its application either to lest (a)Mines in which the seams are almost flat; (b) Mines developed on the horizon system where road-ways are driven level or at gradient of 1 in (a) 200, or inclined seams. (c) Mines having inclined seams and main roadways are driven along the strike. Advantages of Locomotive Haulages Locomotive haulage possesses the following advantages 1. Flexibility of operation: Tubs or mine cars may be collected at any desired points and it can be adjusted to meet the changing conditions to suit the varying needs of the mine. A locomotive will travel on any suitable. Roadway and extensions can be easily arranged, compared with rope haulages especially if there are branches or many curves, it is mo. flexible, and easier to extend and maintain. 2. Saving in man-power: Large tonnages can be handy by a small number of haulage workers with this type haulage. Only one driver per locomotive and one attendant reception and dispatch point will be required in this system." 141 Haulage in Mines the output from a district falls, the locomotive can simply he thicken thus reducing the manpower. In case of rope haulages a fixed number of men are required regardless of the Output. 3. Safety: The haulage roadway is unobstructed. The elimination of pulleys, ropes, rollers, etc. results in a diminution of accidents. The trains are under the immediate control of the driver. The locomotive is provided with a warning bell and a headlight. Derailments are unlikely on a well laid track, and no risk of runaways as the roads are almost level. 4. Speed: Higher speeds are possible with bigger loads and consequent greater output. 5. Man-riding and Material supplies: let is possible to adopt the locomotive haulage for man-riding with a minimum of alteration so reducing travelling time and increasing working time at the face. In mines where stowing materials and appliers have to be handled during coal shift, locomotives can adopted to give additional advantages in such places. Onditionsfor Uses of Locomotive Haulages ne conditions under which the locomotive haulages may seed belowground with advantages are as follows. (1) The gradient, which is best suited, is about 1 in

200 end s vet can barely stop itself when the wheels are Locked the adding. Locos should be employed on gradients mined n 300 in favor of the load. On a gradient of about 7 in12, an1 in 25. Where possible, there should be a slight adverse adientatthe end of a run to assist braking. T (2) maintained, in mines where high standard of track can be e it ca heavy' tale can be operated on roadways where there is heaving to on well ballasted a drained roadways, properly aligned eel possible. Heavy section flat bottom rails should be adiusare or lifting effect of floor and where curves to mirage ndgradedfor tracks. The n rays, where the velocity of air is adequate of diesel (3) Year Keep In intake diesel percentage of firedamp appreciably low. The Comities is somewhat limited because 142 Mine Pumps, Haulage and Winding of air-pollution problems and additional mine ventilate where, 1.C, engines are operated. Ide and (4) Where the roads high belowground are wide an (5) in mines where large output has to be hand can be operated at a high speed and a rapid circulator can be possible. Ion of Indi sees (6) in mines where a flexible haulage is required where the output changes as the development program war, (7) in mines where there IS shortage of manpower. Tonnage can be handled by locos with maximum am safety by a minimum workers. Amour Tractive Factors The tractive force in the rope of rope haulages is other bar externally from a fixed haulage engine which can be mad. Powerful as necessity demands. "But in case of locum haulage, the tractive force exerted depends on its own way and on the friction between the driving wheels and there Rope haulages can deal with any gradient from level over (as in a shaft) within the capacity of the engine and strength of the rope. Whereas the locomotive is limited by horizontal force which the shells will withstand before begin to slip or skid, and it can only be applied to a lime range of gradients determined by the co-efficient static fix ad: or co-efficient of adhesion. Mine locomotive manufactures, have established bit and experience certain practical values for (a) the co-effect of adhesion. Between the treads of locomotive wheels a railhead, and (b) the various factors that influence resistance. These factors, generally classified as resistance, include (a) frictional resistance of bearing locomotive and cars, track resistance to rolling, and amount of wheel flange friction against the rails (resistance' (c) track curvature resistance; and (d) ac resistance. Among the tractive resistances of mine cars Celera the most variable is frictional it varies from approximate proximate kg per ton at starting to 4.4 kg per ton running, and deva 143 Haulage in Mines upon gross weight of car, track conditions, wheel size, bearing adjustment speed. Its lower with heavy axle loads, higher with someone alert wheels and higher with poor roadway and track. Adjustments and temperatures, type of grease used, and, somewhat conditions. Badly worn wheel flanges and grooved wheel treads frictional ictionalresist rename value for both empty and loaded cars. In special cases involving large modern cars with first class increase the resistance. Normally 8.8 kg per tone is used as bearings and excellent track conditions, values of 4.4 kg per ton could be used in estimating. Co-efficient of Adhesion: It is a fraction of the total weight of the locomotive which can be utilized as a tractive force capable of hauling the locomotive and its load. Its value depends on the nature of the steel tires and the condition of the track. For steel wheels on clean dry track and the condition of the track. For steel wheels on clean dry track the adhesion s 25% (0.25), and the tractive effort is therefore 250 kg per ton of weight. For cast iron wheel, on wet road and severe gradients, the adhesion is 20%. It can be increased to about 3% by sanding the rails, and reduced to 5 to 15% on wet greasy rails. Co-efficient of Adhesion Between Driving Wheels and Rails Cent of Locomotive Weight, Steel Wheels and Steel Rails) Clean or rails, Clean starting and accelerating... dry rails, Clean continuous running dry rails, locomotive braking Unhanded Sanded Rails Rails 30 40 25 35 thoroughly 20 30 wet Steady rails moist rails motive power of the combative, through the gear 18 25 Erective Effort: Itisdefined as t 15 20 d as the total force delivered by the wheel treads. INS force is greater than the product of the locomotive weight and the co-efficient of adhesion the wheels and the rails, the wheels will slip. Mine Pumps, Haulage and Winding ionbetwe 144 Draw-bar Pull: It is the force exerted on the coupled t locomotive through its draw-bar, or coupling, and the bra trade resistances of the coupled load. The draw-bar pull why locomotive is capable of developing is determining subtracting from the tractive effort the sum of the resistance of the locomotive. The tract Ideal Gradient: The ideal gradient far locomotive that on which hauls the same tractive force is required to ha depend empty train in bye as to haul the full train out bye. This grad on (a) the ratio of the weights of the full and mea tubs, tubs, or and (b) the running resistance ‘of the locomotive the co-efficient of friction. The steepest gradient in favor of the load is determined by, not by the tractive effort required, but by the braking effort i.e. by the ability of the locomotive to bring the attached loan to rest within a

reasonable distance, say about 60 meters which is the effective range of the headlights. On a gradient of about 1 in12, a locomotive can barely stop itself when the wheels are locked and skidding. The gradient should not exceed 1in 25. Where possible, thereshould.be a slight adverse gradient at the end of a run to assist braking. the diet empty and Braking Effort: locomotive and its attached load are brought forestry the application of the braking effort of the locomotive acting in conjunction with the resistance to motion of the locomotive and train due to friction and gradient. If the grade is uphill, it will assist the brakes; if downhill, itwillactagai them. The braking force applied to the wheels is so designed acts CT uniform uniformly. As the mine cars and tubs are note to habit fitted with akesindividually, there is tendency the wheels ma ore, if than ere is to are not generally the rolling resistances of the locomotive and train overturns. Furthermore, if the brakes are applied to the adverse resist he raise are for a train to and can the wheels may skid on the rails thus reducing force. The roll adverse gradient, helptoarrestthetrain. No dis the adverse the braking be fixe in which the train can be stopped, o distance end, 145 Haulage in Mines. Al calmatives are fitted with i.e. hakes on each of suitable mechanical or the wheels which may be operated P very in the driver's cabin. The cast brake blocks are made of iron and these act on the tread of the cast steel wheel. Sand boxes and feeding arrangements are provided on locos for spreading of sand on rails, these are controlled by the loco operator by a pedal from his cabin. The compressed air type braking. System is served by a two-stage air compressor and air reservoirs, the compressor being driven by the locomotive engine and being automatically cut out when the reservoirs are fully charged. When the locomotive is used for hauling man-riding cars the latter may also be fitted with brakes connecting to the braking system on the locomotive itself by dual train pipes. A hand screw brake is also fitted for emergency operation.

The different types of locomotives available are as follows different types of Locomotives 1. Diesel locomotive. 2. Battery locomotive. 3. Trolley 4. Wire locomotive. Cable reel locomotive. Haulage vapor which is used mainly.in the trunk route either by belt. Compressed 6. Steam air locomotive. Locomotive.

Only a few mines in India are equipped with locomotive natives Conveyor or rope hilly haulage. Diesel, battery and trolley wire type terrain which are ape currently used in our country; two mines in a tie: Approached from surface by admits the System is by locomotives. However natives are currently entire Conditions transport required Opt Com IS required for viable use of the locomotive haulage are not Commonly com met in India. The diesel travel locomotive is flexible in operation within the arioso Diesel Locomotive Copal elf or which it is designed. In one or other of its sizes, it escapable of meeting almost every possible requirement in mines, 146 Mine Pumps, Haulage And Winding ng.t whether for main haulage, gathering haulage, or shunting a suitable a completely self-contained unit, requiring only a pot oil for its operation and it can be used in mines where to dilute

. A track is laid and where the ventilation is adequate toil exhaust gases. The weight of the locomotive may vary from 3 to1 and the power from 15 to 75 KW. The mechanical data design of diesel locomotives naturally vary with di essential manufacturers and the size of the loco. The essentialfea ton, reliability include: compactness, robust construction, relish acing simplicity of control, complete safety operation, good brawl and accessibility for maintenance. The power unit of the locomotive is a diesel engine though engines used in underground mines are two, three, four, and five. Six cylinder units of the four stroke single-acting type that develop between 24 and 100 Hand are governed to run: 1200 to 1700 p.m. The power unit is sometimes called: compression-ignition engine because the fuel is ignited bit heat generated. In compressing the air in the cylinders. Though engine does not require sparking plugs, or and wars on a low volatile fuel. The absence of high tension electric: system, such as is needed for the sparking plugs of petro engine, adds safety points in its favor. The engine is mounted" in a heavy cast-iron frame with suitable locations for engine bearers and other accessories. Alternatively, the frame ma be built of rolled steel sections welded together. Either four six wheels may be fitted according to its size. The diesel engine used in coal mines belowground be of flameproof construction with flame traps at both inlet exhaust sides, and an exhaust conditioner to remove no compounds from the exhaust gases. His intake aired owing the engine passes first through an air filter to remove du then through the intake flame trap. The flame trap co. a number of stainless steel plates

within a steel housing. The On the exhaust side, the gases pass the conditioned before plates are 50 mm wide and welded into position 0.5 mm apart entering the flame trap. clutch with freed lining controlled pneumatically, or a fluid momentary overload torque to be developed, T under long and to or prevent a fluid 147 Haulage In Mines Though transmission gear may be either plate-type friction alive a smoother take-off under load to permit a llama of the engine under any conditions. In either case, the eave is commonly taken to a constant-mesh type gear box three speeds in either direction (forward and reverse). AL wheels and shaft are carried on ball or roller bearings. The: .ebxor-olri Diesel Locomotive gear control is carried by a single control lever. The arrived by a single control lever. The an mission to each axle is made by chain and sprocket aim breaking system is of pneumatic type Whole nan additional hand screw brake is fitted for emergency regiment. The main breaking system is of pneumatic type operation. The Compressed-air is stored in two reservoirs or air pious tinhorn, traction clutch and the power brake and efficient flame proof headlight capable of showing any htlesplaced under the bonnet. The equipment operated by impressed-air are engine starter motor, sanding equipment errors or air equipment operated by OT owner brakes. Striation e into locum similar van unthread or roadway ahead, within 60 meters of vet and a red light in the rear end of the locomotive alit are provided. The power is supplied iron roof headlight y capable of showing any ahead, rear within 60 meters of end of the locomotive ammo driven by the engine. An n by engine. Mine Pumps, Haulage And Winding 148 Possible Hazards locomotive

The hazards arising from the use of diesel locum underground are: (a) Health so here hazards by associated the exhaust wee gas hast wish the outshone are exhaust gases pollution of the underground atmosphere by the (b). Explosion hazards presented by the intake and Openings of the engine, and (c) Fire hazards that engine Con de, oxide Oxygen, nitrogen, carbon monoxide, carbon dioxide, oxide compo kid Consequent on handling t." of diesel fuel underground. Health Hazards. The exhaust gasses. Of diesel engine con known as aldehydes. Of these, carbon monoxide and a nation nitrogen and sculpture, and some evil-smelling compo of nitrogen are most dangerous. The maximum percentage carbon monoxide and oxides of nitrogen must normally cantles than 0.005%and 0.0005% respectively in the general ho of air. Diesel engine depend on excess air for satisfactory combustion, and very little CO and oxides of nitrogen are formed by efficient combustion of fuel. This may be ensured by caret design and maintenance of the engine, and a correct fuel-a ratio. The removal of the aldehydes and oxides of sculptures effected by exhaust conditioner. Moreover, to maintain a sage working environment the provision of adequate ventilation (air velocity not less than 30 meters per minute and not less than 5000 liters of air per minute per rated HP of the locomotive) must be maintained to dilute and remove' the toxic and so dangerous constituents of the exhaust gases.

Explosion Herds: The risk arises from the ignition of firedamp by incandescent particles, or by hot gases or flame produce by back-firing through defective valves. To minimize the has at the measures are: Adequate ventilation, proper checking maintenance of the engine and its valves, flame construction, flame arresters on inlet and exhaust size room Fire Hazards These may arise from the hot exhaust conditioner, leakage of fuel or from handling of fuel. The metal diesel locomotives for underground use are butane construction, and all parts liable to cause substantially in shrouded by steel covers. In addition the foe are built o 149 Haulage, In Mines treasure provided to minimize any risk of fire: (1) the air. Tiring any suspended the engine is cleaned by an inlet air-filter. This prevents particles or carbon to enter hen the engine. The air passes through flame trap which is inserted to prevent any flame passing to the atmosphere in case of engine back- fire, (2) the exhaust gases escaping from the engine are cooled through an exhaust conditioner, and then passes through flame traps. (3) The internal combustion engine used underground is not provided with any electric spark plugs but the combustion takes place due to high compression in the cylinder. (4) The provision of water cooling jackets and temperature gauge, which cuts off the oil automatically and thus stops the engine if the temperature of the cooling water rises above predetermined value. (5) Most of the diesel locomotives are provided with compressed-air tanks for auxiliary duties. These tanks are provided with pressure relief valves and temperature rises above a predetermined value. (6) The lighting unit, including the dynamo, is built flame-proof and is intrinsically safe. (7) To prevent heating of bearings, ball or roller

bearings are used. (8) The oil used and the grease or other lubricating oils approved types suitable for the particular duty.

Additional precautions required to prevent fires include- (1) External surfaces of the engine, exhaust conditioner and locomotive should be kept clean to prevent the building up of deposits of inflammable material. (2) Engine, locomotive should be kept clean exhaust Flame arrestors and exhaust conditioner must be maintained in an efficient condition. (3)) Leakage of oil should be prevented. (4) No fuel other than liquid fluid of flash point less than liquid fluid of flash point less than 68° C shall be (5) used. His fuel oil must be transported in mechanically Strong leak proof and non-inflammable containers. The storage of fuel underground shall be limited and (6) it shall not exceed the consumption over a period mechanically strong leak proofer non-flammable consumption over a period of 48 hours. For the purpose, a suited Tank should be kept in the filling station. 150 Mine Pumps, Hauling And Winding (7The housing and filling stations shall be construe of non-inflammable material and provided equipment for extinguishing tire. we (8) The floor of the filling station shall be surround (9) If any fuel oil is spilled, it shall be forthwith rem surrounded in of spilt by a masonry wall to prevent spreading of spit. fuel outside the station. by means of suitable absorbent which she deposited in a closed incombustible recants and removed from the mine as soon as possible (10) No person shall smoke or use any lighter, lam other than that of an approved type inside the stay or within a radius of 15 meters thereof. Flame Trap and Exhaust Conditioner Diesel locomotives used in mines are fitted with exhaust gas conditioning equipment to render the exhaust flame harmless by removing most of the C0, gases as they leave the engine 9 8 19 2 6 Exhaust Conditioner (1) Engine exhaust, (2) Conditioning chamber-laid ()nan (3) Cont. valve with float, (4) Water, (5) Filter box, (6) Concha chamber-all, (7) Flame trap, (8) Fan, (9) Mixing chamber (6) Condit (10) Exhaust outlet atmosphere. (A) Fine water sip Baffles (C) Silencer. Spray (151 and reducing the evil small of the fumes by removing most of the aldehydes from the fumes. Moreover, it temperature reduces the of the gas to a point to prevent mixture ignition of explosive of firedamp. Haulage in Mines shown the general arrangement of the exhaust conditioner is amounting in the in figure.

The exhaust gases from the engine minute enters all to about 0.085 cubic meters per B.HP.per and Tone water spray conditioner box at (1) and are mixed with a (A) before being forced on through a water- oath in first conditioner chamber. The water traps hot particles engine an washes out the sculpture err oxides and the aldehydes. The level in this chamber is regulated by a control valve winch, O in the event of the water level getting too low, Gann the fuel supply to engine and apply the brakes. I now he pass through a filter box (5) containing slag wool fumes now pass and are then number diverted by a series of baffles (B) to the second and its water levels kept at the same level as that of h Owner chamber. This the first chamber is similar to the first chamber theater by a and slam Conditioner chat control valve. The fumes travel through into the flame-trap (7). This flame-trap consists of an f ND slag wool filter box and are directed by a series of baffles .Though in less steel plates with 0.5 mm gap between each plate. This removable flamenetrap and also the filtering materials are readily removable e and these are replaced once every 24 hours so that year always clean and assign efficient. amber through through the flame-trap the air fumes enter a mixing s here they mix with about 30 times their volume or amber ash why and safe fumes utter and supplied by forcing fan which also sweeps the now outlet. AEilenencer is attached to the exhaust end for comfort to nescient the outside atmosphere by exhaust sears Battery Locomotive Aura Battery ads and carvel anywhere where tracks are laid, pro sleep flare Emotive is independent of an outside source flam re-laid, provided Curves permit the passage. It consists less flame Or or chassis carrying all the propelling mechanism Mine Pumps, Haulage And Winding and mounted on wheels and axles that are driven by two D.C. electric motor through totally closed gears run 152 by on in oil.

The motor is getting current from a storage battery car arrive a casing on the upper part ofthechasis. E-in forced steel buffer plates, supported by helical springs, file ND of The chassis is built of steel plate 50mmthick with car re on cast steel boxes. A 60 watt lamp with flameprooffittin mounted at each

end of the locomotive. At one 'end of deed which contains the controller for the motor, brake hand-wheel, sand levers and warning bell. A theocratic braking IS providedwhia el, sandy locomotive a compartment is provided for the driver why can be used in emergencies for controlling the train down acts gradients. A me chemical braking is also provided for nor use and to guard open circuits or other.

Electrical defer - -- Battery Locomotive General Outline (Plan View) terry the figure shows the general outline of a 3-tonne be locomotive. It illustrates many of the features that are re0 aired 2.692 on all locomotives. Internal length 1.625 m; Overall lengths m; internal depth 0.483 m. It shows the position or which drive the axles, controller handle, Beam type head Buffer, Battery container, Hand-wheel, etc. 153 Haulage in Mines Battery locomotives are made in sizes from 1.5 to 25 tannest weight and with rated drawbar pulls of 182 kg to 3859 kg at speeds 4.5 to 12.8 km per hour. The batteries in the locomotive Proportion constitute a large of the total weight and the cost of battery usually locomotive. Locomotive. There they are two lead-acid traction type batteries on a volt battery is made up of a varying number of 2- voltage. Lead-acid cells joined up in series to give the required 5.35 years the and life of the batteries in practice range from 3.2 to not be made from 570 to 1960 full charges. The battery can ventilated. flame-proof and its container has to be well Flameproof Gathering Battery Locomotive (Model Ldag-05, Poland) other lead-acid storage battery is a mechanical assemblage2 (negativeIcals-lead e peroxide (positive plates), one lead negative plates adsorbed locomotive, the active part of the electrolyte is absorbed affection by in the specifl1C battery to drive telecom dates) and an electrical energy is taken from the h positive the battery. And negative plates.

This results in When Datary being c when being charged, the electrical energy. absorbed by the battery, convert it and reduces the efficiency of vets the chemicals formed during discharge, Mine Pumps, Haulage And Winding 154 y of the ged.The restoring them to the original form. The specific gravity. Electrolyte is increased until the battery is fully char the when the spy best conditions of a fully charged battery is when that shorter battery life. If a battery is operated at 1.20 result in a prohibitive loss of capacity. Gravity is 1.28. The greatest capacity is 1.30 but 1.20 it result towel During its useful life, the battery requires daily char A fully charged battery gives service about 8 hours of rig traction duty. At one the end of a shift, it has to be placenta charging rack for about 8 hours to charge it fully. Weekly up with distilled water, and occasional cleansing of thing tops and connections, with possibly the insertions of electrode from time to time are essential. Weekly top new There cad is a constant hazard in the use of a lead-age.

Not traction type battery because of the evolution of hydrogen int. the mine atmosphere. This is especially dangerous if a batter is overcharged or accidentally damaged and broken open. The explosive range of hydrogen when mixed with air extends from 4.1% to 74.2% and the presence of any other inflammable gases (e.g. methane, carbon monoxide, etc.) will enlarge this limits. It is, therefore, essential that charging stations under. Ground should be carefully sited and planned out. , bay7% Battery. Charging Station (For2 Locomotives) for charging purpose underground, a special charring station must be provided, inflammable constructed throughout of n materials. It must be adequately Ventilated and so Haulage in Mines 155 that the gases evolved are carried direct to return arranged that airway.

The arrangement must include Concrete bays to receive the batteries for re-charging. Lifting block hung from roof girders to enable the arteries to be taken from the locomotive on to the bays. Tentatively, a mechanical roll-on or roll-off system may be used for the purpose. 3. An inspection pit below the track to enable Examination, repairs or overhaul of the locomotive. The minimum length of apt for one locomotive is about 4.5 meters, tenth about 0.91 m and pit should have a slight fall to a sump at one end for drainage. A well laid-out charging station or garage would have a high standard of illumination and white washed to enhance the effect of illumination. A second men’s of egress is necessary and this should be connected directly to the return by men’s of steel Sand regulator so that a through current of air is obtained. Binds and fire extinguishers should be conveniently sited.

Underground Locomotive House & Battery Charging Station for 4 Locomotives nagging (1) Report room; (2) Stores (3) Generator (4) pays (8) bays; (5) Work bench; (6) Generator; (7) Charging Inspection pit; (9) Sand bunkers. Charging the batteries: For charging the batteries direct current required but alternating current is used exclusively in mines. 156 Mine Pumps, Haulage and Winding t so a rectifier unit is required to supply direct current at s required voltage. The most common methods of rectification are (1) The motor-generator set, this being a.m. shunt generator driven by an A.C. motor, either synchronous squirrel-cage; (2) The rotary converter; (3) The glass h mercury arc rectifier; and (4) The selenium Oxide metal recti oat The motor-generator set enjoyed the greatest popularity the higher efficiency of mercury arc rectifiers over a wide in blue range suggest the increasing use of the latter types, Th. charging panel or switch-board should include a double-pol switch and fuses, an ammeter, a regulating resistance and an automatic cut-out to disconnect the batteries if the supply fails Advantages :A storage battery locomotive has several distinct advantages (1) The. Dangers from an overhead trolley wire are eliminated. Rails need not be bonded. (2) The locomotive is flexible, simple to operate and responds quickly to the controls. (3) If power supply is temporally shut off, the locomotive will continue to operate. (4) Peak power load can be reduced, since they do not draw on the power line while operating. The batteries can be charged during the night shift when the demand on the power line is relatively light. (5) Electrical losses in the trolley 1line are avoided. (6) No fuel is wasted while idling. (7) There is no contamination of air, no noise and vibration. (8) They are most locomotive and suitable on short hauls, as gathering for the transportation of men. Trolley Wire Locomotive Electrical trolley locomotives are compact, simple operate, have to efficiency and usually the lowest power cos of all types. The chief advantage of trolley locomotive over other the rtyptypes is that its supply of power is external, and therefore, unlimited its field of action lies mainly in hauling large tonnages over ed.! Ong Haulage in Mines 157 distances and fairly steep gradients along specially constructed main intake haulage roadways of ample size properly supported and carrying large volumes of air.

Its disadvantages are: (1) The rails need to be bonded; (2) The hanging of a bare trolley wire introduces risk of open sparking which might cause a fire and explosion hazard in a gassy and dusty mine; and (3) A danger of electric shock to persons by Contact with bare conductors. A further disadvantage is that, when haulage extensions are needed, the overhead conductor system and the track must be extended, the overhead conductor system and the track must be extended which results some loss of flexibility in operation. Trolley locomotives are operated on direct current, commonly 250-volts D.C. Which is more economic in design of motors and control and less dangerous than some nominal A.C. voltage. The driving unit usually consists of two or more series-wound D.C. motors driving the axles through suitable gearing. Such motors are more suitable for haulage work, giving high torque al low-speeds and being capable of smooth speed control through the medium of a controller. The use of two or more motors helps it easier to start because, as the motors are geared to separate axis, the grip of wheels is brought to Dear on the rails. Moreover, if one motor becomes disabled, ten locomotive can still work by the others.

The armature and ten fields of the motors can be joined up in various series and parallel combinations, the speed of the locomotive can be regulated without much waste through resistances. Underground Trolley Locomotive (Centre-cab type, Model Ld-21 Poland) the size of the locomotive may range from 8 to 25 tones n weight with horse powers from 60 to 375 and hauling speed 9.6 km to 16 km per hour. The maximum that can be developed Mine Pumps, Haulage and 158 be attained up to speeds about 12 km per hot speeds up in haulage may be 15-tonne or more. The s combative for is about 25 % of the total weight of the loomed which the haulages are chiefly smaller.

The large loco the univalent locomotive erective effort falls as the speed rises. Higher r why km per hour are exceptionally employed. Gather man heavier haulage may be obtained by coupling two alien together to form a tandem from the The power for electric traction may be obtains overhead line by a trolley-arm or pantograph and the curt the two and then through the frame, wheels and rails or an art Use overhead conductor in lieu of rails. Electrical taming two overhead conductors. Insulated extra rails may also be must return back to the generating station through used for the same purpose

Underground trolley systems generally use track rectum In this case the running rails from the earth return and it then essential that they must be continuous from one end the other. This entails the bonding of every rail joint by coup conductors. Cross bonding between two rails is also essential at intervals about 60 meters.

The bare overhead conductors are made from hand-drawn cadmium copper or hand drawn copper of grooved wire section the conductors are supported through insulators from short cross-wires of mild steel. An earth leakage wire is connected to each cross-wire. For underground work, care must betake 10 keep the sago the wire small and the conductor as Ned parallel to the rates possible. Suitable hangers should used and spaced at intervals of 7.6 m to.9.1 m on straight to 1P and 4.5 m on curves to limit the sag Cent.

Isolation switches of conductor section should in for cutting off power from s easily accessible positions in the roadside 1he track or rail return system in trolley lookout has the following advantages can Only one overhead be suitably conductor is required placed. 2. The locomotive is somewhat somewhat simpler simpler as only one collector has to be provided. Haulage in Mines 159 the alignment or a single overhead track and the turnouts are conductor with easier to make. with an insulated or double Assess some distinct overhead wire system also advantages, laminated, accidental firing such as, bonding of rails of shot due to stray n not occur, risk of electric current shocks is minimized. In some countries abroad, trolley locomotives favored as the most have been transportation economical system of underground date of different system models in non-gassy mines. The main technical in the table. The used in Polish coal mines are shown Suspended locomotives are fitted with two D.C. nose parallel connections traction motors and with-shaft controllers for series and driven theocratic braking. The wheels are by means of single reduction gears. The driver's cab is situated at one end of the locomotive while in the other end, the with attendant's cabin is placed. The locomotives are equipped hand brakes.

These models are being manufactured indigenously with several modifications. Technical Date of **Underground Trolley Locomotives** Type 2 monition locomotives, which are trolley locomotives fitted withUxiliary a storage battery are employed in some rolled places where there is no trolley wire. In combined lamprey ND battery locomotives for underground mines, trolley wire flam battery reign countries. This enables the' locomotive to run on the bat rival equipment and batteries should be used. 160 Mine Pumps, Haulage And Winding Cable Reel Locomotives is The single trolley locomotives may be modified in design by adding a cable reel for gathering mine cars where there? No trolley wires in the rooms. Acable-reellocomotive carries rubber-covered cable, about 150 meters long. The free end o the hook, cable is fastened to the trolley wire by a Jong insulated or alternatively, socket of mains the cable end is plugged into a special supply. The lolcomotive can then pass the room, paying into out the cable in. the middle of the goes. On track as it the return trip, the reel is rotated by power cable is wound up on and the it. geared A drum crab locomotive in has a flexible steel wire rope on a the trolley-wire remains on locomotive. The locomotive outside the room main track, while the flexible rope is mine pulled can out and by then hand wound into the heading.. It is hooked onto the on the locomotive. up by an auxiliary motor mounted cars up a steep The crab locomotive is useful for pulling gradient. Copressed- Air Locomotive The compressed air Supply-and locomotives carry their own power from are flexible in operation within the radius of travel the charging most stations for which they are designed. The important hazard. advantage of this locomotive is safely from tire nor The locomotives require no trolley wire, do not spats emit noxious gases. The high cost of instaliation of ne locomotives and the auxiliary equipment, such as high pres sure mains, multi-stage compressors, charging stations, the nig speed of the locomotive underground, the stopping for charg her the fogging of the mine air from the cold exhaust and the e or irregular starting, especially under heavy loads, etC. mitigated against their introduction in undergroundmin s. The horse-power of these locomotives is 30 to 40 formain road work and 12 to 14 for auxiliary works. The wel9 s vary from 4 tones to 10 tones according to their sIze Haulage in Mines 161 High pressure compressed-air is usuaily produced on the

surface by multi-stage reciprocating compressor. and conveyed to the charging or air filling stations belowground through solid drawn steel pipes of 2.86 cm diameter in secondary roads to 5.08 cm diameter in main raods. Large air cylinders carried on the locomotive are charged from air receivers with special valves which are located at suitable points or filling stations along the main raods. The nunmber off Compressed air cylinders per locomotive is 3 to 6.but up to 9 Cylinders are used in some cases.

Spiral chute:

Applicability:

- Spiral chute are helical construction of spiral chutes to provide a large vt travel in a mine area.
- It is a vt transport system used for bringing down materials from upper level is or seam to lower without any machine power.
- The spiral chutes are normally installed in vt.

Construction of Spiral chute:

- The spiral chute may consists of one or more inlet section the individuals spiral sec & annulet sec.
- In order to transport and installation of the sec. The ht of each section is according to the dia of chute.
- The circular quarter coning sec consists of mild steel & move flat flanges to connection.
- The suspension of the casing in the staple shaft may be done by fixing flanges of the tube sec to cross beam fixed on to the staple shaft side of proper intervals & or by using cracked or plates held or to the tubes.
- A strong support is provided at the base of the chute. If the chute is used as a bunker, large loads will have to be carried in most cases spiral section are bolted to the inside of the casing & sometimes giving a cause it and providing continuous & constant resistance path to the material handled of each sec is usually equivalent to half a pitch so that two sec are raised for complete spiral chute for 360°, the tangent angle of spiral is about 70° at the center hole and about 23 at the outer casing the helix sec are near.

Working operation:

Nickel, Chrome, cast iron which has high impact resistance. Qualities to minimize the chute, the center hole about 25mm dia should be provided. It provide as immediate outlet for the time coal. Where the chute section clear and maintenance.

The inlet chute is fitted to deliver coal or material or material in the direction, if the upper spiral sec. The coal is conveyed by a belt conveyor goes down the spiral chute and loaded in both mine cars. The loading may be done by means of slitting door operated by a material cylinder fitted to a hopper at the base of the chute. Alternatively the control of the discharge from the mouth of the discharge chute can be carried out by cut off doors by a hand operated balance.

A 1.5m of a required a staple shaft of 2.75-366 dia whose surface capacity about tone and can deliver 500 tones coal hour.

Advantages:

1. It provides a continuous system for transport of material from upper to lower level.
2. High capacity and low operating cost.
3. No excavation for winder.
4. Easy to install.
5. Less man power required.
6. It has no moving parts and required no power.
7. It can be used as storage bunter in the event of minor break down.

Disadvantages:

1. In section in the chute is difficult.
2. IT provided only one transport.
3. Most dust is created by friction.
4. Chute presents some construction to ventilation.
5. Disintegrated and detraction of coal so that times are increased at the expanse of reducing the preparation of larger side.

Describe constructional feature of bicable ropeway.

Bicable ropeway: The rope has a fixed track rope along which carries are hauled by an endless traction rope. The bicable ropeway has:

1. Two track rope or cable stretched at required tension.
2. Endless & traction rope for having the loads.
3. Carries suspense from the tracking rope and hauled by the traction rope.
4. Machinery & arrangement for loading & unloading carries suspending the track ropes & driving traction rope.

Ropes: The rope used in bicable rope ways are classified as (a) track rope in which carries roll. (b) traction or hauling rope which cause the movement the carries.

Track rope: These are usually locked coil rope made of large size wires in order to have long life. Locked coil rope provides smooth surface for the movement of the carrier wheat and the surface wear in its relative uniform. The traction of safety for the track rope during installation should must be with drawer from the service when of reduce to 2.5 one end of the track rope is anchored & other end is tensioned. They are installed in section or length 1 to 1.5 km to allow unicorn wear of the surface the rope should be turned through $^1/_4{}^{th}$ of revolt every month.

Traction rope: commonly used traction rope can be strong Lang stay with fiber core. The rope dia varies from 12 to 46 mm. the factor or safety should be 5 drawn when it comes down to 4.

Carries: A carries of a bicable ropeway has following components, carriage, hanger, bucket, grip for traction rope. The carriage is the part which runs on the track rope with the help of wheels is two for light loads and four for medium or heavy loads.

Hanger: The hanger is suspended from the carriage such that it is always remain vertical.

Bucket: It is supported by hanger. Its design is similar to that mono cable one.

Grip: The grip the traction rope is usually on the carriage. For the automated repairing the esipis always actuated by the weight of carrier.

Trestles: The trestles for bicable ropeways provide support to both the track and traction ropes. The track ropes rest on the saddles at the top cross beam & the traction rope on the sheaves at the cross beam below. The vertical distance between the cross beam should be sufficient to allow free movement of the carriers.

Saddles: There are rolled ropeway provide support to both the track & traction rope. The track rope rest on the saddles at the top cross team & traction rope on the sheaves at cross beam below. The vertical distance between the cross beam should be sufficient to allow free movements of the carriers the grove dia should be 1^{st} & the depth of the groove where is the diameter of the rope.

Classify underground & surface haulage system.

Surface haulage system: Track, Dump truck, Dumper, Conveyor, Aerial ropeway, Hydraulic transport.

Underground haulage system: Rope haulage, Locomotive haulage, Conveyor, Skip haulage, Gravity haulage.

State factors affecting design of a haulage system.

- Surface and underground mine working.
- Production to achieve.
- Capacity of haulage system.
- Surface topography.
- Deep of the deposit.
- Characteristics of mineral deposit.
- Geological distribution.
- Location of mine.
- Applicability of electricity & capital manpower.
- Distance of haulage system.

State applicability, advantage, disadvantages of hydraulic transport in mines.

Applicability: The field of economic application of hydraulic transportation in mining is continuously expanding.

1. It is widely used in opencast mining for both stripping & mining of the mineral.
2. In placer mining it is used in conjunction with us.
3. It is also used in beneficiation plants and for removing waste rock.
4. It is used for slowing for removing waste rock iron underground dump to surface and for transporting minerals.
5. It is used in hydraulic mines where wet concentration process are used on the surface.

Advantages:

1. It is simple and fewer operation.
2. It is continuously of mining process.
3. It has large OMC.
4. It has low capital investment.
5. It requires less development time.

Disadvantages:

1. It has less power & water consumption.
2. It has large degradation of minerals.
3. It is difficulty or dewatering in mineral.
4. In hydraulic transportation by pump require hydraulic folders.

Discuss theory of hydraulic transportation of solid in mines. (without derivation).

In this system transportation of solid in water on branch transport in open channels and pipes.

The distant feature of this mode of transport is that of solid of higher density than water than have to be kept in suspension and transported along with it which call for the transporting stream to have certain definite operates various explanation have been advanced for the machines of suspension of solid particle in water. The lifting force required to hold the solid particles in suspension has at first through to be due to differences in state pressure between the stream velocity in minimum and top of the stream where velocity is maximum. But latter work should that the valve of this lifting force is sufficient only to just leave the particle. At a small height from the bottom due to fall in the velocity gradient due to the turbines of the stream turbine flow the velocity of an element of water keeps changing continuously and when it is on upward direction its vertical component help in lifting the particle even up to the top of the stream. The downward velocity of the element on the other hand pushes the particle as a result of which the solid particles tracks unregulated, as it is transport along the stream. The attitude of transverse motion of solid part depend on the degree or turbo fence the trajectory pending to be almost straight with high turbulence. The following terminology commonly used in hydraulic transportation. The velocity of the stream means the average velocity is that minimum average velocity of the stream at which all particles travel in suspension. The intensity of turbulent fluctuation is the rout mean square valve of fluctuation is of actual velocity

$V^1=\sqrt{AV^2} + \sqrt{(V-V)^2}$

The setting velocity V^3 is that constant term in velocity of free falling particle is outer. The hydraulic gradient is the resistance locomotion of flow performs length of conduct. In projection a hydraulic transport system must be determined of all other performances. Such as the cross section of the conduct the type & power of the pump of the gradient required in case of the gravity transport the specific energy loss etc. defend on it. To apply this theory to solid particles having a substantial weight suspended in a liquid. It is necessary to know the relation between the velocity of both the solid and fluid phases of the flow.

$$V = V_0 T \frac{V_1}{V_0} \left(\text{lay} - \frac{v_2}{2}\right)$$

Gravitational theory: This theory contain to the diffusion theory assume the stream to lose a part of its energy in keeping the particle suspended. The main energy equation on the theory A≠B≠C

Where, A = Total energy spent by stream.

B = Part of energy spent in overcoming resistance to motion of the stream.

C = Part of energy spent in keeping particle in motion.

Definition: It is the method of mechanize mining where all or most of the operation are performed by a stream of water.

The main operations of hydraulic are hydraulic breading hydraulic transportation from face to pit bottom. Hydraulic lifting from the pit bottom and dewatering of the mineral.

What are the various factor to be considered for adopting a good transportation in mine.

The fundamental equipment of hydraulic transportation are hydraulic feeder, hydraulic elevation pipes ranges, dewatering devices.

Hydraulic feeder: Many types of hydraulic feeder has been tested in recent years. Such as chamber type, spiral types, drum type. The chamber type feeder found the to be most reliable of all.

Transported material is fed from conveyor into one of the equalizing chamber through an intermittent feeder & spherical valve. After the chamber is fitted the valve is closed and high pressure water allowed entering equalizing chamber. The valve is opened to air entrapped with the solid escape.

The lower spherical valve is opened & solid settle down into the mining chamber. The chamber work are alternatively, this ensuring a continuous supply of solid. The pipe serve to remove the excess water from the chamber with in they are filled with solid. All the operation of feeder are automatically controlled by hydraulic relays, the cycle of work of each chamber covers.

Hydraulic elevators: These are used for auxiliary operates in shaft sinking and for transporting slurries over small.. it is a conductor pump consisting of pipe with a nozzle through which high pressure water is injected in to chamber. They are simple in construction & are reliable in a operation due to absence of rotating parts. Unlike pumps they can hyre with air in the suction stage.

Pipes: Steel pipes with climates up to 600mm and wall thickness up to 15 mm are commonly used for hydraulic transportation.

Dewatering devices: The simplest method of dewatering gravitational devices, special dewatering devices such as dewatering screws, thickness, centrifuges etc are used.

Rope haulage:

The transportation in any underground coal mines & the metaliferous mines in termed as haulage and the haulage which is termed as haulage & like haulage which is done by means of wire rope is known as rope haulage. There are four types of rope haulage. (i) Direct rope haulage, (ii) Main & tail rope haulage, (iii) Endless rope haulage or main rope haulage, (iv) Gravity rope haulage.

Direct rope haulage:

Applicability condition :

1. It is used where gradient is more than 1 in 10.
2. Where there rope speed is 8-12 km/hr.

Description:

1. It is the simplest system of transportation by using one pulling rope & one haulage drum for the hauling the materials in tubs or mines cars up a gradient.
2. The haulage engine is situated at the top of the inclination & the drum coupled it.

3. In this system one end of the wire rope is attached to a set of tubs & the other end is fixed rigidly to the drum.
4. The empty tubs attached to the rope travels down gradient by their own weight due to the force of gravity.
5. The drum is clutched during the downward movement of the set of tubs.
6. At loading points the tub or mine cars are fitted with material and than after the motor is engaged and the material & transported to up gradient.
7. A slip ring motor is generally used for this purpose.
8. The system can also be serve branch roads deviating at an angle of not more than 40° from the main branch.
9. A back stay is fixed to the last tub when it is hauled up gradient.

Advantages:

1. It is the very cheep & simple in construction.
2. As it is a single track mining supervision is easy.
3. It is very useful in steep gradient.

Disadvantages:

1. As a single track is available that's why it is does not provide continuous production.
2. As it is a single track mining the maintenance single track is more.
3. A derailment is associated with heavy damage because of the high speed.
4. Serve braking duty when the tubs more downward.

Endless rope haulage:

Applicability condition:

1. It is applicable when the gradient of road is about 1 in 6.
2. The rope speed in the haulage is about 3-7 km/hr.

Description:

1. In an endless rope haulage & rope moves continuously round a drive & returns sheave or pulley.
2. Especially design mining car are attached one by one with the rope by the help of arrangement.
3. It may over rope type or under rope type.
4. The main components endless rope haulage are.
   (a) Motor – A squirrel cage induction motor is used.
   (b) A square wheel or a Clifton pulley.
   (c) An endless rope.
   (d) Clips for attachment & detachment.
   (e) Two parallel track.
   (f) Tensioning arrangement.
   (g) Other main units like shaft assembly transmission system, breaking system coupling.
5. In this system there are two parallel tracks sides by side one for the loaded tubs & the other for the empties & on endless rope passes the driving drum located at the out bye end of the haulage, road to the in bye end via a tension bogey.
6. In this system, the rope moves in one direction only.
7. A squired cage induction in to motor is generally employed in driving unit which is coupled to the shaft of Clifton pulley through flexible coupling & reduction gear box.
8. The tubs are attached to the rope at regular interval with help of clips so that the entire rope length has tubs on it a intervals.

Advantages:

1. It provides at lower speed, so risk of accident is less.
2. Less wear & tear of the truck due to low speed.
3. As it is double track mining the system is well balanced & the power cost is low.
4. It is applicable for undulating surface as well as the construct shaft.

Disadvantages:

1. More man power is required to attach & detach the clip.

2. If any derailment occurs the total process will stop.
3. Large no of tubs & clips are required.
4. It can not serve main roads & branch road simultaneously.
5. It requires larger galleries for the installment of two tracks.

Main & tail rope haulage:

Applicability condition:

1. It is applicable for undulating strata's.
2. The speed at the haulage in around 1.5-2.2 m/sec.

Description:

1. In this system haulage engine provided with two separated drums one for the main rope & another for tail rope.
2. The main rope hauls the set of loaded tub where as the tail rope transported back the set of empty tubs.
3. It can operate in single track in narrow path.
4. The length of the tail rope is double than the length of the main rope.
5. During hauling of set of loading tubs from the return & towards the driving unit the tubs are attached to the main rope with the help of clips.
6. After clutching the tail drum & engaging main drum the loaded tubs are hauled up the gradient similarly after attaching the empty tubs to main rope & engaging the tail drum and clutching the main drum the empty tubs go down gradient at the point of loading.

Specification:

1. Power ranges – 30-75KW.
2. Voltage – 440V-33K.V
3. Rope dia – 16-22mm.
4. Speed at the haulage – 1.5-2.2m/sec.
5. Capacity of haulage drum – 300-800m.

Gravity haulage:

1. This is a haulage without any motor or external source of power.
2. It consists of cast iron pulley 1.3m-2m diameter having a brake on one side and a stop brake.
3. It is located at the top an inclined roadway and is employed to lower the loads by gravity attached to one end of the rope while simultaneously hoisting implies attached to another & of the rope.
4. A single track is provided for this haulage which is branched at the mild piston of the roadway. The length of the branch is equal to the length of the set of the tubs.
5. The pulley used for it is vertical and is known as gig pulley.
6. The pulley is hoisted in a past & is guarded by iron, forms & the wire rope is allowed to make in the groves of gig pulley.

Double drum balanced direct rope haulage:

This is a modification of the direct haulage system. In the double drum method, two drums are provided so that when a train of full tubs is being hauled out bye, a set of empty tubs is lowered in bye. Both the drums are fitted with clutches and are mounted on the same shaft, weights of the rope and tubs are balanced and the only unbalanced load for the haulage engine is generally of the mineral. This results in a reduced peak power demand and easier braking. The system gives highest output as each trip of the ropes brings the loads and there is a regular delivery of the loaded tubs. The system requires wider road for the haulage track and the different arrangements of the tracks.

State factors affecting design of belt conveyors, cable belt conveyors and steel cord conveyor.

1. Belt conveyor: The belt conveyor is basically an endless belts in a straight the stretched between two drums, one driving the system and the other acting as a return drum.

The system of transport by a belt conveyors consists of the following:

- A flat endless belt which continuously travels and carries on top surface the materials to be conveyed.
- The idlers which support the belt.
- The structure of angle iron or channel iron on which the idlers are mounted.
- The tension arrangement for keeping the belt in proper tension inclining the loop taken up arrangement.
- The drums as the discharge end and opposite end (tail end) over which the belt passes.
- The drive is an endless thick flat strip of woven cotton, rayon or nylon fabric laid up in plies or layers and their surfaces and sliders covered with rubber plastics on PVC. The type of fabric the number of plies and reinforcement, if any in the belt determines the strength of the bottom.

2. Cable belt conveyors: In this type, the driving tension is taken by two separate steel wire ropes, one of each side of the belting and not by the belting it self.

- Belt only carries the materials and is provided on either side with shoes, which rest on carrier ropes.
- Straight course is essential for operation.
- A 1m belt at 75mm in has a rated output of 300 te per hour.
- Rope drum is generally 25mm.
- Sizes of belt are available for long lengths, particularly on inclination cable belts conveyors are at present not used in Indian mines.

3. Steel cord conveyors: This is in essence the usual type of belt conveyors but the rubber belt is reinforced with steel cords and the belt does not stretch, appreciably in operation.

Find out carrying capacity of belt conveyors, cable belt conveyors and steel belt conveyors.

The carrying capacity of the belts is as follows:

For a toughed belt with a speed of 30m/min with uniform feed of coal.

Belt width	Tonne/hour
650mm : common as face or gate conveyors	50
750mm : common as face or gate conveyors	70
1000mm : common as truck conveyor	105

If the belt speed is 60m/min. the capacity is obviously double. The capacity can this is calculated. If the feed is not uniform as very often happens, the capacity will be usually 30 to 60% of calculates nearly 50% carrying capacity. The maximum lump size carried by a belt conveyors is limited to about half the belt width but large size like this cause spilling of the materials. The carrying capacity of toughed belt conveyors is given by T=abv.

Where

T=the carrying capacity (in tones per sec)

a=the average cross sectional area of materials (tn m^2)

b=the bulk density (tonne/m^3): this relates to density of broken material including air spaces.

v=speed of conveyor belt (in m/s) for a belt of width the value of the area a.

Varies approximately between $^{w2}/_{10}$ and $^{w2}/_{12}$ depending on the nature of the materials.

Constructional features of belt conveyor:

The belt conveyor is basically an endless belt in a straight line stretched between two drum one driving the system and other acting as return drum.

- A flat endless belt which continuously travel and carries on its top surface the material to be conveyed.
- The idler which support the belt.

- The structure of angle, iron ore channel or which the idler are mounted.
- The tension arrangement for keeping the belt in proper tension including the loop take up arrangement.
- The drum of the discharge end and opposite end cable end over which the belt passes.
- The drive head coupling the electric motor coupling gearing and snub pulleys.

1. Belt: It is an endless thick flat strip of woven cotton rayon or nylon fabric laid up implies or layer and their surface and sides covered with rubber plastic or PVC. The type of fabric the number of plies and the reinforcement. If any in the between the strength of the bottom. Belt having nylon fabric are string nylon observing high resistance to longitudinal bearing and damaged due to edge turn up.
2. Idler: The idler is long pulleys moving in its own axial and ball bearing and filled with grease for transport or broken and loose material the flat belt should be given toughed shape for that length which has to accommodate the minerals and such belt toughing is achieved by a set of three idlers at one place the meddler idle being horizontal and two or either side of 20° to 30° the horizontal.
3. Structure of angle iron which the idler are mounted: The idlers are supported on channel iron frame work and the number of such frame work 3.4m long joined by bolts and nuts. The frame work in underground mines on floor of the road way but some strengthen it particularly of the discharge and may be suspended iron the roof bye eye belt and chain such suspensor necessary where a belt conveyors has to cross a track.

Constructional features of cable belt conveyors:

- The belt on this case does attached to the driving medium belt, it is merely rest as well as driving by two endless rope. The specially constructed belt mounted with shoes which best over the cable sever only the purpose of supporting the materials to be conveyed.
- The cable transit the driving pull no toughing idler are provided to support the belt but the enables are supported by grooved pulley mounted on line stand set at regular interval through out the length of conveyor.
- At the delivery and tail end the belt is separated froes the wire rope with the help of specially adjusted pulley which offset the cable and belts supporting idler caving limited raise the belt from the rope before re attaching with then again.
- The cable is made of either sleep wire ropes of langslay construction with a fibre core having diameter ranging from 22mm to 62.5mm cable have a wire strand core endless cable rope remover the supporting pillar of diamond verifying from 300 to 400. the pulleys are attached with the lines stand.

LOCOMOTIVE HAULAGE:

Locomotive haulage can be used in a mine:

1. Where the gradient of the road way is mild. Nearly flat gradient is preferred. A gradient of 1 in 15 against the loads is considered to be the limit though locos are generally employed on gradients milder than 1 in 25.
2. Where the loco track is in settled ground not subjected to movement by mining operations.
3. In the intake air ways, where air velocity is adequate to keep fire damp percentage appreciably low. If diesel locos are used the exhaust gases of the should be diluted by the air current sufficiently well so as to be unharmful to the workers.
4. Where roads are reasonably wide and high.
5. Where the transport of mine cars involves long haul distances. Small locos for gathering loads in the district and also for shunting and marshalling in the pit bottom are not uncommon.

Locomotive haulage consists of:

1. A chassis which is a rigid frame work of rolled steel sections.
2. Driving wheels on axels, springs, and brake blocks mounted underneath the chassis.

3. A power unit. This is a diesel engine, electric DC motor or compressed air motor, mounted on the chassis. Petrol engines are not permitted by law in underground mines as they produce a large amount of carbon monoxide.
4. Operators, cabin equipped with controls, brake operating system, sand boxes, horn.
5. On medium and large size locos, an air compressor for powered brakes.
6. Lights at both ends.
7. A hand screw brake for emergency, as required by law.

Diesel Locomotive :

These are commonly used in a number of mines. Their weight ranges from 3 te to 15 te and the power from 15 kW to 75 kW. The power unit is diesel engine with 2, 3 or 4 cylinders of 4 stroke cycle, compression- ignition type. Heavy duty locos are of six cylinders. Locos used in underground coal mines have the power unit in a flameproof enclosure as a safeguard against ignition of fire damp. The intake air going to the engine passes first through a filter and then through a flame trap. Similar flame trap is fitted on the exhaust side of a diesel engine. A flame trap consists of a number of stainless steel plates contained within a stainless steel housing. The plates are 50mm wide and welded into position with gaps of 0.5 mm between adjacent plates. The exhaust flame trap can be easily removed from its housing and it has to be thoroughly cleaned every day. On the exhaust side the hot exhaust gases of the engine pass through an exhaust conditioner before entering the flame trap. These exhaust gases should have very low percentage of CO and other noxious and poisonous fumes before they enter the mine atmosphere of restricted airways. The diesel combustion has therefore to be satisfactory, and diesel oil should have a flash point of not less then 65˚ C. The maximum permitted percentage of CO in the exhaust gases before they enter the mine atmosphere is 0.2% but usually it is between 0.02 and 0.04%. In coal mines diesel locomotives are not allowed to be used where the percentage of inflammable gases is more than 1.25 in the general body of the air.

Overhead wire locomotive (or trolley wire locomotive):

The trolley wire locomotive is equipped with electric motor fed with current from overhead electric wire through a pantograph or through a long pole which is kept pressed against the overhead conductor by spring tension. Only direct current is supplied to the overhead wires though in some foreign countries AC is permitted. The main advantage of AC is that conversion equipment is not required between the supply mains and the overhead wires. The shock hazards are, however, much more serious with AC. An important advantage of DC for traction is that the DC series motor is unrivalled for traction duty. The DC supply to overhead wires is at 250 volts. Trolley wire locomotives are used in a number of coal mines near Kurasia colliery and a few other coal mines of degree-I gassiness though the DGMS office is generally conservative in granting permission for their introduction in underground coal mines.

Advantages of trolley wire locomotive:

1. High efficiency, of all the different types of locomotives used in mines, trolley wire loco is the most efficient.
2. High overload capacity. For short periods, specially during peak loading activity, overloading of the motors does not pose any problem.
3. Simple maintenance. Most of the skilled work is to be done in the power house.
4. High power/weight ratio. The motor speed can be easily increased to give more reactive effort.
5. Reliability. It is robust in construction and not liable to breakdown.
6. Good control. It gives smooth acceleration and high torque.

Direct rope haulage: This is the simplest system employing one pulling rope & one haulage drum for hauling mineral in tubs or mine cars up a gradient which is generally steeper than 1 in 10.

Aerial rope way: Aerial rope way are used for transporting materials especially where topographic and climatic condition do not permit other methods of transportation.

Spiral chute: spiral chute is a vertical transport used for bringing down mineral from upper level to lower level without any mechanical power.

Hydraulic transport: Hydraulic transport means conveying of minerals from the face to the pit bottom & from pit bottom to the pit top.

Locomotive haulage: It is the most commonly used system of u/g transport for relatively long distance the load is carried on sets of cars which from the train with the locomotive.

Man riding: Transport of man by special car at controlled haulage speed in horizontal or inclined roadway is known as man riding cars. Man riding needs special truck equipment terminal station & winches.

Draw bar pull: This is the part of the tractive effort which remains available for pulling the connected load of mine cars after deducting from the total tractive effort.

Idler: The idler is along pulley moving on its own axle & ball bearing and to filled with grease. The belt travels on idler placed at interval of 1.5m to 2m.

Tractive effort: It is the force required to cause movement and the tractive effort depends on the of the loco & also on the frictional adhesion between the locomotive driving wheels & the rail track.

Clifton pulley: The driving pulley of an endless haulage is an Clifton pulley or surge wheel and is of a special shape to protect the man driving wheel from wear the pulley is fitted with renewable line of C.I. or soft steel segment having a taper of about 1 in 8.

Screw clip: The clip is tightened on the rope by a handle and screw & the handle is coupled to the drawbar of the tube by a long steel rod hinged to the clip.

Scraper: It is used in coal mines for coal cutting & loading whether and stone or coal.

Exhaust conditioner: The exhaust conditioner contains a both of solution of salt and like sodium sulphate or hydroquinone which absorb the noxious competent of the exhaust gases such as carbon dioxide, oxides & nitrogen.

Flame trap: Flame trap consists of a stainless steel installed at both inlet & outlet sides of engines to prevent ignition of fire damp mixture from inlandestent particles of the exhaust gases.

Tipper: The tipper are used in underground mine for tapping mineral to the belt conveyor from the tub. From the decking level the loaded tubs are taken to the tippers via a weight bridge. Tippers are electrically operated.

Creeper: The creeper are used in underground mine for handling empties tubs and elevates them to little above the decking level & gravity above the decking level & gravity to the otherside of the cage. A Creeper on a load side is not desirable.

Flight chair: This is essentially an aerial ropeway with the rope supported by the roof hung pulley carriage along the roadway. A miner attached a chain or track to rope & goes by sitting when going from one place to another.

Safety features of diesel locomotives: The important safety features of diesel locomotives are as follows. Water cooled, Conditioner box, Which cool & remove the noxious gas from the locomotive exhaust.

Where spiral chutes is constructed: At the staple shaft of an underground mine.

What type of rope are used for track & traction rope: Track rope- locked coil rope, traction rope- A standard long stay with fiber core rope.

Function of jazz rail: The principle of the device is that the tub traveling in normal speed path over the section jazz rail. If the tubs travels at an excessive speed they work fair to get round the bend is derailment is occur.

Belt take up arrangement: In the conveyor belt transportation system for maintaining the proper tension of the belt for flexible moving of the belt the belt take up arrangement is provided.

Condition for adopting main & tail rope haulage: This system of haulage is suitable for undulating roadway where it is impossible or undesirable to maintain the double track required for endless rope haulage.

Ore bin: It is one type of inclined drift which is connected to shaft that facilitate the quick loading of ore directly in the skip but not needed in winding.

Trolley wire locomotive: This locomotive is light type having weight of 4.5 tonne are used for shunting work at underground station & these are equipped with electric motor with current from overhead electric wire through long pole.

Idler gradient: The idler gradient for a locomotive haulage is that on which the same traction force is required to haul the empty train in by as to haul the full loaded train out by.
The gradient depend on (a) the rate of weight of the loaded & empty tubs. (b) the running resistance of the locomotive & tubs or depends on the co efficient of friction.
Bicable rope way: It is the rope way which has two fixed track ropes which carries the load in tension and endless traction rope which haul the load.
Twin cable: It is the rope way consists of two track ropes to support the carrier & on endless traction rope.
Angle station: When it is not possible to take straight line. Angle station one provided to change the direction of the track ropes of two adjacent arm terminate by means of enchorage or tension gear.
Trestles: These are used for supporting the track and traction rope as well as giving the necessary profit to the rope way.
Belt: The belt is an endless thick flat strip of woolen, cotton or nylon fabric laid up imples or layers and their surface & sides covered with rubber plastic or PVC.
Main tail rope haulage: In this system the haulage engine is provided with two separate drums one for the main slope which hauls the full train out and one for the tail rope which hauls the empty in.
Mono rail system: A rope bukted monorail by sten embodies an overhead II, section raise suspended from roadway support or roof be it carrying a train or through lifting beams or monorailing chain or lift monorader.
Tail rope: A tailrope haulage is one in which the haulage is switched at a lower level & the empties are hoisted up the stopping trucks. The haulage poster to the term of empty tubs.
Distinguish between bin & bunkers: Bin: It is a temporary of broken ore near the shaft in underground metal mines. Bunkers: It is storage of brake ore in underground metal mines.