NARAYANI INSTITUTE OF ENGINEERING & TECHNOLOGY
ARAHAT, ANGUL

6th Semester, Mining Engineering

MNT – 602

Sub: - Mine Machinery-II

Chapter – Underground Face Machineries

Underground Face Machineries

COAL CUTTING MACHINE(CCM)

Definition:
A coal cutting machine (CCM) is to make a groove or cut 2 meter to 2.5 meter in depth & 125cm to 175cm height at a coal face. The cut is across the whole width of the gallery in board & pillar system & across the whole length of face in long wall mining.

Advantages are as follows:
1) It gives extra free face for efficient blasting.
2) To increase coal output per blasting
3) High rate of advance.
4) Straight & systematic advance.
5) Systematic roof support can be installed.
6) Roof is not damaged.
7) Less explosive is used.
8) More safety in gassy mines.
9) Dirt bands removed easily.

Classification of Coal Cutting Machine (CCM):
1) Depending upon the Position of Cut
   a) Under cutting coal cutting machine (CCM): It gives cut at floor level only.
   b) Over cutting coal cutting machine (CCM): It gives cut at roof level.
   c) Middle cutting coal cutting machine (CCM): It gives cut anywhere between roof & floor.
2) Depending upon Design
   a) Short wall coal cutting machine (CCM)
   b) Long wall coal cutting machine (CCM)
   c) Bent jib coal cutting machine (CCM)
   d) Arc wall coal cutting machine (CCM)
   e) Arc shearing coal cutting machine (CCM)

Theory: -
Many type of coal cutting machine have been designed and the process of development is continuous. The coal cutting machine which are generally used to give either an undercut, middle cut, to cut or side cut for making a free face for efficient blasting operation are as follows:
1) Long wall coal cutters.

2) Short wall coal cutters.
3) Arc wall coal cutting.
4) Arc shearer.
5) Percussive coal cutters.

1) Long wall coal cutters: -

The chain coal cutter this machine is built in three parts.

a) The cutting unit.
b) The hauling unit.
c) The drilling unit.

a) The cutting unit: -

This comprises a cost steel gear head which encloses the reduction gear usually a combination of spurb and bevel gearing between the motor and the cutting chain driving socket. It serves also as a support for the cutting chain jib all shafts are carried on boll and roller bearing.

Chain jib*:* This consist of three main components.

a) The jib head or bucket of cost steel swinging on the gear head.
b) The jib post or support bar of head treaded steel, bolted into a socket on the jib head and giving rigidity to the jib of rollered steel bar and which is supplied on to it.
c) The jib of rolled steel bar and plats security riveted together, forming the chain path and provided with renewable hardened steel wearing strips.

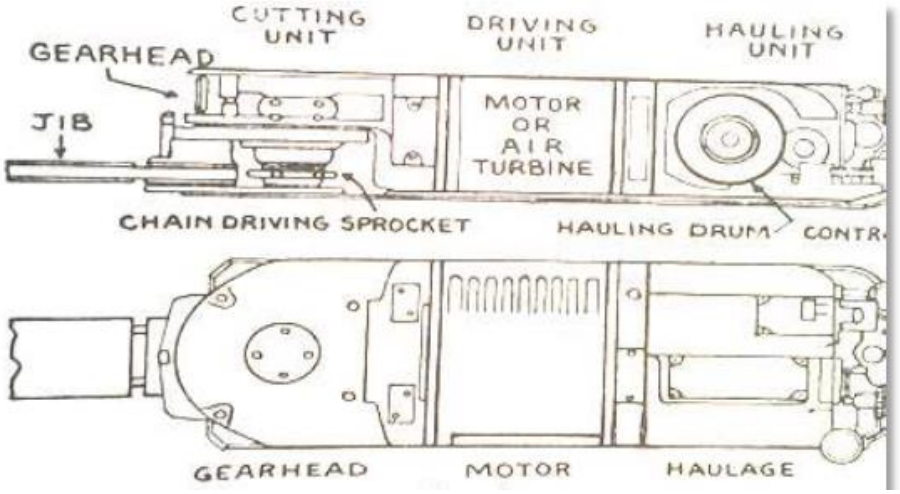

Fig -1

In some cases, a sprocket is provided at the outer end of the jib so as to reduce the wear of the cutting chain and jib, especially in hard coal, otherwise a plan end jib is being used in CCM.

The jib can be locked in line with the machine for fitting or it can be swing to either side and locked (at rather less than 90° to the body of the machine) for cutting. The spring-loaded-locking pins engage automatically at the appropriate position. The length of the jib may be anything form 0.95m-30m, depending on the desired depth on many factor including the nature of the coal and its associated roof and floor, the thickness of the seam and facilities for clearance.

The cutting chain: -

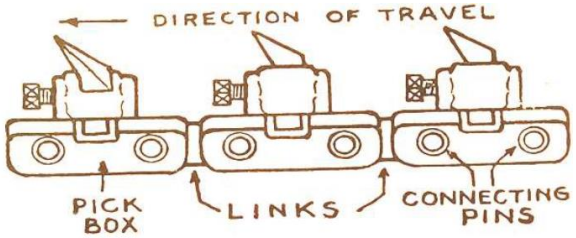

Fig -2

It consists of a series of case-hardened or alloy steel pick boxes, joined together by links and connecting pins in such a way as to resist all twisting and bending excepted that necessary for going round the jib.

Each pick-box has forgotten upon it a block which carries the pick at the required angle, the pick itself secured by a set-screw.

In a given chain, all the picks at a given angle form a “line” of picks and the number of “lines” may be 7, 9 or 11. The angles of the picks and their arrangement in the chain & depend on the nature of the material to be cut and the position cut in the seam and are best found by experiment, the tougher the material. The greater the number of lines of picks that are necessary.

All the picks in each line, of course, must be set to the correct gauge so that they project some distance. If the coal is tender and apt to sit down on the jib. The clearance may be increases by increasing the projection of both top and bottom line of picks. It the jib rises in the seam and leaves coal on the floor, the projection of the bottom like of picks may be increased to counteract this tendency.

The normal “kerf” or thick of coal cut is between 16.67m – 21.67m but winder cuts upto 8 in, can be made in easy ground by using a winder set chain whilst special chains are also available to give **thinner cut of 10.55m – 13.50m.**

The picks: -

Coal cutter pick may be mode of a plain high carbon steel containing 0.60% to 0.65% carbon, about 0.50% managanese and only small traces of sulpher and phosphorous such a steel has the requisite. Straight and toughness and will take a sharp cutting edge. When forget and heat-treated. It is essential that only sharp picks should be used forged to the correct shape.

To sharpen carbon steel picks they should be forged at a temperature of 1000°c (bright orange) down to 850°f (dark orange) and should be allow to coal slowly in air. The cutting edge should be wider that the rest of pick so as to give side clearance.

To harden and temper the cutting edge, various method is in use a good method being as follows:

1) Re-heat the need of pick to about 80.0°c (bright red)
2) Partially coal the bit in the water until the remainder of the neat is dull red.
3) Clean the edge of the pick bright with emery or a piece of sand stone.
4) Coal by complete immersion as soon as the point assumes a straw closure.

The shank should not be hardened, for this would make it too brittle and the pick set-screw would not bite.

Sometimes, alloy steels containing chromium, tungsten, etc. are used for the picks because they have longer life and require less frequent sharping, but they are much costlier and require more care full heat treatment.

For abnormal conditions, plain, carbon steel picks may have their cutting edges tipped with special non-ferrous cutting material, such as widia or satellite.

These have a natural hardness approaching that of a diamond and can only be sharpened by grinding with special wheels.

Type of Picks:

a) **Throw Away Type:** These picks are made of high carbon steel; they can be prepared in mine workshop & required sharpening after every shift. These picks are very cheap.

b) **Tipped Picks:** The trips of these picks are made up of tungsten carbide, they required sharpening after every 50 to 100 cuts, and these picks are costlier.

c) **Reversible Picks:** It consists of two cutting tips made of tungsten carbide. It can be used for 100 to 200 cuts, the main advantage of these picks is that they can be used in either direction, these picks are very costlier. The picks are mounted on the cutting chain on the pick boxes, these pick boxes are connected together with the help of pin & links.

b) The hauling unit: -

In the machine being described, the haulage gear comprises two ropes drum one at each side of the machine. Driven by the motor through a series of straight cut at the end of the machine to facility turning and jibbing in each drum carries 40 yard of (36.4m) of 1.27 cm rope or 22.75m – 27.3m of 0.625-inch rope.

When cutting only the drum next to the face is in action. The rope being secured to and anchor prop set some distance away. This arrangement of the rope together with the face that the jib, when fixed in position for cutting forms and angle of rather less than 90° with the machine, tends to keeps the machine tight to the face and renders of use of guide rails or "fenders" normally unnecessary except when the face is advancing to the rise cutting speeds can be adjusted to 10, 20, 30, 40, 50 or 60 inches per min.

When fitting the haulage drum is driven through a different set of gears to give a rope speed some 7.5 m/m or more in some machines. Half the stated speed can be obtained.

When describe by pushing the rope around a pulley at the anchor prop. And back to the machine to which it is then attached the arrangement being term using a "double rope".

c) The Driving Unit: -

This occupies the central portion of the machine and may be either an A.C. Motor or a D.C. Motor or compressed air turbine.

- In mines where it's use is permissible electrical is nearly always preferred because of the greater efficiency.
- The greater cutting speed obtained, the ease with which the system may be extended and the lower running cost.
- In some mines however compressed air must be used for reason of safety although it is much noisier and create dustier condition at the face.
- The dimensions capacity of longwall coal cutter described are : length about 2.4 meter; width about 0.78 meter; and height 0.48 meter. A smaller model is also available having a height of only 0.30 meter.
- The cutting capacity depends on the nature of the coal. The condition underground and the skill of the operators, but double unit regularly been cut in one shift by one machine on a gradient of 1:3 and under and indifferent roof, a machine of the type described regularly fitted down the face and them cut up the 136.5m all with in shift.

2) Short wall and cutters:

Short wall machines are used of cutting in the room and pillar system, both in the developing rooms or heading and in pillar extraction; or where the face are too large or gradient too sleep for are wall machines; or for the rapid driving of one or two headings.

The cycle operation consists of cutting, drilling, blasting and loading & may be completed in several time in each shift in the working place to which a machine is allotted.

The short wall coal cutters differ from the long wall type in that it is specially designed to sump straight in and cut across a short face only, being then withdrawn. For such work that jib is permanently fixed in line with the machine and special arrangement are made for manoeuvring it is required.

The machine is divided into two compartment: -

a) The power unit, bearing either an A.C. or a D.C. Motor and

b) The gear unit which drivers the haulage drum and cutting chain

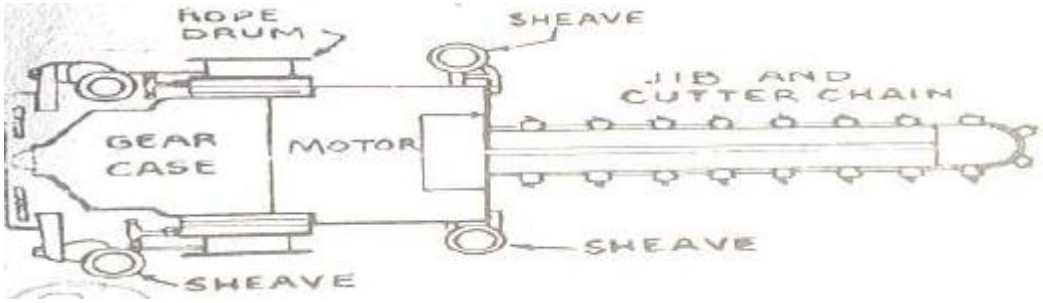

Fig-3

Comparisons: -

Short Wall Coal Cutting Machine (CCM)	**Long Wall Coal Cutting Machine (CCM)**
1) It is used in board & pillar method.	1) It is used in long wall method.
2) The cutting jib is fixed in line with the machine.	2) The cutting jib can be moved with respect to machine in either direction at 90°.
3) The jib is longer.	3) Jib is shorter.
4) This machine is large in overall dimension because the haulage drums are mounted out side machine.	4) The machines are smaller in overall dimensions because the haulage drums are inside the machine.
5) It can be used as flight loader.	5) It can be used as flight loader.

3) Arc wall coal cutter: -

The arc wall machine, like the short wall machine is used for driving relatively narrow headings as in the room and pillar system, but it is mounted on wheel, or on caterpillar track and cuts the face in a semi-circular arc.

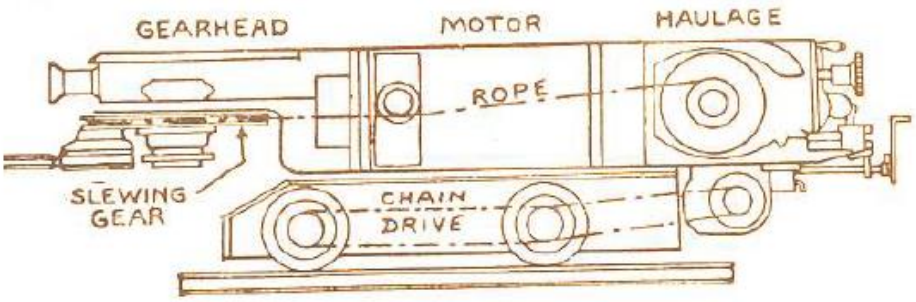

Fig-4

The essential difference between the arc wall coal-cutting and long wall m/c.

A. It is mounted on a boogie or chassis, with chain driven wheels, giving a fitting speed of some 24 meter per minute. The wheels have wide trades and deep flanges to prevent derailment and are fitted with a power full screw-operated brake.
B. It is fitted with slewing gear to enable the jib to be swung by power through an arc of about 240° for this purpose. The two ropes drums project clear of the sides of the machine (as in the short wall coal cutter) and the ropes pass from each drum direct to the jib head. When required one of the ropes may be used for moving a wheel-mounted machine on gradients on which the wheels would slip, say steeper than 1:8 for fitting speed then being 6 meter per minutes.
C. The gear head is longer by 6 or 7 in them in a long wall machine to allow the jib head to be larger in diameter for-case in arc-cutting and to let the jib swing through the required angle.
D. The length of the jib, i.e. its protection beyond the frame of the machine, is usually 1.8 meter or 2.1 meter or longer is special cases a 1.8m jib sweeps a radius of 2.25m, cut a depth of 1.8m, and forms a place 4.5m wide. A 2.1m jib sweeps a radius of 2.55 meter, cut a depth of 2.1 meter and forms a places 5.1 meter wide.

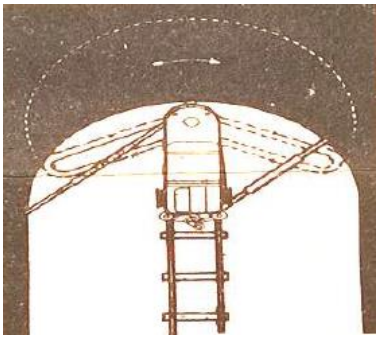

Fig-5 (Arc walling)

4) Arc-shearer: -

This differs from an ordinary arc wall machine in that it is fitted with an adjustable gear head. Which enables the jib to be rotated in the vertical plane through any angle so as to cut horizontally either near that bottom or near the top of the seam or to shear the coal vertically at either side of the place. It is therefore, sometime described as an arc shearer.

An arc shearer may be mounted either on wheels or on crawlers, and it may be driven by an electric motor or a compressed air turbine. The machine is clearly more versatile that an arc walls and can therefore deal more successfully with the variable condition met with underground.

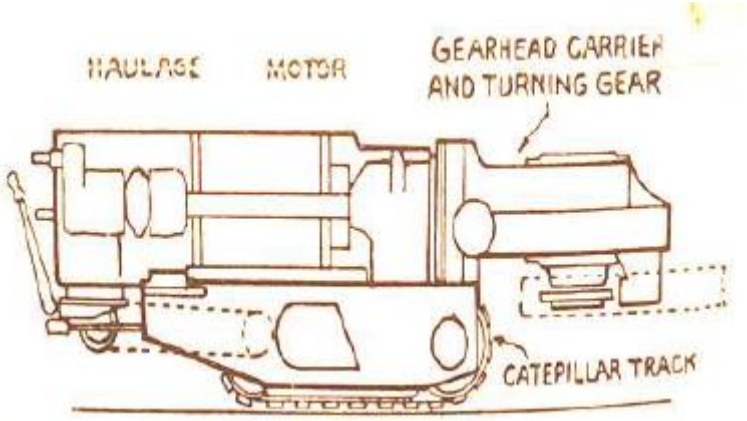

Fig – 6 (Arc-Shearer)

5) Percussive coal cutters: -

This types of coal cutter are essentially a heading machine for use in narrow working and is adoptable to either undercutting, over cutting, shearing (nicking) or scalloping (breaking down) the coal.

Such machine is likely to be more effective than the pneumatic pick where the coal is very hard nature or the cleavage plane are not well defined and when fitted with a vertical guardant for shearing or punching (scalloping) purposes, it enables short firing to be dispensed with altogether for coal getting.

It thus provided an alternative to short wall or arc wall coal cutters in seams where blasting is undesirable although it cannot generally be regarded as an adequate substitute for these machine under ordinary condition. A typical percussive coal –cutter driven by compressed air consist of five essential parts: -

1) Supporting column of steel tubing, with screw adjustment to suit the height of the seam.
2) Toothed quadrants or segments one vertical and one horizontal, where by the cutting tool can be revolved horizontally around the column for

undercutting plane for shearing or nicking by a combination of both movements. The tools can be directed to any point on the coal face.

3) Air drill with a piston and valve mechanism where by a reciprocating or punching motion is give to the cutting tool. It's position on the steel column may be varied to any height between roof and floor the piston with its cutting tools gives 300 to 350 blows per minutes and also rotates. The tool at about 80 to 90 rpm be feel for word as required by the handle and screw feel.
4) Extension road 0.60 meter, 1.2 meter, 1.8 meter, 2.4 meter, 3-meter-long respectively and having conically shaped ends one end fits the drill chuck and the other cutting bit.
5) Cutting bit of tool steel 0.09m diameter and weighting 5 lb. they usually have five cutting prongs or edge, but may have 3 or 7 prongs in certain cases.

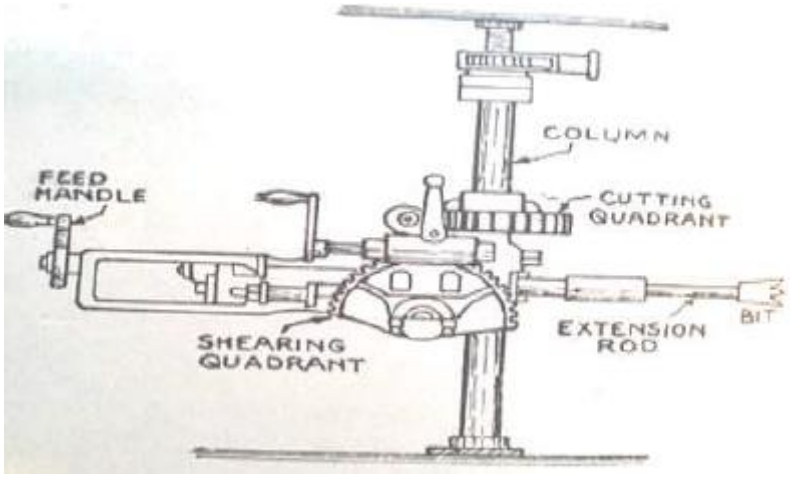

Fig-7

Haulage Gear Arrangement for Coal Cutting Machine (CCM)

- In a haulage gear arrangement, the speed of motor shaft is reduced by two stage speed reduction gear box.
- The motor shaft connected to two spur gear A & B by which the speed is reduced to 2/3rd time.
- Now it is connected to worm & worm gear arrangement through which the speed is transmitted in perpendicular direction & is reduced to 1/5th or 1/7th times.
- At the upper side of worm & worm wheel is connected to another spur gear arrangement where speed is reduced to 1/4th to 1/13th times on the lower side & worm & worm gear.

- There is a spur gear with a ladder placed to transfer the speed of one wheel to another in the same direction.
- There is a pinion drum which may be connected to low speed by the log clutch.
- The drum pinion rotates the drum gear which is connected to handing drum. In this manner speed is reduced. Rotached & pull arrangement at the low speed side just to prevent the rotation of handling drum in opposite direction.

Cutting Gear Arrangement for Coal Cutting Machine (CCM)

- In this CCM only one motor issued for cutting hauling.
- One side of more shafts is connected with the handling gear arrangement & the other side is connected with the cutting gear arrangement.
- The motor shaft is connected with the spur gear arrangement where speed is reduced to ½ to 1/3 times.
- There is a lever gear which is connected to spur gear where speed is further reduced & transmitted in perpendicular direction.
- The lever gear is connected with a dog clutch which may be connected to the sprocket wheel to rotate the cutting jib.

MECHANICAL LOADERS

It is used for loading of coal or material in the driving road. It is having an apron plate to collect the blasted material from the apron plate & transport it to the discharge end. The discharge end of the loader can move in vertical & horizontal plane.

Apron plate is lowered to touch the ground & it is inserted into the blasted coal or rock. As apron plate is full & blasted material, it is lifted upward to transport the blasted material on the chain conveyor is in motion & as soon as it receives the material to the discharge end from where the material can be loaded in the tub or conveyor etc. it has crawler mounted chain.

Joy Loader

It is used for the loading of coal or rock in the drivage road. It is having an apron plate over which two gathering arms are mounted in the eccentric. There is a chain conveyor to transport the coal from apron plate to discharge end. The discharge end of ladder can move in a horizontal and vertical plane. The apron plate is lowered to touch the ground end at the same time the two gathering arm are rotating continuously. As soon as the apron plate is inserted in the blasted material & loads on the chain conveyor this is in motion. The chain conveyor transports the blasted material to the discharge end where it is loaded in the mine tub or conveyor etc. it is crawler mounted machine.

Load Haul dumper (LHD):

- Also known as a scoop tram
- specialized loading machine manufactured for the underground mining industry.
- LHDs are used in >75 % of u/g mines throughout the world and are suitable for small and large tunnels, mines, chambers, and stopes.
- It performs loading, hauling and dumping of bulk materials

Fig-8

LHD is categorized into two types:

1) Diesel LHD
2) Electric LHD

Selection: - It depends upon the following factors:

1) Size of operation
2) Length of haul
3) Height of seam
4) Operating condition
5) Local permissibility
6) Experience

Specifications: -

Standard bucket capacity	1.6 m^3
Breakout force at bucket blade	55kN
Lifting time	7.5 secs
Lowering time	6.5 secs
Time of roll forward	5 secs
Electrical components	Flame proof for U/G gassy mines
Travel speed	0-8 km/hr (high speed mode); 0-3 km/hr(low speed)
System pressure(max)	400 bar
Traction motors	variable axial piston type
Displacement	107 cc/revolution
Drive power(max)	45kW
Hydraulic medium	HFDU 68
Tramming radius	2300mm

Side Discharge Loader (SDL):

1) mounted on a crawler track and is designed for loading the broken rocks onto a conveyor or into the tub in coal or stone workings.
2) The high travel speed (0.7 m/s) makes it suitable for working with the discharge point up to 10 m from the working face with no appreciable reduction in loader output.
3) The loader can be employed on gradients rising or dipping up to 18^0 (1 in 3)
4) It is totally flameproof.
5) The SDL may be adopted for discharge on the left or right side. Bucket capacity is 2.032 te (maximum).

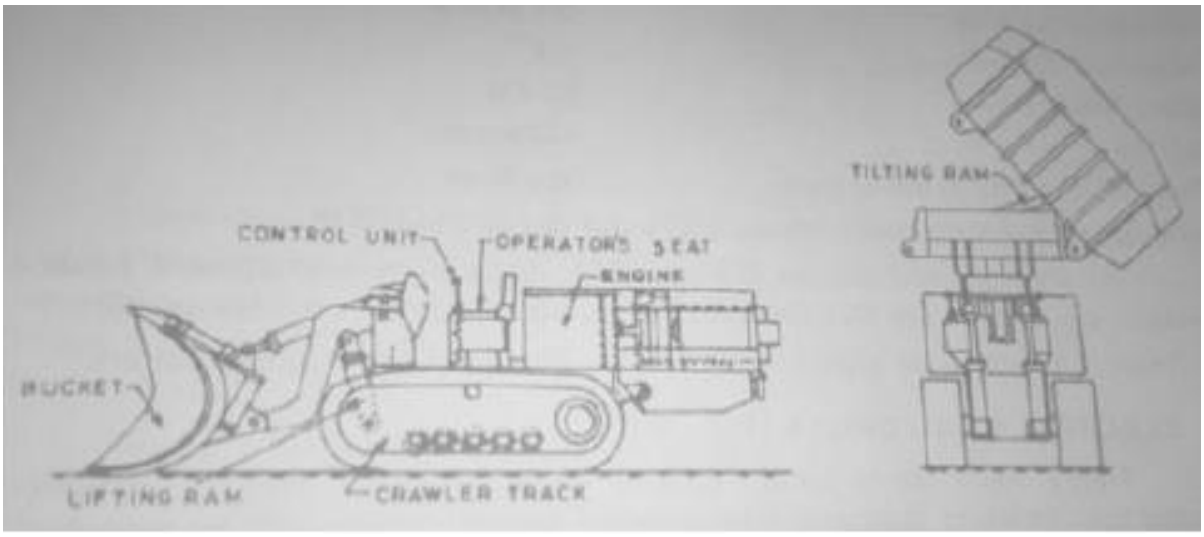

Fig-9

Optional components:

1) Cable reel
2) 0.1m3 coal bucket
3) Head light
4) Dust suppression kit
5) Dump valve with lock and key
6) Average output expected from each SDL/day is 200 to 500 tonne/day.
7) This equipment is used for applications in underground mining.
8) It is indigenously designed and developed by in-house R&D.
9) This equipment weighing 9 tonnes, is fitted with 1cu.m. bucket.
10) Fitted with powerful 55 KW motor operating at 525V, 50Hz,
11) This equipment ensures very high productivity.
12) It is ideally suitable for deployment in underground mines where intermediate or Semi- mechanization is used.

Specifications: -

Standard bucket capacity	1.0/1.5m^3
Travelling speed:	2.6 kmph (max.)
Total weight	8500/9000 kgs
Ground pressure	0.9 kg/cm^2
Tractive force	5200 kgs
Break out force	3000 kgs
Electrical components	Flame proof for U/G gassy mines
Negotiable gradient for driving and loading:	1:4, cross gradient 1:6
System pressure (max)	125 bar
Traction motors:	Radial piston fixed displacement type
Payload(max):	2.0 MT
Drive power (max):	55 kW
Hydraulic medium	HFB 68