Lecture Note on Blast Hole Drilling

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BLAST HOLE DRILLING

Scope of drilling engineering

Scope of drilling engineering to,

1. To make a nation / a country wealthy

Each of the mineral deposit is a source of unending treasure. When all the mineral deposits of a nation or a country will explorce then the no. of treasury will be estimated. Then a country or a nation will be automatically wealthy.

Most of the riviers are filled with valuable placer deposits such as gold, platinum, silver, diamond etc. All these placers will be explored through drilling and they will be extracted by hydraullic mining method. Then a country will be automatically wealthy.

Ocen floors are enriched with valuable minerals such as Mn, Cu, Cr, Ni etc. They can be explore through drilling only. If they will explore then a country will be automatically wealthy.

There are many hydrocarbon, coal and uranium deposits. If we explore them then our total reserve willbe estimated and a country or a nation will be automatically wealthy.

2. To make a nation / a country powerfull

Through drilling we will reached at magma and geothermal energy level. If we are able to tap this geothermal energy then we will be used them in the power plant to produce a large amount of power which fullfill our power requirement. We will use this power in allpurposes. So a country will be automatically powerfull.

In coal bed there are lot of methane gases. If we will do methane drainage drilling inorder to tap this gas then we will utilised the gases in the field of powerplant and can produced large quantity of power.

Our earth crust contain lots of coal, hydrocarbon and uranium deposits etc. There is only way to explore them is drilling. If the hydrocarbon deposits will explore then tapping of hydrocarbon is possible. Again if uranium & coal deposits will be explore then we will use them in thermal powerplant and produce large amount of power which fulfills our requirments for several thousand years. There are also lots of natural gases deposits along with hydrocarbon deposits. We can use them for power production.

3. To make a nation or a country prosperous / developed

If a country will be wealthy and powerfull, then it will be automatically prosperous / developed country or nation. It is possible only through drilling.

4. To satisfy the growing people by creating more field of employement

Through drilling more field of employment is possible. Industry can accomodate more no. of man. But as long as the raw materials are available, industries will run. Industries requires raw materials & raw materials are being explored by mining industry only. So industries are depends on mining. But mining industries cannot be established without drilling industries. Because drilling is key to open the treasures of underlying minerals.

5. To raise the financial therinometer of a country / a nation at once

Money being exchanged with gold. If sufficient amount of gold can be extracted, then the financial thermo-meter of a country will be raised automatically.

primary stage gold are found in vein. secondary gold deposits are found on river bed. First it can be explore by drilling and then it can be extracted by hydraulic mining / aulvial mining methods.

Beside this economic thermometer of the country suddenly grow by exploring other valuable mineral deposits such as surface gold deposits, uranium deposits, hydrocarbon deposits etc.

If we enhance the gold collection percentage then automatically economic thermometer will be raised at once.

6. To enhance the state revenue

If more numbers of mineral treasures are explored by drilling, then more no. of mining industries will be setup. so more no. of industries will be setup as the availability of raw materials is more. This leads to increase the amount of collected revenue in the state.

7. For overall developement

The scope of drilling engineering is to make a country wealthy, powerfull, prosperous and developed. Drilling industry will be provided more field of employment by setting up more no. of mining industries. By drilling the financial thermometer of a country will grow by exploring the valuable mineral deposits.

Scope of drilling

1. Ability to understand

Drilling is the art of digging hole on the surface of earth to get the core of the strata and other purposes economically.

The drilling operation which has to be carried out to know the details of the mineral deposit such as depth, thickness, extension, volume and quality of deposit is known as explorcatory drilling.

The drilling operation which has to be carried out for blasting purpose is known as blast hole drilling.

The drilling operation which has to be carried out to tap water is known as water well drilling.

The drilling operation which has to be carried out to tap hydrocarbons is known as oil / natural gas well drilling.

2. Extent of knowledge or caught of knowledge

Developement of knowledge consists of 3 items

(I) Drilling techniques
(II) Mechanism of drilling machine
(III) Geology

3. Limits of action

To reach at geothermal energy and magma is our objective.

The maximum diameter of the bore hole is 200" & depth is 3KM for mineral exploration.

The maximum diameter of the bore hole is 6' & depth is 7 KM for oil well exploration.

4. Opperturnity

There are lot of opperturnity in oil well drilling, advanced drilling like directional drilling, prospecting drilling etc not only in India but also in world.

5. Aim or Aimed at

Our aim is -

(I) To obtain the core of the strata.
(II) To know the details of the mineral deposits.
(III) To make hole for blasting purpose.
(IV) To reached at magma and geothermal energy.
(V) The aim to tap oil, hydrocarbons, gas & water.

6. Intension

Our intension is to -

(I) Tap the oil, natural gas, hydrocarbons and water.
(II) To reached at magma.
(III) To reached at geothermal energy.

Introduction to Blast hole drilling

Thermal method were probably the first techniques used to break the rock. The fires were used to break the mining face.

Then hand hammer drilling for short holes was in use in mines, road cut and tunnels. In single hand hammer drilling bit was held and rotated in one hand & stroked by 1.8 kg hammer held in the other for drilling 32mm size hole.

Then the evolution of machines with pnematic pistons and TC drill bit are used.

Then hand held churn drilling is adopted. In this the bit is connected with a bar and falls freely to creat impact on the rock. steam power is required to operate this drill.

Then diesel operated churn drills are used and churn drill are replaced by piston drill. In this drill the extension of piston carried a chuck which held the drill steel.

With the passage of time pneumatic hammer drills replacing hand hammer drills has been developed. This was a precursor to today's Jackhammer drill leading to evolution of Down the hole hammer drill & Independent rotation drill.

Mechanical drilling with steam pressure replaced mannual drilling followed by compressed air, hydraullic and electric motors which has been found more efficient, convinent and safe for blast hole drilling.

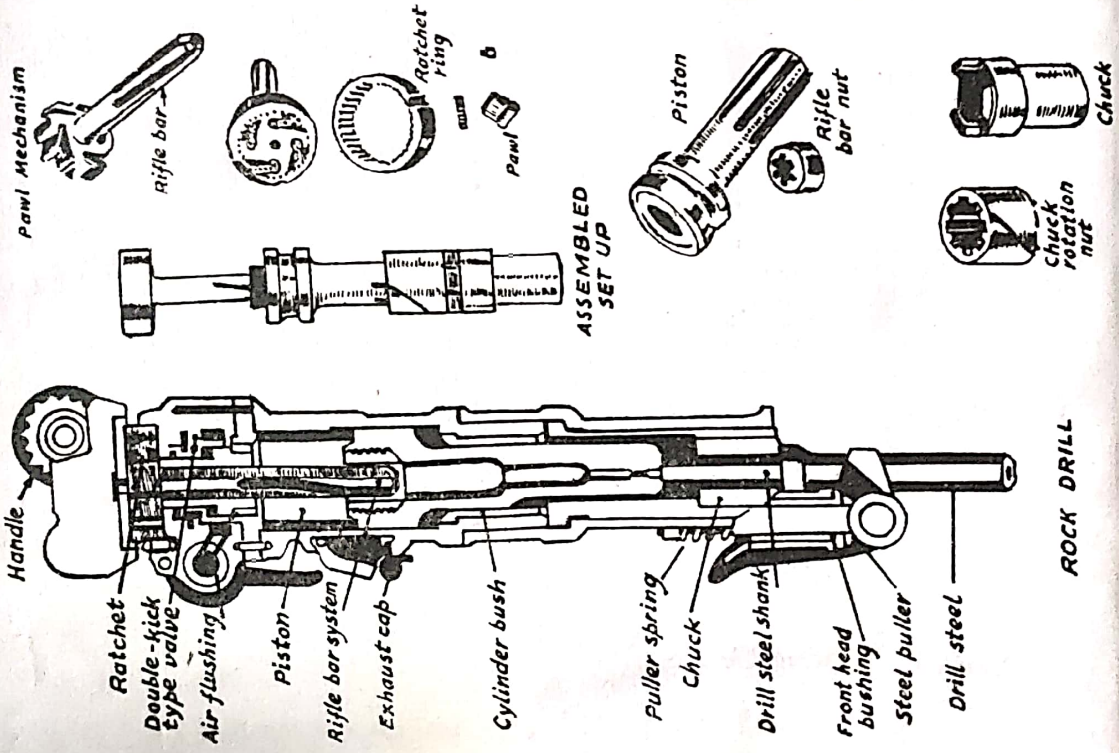


Fig 4.2. Rock drill with its components.

Blast hole drilling by rock drills

Rock drills

Compressed air operated drills are generally known as rock drills.

Rock drill is the term applied to all the machinaries using compressed air for drilling holes into rock by combined percussive and rotarey action.

Classification of rock drills

To meet the various conditions rock drills are available in various types and weights and each rock drill provided with alternative speed of rotation by changing the rifle bare and rifle ban nut.

The rock drills are classified mainly as follows

(I) Jack hammer (sinkers)
(II) Drifters
(III) stopers
(IV) Wagon

(I) Jack hammer

A jack hammer is a hand held un mounted drill used for drilling vertical holes downwardly. Jack hammer may be mounted on airleg. Jack hammer is commonly used for dry drilling and can be adopted for wet drilling as well.

- Weight = 15 to 25 Kg
- Hole depth = 3 meter
- Diameter of hole = 25 to 37 mm

(II) Drifter

A drifter is a mounted drill generally adopted for horizontal drilling which is extensively used fore mining and tunnel driving work for wet as well as dry drilling. It is heavier than jackhammer drill.

(III) stoper

A stoper is a drill for drilling upward. It is used normally for wet drilling. It derives its name from its widespread used in mine stopes.

(IV) Wagon drill

A wagon drill is a essentially drifter type drill capable of movement up and down vertical guide and mounted on a portable frame fitted with two wheels. The hole diameter from 50 to 100 mm (6") & depth ranges from 3m to 15m.

Field up application of rock drills

The hole diameter is normally 100 mm.
The hole diameters are ranging from 1" to 4" diameter but in case of wagon drill it is 6"

For drifter – 1" diameter
For stoper – 2" diameter
For wagon drill – 6" diameter.

These are deployed to bore hole in hard, firm and stable ground conditions.

Jack hammer drill

Different parts

(I) Air entrance
(II) Throttle valve
(III) Automatic valve
(IV) Ratchet and powl mechanism
(V) Air distributer
(VI) Rifle & twist bar
(VII) Cylinder
(VIII) piston
(IX) Rifle bare nut
(X) chuck driver
(XI) chuck
(XII) Retaining Holder / clamp
(XIII) Drill steel

Sketch

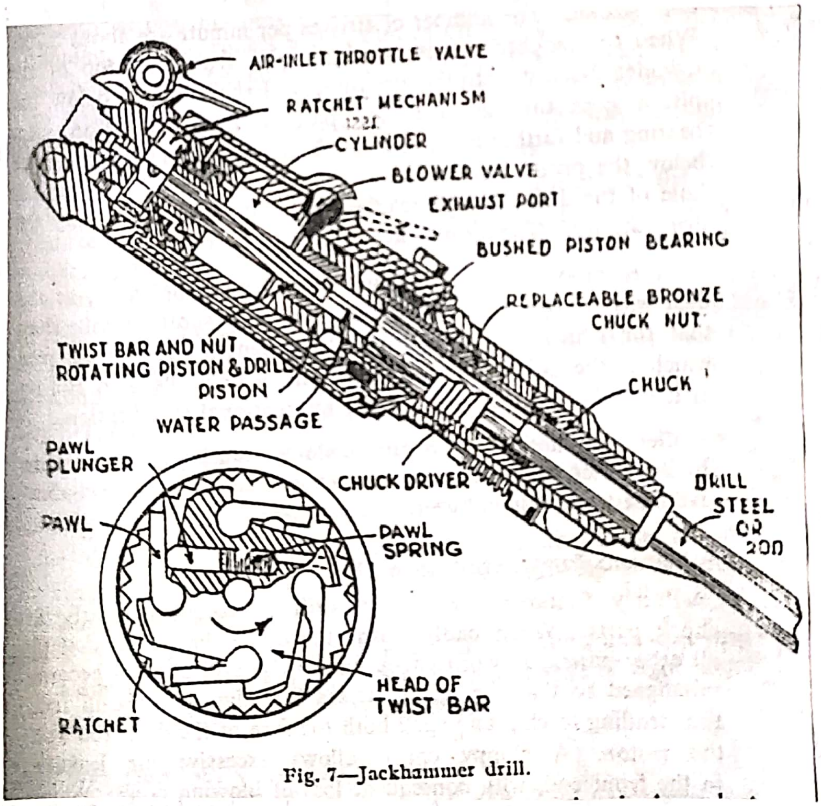


Fig. 7—Jackhammer drill.

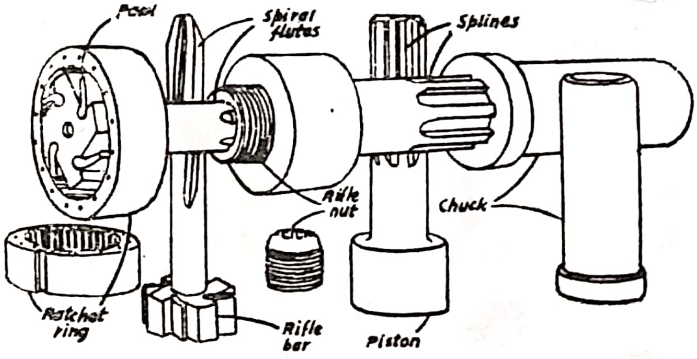


Fig. 4.1. Exploded view of rock drill.

Working principle of Jack hammer drill

Compressed air from delivary pipe comes through a hose pipe and enters the drill through curved metal tube with swivel connection. The speed of the drill is manually controlled by throttle valve which regulates the quantity of air. The air passage is passed through the powls on the rifle bare in to an automatic valve which directs the compressed air alternately to the top and bottom of the cylinder.

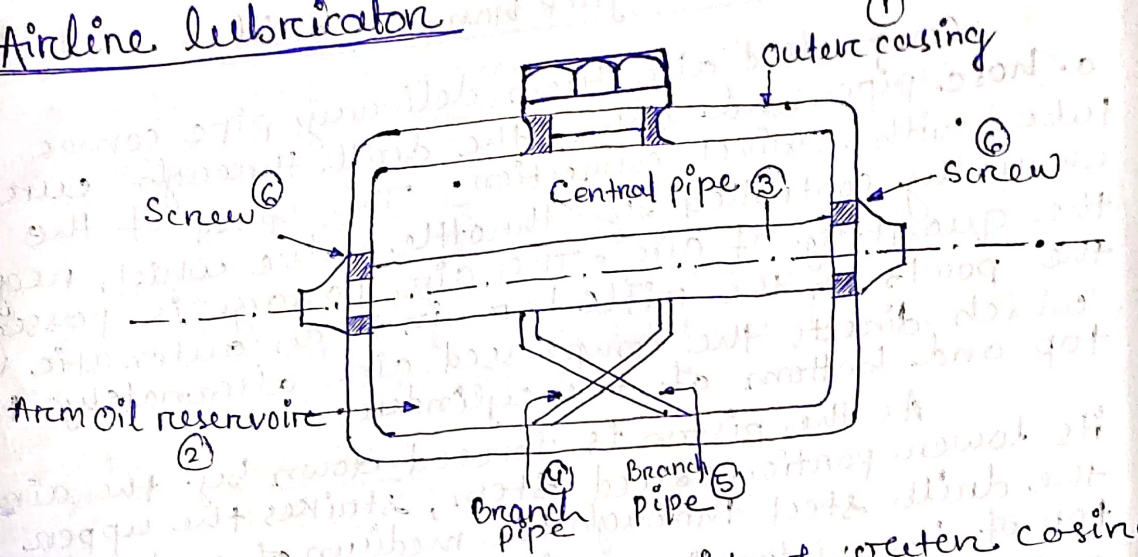
As the piston is forced down by the air pressure, its lower pontion called stem, strikes the upper end of the drill steel through the medium of a chuck. On the top of the piston is a rifle bare nut having splines which match with those of the rifle bare. These splines are not straight but slightly twisted or inclined.

The upward movement of the piston is also by compressed air entering the bottom of the cylinder through the automatic valve located on the upper pant of the rifle bare. As the piston moves up, the rifle bare splines accepts a twisting force on both rifle bare and the piston. The rifle bare is held by the ratchet and thus compelled the piston to turn. On the downward stroke of the piston, the rifle bare turns. The piston therefor experienced slight rotation during the compleated cycle of one up and down stroke.

The stem of the piston has straight splines corresponding with those of chuck driver. The twist which the piston undergoes in each cycle of up and down movement is transmitted through stem to the chuck drivers, through it to the chuck and through the chuck to the drill steel. The drill steel therefore receives hammering during each down stroke of the piston and between successive stroke, it receives a straight twist. So that the drill bit strikes new suntace of the rock during each stroke.

Exhaust From below the piston goes through a drilled passage in to the piston stem bearing and further along the chuck driver splines in to the space below the piston stem. Therefore it enters the central longitudinal hole of the drill rod and reaches the drill bit to clearc away the drill cuttings and air also keeps the bit cool.

Airline lubricator



Airline lubricator consists of outer casing ① containing inside arem oil reservoir ②. Air flows through the gaps between the outer casing and oil reservoire. The central pipe ③ having two branches ④ & ⑤. is free to rotate and hence the branch pipe always occupy the bottom piston and are impreges in oil respectively the position of the casing. The compressed air flaming through the lubricator develops a positive pressure on the left hand side of the pipe ③ and neptive pressure on the right hand side. This causes a small flow of oil through pipe ⑤ in to the out going air stream. The oil consuption can be regulated by adjusting the screw ⑥.

Frictional wear in a drill is confind mostly to chuck pcarts, When body worms the chuck bearings to destroy all parts. A worn chuck allows the drill string to became allign. so that the piston strikes the edge of the drill rod. Thus tends to chip & spall both the face of the drill riod & the piston. A slopy chuck allows excessive air leakage in the front end resulting loose of blowing power which ends the rotational difficulties.

An oil bottle and the lubricator is used in the air line to supply lubricating oil to the drill when it is working. The oil bottle is placed between the air receive tenk and the drill but it should be as close to the drill as possible. As the air and oil may seperate almost completely in (3-5)m, oil from oil bottle is blow in to a fine spray when compressed air passed through the hose pipe and the spray is carried to the drill along with the compressed air. The oil bottole has an arrow and it should be connected to air hose pipe that the air moves in the direction of arrow. The oiler is automatic and operated

by the flow of air.

To know whether the drill getting enough oil, hold a smooth surface infront of the exhaust port while the drilling is running. It will collect a thin film of oil in a short time. If the machine is getting adiquate lubrication of full oil bottle last 3 to 4 hour. It is reqquired to add about a quaten cup of oil directly to the air intake of the drill before connecting the hose. This takes up the time lag between the starting of the drill and the movement when the oiling device takes air.

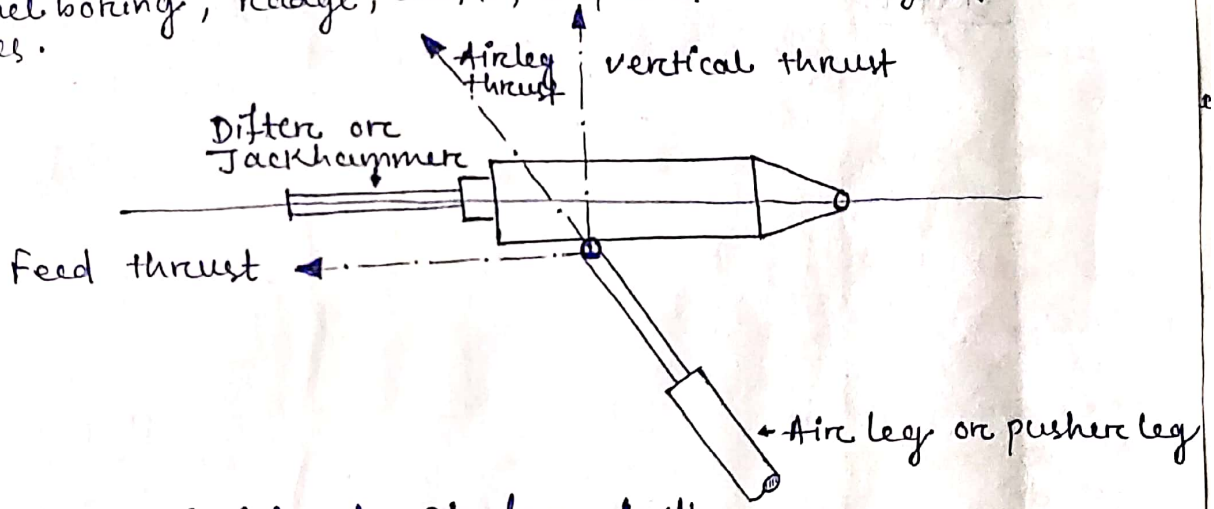
The oil, suitable for lubrication are shell clavues 27 Tonaf, Shell A11, Essar grade tron65, Caltex Capell oil B or mobile almooil NO3.

Air leg drill

Field of application of air leg drill

Airleg drill is suitable for drilling horizontal shorts blast holes upto 1.5 m i.e 5'.

Application of air leg drills are drilling blast holes, tunnel boring, raidge, drift, stopes & in underground metal mines.



Working principle of air leg drill

Air leg drill with air feed leg / pusher leg, jackhammers are deployed for tunnel driving for general sub level development. It is suitable for drilling horizontal short blast holes upto 1.5 m (5') long holes.

Airleg consists essentially of a cylinder in which there is a piston with its rod extended through the front end. At the bottom of the cylinder there is a centre end and steel pin is to keep the device steady on the floor. A Y-pipe is incerted in the air hose to supply compressed air to the drill. The air passed through the control tumbler and push bottom valve (for momentary air pressure released) and the hollow piston rod to the bottom of the cylinder. The tumbler enables the air in the cylinder to be regulated.

exactly that required to support the drill and furnished the feed pressure. The thrust which can be exerted by an air leg depends on the air pressure and diameter of its cylinder.

As the hole gets deeper the air leg lies over at more & more of an angle. So that the feed thrust decreases. The vertical thrust must be maintained to balance the rock drill weight, least its start to hand on the steel with the collar of the hole as fulcrum. The thrust required for air feed depends upon the rock drill piston diameter and the line pressure.

Wagon drill

field of application of wagon drill

Wagon drill is applicable for boring in hard, stable and firm ground up to the depth of 15 m & diameter is 6". Wagon drill used cross chisel detachable bit and drifter empcarting 1500 to 1800 blowes per minute.

sketch

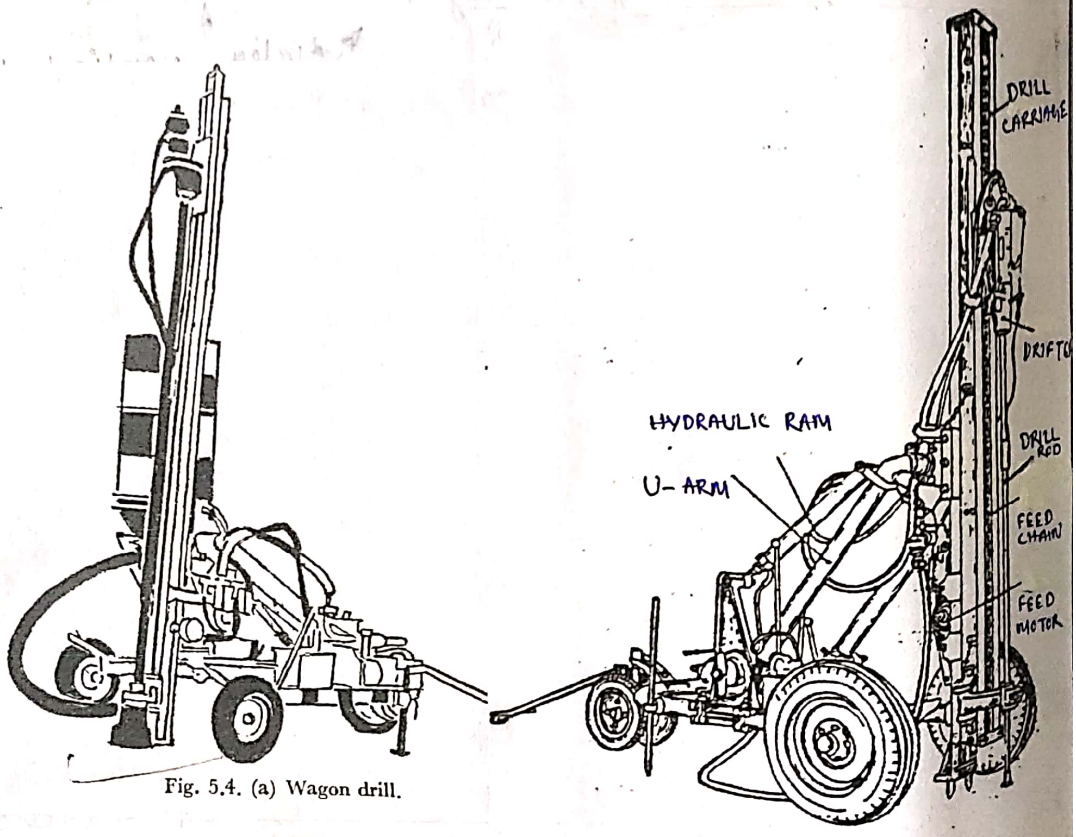


Fig. 5.4. (a) Wagon drill.

Fig. 4.50—Wagon drill

Working principle of wagon drill

Compressed air drill mounted on mobile frame is known as wagon drill. The frame may be wheel mounted or crawler chain mounted. The drills is used for blast hole purpose of diameter ranges from 50 mm to 100 mm for a depth of 3mt to 15 mt. The differ on the wagon drill works same as jackhammer but it has provided with four levers. out of which one reverse the rotation keep on steady when the lever is in nutrial position. Another lever is provided for the movement of the mast i.e up and down. The third lever is provided to give rotation to the drill string. The fourth lever is provided to imparting hammering action on the bit and used as flushing lever to remove the cuttings and cools the bit.

The mast is about 3m long. Hence the tower of drifter is also 3m. The mast of the wagon drill is capable of travelling from vertical to horizontal and vertical or inclined drilling up to 40°. The mast can be raised or lowered through a vertical distance of 01m by hand operated cranking lever. The U-frame is mounted on three wheels, out of them two wheels are of longer diameter and attached at the front side of the U-frame Another one i.e back side wheel which is smaller in diameter. The travell of drifter up and down the mast is by chain operated by a air motor. The feed during drilling can be varied to suit the hardness of the rock. Drill cuttings are removed to the surface by 4th lever which is provided to regulate the quantity of air to drill rod for wagon drill around having 35 to 37 mm in diameter & length from 01 to 03 m during drilling. The drill rod is hanged with drifter by keeping the rod steady and running the drifter for a little feed. In reverse operation the rod rotated in anticlockwise direction.

Churn drill

Field of application of churn drill

Churn drill can be suitable for medium hard to extreme hard ground condition. It can be also used for soft alluvial formations using casing.

churn drill is unsuitable for boring in clay, mud and soil (Black cotton) etc due to less rate of penetration.

Types of churn drill

Churn drills are two types

(i) Spudding beam type
(ii) Walking beam type

spudding beam type used for shallow depth and it is lighter in weight.

Walking beam type used for deeper holes and it is heavier in weight.

In cable tool churn drill method the penetration of ground is acheived through or by a succession blows made by the boring tool which is chisel type. Between the blows the tool is rotated slightly to mentain the position of the cutting edge relative to the ground and mantain the circular shape of the hole. The rate of penetration depends on the nature of the ground, weight of the tools, the height to which they are raised on each stroke, the type of the cutting bit and the no. of blows/stroke per minute.

Cable tool rig / cable tool churn drill

The principal components of cable tool churn drill are,

(1) Frame - The main frame is made up of welded steel. All the mechinaries are mounted on the main frame. power is transmitted from engine to machine by belt.

(2) Spudder - The spudder is in the centre of the frame and it is supported two bearings mounted on the centre I-Beam.

(3) Bull reel - The bull reel hoist and lower the drilling tools in to the well.

(4) Casing reel - It is called calf reel. It is used to hoisting and lowering the casing string. (casing pipes)

(5) Sand reel - The sand reel is used to hoist and lower the bailer which removes the drill cutting from the bore hole.

(6) Mast / derrick - The telescopic type structural steel mast or derrick is used for hoisting and lowering of drilling equipment.

(7) pit man - The pitman arms connected the ends of the spudding beam / walkingbeam to the crank. The spudding or walkingbeams impact the reciprocating up and down of the drill string.

⑧ Counter shaft - It is provided with a disc type clutch for providing bull reel, casing reel and spudder etc.

⑨ Cat head - Generally used for moving heavy material at the job location.

⑩ Prime mover - steam engine, I/C engine, generator operated I/C engine or direct AC or DC motors can be used as source of power for cable tool drilling.

⑪ Drill string - The tool is used in cable tool drill string comprise a drilling bit, a stem, a drill jar and rope socket.

ⓐ Drill bit - Bit normally have screwed joint provided at the top and below the collar of the joint. The bit is up square or rectangular section to allow the application of range. Various types of bit having cutting edge are available to cut rock.

ⓑ Drill stem - It is used above the bit to give additional weight to the bit. so that the bit will cut the rock

ⓒ Drill jar - The two parts of the jar telescope or side within each other the distance of travell either way is from 4" to 8", it helps to give slight rotation to the drill string. The sharp jerk which the jar gives to the bit on the upward stroke prevent the bit and stem from sticking on the hole.

ⓓ Rope socket - The uppermost member of a string of tool is the swivel rope socket. This consists of an inner portion to which the rope is attached and an outer cylinder to the bottom of which one of drill jar is screwed.

Working principle of cable tool churn drill

Cable tool churn drill utilise the principle of freely falling of chisel bit (weight) to deliver blows against the bottom of the hole by the movement of the spudding / walking beam. The lifting and droping of drill string developes the mechanical energy that breaks up the ground formation and bores the hole. Drilling in this system is accompained / accomplished by a tight line, so that the bit strikes the bottom of the hole when straight cause it to give turning action to the drill string by the rope socket to strike the bit on new surface. Then the drill string is withdrawn from the hole & 2 to 3 bucket of water is to be poured in to the hole to moist the cuttings form sludge. After few minute a bailer is lowered to the bottom of the hole for cleaning the sludge. Tools for bailing, drilling & casing lowering are carried out on seperate lines

or cable on indipendant reels or drums and passes through the sheaves fitted on the mast.

The boring system is carried out with the help of a casing pipe to prevent the caving of the hole. The pipe is driven with the drilling tools, the drive clamp and the drive head. casing pipes are generally needed to be incerted telescopically. This triple action of drilling, removing cuttings and drilling down the casings continues and the cycle is repeted up to the requlired depths to be bored.

figure

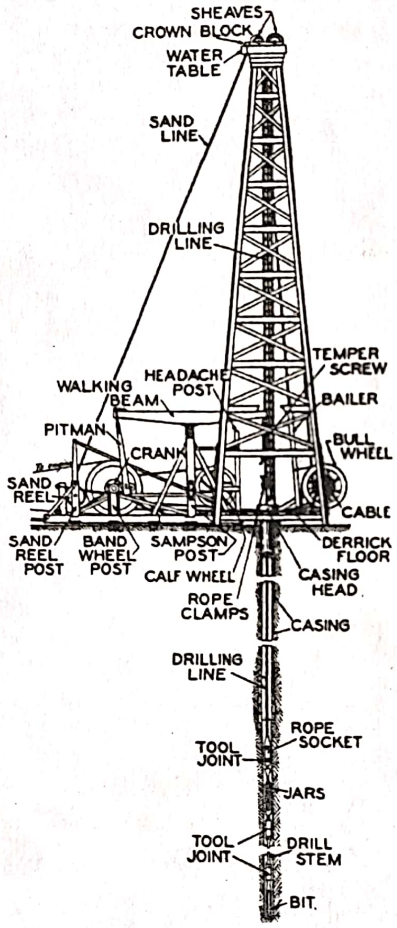


Fig. 4.1. American standard cable tool rig. After Brantly,[2] courtesy AIME.

varicocs tepes of mountings

(i) skid mounting
(ii) crawlerc mounting
(iii) Mobile frame mounting
(iv) Jeep mounting
(v) Truck mounting
(vi) Trailerc mounting

Various types of feed arrangements

Various types of feed mechanisms are as follows

(I) Air cylinder feed
(II) Motor feed
(III) Mannual feed

(I) Air cylinder feed

With pusher leg sinkers are deployed for horizontal drilling. Airleg is suitable for feeding up to 1.5m or 5'

Air cylinder feed are two types -

(a) Bench feed, (b) Auto feed

(a) **Bench feed** - used for long hole drilling in mines and water well drilling. It is suitable for holes up to 15-25 meters.

(b) **Auto feed** - It is used for mechanised drifters and tunneling

(II) Motor feed

It includes (a) Chain feed, (b) Screw feed, (c) Hydraulic feed

(a) **Chain feed** - In this system a chain running between two channels and powered by an air, electric or hydraulic motor driving a sprocket through a worm and worm wheel type gear box. The chain is attached to the travelling drill mounted which runs on the top of the channel.

(b) **Screw feed** - This feed is air powered. The feed screw used for drifters and diamond drills depends on the advance of feed not along the length screw. When the feed screw is rotated and held in one plane, the drill is attached to the feed. The feed screw is rotated making the drill move forward.

(c) **Hydraulic feed** - This feed can be used with both light and heavy rock drills. The rock drills are mounted on craddle which is powered by hydraulic cylinder which draws the machine craddle along the feed by means of a chain. The chief advantages of this feed is the smooth step controls of both feed force and feed rate with a damping effect on rock drill recoil.

(III) Mannual feed

While operating a rock drill thrust is provided by manual effort. Sufficient thrust weight has to be applied to mantained an equilibrium between rebound of the drill and frictional drag of the drill string.

Manual feed has to apply for hand held designed rock drills. When manual feed becames unbearable deployment of feed mechanism are nedded.

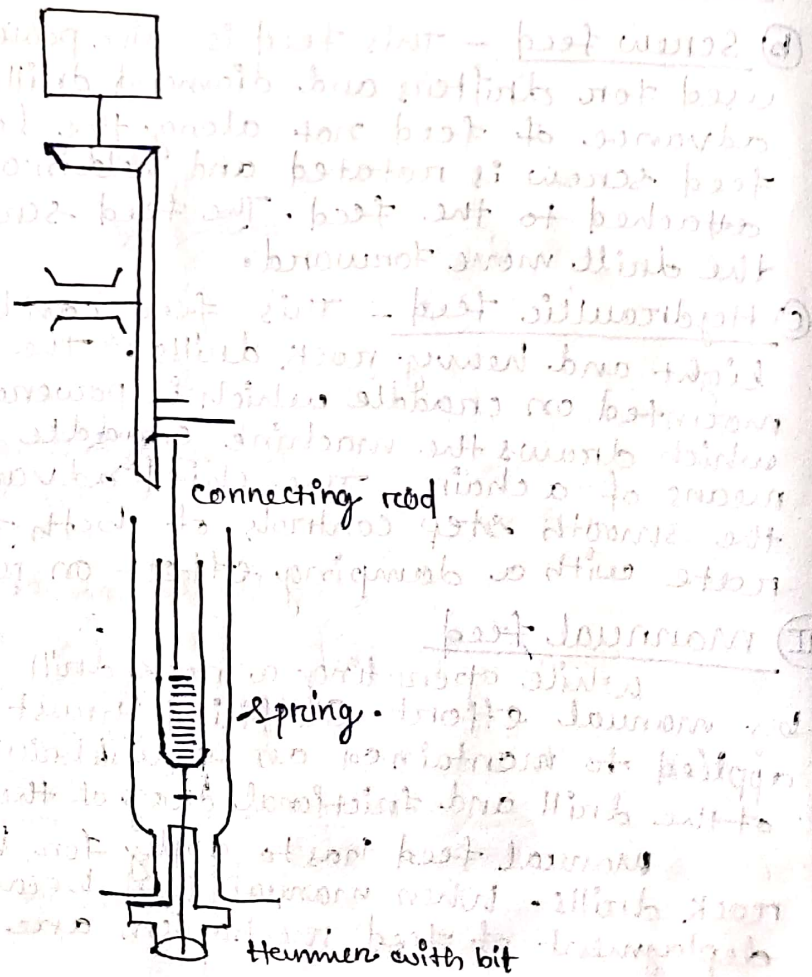
Working of electrically operated blast hole drills

compressed air power is costlier and compressed air machineries are less efficient. That's why development work has been going on for perfecting electrical drill hammers. Though electric hammer have been produced, these drills have not come to the steage of replacing prematic hammer drills. One of such drill is claimed to be able to drill 3.6 meter deep holes with up to 50 mm diameter. It has an independant rotary system going a rotational speed of 80 rpm and a percussive system that give 1400 blows per minute. The machine can be run on normal frequency (50 cycles/sec) or high frequency (200 cycles/sec) AC or DC power supply.

Electric hammers are of two main types

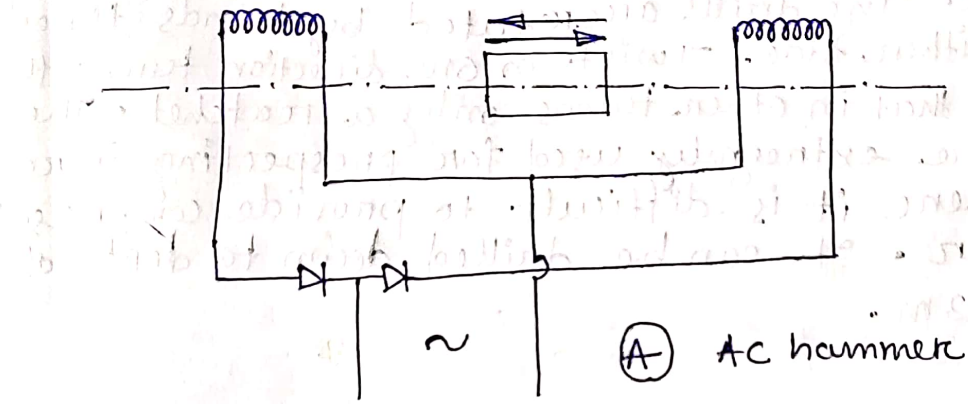
ⓐ Electromechanical type
ⓑ Solenoid type

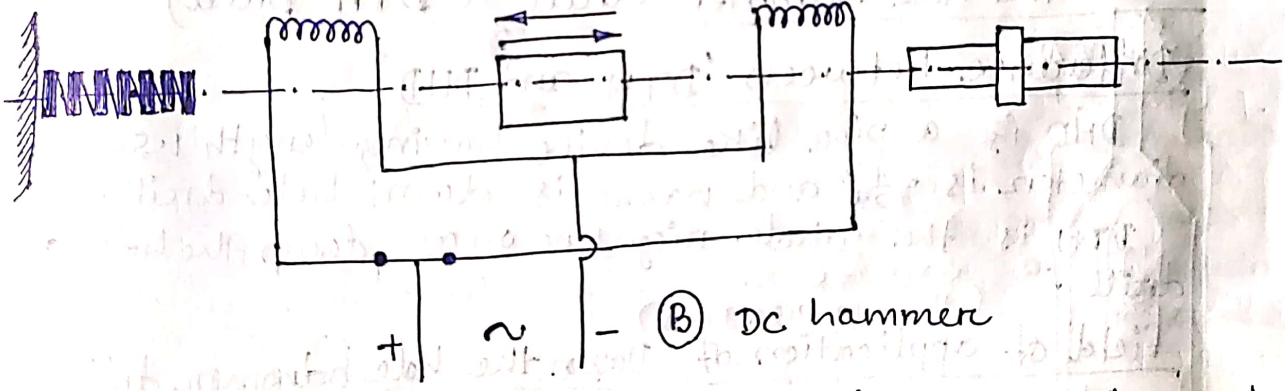
ⓐ Electromechanical type



The rotary motion of the electric motor is converted to reciprocating motion through eccentric screw mechanism. In eccentric type the hammer is connected to the eccentric by a connecting rod through a spring, for increasing force of impact. Such hammers are reliable but are heavier than pneumatic hammers of corresponding power.

(b) Solenoid type





Solenoid hammers are simple in construction and consists of a hammer that moves in alternate magnetic field created in two coils. At the end of back stroke the hammer is stopped by a spring. Such hammer can work on AC or DC supply.

Figure A shows an AC hammer where the two windings are alternately excited with current from a rectifier. During half of one cycle, the current is supplied to the one winding & during the corresponding half of the next cycle to the other.

Figure B shows a DC hammer. The windings are switch on and off by a mechanical switch, the contact of which turns quickly. Solenoid hammers are reliable & have long life.

Petrol driven drills

These are operated directly by two cycle petrol engine using only one cylinder. Explosion on the top portion of the cylinder drives the free running piston down on the anvil block which transmit the blows to the drill steel. A cam operates a circuit breaker and fires the next charge. The engine exhust maybe used to flush the hole or a seperate light portable compressor may be used for air flushing of the hole. The drills are rotated by hands through 90° on either side. Twist in one direction turns the bit while that in other turns only a ratchet. These drills are extreemly used for prospecting in remote area where it is difficult to provide compressed air power. It can be drilled down to depth of 2.5 m to 3 m.

Down the hole hammer drill (DTH Drill)

Difference between DTH and DHD

DHD is a pipe like device having length 1.5m and diameter is $5\frac{1}{2}$" and name is down hole drill.

DTH is the whole rig known as down the hole hammer drill.

Field of application of Down the hole hammer drill

DTH / Down the hole hammer drill are used for rock drilling, tube well drilling and oil well drilling.

for rock drilling any types of hard formation including quartzite, granite, chert, basalt etc can be drilled by DTH drill. It can be deployed for blast hole drilling in both underground & surface requirments.

for blast hole drilling -
Hole diameter = 1' to 4' & depth = 15 m to 150 m

for oil well drilling -
Hole diameter = 40" & depth = 1 Km to 1.5 Km

for seismological prospecting -
Hole diameter = 40" & depth = 30 m

for water well drilling -
Hole diameter = [illegible] & depth = [illegible] to 150 m

DTH Drill

The different units of DTH Drill (Down The Hole Hammer Drill) are as follows.

(1) Mountings - DTH rig are mounted on mobile frame, crawlers, Trailers, Truck, Jeep etc according to their capacity to bored depth of the hole for easy movement of the rig.

(2) Prime movers - IC engines, electric motors (AC/DC), IC engines operated gensets may be used as a source of power for the drill and the compressor.

(3) Compressor - Rotary vane type or reciprocating compressor is used to supply the pneumatic power to the different unit of the rig.

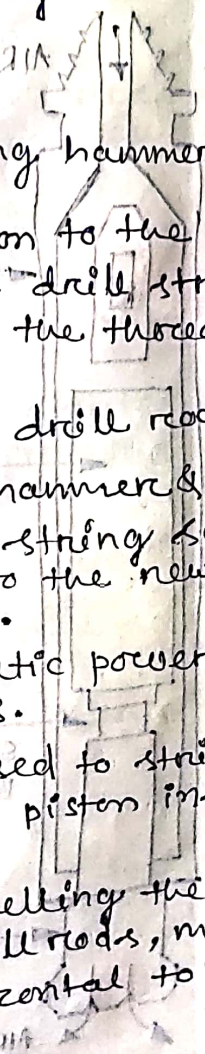
(4) control pannel - It has been provided with some lever for imparting hammering action, rotary motion, hoisting and lowering of drill string, Raising of the mast from horizontal to vertical position and lowering of the mast from vertical to horizontal position.

(5) Mast - The mast is use to give vertical clearance for hoisting and lowering of drill string.

(6) Rotary head - Its function is to give,
(i) Rotation to the drill string.
(ii) Allow the flushing air for imparting hammering action on the bit.
(iii) It helps to give up and down motion to the drifter
(iv) It helps in hoisting and lowering of drill string.
(v) It also used to tighten and loosen the threaded joints on rods, bits etc.
(vi) It help full in pulling the jammed drill rod.

(7) Drill string - It consists of drill rod, hammer & bit.
(a) Drill rod - Drill rod rotate the drill string so that the bit will strike hamering action to the new surface of the bottom of the hole for all times.
It also convey the pneumatic power to the hammer & to flush the cuttings.
(b) Hammer - The hammer or DHD is used to strike the blows on the bit sank directly by a piston inside it.
(c) Bit - It is use to cut the rock.

(8) Hydraullic pump - It is used for levelling the rig with jacks, pulling the jammed drill rods, making the mast vertical to horizontal & horizontal to vertical position.



(9) Water pump - It is also being provided in the DTH rig for supply water under pressure to clean the different units of rig as well as tools and to supply foam for flushing of sticky material.

(10) Jack - There are 4 jacks on the 4 corner of the rig to keep the rig in levelled position.

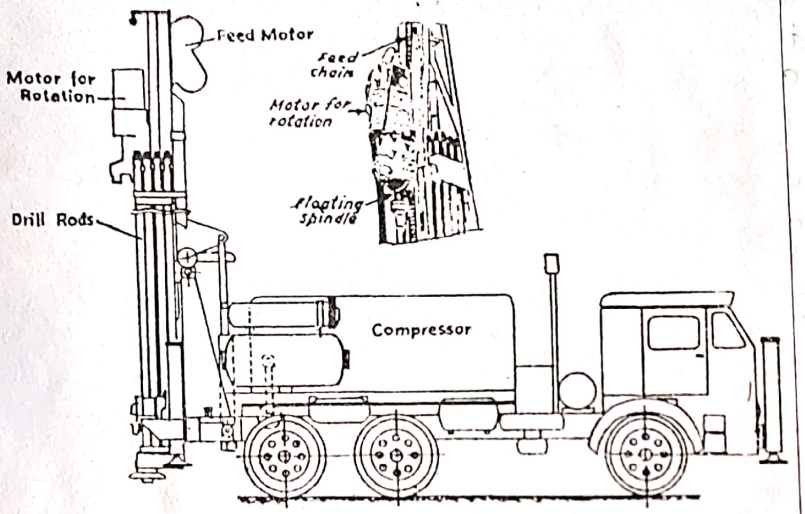
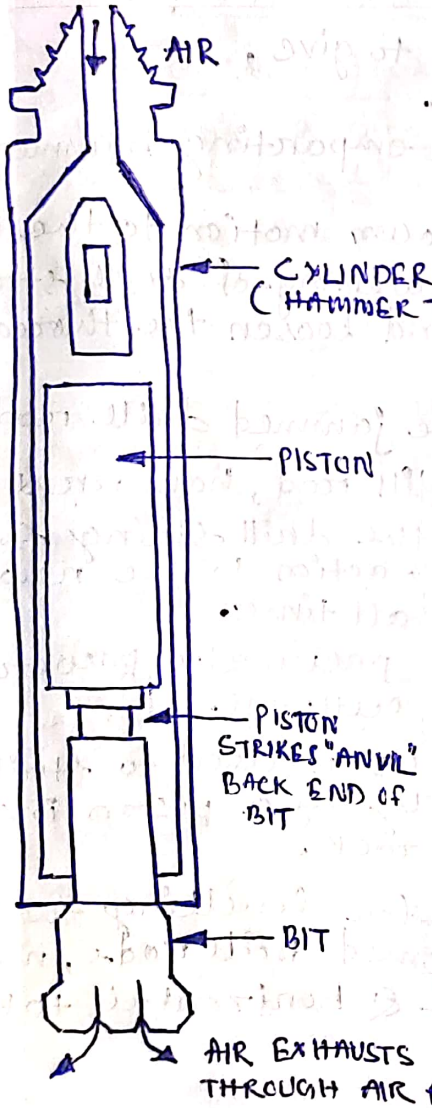


Fig. 5.9. DTH drill with air motor drive.



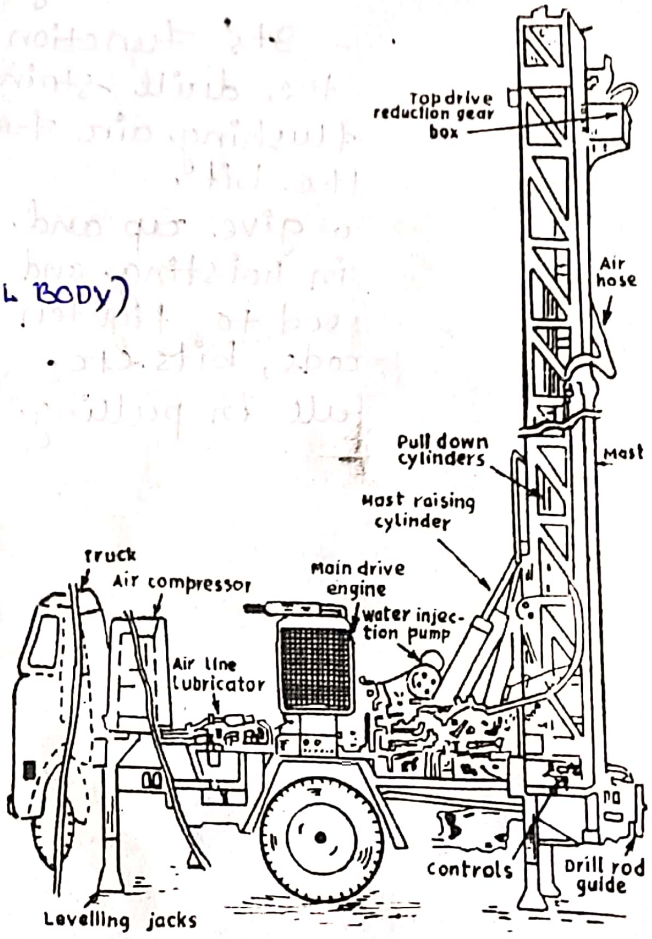


Fig. 5.10. DTH drill with hydraulic motor drive.

Drilling operation with DTH drill

Drilling operation carried out with a DTH drill as per the following sequence of order -

priliminary operation

- Set the rig on borehole point.
- Bring the rotary head to the bottom of the mast.
- Raised the mast from horizontal position to vertical position by manipulating the hydraullic pump -
- With the help of hydraullic pump manipulate the rear leg jack and keep the spindle of the rig in leveled position by observing the reading of clinometer attached to the mast.
- Level the front end of the rig by levelling the two jacks on the front side and see the rear side in leveled position or not.
- Conduct the daily checking operation to all check points and if there is any shortage of water fuel or lubricant etc refill them.
- close the outlet valve of receive tank.
- Disengauge the clutch from compressor to primemover & keep it in neutral position.
- Check the battery connection of self starter and crank the motor to run the engine. The engine should not be run continuously for 90 seconds.
- let the engine to be run for worming up upto 2 minute read the meter fitted for engine that they are in working condition & safe condition.
- When the constant tuning of engine heard, run the compressor by engeuging the clutch.
- let the compressor to be run for few minutes. It will start air pressure to built up inside the receive tank - When required pressure in the receiver tank obtain, the compressor automatically run smoothly with out high sound wave.
- Keep all the levers in neutral position and see that no lever should be in engauge position.
- Come to operating place. Now you have adequate power use it properly.

Drilling operation

To carried out drilling operation the following procedure is to be followed.

- Raise the rotary head to the top position of the mast rotary head has box thread -

- Bring a drill pipe and fix it to the pin thread of the rotary head to give the drill pipe.
- place a timber on the hole point & bring the DHD fitted with bottom bit & keep it in vertical position. Lower the rotary head with rod to attached with the drill pipe with DHD and join DHD by manipulating the rotary lever.
- Test the DHD on the wooden block by manipulating the flushing lever to know whether the piston is imparting hammering action or not. If it is ok, then raise the rotary head slightly up the surface with DHD.
- Remove the wooden block & give feed to the drill string with flush.

Steps taken to minimise the noise of hammer drill

Hammer drill emits a high intensity of sound over a wide frequency range. person exposed to a high sound level in the high freequeency range for a long period have their hearing power impaired.

A safe sound level for a life time of 8 hours daily exposure is 95 decibel of freequency not exceeding then 425 cycles.

The intensity of sound of a machine operating by an operater depends on the surrounding. In open air the intensity at the ears of the operater is much less then a confined space. The intensity of sound is depends on the surroundings. While in open air intensity of sound drops by about 4.3 decibel per meter distance from source. In 2.4 m * 2.4m untimbered drift, the rate fall in sound intensity is 1 decibel per meter distance.

Rock drill produce sound level generally in excess of 100 decibel.

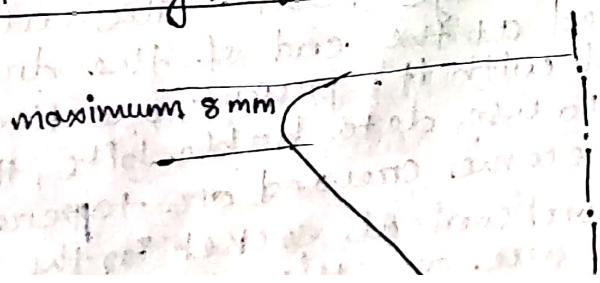
The sound source in rock drill can be classified as (a) Due to the jetting action of the exhaust. This is common to both hammer drill and pneumatic rotary drill.
(b) Mechanical noise in the drill.
(c) Noise due to the vibration of drill steel and bit.

Exhaust noise can be sucessfully muffled by providing a long exhust hose that carries the exhaust away from the drill or by attaching a commercial automative muffle at the exhust.

Mechanical noise has been substencially muffled by providing a sound proof covering over the drill.

It has however being difficult to suppress drill steel noise. Rubber collars were tried to this end but have not been verry sucessfull as they are not verry durable which may hamper the safety of workers.

Bit regrinding, gauge wear of bit & effect of gauge wear



Allowing greater wear before regrinding the bit causes greater carbide loss during regrinding. Beside this worn bit causes stress concentration in them and may lead to their failure. The rate of penetration decreases with blunting bit thus leading to greater stress in the bit. Wear of the cutting edges causes excessive gauge wear of the bit which became significant in highly abrasive rocks. Gauge wear reduces the normal clearance angle of about "5°" and produces an inverse tapper in the bit. Regrinding is recomended as soon as inverse tapper (measured from the extreme tip of the bit reaches at "8mm". Excessive gauge wear causes tortional loading of the incert because of lateral restriction. It also thrust back the impact stress to the drill string and even in to the drill orc rig, thus affecting their life. forbit of largen diameter, different limit of wear are recomended before regrinding.

Example

A 150 mm diameter corcss bit is recommended to be regroind when there is a wear of 5 mm at a distance of 5 mm from the periphery of when the gauge wear produceses a curviature on the side with a radious equal to 5 mm.

Grinding of TC incerts should be done with course and soft grinding wheel formed by bonding silicon carbide particles in a relatively soft ceramic binding material.

Drill steel

It is a drill rod of which one end having cutting tools and another end having a shank to fitted in the chuck.

The term drill steel applies to the drill rod which is shanked at one end to fit into the drill chuck and is provided at the other end with a suitable cutting edge orbit. The cutting edge on bit are formed at the end of the drill steel itself and is integral with it. present practice, however, is in general to use detachable bits, the end of the drill string became crewed or tappered to fit in to the screwed or conical socket in the rod. Such detachable bits are oviously more convinent for transporting, for changing bit during drilling operations and for resharping at the surface.

Drill steel range from 1 to 14 inch diameter and are normally made in lengths of 20, 40, 60, 80 inch. The crossection is generally hexagonal & sometimes round. plane hollow steels are generally used to enable the cuttings to be cleared out by a jet of air or wet drilling to be adopted supress dust.

Composition of good drill steel

The type of steels used may be a plain carbon to steel containing 0.65 to 0.85% carbon, 0.15 to 0.18% silicon, 0.30 to 0.35% manganeese and as little sulpher and phosphorous as possible.

Sulphare causes brittleness when hot and phosphorous causes brittleness when cold.

A nickel-chrome molybdenum alloy steel maybe used which is stronger & has a long life.

Design of drill steel

The design of cutting edge of bit are different to suit different types of formations. The designs are single chisel, double chisel, cross chisel bit, rose bit, oblique cross bit, z-bit etc.

Single chisel bit is used for soft ground of even structure.

Double chisel bits are suitable for medium hard ground.

cross bit is used for hard ground.

oblique cross bit for hard ground but more difficult to sharpen.

Rose bit is used for very hard ground.

Z-bit is suitable for soft medium ground.

Forging and hardening of carbon steel bits

The cutting edge in integral steel, the shank & bit must first be forged to the required shape at a temp of about 1000°c (bright orange). The heating preferable being carried out in a special temprature controlled furnace and the forging continue up to a/ down to a temp. of 850°c (dark orange). There after the steel should be allowed to cool slowly in air or in oil.

To harden the cutting edge it must be heated to a temp. of 750°C to 800°C (bright red) and cooled off rapidly by either

(a) Deeping the cutting edge in water until it cools down to 300°C (Black) & then quenching the whole tool in water.

(b) quenching the tool in a suitable quenching oil.

(c) In some cases the heated bit is first partially cooled & is then withdrawn.
It is now cleaned rapidly & the heat from the rest of the tool is allowed to flow back & reheat the cutting edge until the right tempering heat of about 230°C (straw colour) is obtained

The 1st & 2nd method are purely hardening process while 3rd is a hardening and tempering process.

Advantages & disadvantages of integral steel

Advantages

- They are cheaper than the steel and detachable bit together.
- Regrinding is simpler.
- With integral steel it is possible to drill smaller diameter holes because of the smaller steel size.
- Withdrawl of the rod from the hole is easier with integral steel.
- The absence of joint between the steel and the bit increases the overall strength of the steel as well as results in more efficient energy transfer to the bit.
- There is no. of problem of detaching the bit from the steel which may sometimes need special bit detacher.

Disadvantages

- With integral steel the whole steel has to be carried for regrinding while with detachable bit may the bit needs to be transfered/transported.
- For deep drillings holes in reletively hard rock which may requires several regrindings of the bit during the course of drilling the hole.

- Bit failure makes the steel useless in integral steel. In case of detachable bit, bit failure of the steel at the bit end needs only cutting of new thread or turning a new taper.

physical properties of rock and minerals

physical properties of the rock or minerals are includes the colour, hardness, specific gravity, grain size, porosity, permeability, degree of fracturing, jonting cleavability, friability etc.

Ore having colour distinct from that of waste rock are easily enable to shorting. Softer ores are easier and cheaper to mine. A substencial difference in sp. gravities ore and waste helps in concentration of the former. Grain size determine by the method of concentration and recovery of value.

porosity and permeability of the mineral deposit determine its likely water content and water inflow during mining. some deposits i.e limestone admit much water inflow.

Degree of fracturing, cleavability, friability etc of the rock or mineral body are of great importance since they are determined the percentage of fines produced during mining. Highly fractured, cleavable or friable rock or mineral deposits producing larger portions of fines. Degree of fracturing, cleavage etc also affect the degree of fragmentation in blasting as well as the strength of the ores.

Drillability of rock

generally defind as the rate at which it can be drilled or the time taken to drill a unit depth of the hole. (say time taken to drill one meter into the rock)

concept

The rate of drilling in a rock is as much governed by the rock characteristics as by the drilling condition such as shape, size and the material of the bit, no. of cutting edges, applied thrust, rotational speed, the efficiency of flushing & the power of the drill (power per blows x No. of blows per minute which in turn is a functions of the condition of the drill and compressed air pressure)

provided the drilling conditions are kept constant the rate of drilling is depends on the rock characteristics which is expressed as a drillability of the rock.

In rotary drilling the drillability of the rock is mainly a fun of compressive strength and abrasivity of the rock. In percussive drilling the compressive strength

and elastic property of the rock mainly determine the drillability.

Rock Mechanics

Rock mechanics was defind by the committee on rock mechanics of the "Geological Society of America" in the following term.

Rock mechanics is the theoritical and applied science of mechanical behaviour of rock. It is that branch of mechanics concerned with the response of rock to the force field of its physical environment.

Mechanical properties of rock and mineral

The mechanical properties of rock for most purposes, the rock cheracteristics may considered as followes –

1. Petrographic properties
2. Elastic properties (static & dynamic)
   - (a) Young's modulus.
   - (b) Modulus of rigidity.
   - (c) poissions ratio.
3. Strength of the rock
   - (a) Tensile strength and modulus of rupture.
   - (b) Compressive strength.
   - (c) Shear strength.
4. Hardness and similar properties
   - (a) Selerscope hardness
   - (b) Abrassive hardness
   - (c) Mohr's hardness
   - (d) Impact toughness
5. Volumatric properties
   - (a) Aparent porcosity.
   - (b) Aparent specific gravity.
6. Other properties
   - (a) Fatigue
   - (b) Creep – viscosity or plasticity
   - (c) Thermal expansion
   - (d) Compressibility
   - (e) Grannular structure & strength

⑦ Behaviour of the rock under high confining pressure.

⑧ fundamental strengths of rocks.

⑨ Miscellaneous

ⓐ Drilling characteristics of rock

ⓑ Blasting characteristics of rock

Source of rock drill trouble & suggested remedies

Rock drill trouble chart

1	Rapid wear of rifle bar and/or rifle bar nut.	Usually due to faulty lubrication. May also due to grit in machine or contamination of oil.
2	Breaking of piston and/or rifle bar.	Usually due to the heat cracking caused by faulty lubrication & may also caused by bad steel shank or excessive chuck wear.
3	Spalling of piston face.	May be due to steel shanks having improperly shaped & badly worned chuck.
4	Breaking side rods.	May be caused by uneven tension of rods or by loose rods Usually caused by piston and/or spacer bushind.
5	Broken powls.	Invariably caused by the operater turning the rod/drillsteel in wrong direction with a pipe wrench in an effort to free stuck wheel.
6	Broken or battered water tubes.	Shanks are improperly punched or badly worn chuck.
7	Drill refuses to start.	May be plugged exhaust ports, valve stuck by gummy. Lubricants or chucked air passage due to dirt or rubber from worn hose lining.
8	Broken steel shank.	Usually caused by worn chuck
9	Drill refuses to rotate or weak rotation.	maybe caused by bad drilling ground, mud/clay, maybe due to worn chuck, chuck nut, piston rifle nut, rifle bar etc.
10	Drill does not have standard hoisting power.	May be due to short shank, short piston, low air pressure, air filter may be chocked.
11	Drill heats	New drill may heats due to close fits, heavy work load/lack of oil. may be due to faulty lubrication and hot air.

THANK YOU