



**MÁSTER EN INGENIERÍA
DE PETRÓLEO Y GAS**
OIL & GAS ENGINEERING MASTER'S DEGREE

COURSE DE3: DRILLING ENGINEERING

COURSE DE3.1

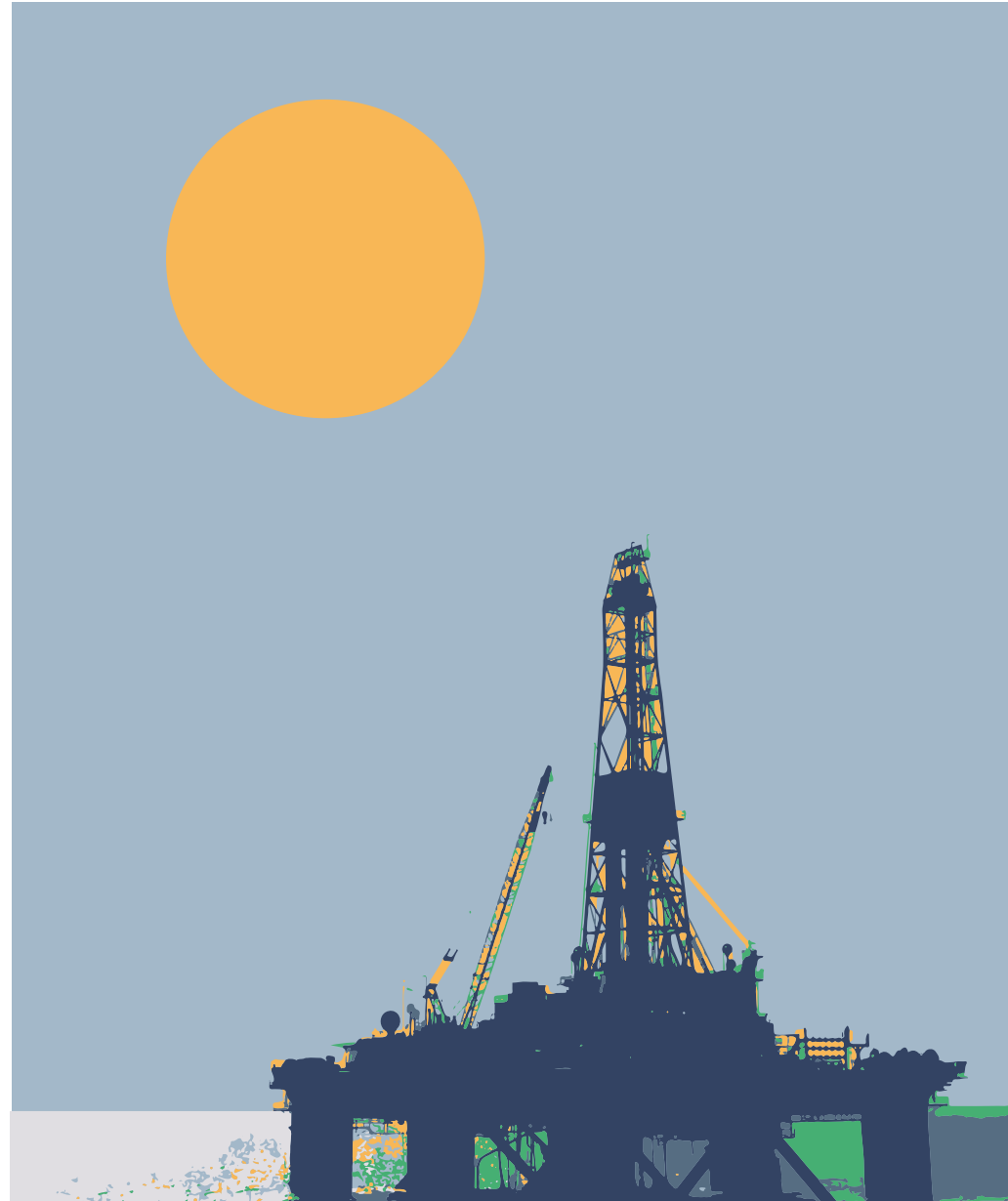
BASIC DRILLING TECHNIQUES

**Doc C: General Description of the
Drilling Site, Process and Equipment**

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Mining Technology Innovative Lab

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ORGANIZA:



COLABORA:



PARTICIPA:

HALLIBURTON





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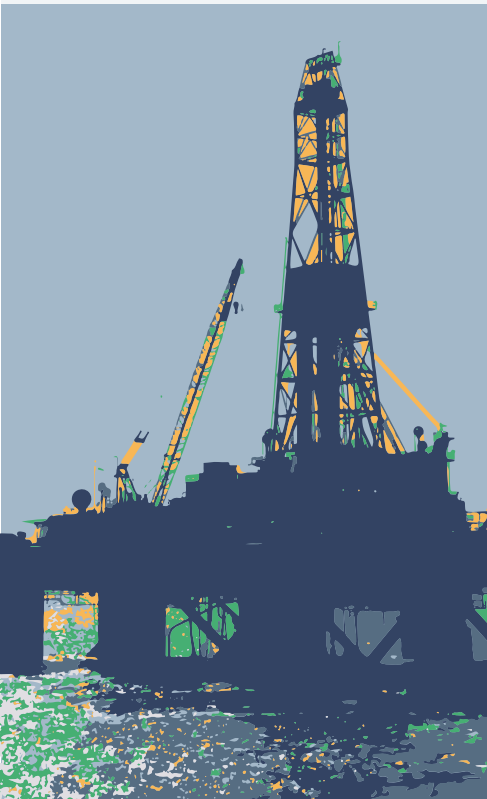
All the ideas here developed have a general and educational nature and the scope of use is limited exclusively to the training of UPM students. The response to a particular case will always require a specific analysis to be able to determine the suitability of the solution and the risks faced in each case, in addition to the incidents in operating costs. Always consult your trusted engineering, consultant, distributor and manufacturer in each case.



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1. Site preparation

- The first task in a well drilling project is to prepare the location.
- This starts by building a road to the site, clearing the area where the drill will be set and providing infrastructure for water and electricity.



- Once the location for the site has been established, the area is prepared for drilling, with the following steps:
 - Site Preparation
 - Clearing vegetation
 - Access construction
 - Leveling Site
 - Excavating and Trenching
 - Construction of the Conductor Hole, Rat Hole and Mouse Hole
 - Conductor Hole and Pipe
 - Rat Hole
 - Mouse Hole
 - Transporting Equipment
 - Transporting Equipment by Truck
 - Unload at Drill Site



- Before well drilling can begin, the company must clear vegetation and construct a pad for the drilling rig and other equipment used in preparing the well.
- Drill pad sites are often located some distance from public roadways. Therefore, operators must also construct an access road between the public road and the well site.



ENGINEERING
DRILLING TECHNIQUES
Application of the Drilling
Equipment

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POLITÉCNICA



- To prevent contamination of the soil or the water table during drilling, an earth pit is dug and lined with a thick layer of plastic to hold rock cuttings and drilling mud.



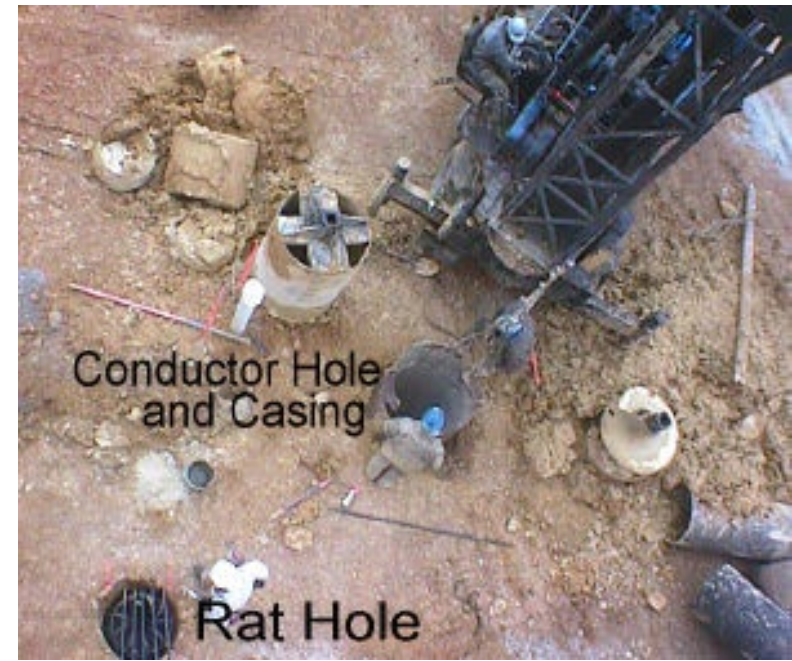


Yacimiento de Manifa (Arabia Saudí)

- The drilling process uses a large volume of drilling fluid that is circulated through the drill pipe and drill bit, then back to the surface.
- As the fluid returns to the surface, it carries the ground-up rock particles (drill cuttings).
- To manage the returning fluid and the drill cuttings, a reserve pit is needed.
- It must be located next to the drilling rig to catch the drill cuttings, used drilling mud to be discarded, and other materials.
- Some operators also construct **separate auxiliary pits that collect fluids that fall onto the area directly beneath the rig.**



- Next, a pilot hole is dug for the main hole at a precise location marked by the survey crew.
- Two other holes, the “mouse hole” and the “rat hole” are also dug in close proximity to the main hole to hold pieces of equipment and pipe during the drilling process



- After all the previous operations, it is time to bring in the rig equipment and proceed to assemble it.
- A rig capable to drill a 10.000 foot well requires 50 to 75 people and 35 to 45 trucks to move and assemble the rig, normally in about 3 days and a half.



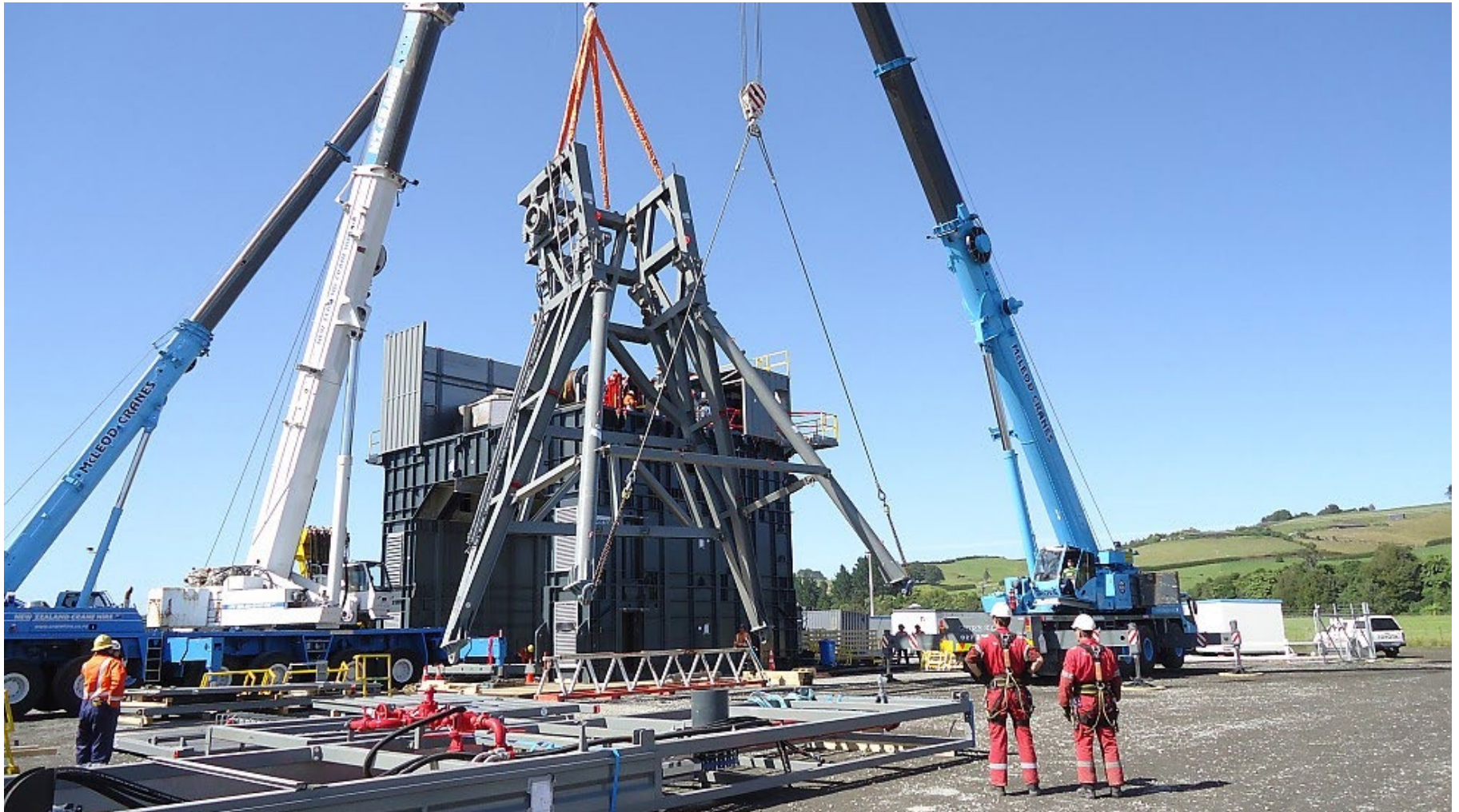


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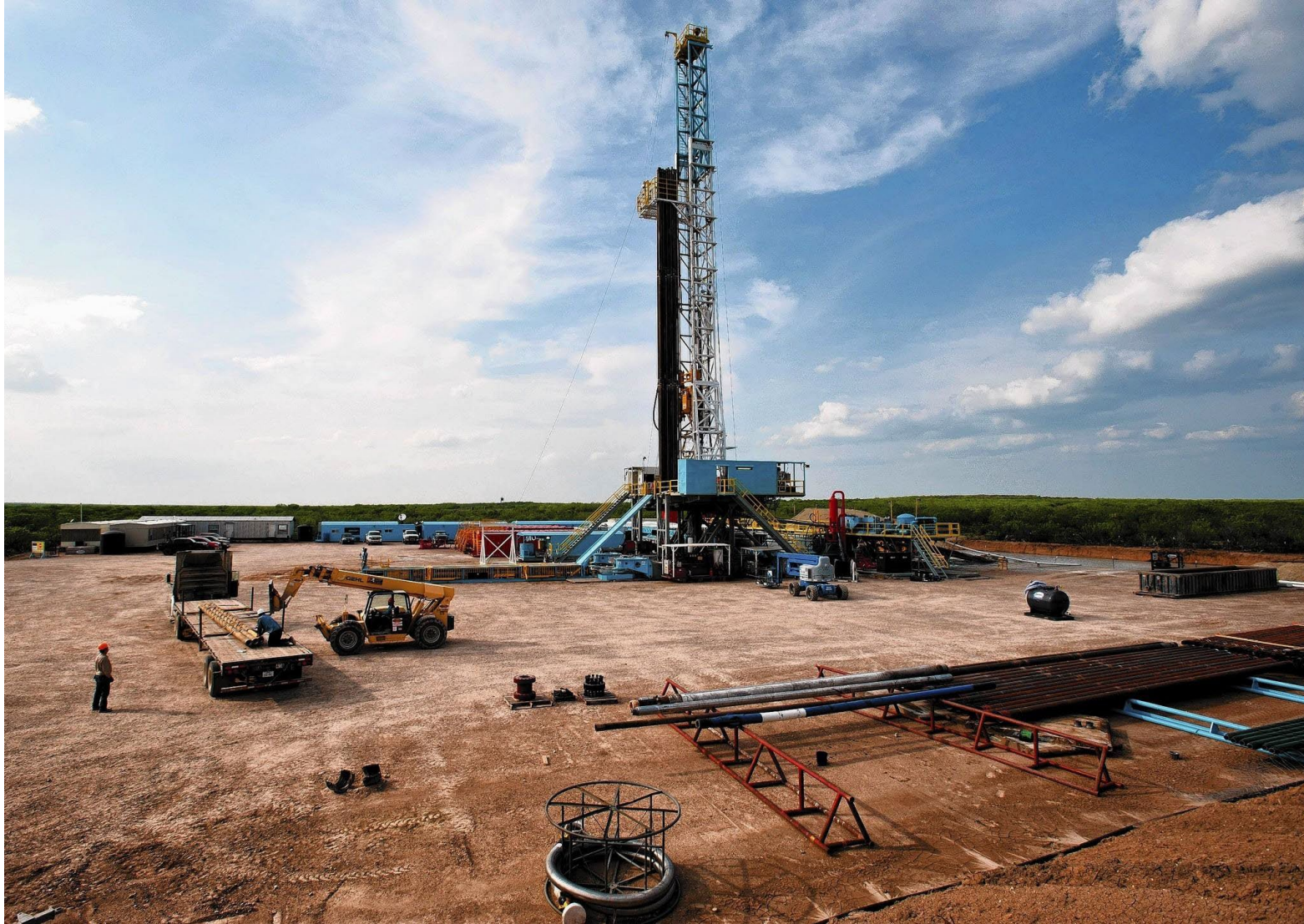




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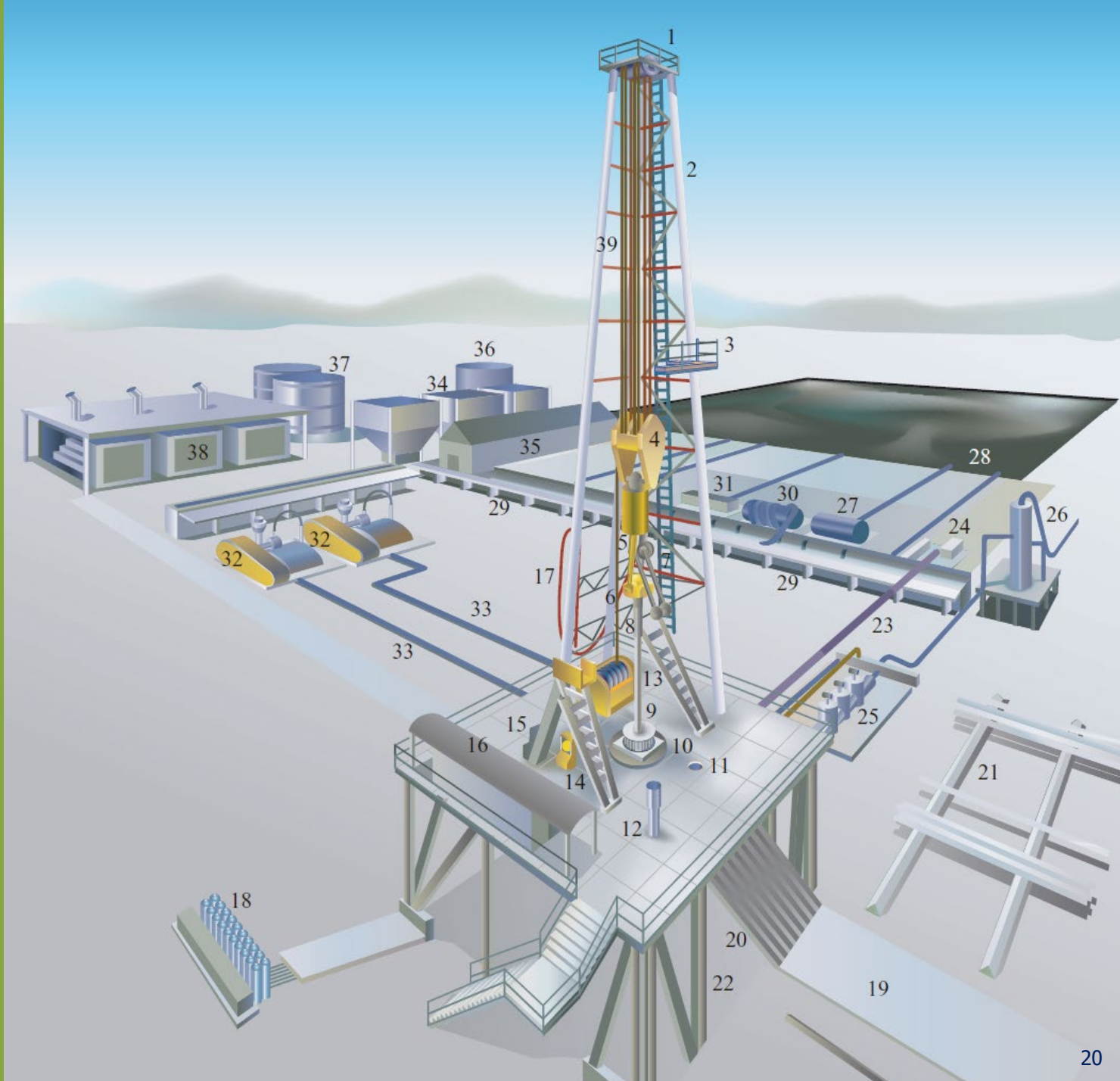


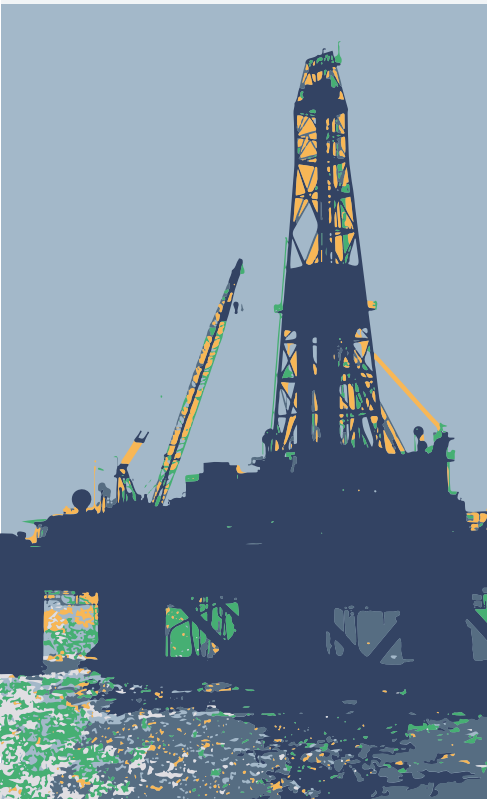


- The rig is then inspected to make sure it meets all specifications and safety standards.



- 1 crown block
- 2 mast
- 3 monkey board
- 4 traveling block
- 5 hook
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- 26 mud gas separator
- 27 degasser
- 28 reserve pit
- 29 mud pits
- 30 desander
- 31 desilter
- 32 mud pumps
- 33 mud discharge lines
- 34 bulk mud components storage
- 35 mud house
- 36 water tank
- 37 fuel storage
- 38 engines and generators
- 39 drilling line



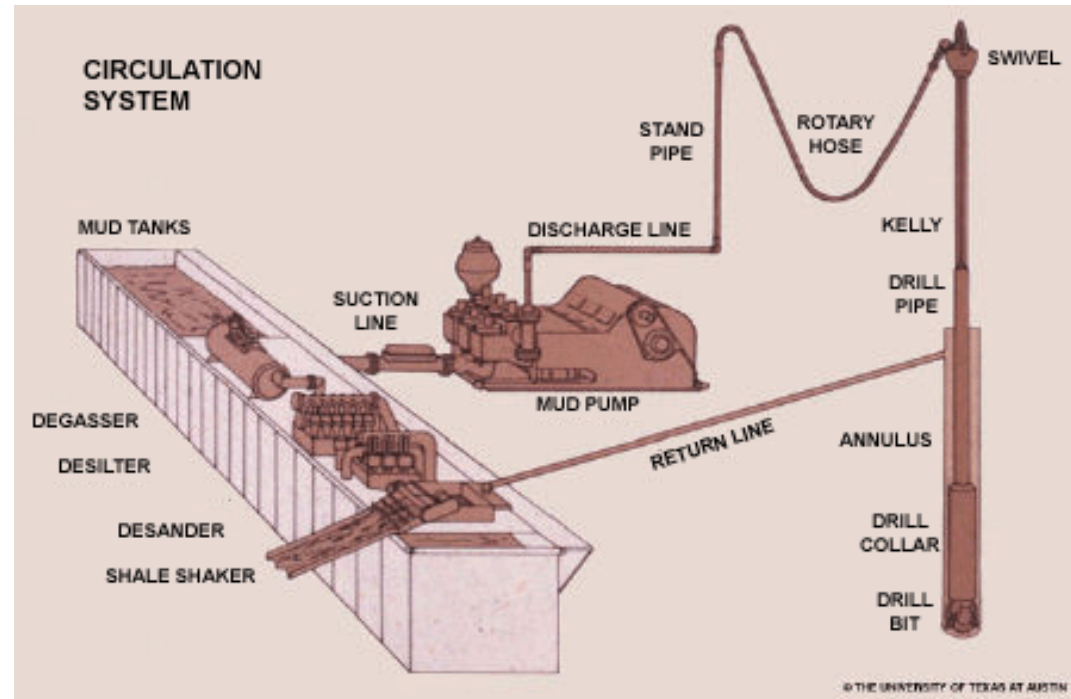


2. General description of the drilling process

- Rig operations continue 24/7, typically stopping only one day per year on Christmas.
- Two shifts of complete crew are assigned to the drill site for the entire project.
- Drilling happens in stages: drilling, running and cementing new casing and then drilling again, until the bit reaches the depth of the targeted zone.
- A bit generally lasts for 4500 to 6500 feet of drilling. Replacing the bit requires to remove all of the entire string of drill pipe. This process, called “stripping out”, can take several hours before it is done.



- From the platform, the drilling fluid is circulated through the hole to cool the bit and keep the walls of the hole intact and to help keeping the cuttings from plugging the hole.
- This mud passes through shakers that separate the cuttings and send them to the pit.
- Additional mud system equipment (desander, desilters and degasers) remove small particles and gas from the mud.
- The clean mud is recirculated back down into the hole.



Blow Out Preventer (BOP)



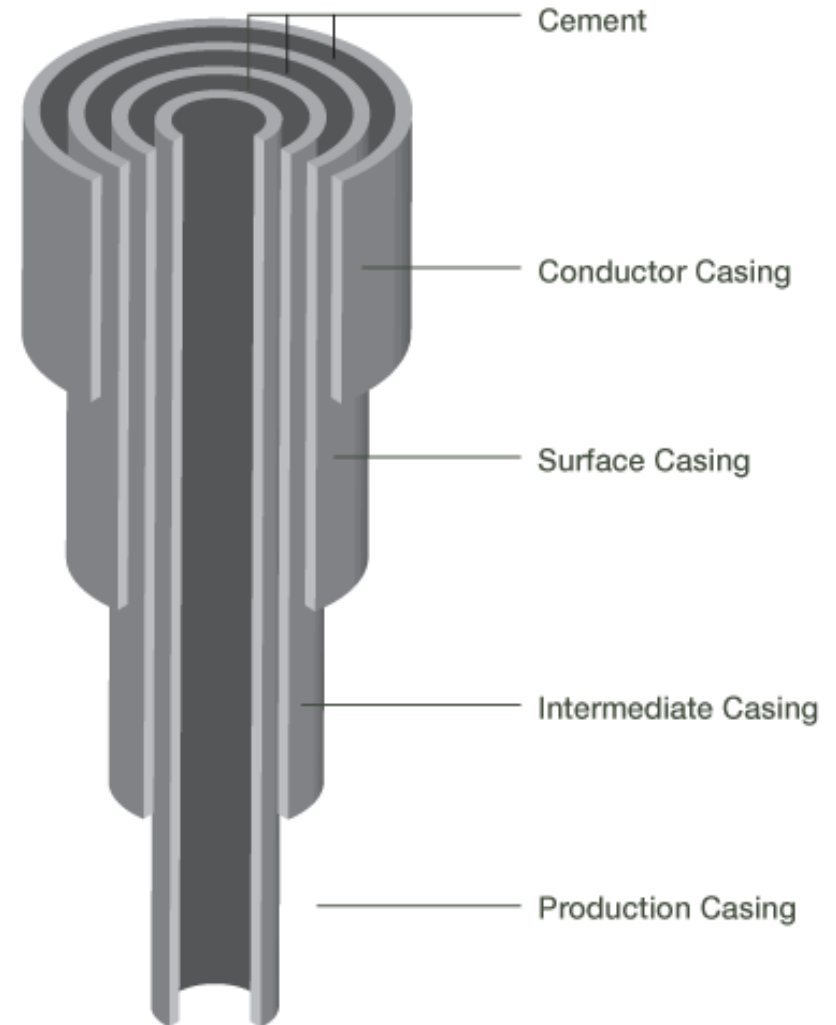
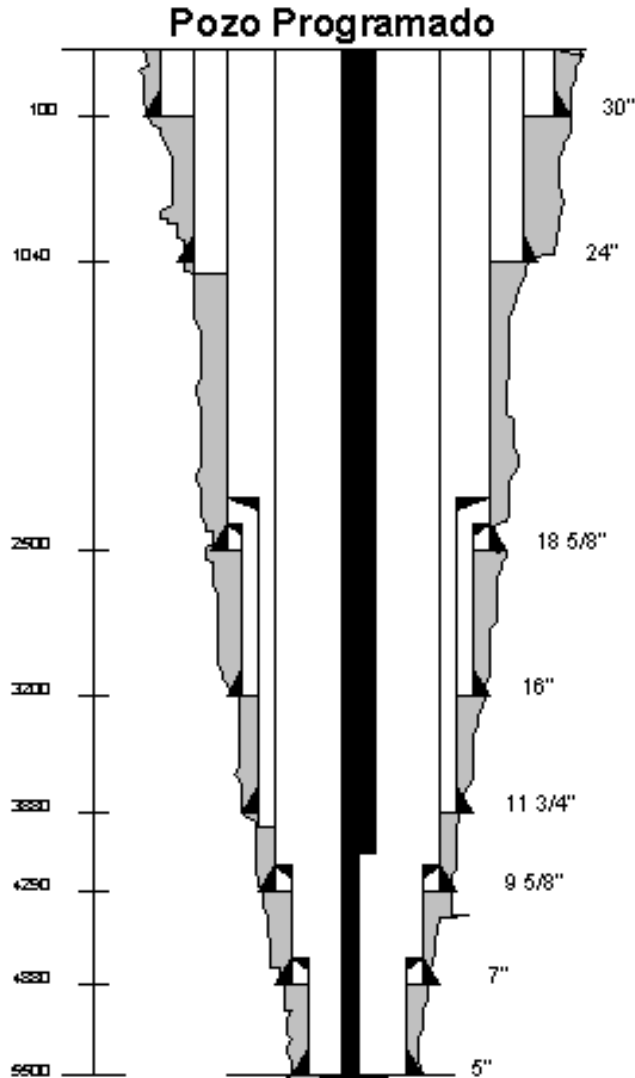
- The Blow Out Preventer (BOP) is installed on top of the casing head before drilling commences.
- It contains high pressure safety valves designed to seal the well hole and block the emission of gases or fluids, to prevent a blow out from occurring.
- Drilling begins with a hole of the designated surface depth, usually about 15 to 100 feet below the water table.
- Special care is taken to prevent the contamination of the groundwater by isolating the watertable from the well with cement and steel casing.

Well casing

- The casing consists in a set of metal pipes installed in a recently drilled well.
- It is aimed to:
 - Strengthen the walls of the well,
 - Ensure that any eventual leakage of oil or natural gas through the walls can not occur while the hydrocarbons ascend to the surface, and
 - Prevent any infiltration inside the well by fluids or gases from the surrounding rock
- Installing the best suited casing for each situation is an engineering work very rigorous and delicate.
- Different types of casing can be used depending on the well diameter, the rocks and formation characteristics, and the pressures and temperatures all along the well.
- The casing is cemented in situ.
- Normally there are five types of casing, as described in the next pages.

Typical Well Casing Diagram

(Not to Scale)



- **Conductor casing:** It doesn't measure more than 20 - 50 or up to 100 feet long and it is installed before the beginning of the main drilling operation to prevent the deterioration on the top of the well and facilitate the circulation of the drilling fluid from the bottom of the well.
- **Surface casing:** It is the following type of casing to be used. It can measure between 100 and 400-1000 m in length and has lower diameter than the "conductor casing" to pass through it. Its main purpose is to protect the surface aquifers of the drilling developed in the well and prevent contamination by leaks of hydrocarbons or salty waters of lower formations. It also serves as a return of the drilling mud.

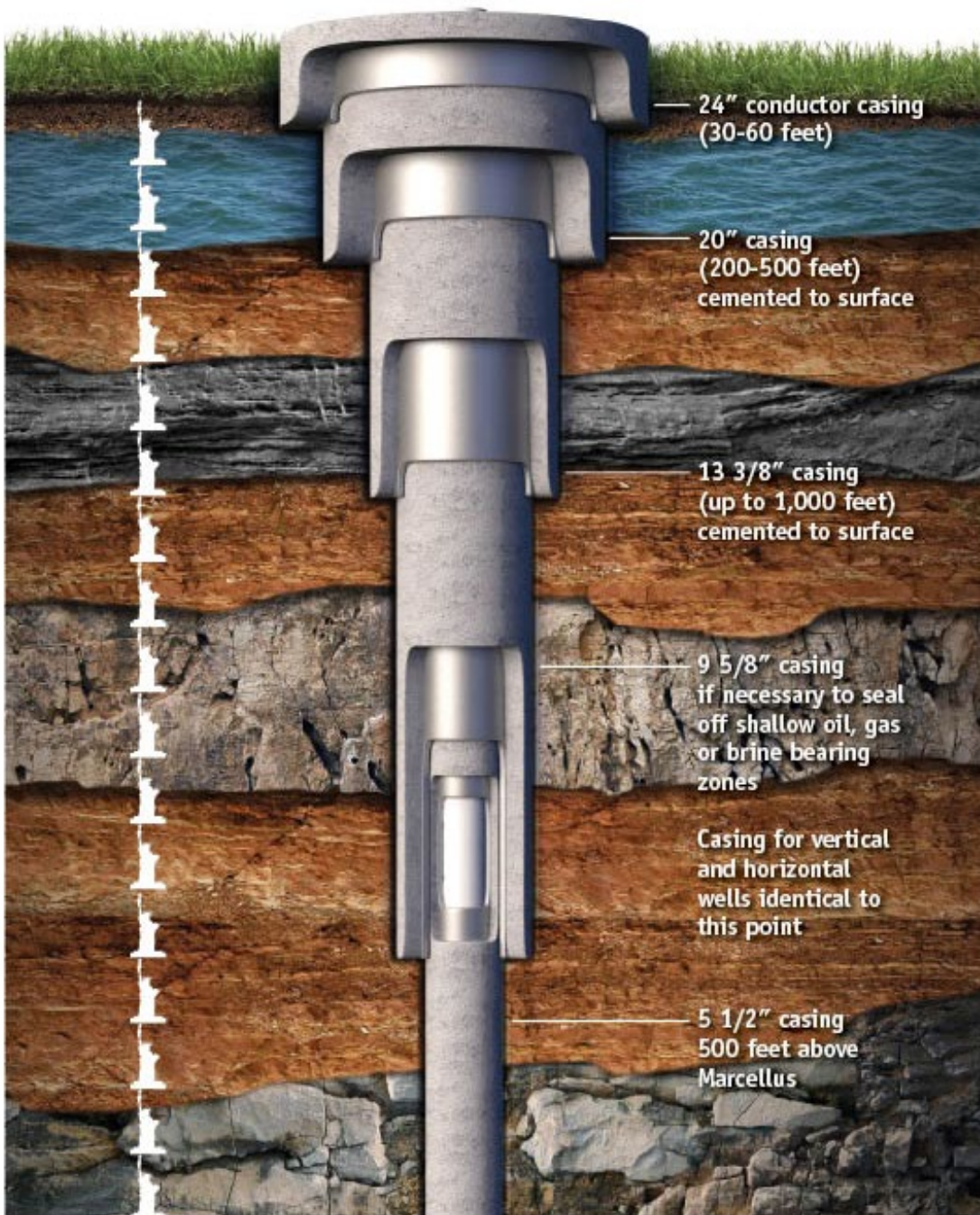
- **Intermediate casing:** It is usually the longest casing section to be installed in a well. Its main function is to prevent damage to the walls of the borehole during drilling operations due to abnormal pressures, presence of formations that can contaminate the well (saline formations or saline aquifers, etc.). In some occasions temporary covering pipes that are hung from the previous casing and are not cemented, can be used.
- **Production casing**, also called “oil string” or “long string”. Installed at the end of the intermediate casing and at the end of the operations, it is the deepest section of the casing of a well. It is the casing that allows to install a duct from the surface down to the oil-producing formation. The size of the production casing depends on numerous considerations, including the type of equipment for oil impulsion, the number of completions to install, the possibility of a further redeepening of the well, etc. **It also plays a vital role in preventing blowouts as it permit the sealing of the formation down from the surface if dangerous levels of pressure are achieved.**

- Once installed the casing, it is necessary to insert the 'tubing' through the casing from the surface down to the formation. The hydrocarbons that are extracted can circulate through it and up to the surface. Between the production casing and the tubing there is a packer at the bottom of the well.
- A production casing varies between 5 and 28 cm in diameter (2-11 inches), being the majority of the production wells of 6-inch.

IQUES

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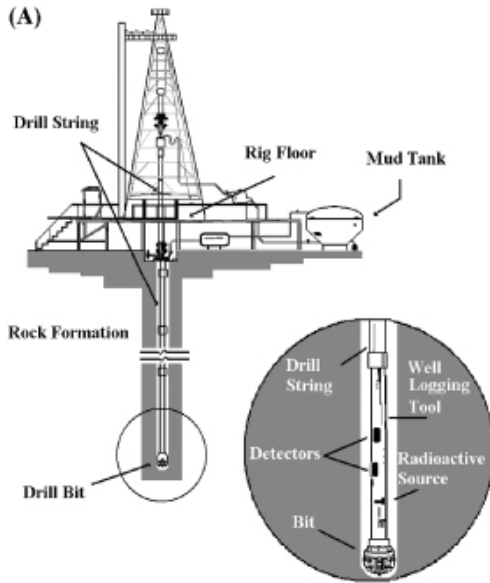
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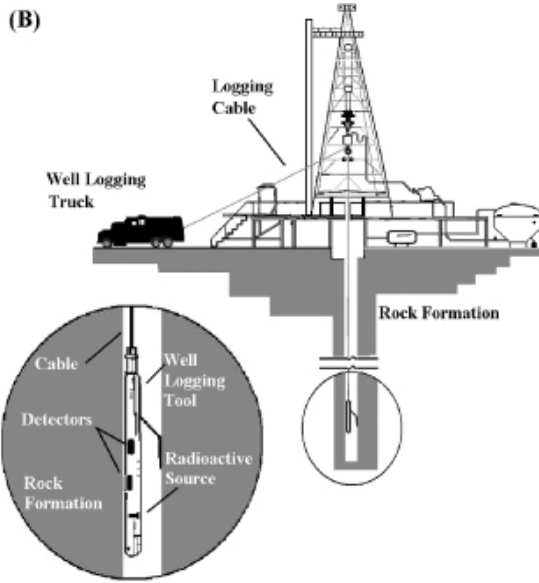
Well characterisation

- The bit is the cutting element used in the rotary drilling.
- As the bit turns, it crushes the rock efficiently and the shot out fluid loosen and carry these rock chips up to the surface.
- New sections of pipe are added to the drilling string as the bit drills deeper.
- When the hole reaches the designated depth, the Derrickman circulates fluid through the hole to acondionate it for logging. This is the process of measuring and recording the characteristics of the well.

(A)



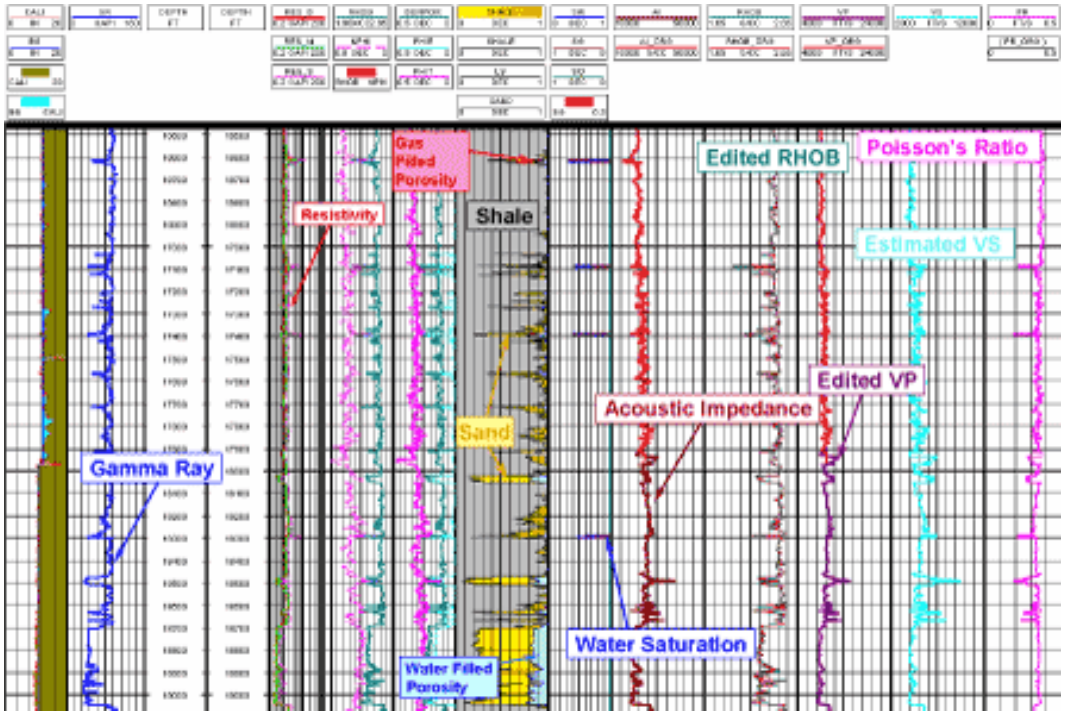
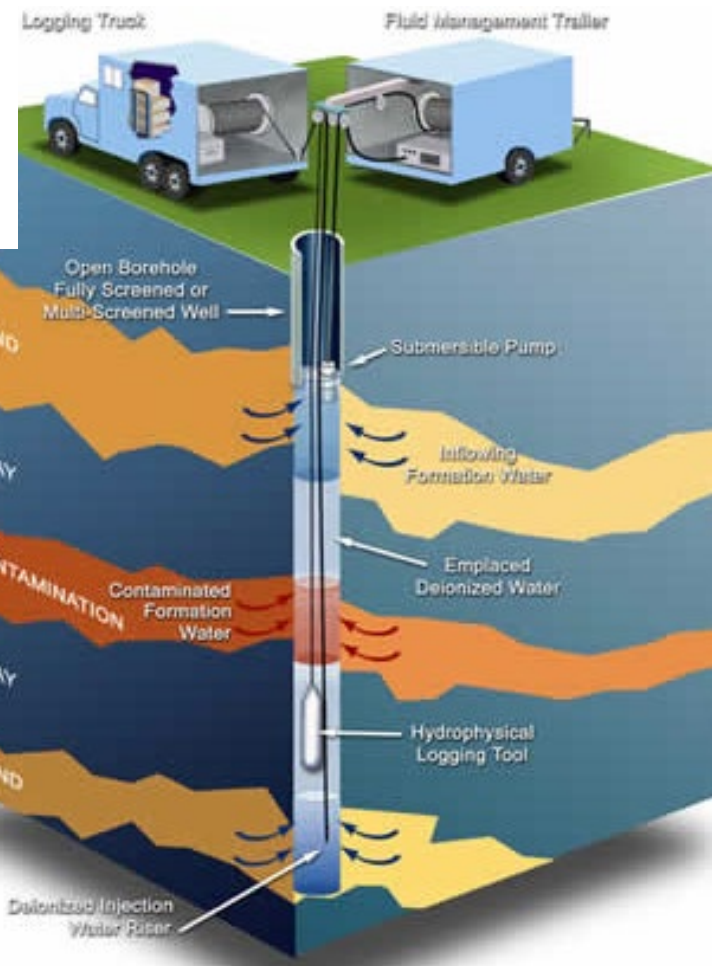
(B)



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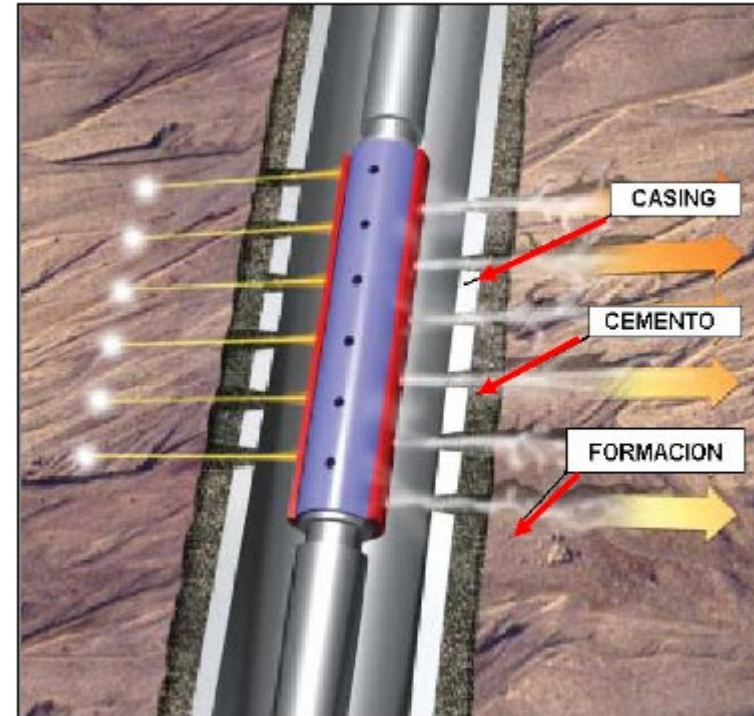
- The logging information lets the oil company determine if the well indeed can produce oil or gas. At this point, the company will decide whether the well is to be completed or closed and abandoned.
- If the well is designated as a producer, the crew inserts the pipe back into the hole to ensure that the hole is still intact and circulates mud fluid again to test the casing.
- If everything tests positively, they remove the drill pipe and rack it.
- At this point, the crew inserts the last string of production casing that runs the entire length of the hole and cements the casing inside the hole.
- The production crew then brings in the workover unit and rigs it up to prepare the hole for production.
- The crew runs small diameter tubing into the hole as a seal to avoid the oil and gas to flow up the well.



Workover unit

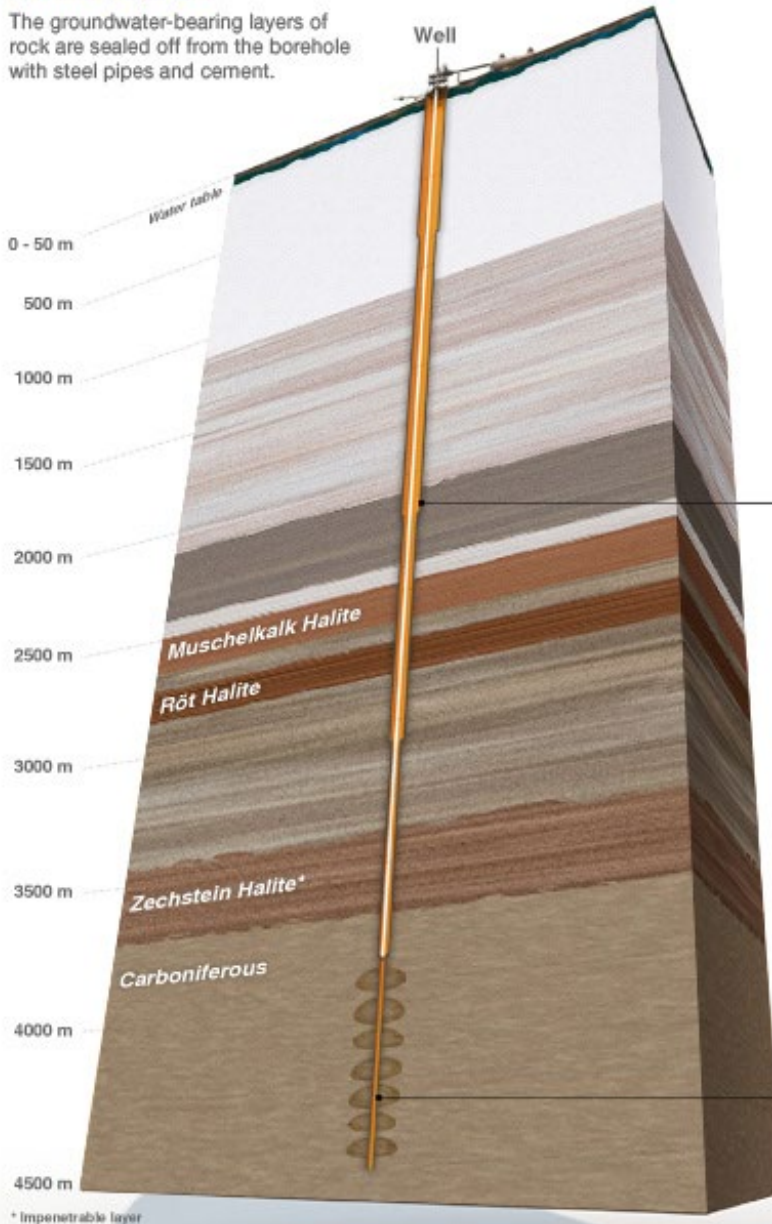


- Next, the workover unit trips out the hole and picks up a perforating gun which the crew lowers into the well to production depth using a thin metal cable called a wire line.
- An electrical signal is sent down the wire line firing the gun and igniting explosive charges.
- These charges create holes through the cement casing and the formation, connecting the well bore to the reservoir.

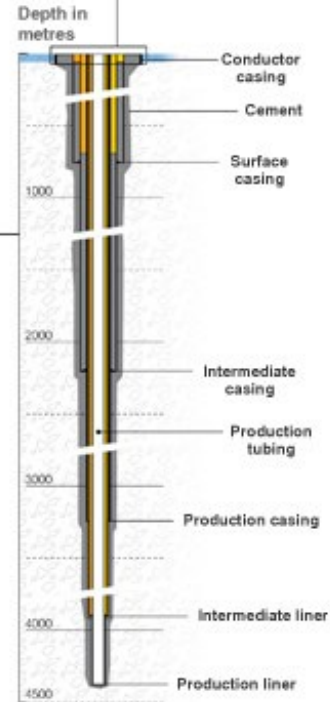
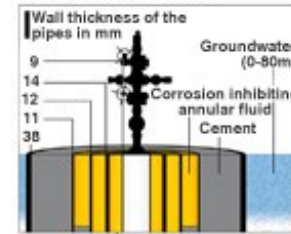


WELL SEALED

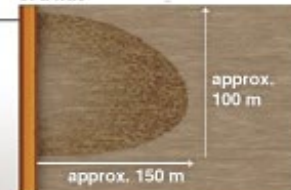
The groundwater-bearing layers of rock are sealed off from the borehole with steel pipes and cement.



Casing of the well in the freshwater-bearing layer.



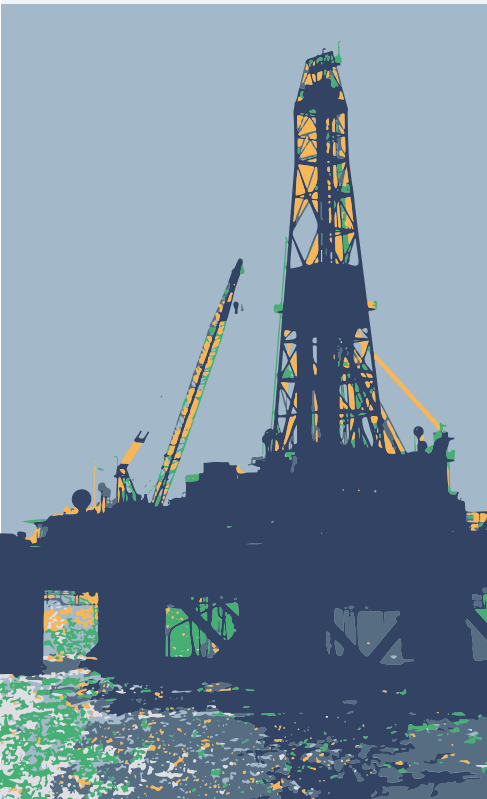
Schematic diagram of a frac



Fuente: <http://www.wintershall.com/>

- To stimulate the flow of hydrocarbons, it is sometimes necessary to introduce fractures in the well and the formation. This involves pumping air, sand and fluids under extreme pressure down the production tubing and out through the perforations.
- The process fractures or forces cracks into the formation. The remaining particles will hold the cracks open releasing the oil or gas.
- Monitoring the flow enables the crew to determine the best location for the choke, the device that controls the flow of the oil or gas.
- In the deposits, hydrocarbons are subjected to tremendous heat and pressure. The same pressure has kept the hydrocarbons locked in the formation for million of years.
- Once the pressure is released, they are allowed to escape through the fractured zone and flow into the well bore.

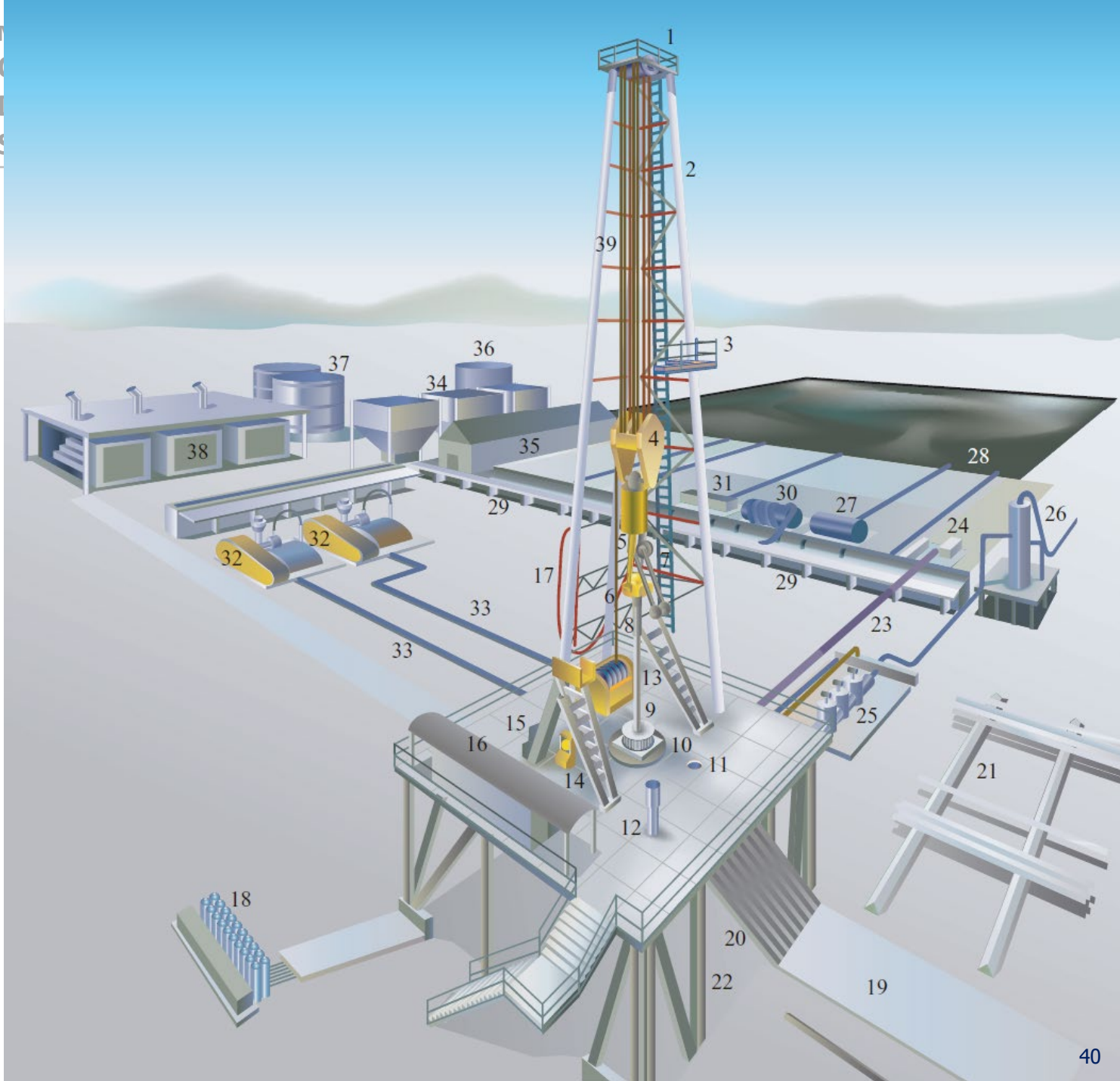
- The oil and gas can now travel up the casing string. The well bore is isolated from the surrounding formation with casing and cement preventing any contamination.
- The final step is to install a pump jack or production wellhead called a “Christmas tree” on the well.
- It is then time to produce the well and plan for any future field development.
- Many other factors can affect the oil and gas drilling process, but the bottom line is this one.



3.

Elements of the drilling equipment. Basic drilling systems

- 1 crown block
- 2 mast
- 3 monkey board
- 4 traveling block
- 5 hook
- 6 swivel
- 7 elevators
- 8 kelly
- 9 kelly bushing
- 10 master bushing
- 11 mousehole
- 12 rathole
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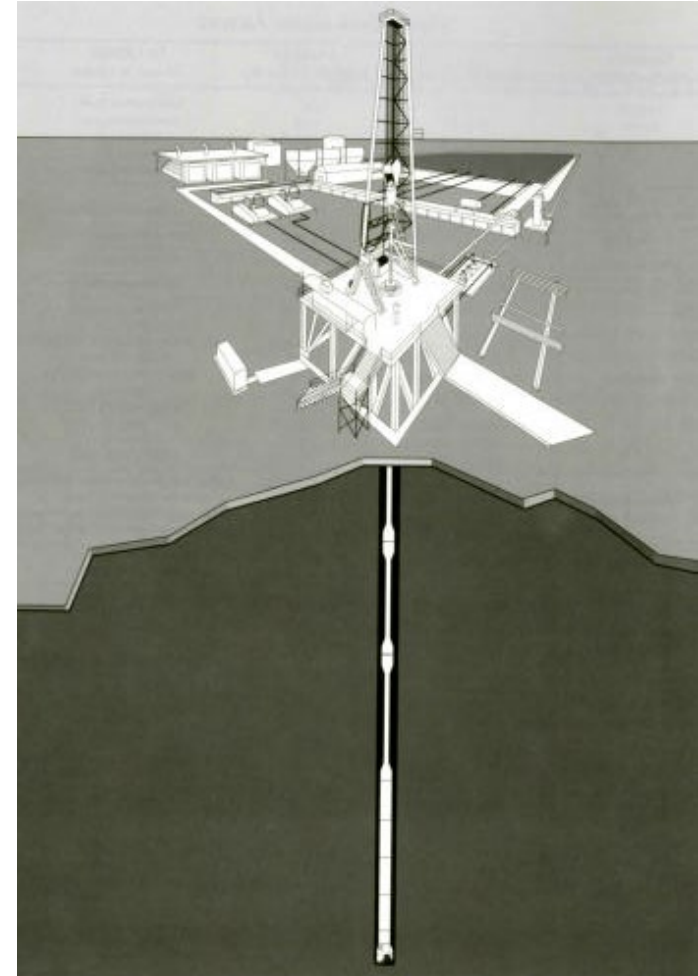


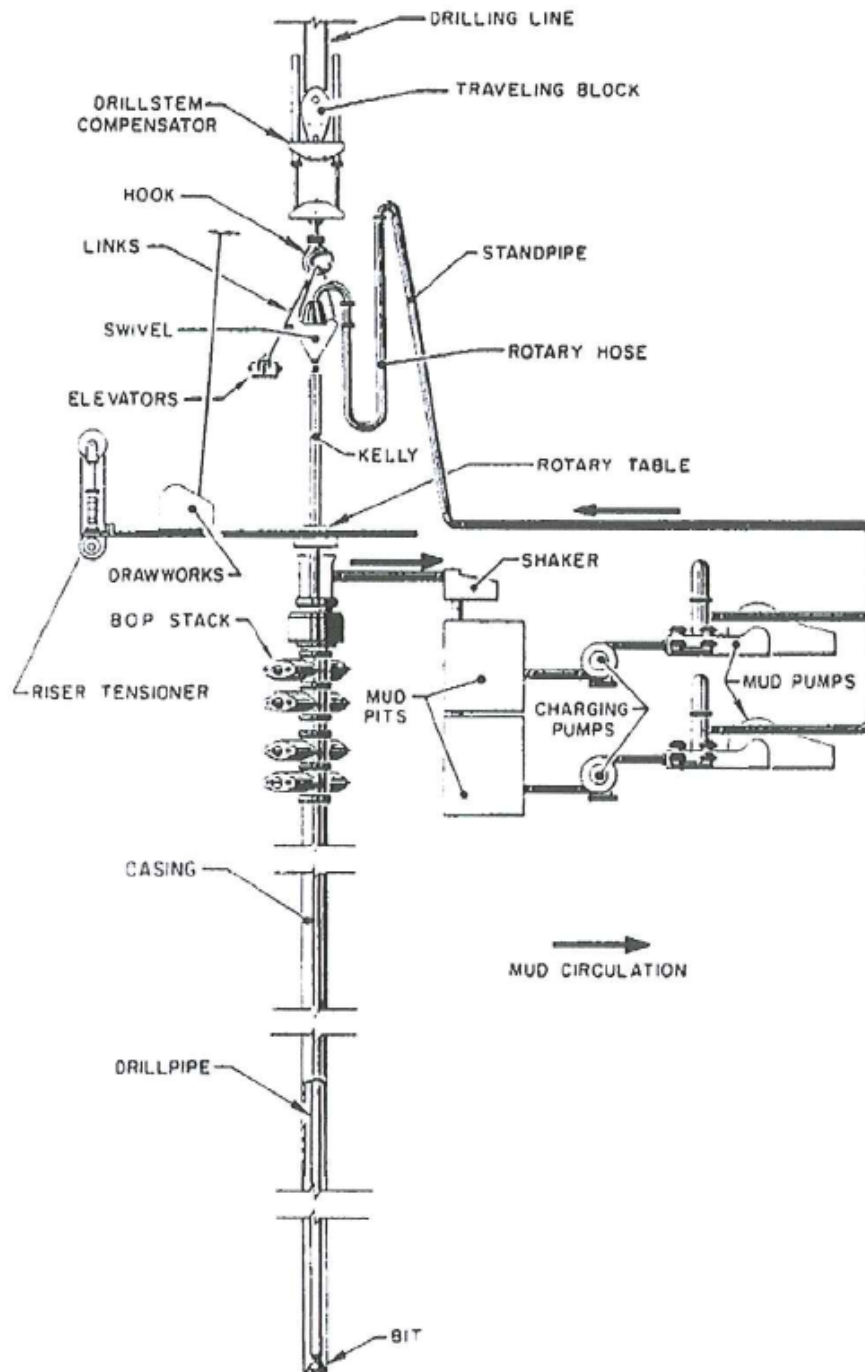
Basic systems of the drilling equipment

The 5 most important systems in a drilling rig are:

1. Power system
2. Rotation system
3. Hoisting and loads lifting system of
4. Fluid circulation system
5. The BOP – Blow-Out Prevention system.

To these elements, the console of the driller can be added.

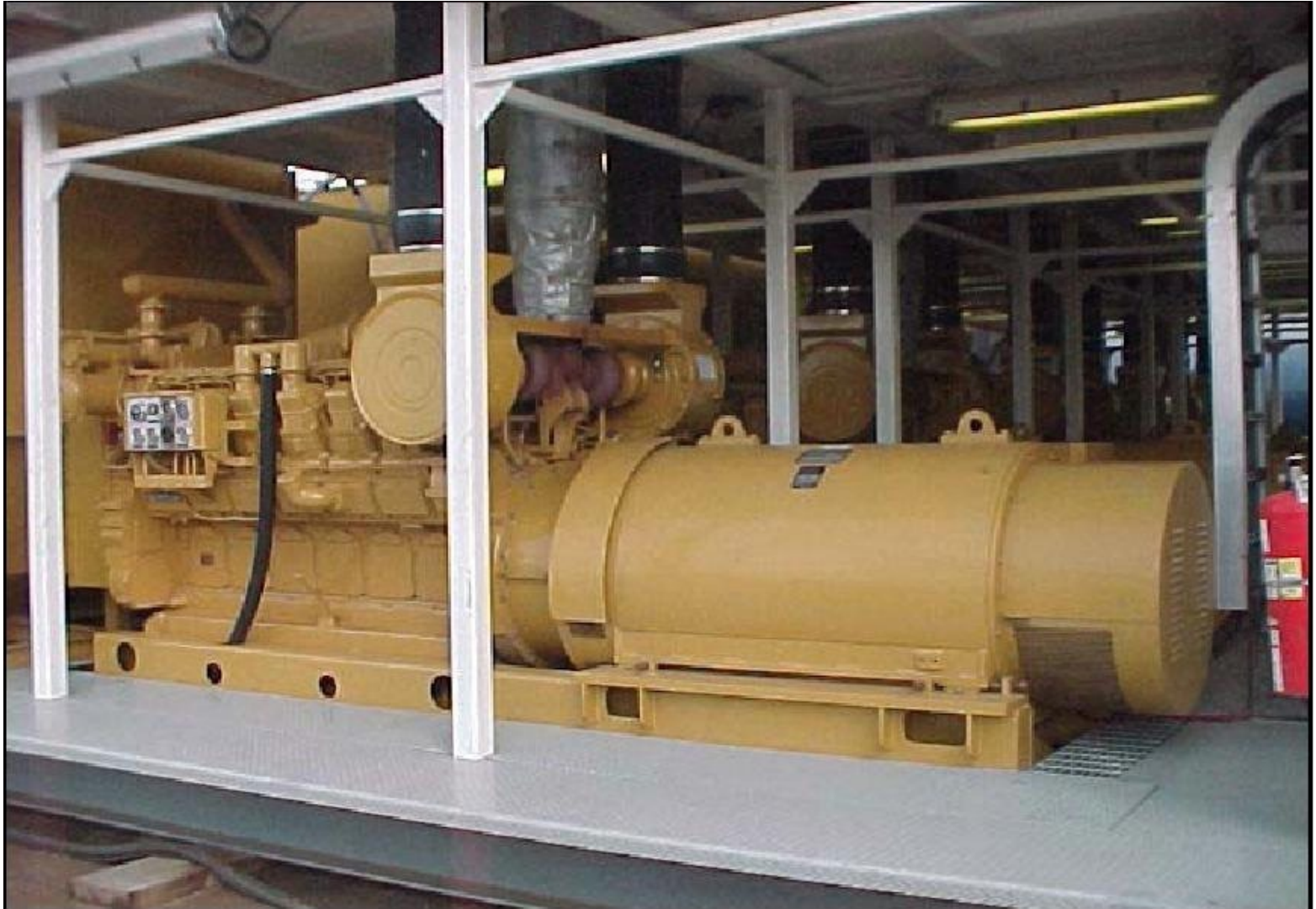




1. Power System

- They can be divided in two big types:
 - **1. Power generation:**
 - The most common form is the use of Diesel engines (image 1).
 - The number of engines depends on the size of the drill rig and auxiliary systems
 - Many modern rigs have 8 engines or more.
 - **2. Power transmission**
 - **Electric transmission:**
 - Most of the equipment currently used has this form of power transmission
 - Generators produce electricity that is transmitted to the electric motors through electric cables.
 - **Mechanical transmission:**
 - It is not very used today but it can still be found on some old drilling rigs.
 - It consists in a series of straps, chains, pulleys, toothed pinions and gears.
 - It is also called composite transmission system

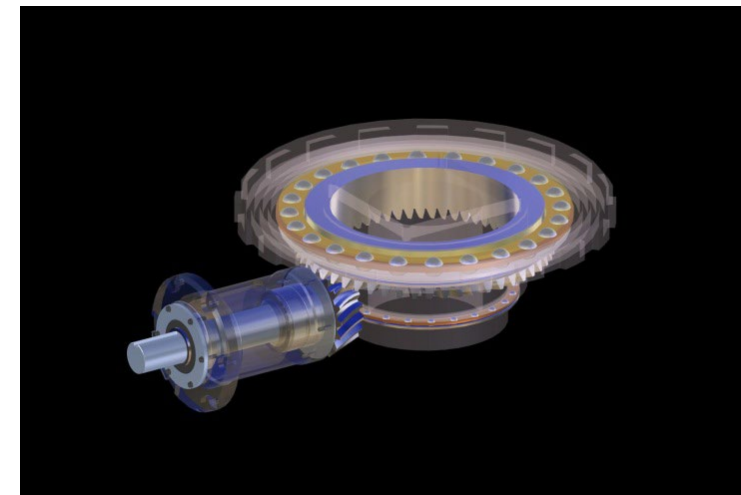
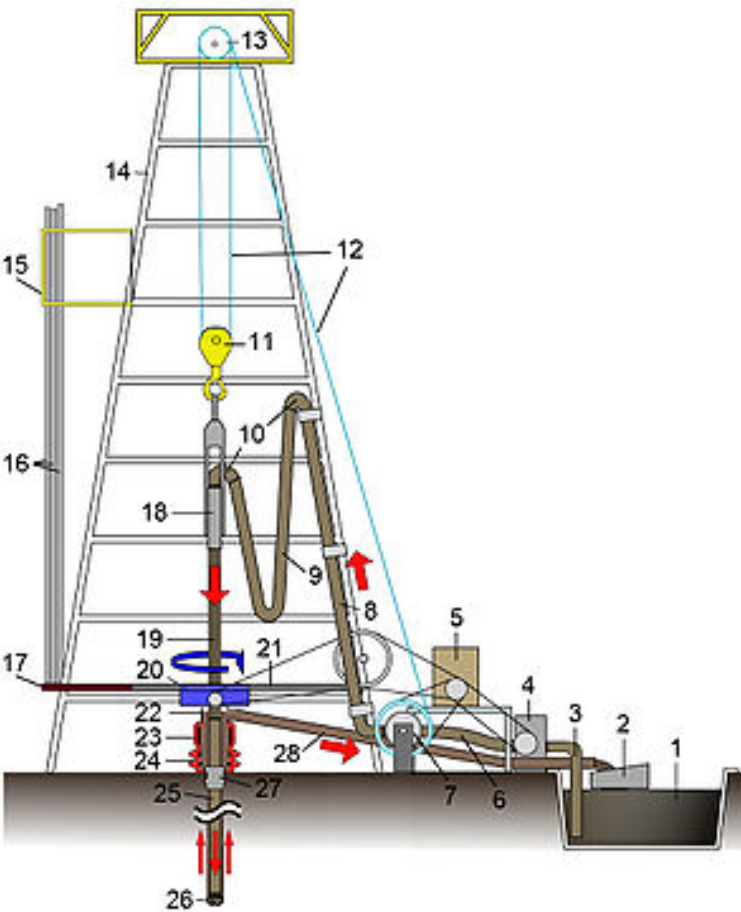




2. Rotation system

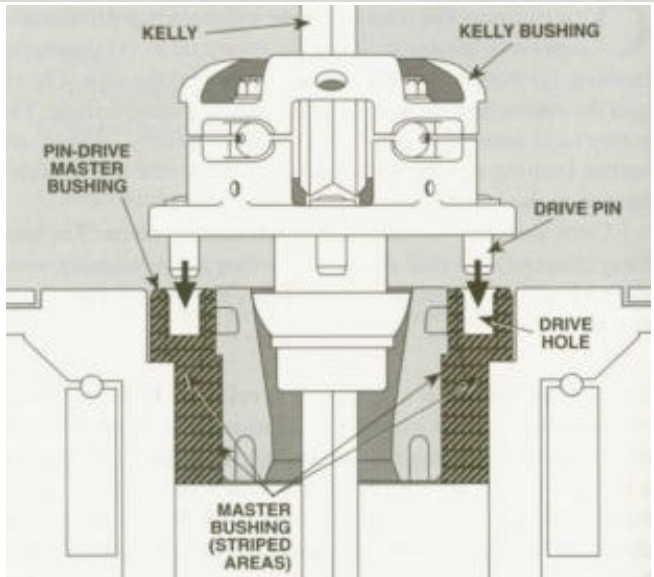
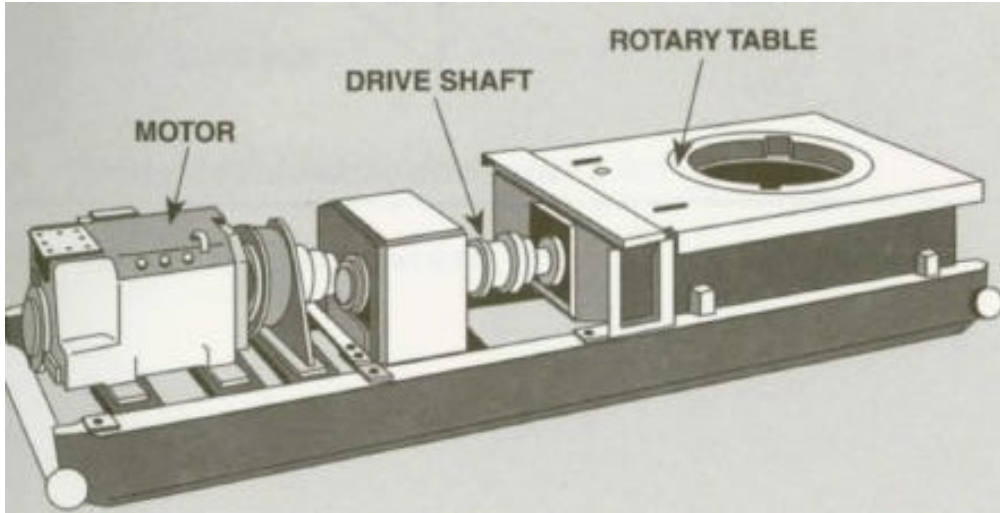
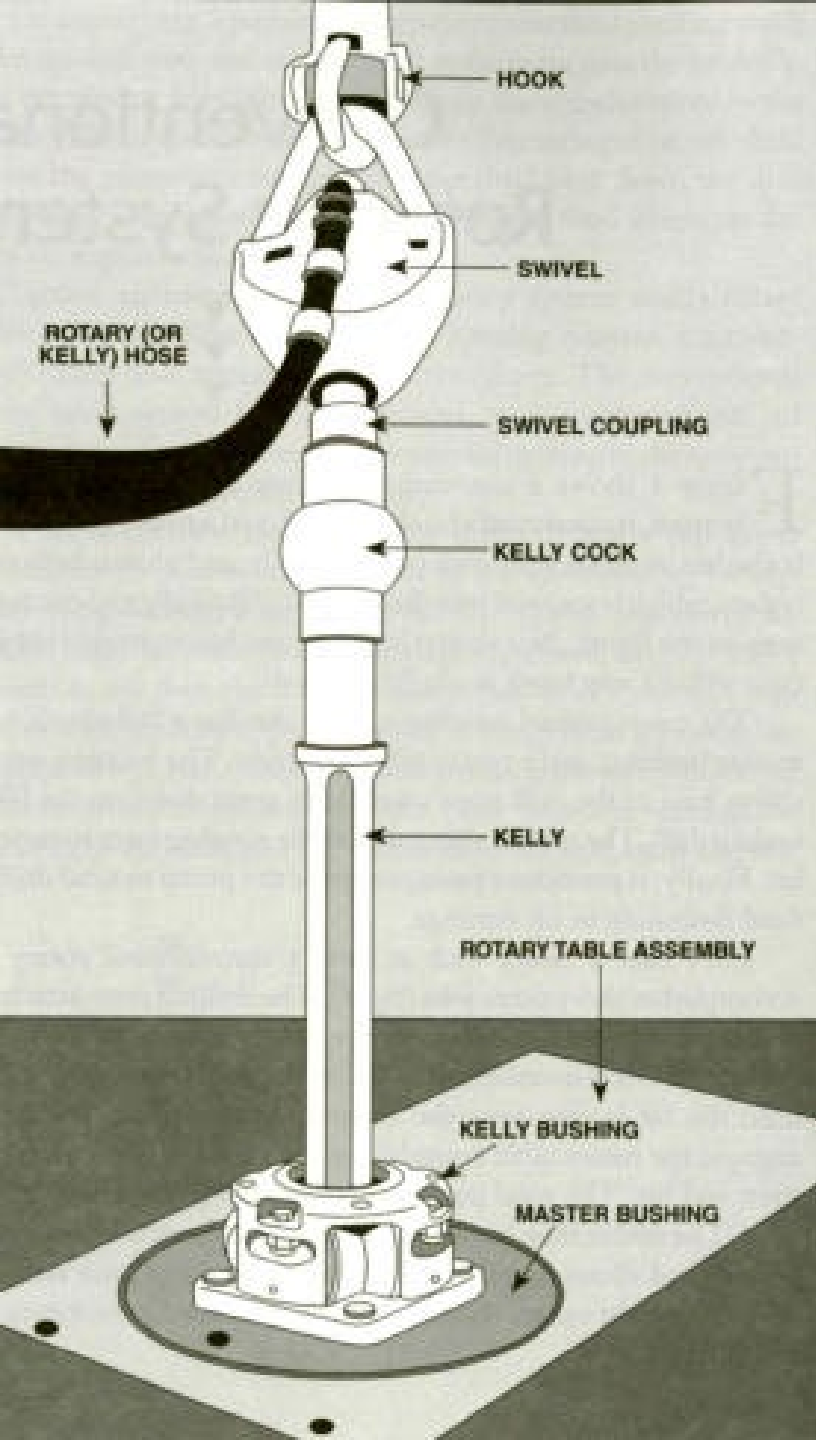
Has three main components:

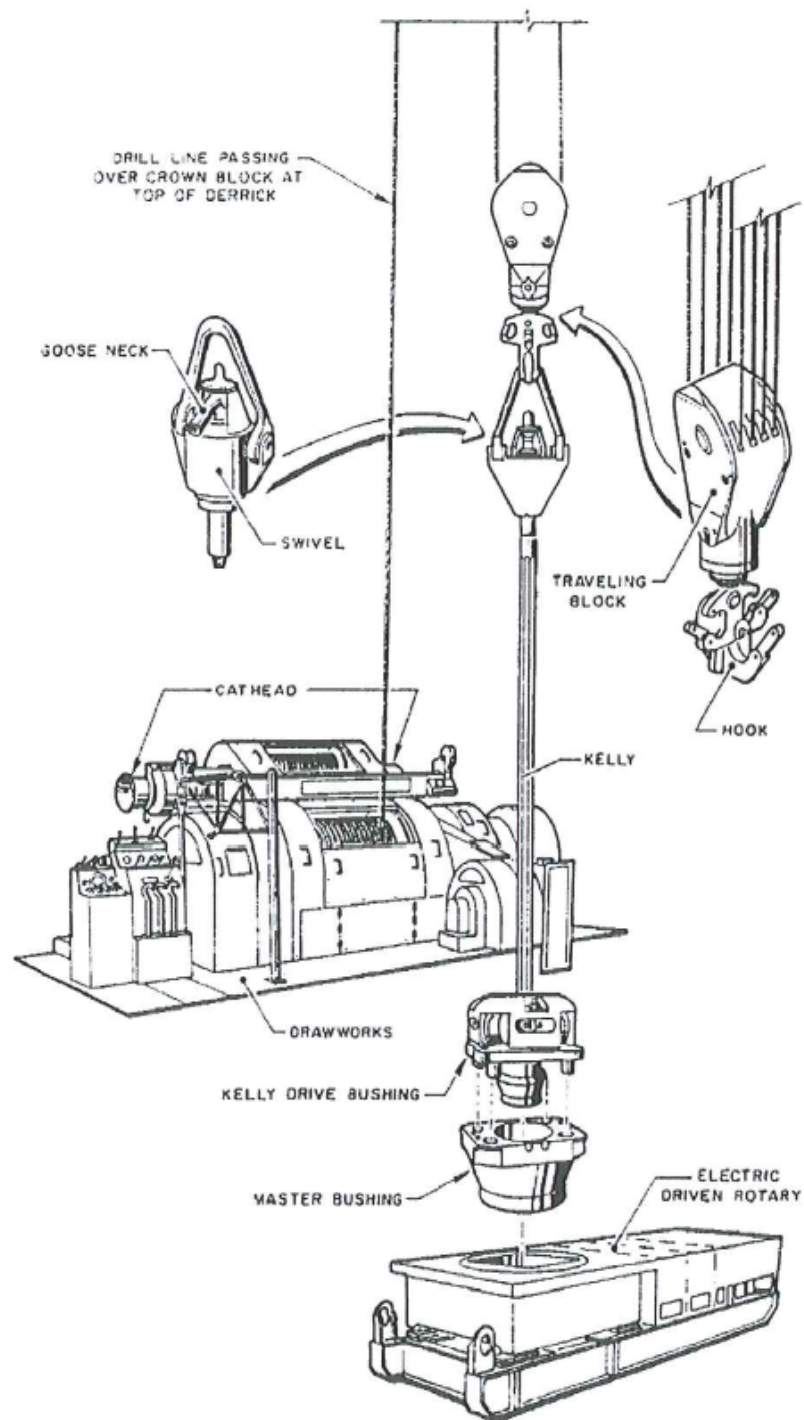
1. The Rotary Table or the Top Drive Assembly.
2. The drill pipe.
3. The drilling bit.



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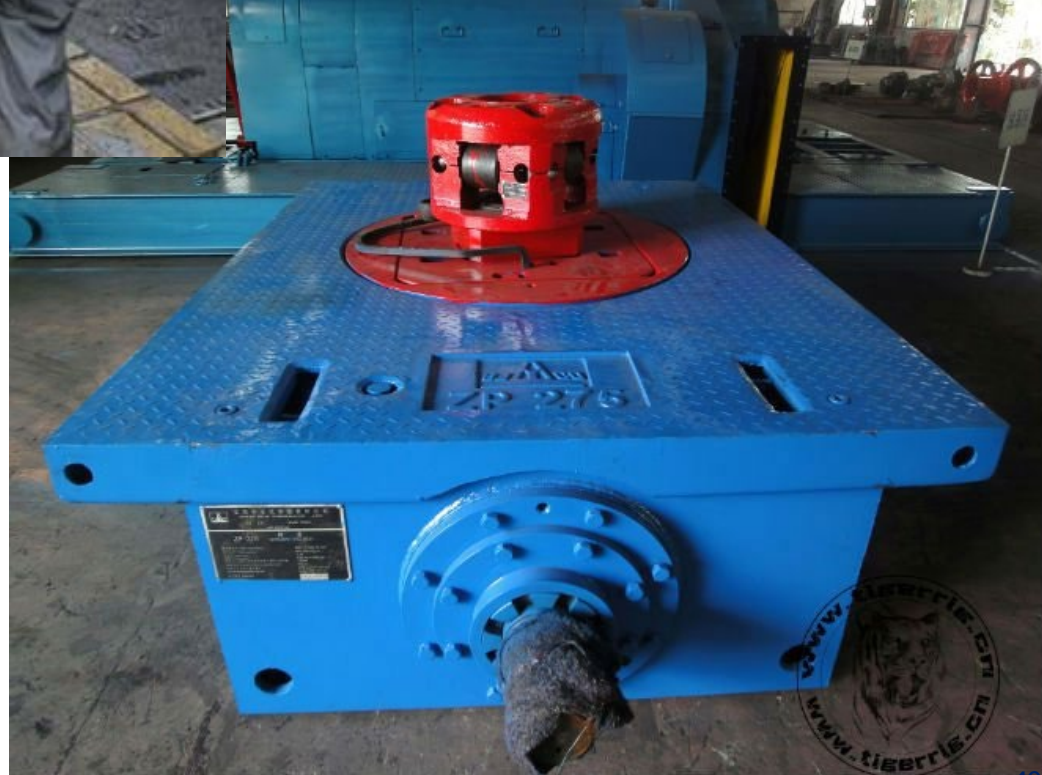
2.1. rotation system with transmission bar – The Kelly bar





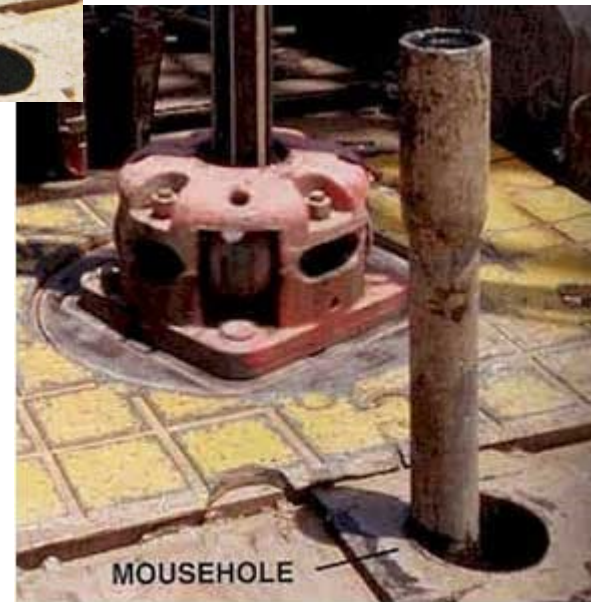


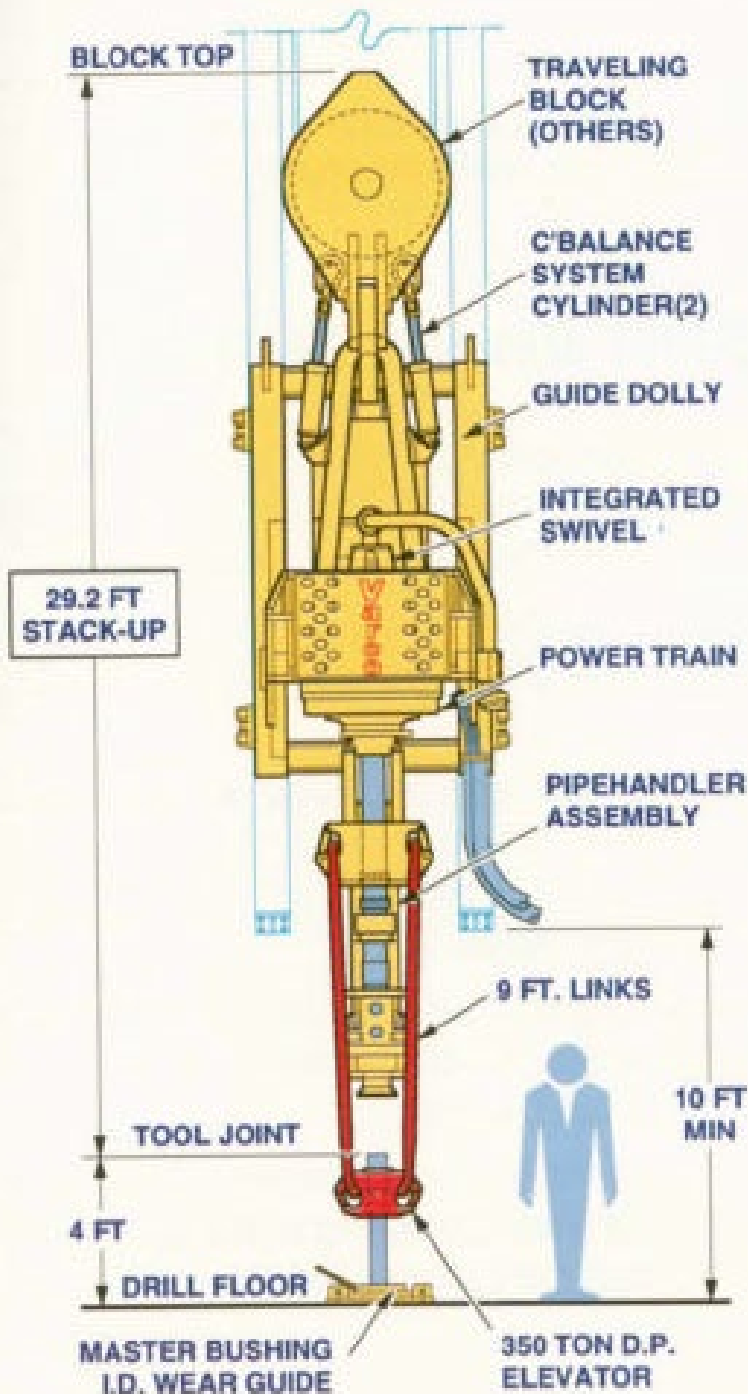
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Drilling
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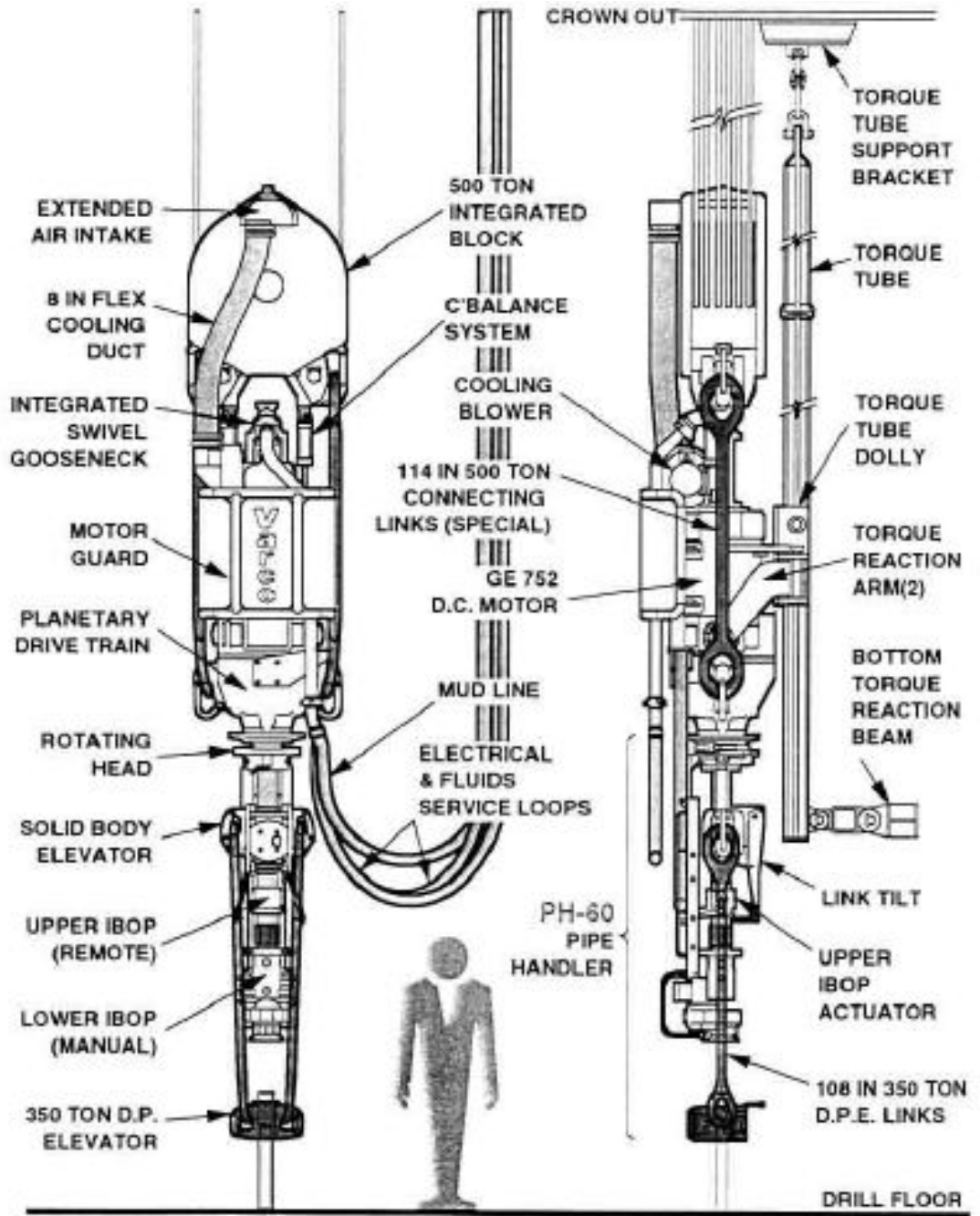
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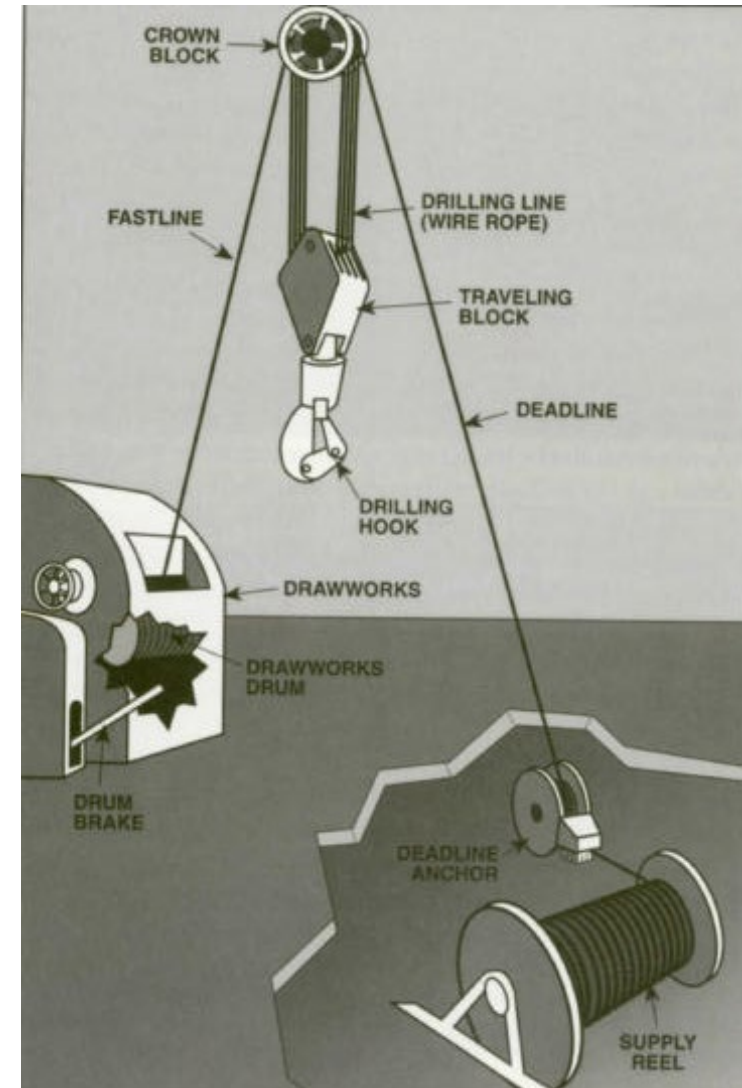
2.2. “Top Drive” rotation system

- The Top Drive System was a great technological revolution as it allowed to replace the Kelly bar and the rotary table.
- It allows to drill with triple bars instead of individual bars as happens with the rotary table. This reduces greatly the work of loading and unloading bars and increases the drilling speed.
- It is especially suitable for directional wells or wells in cluster.



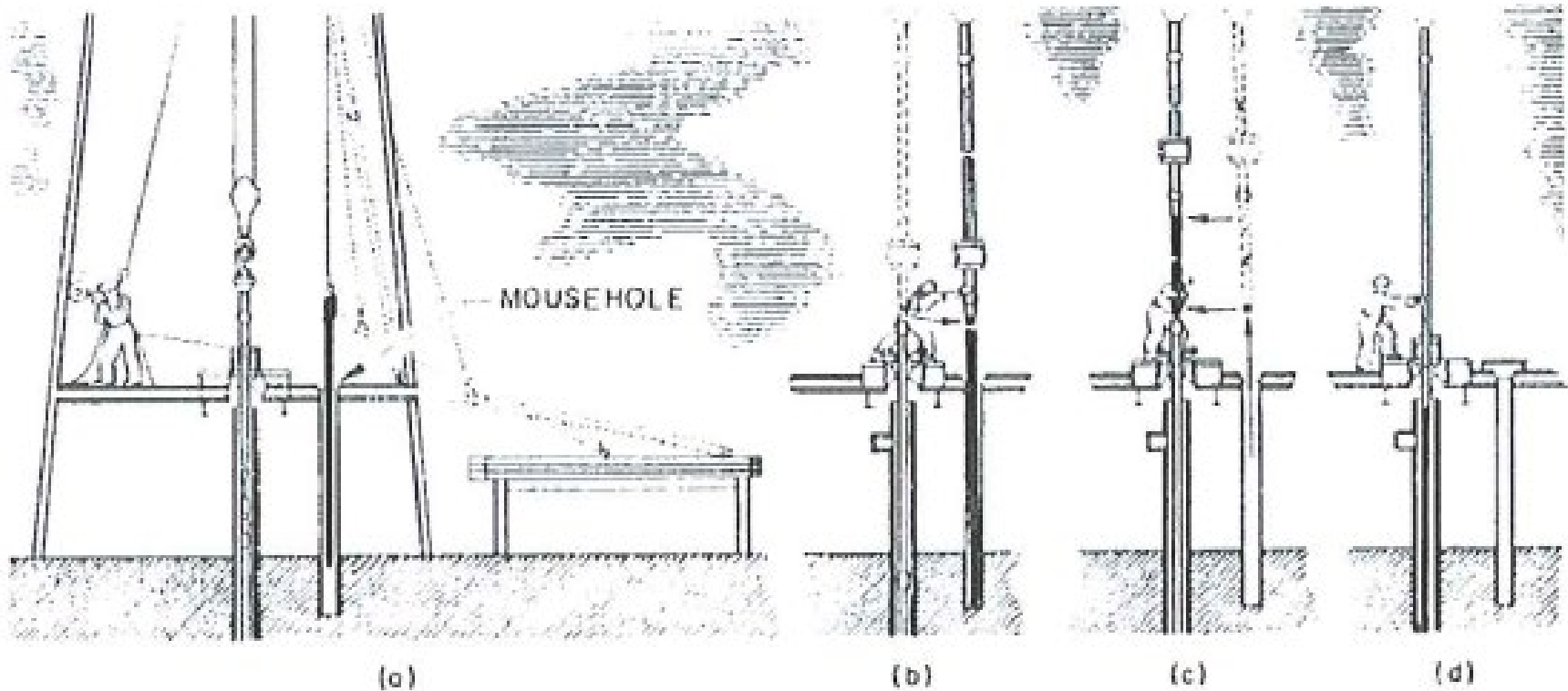
3. Hoisting system

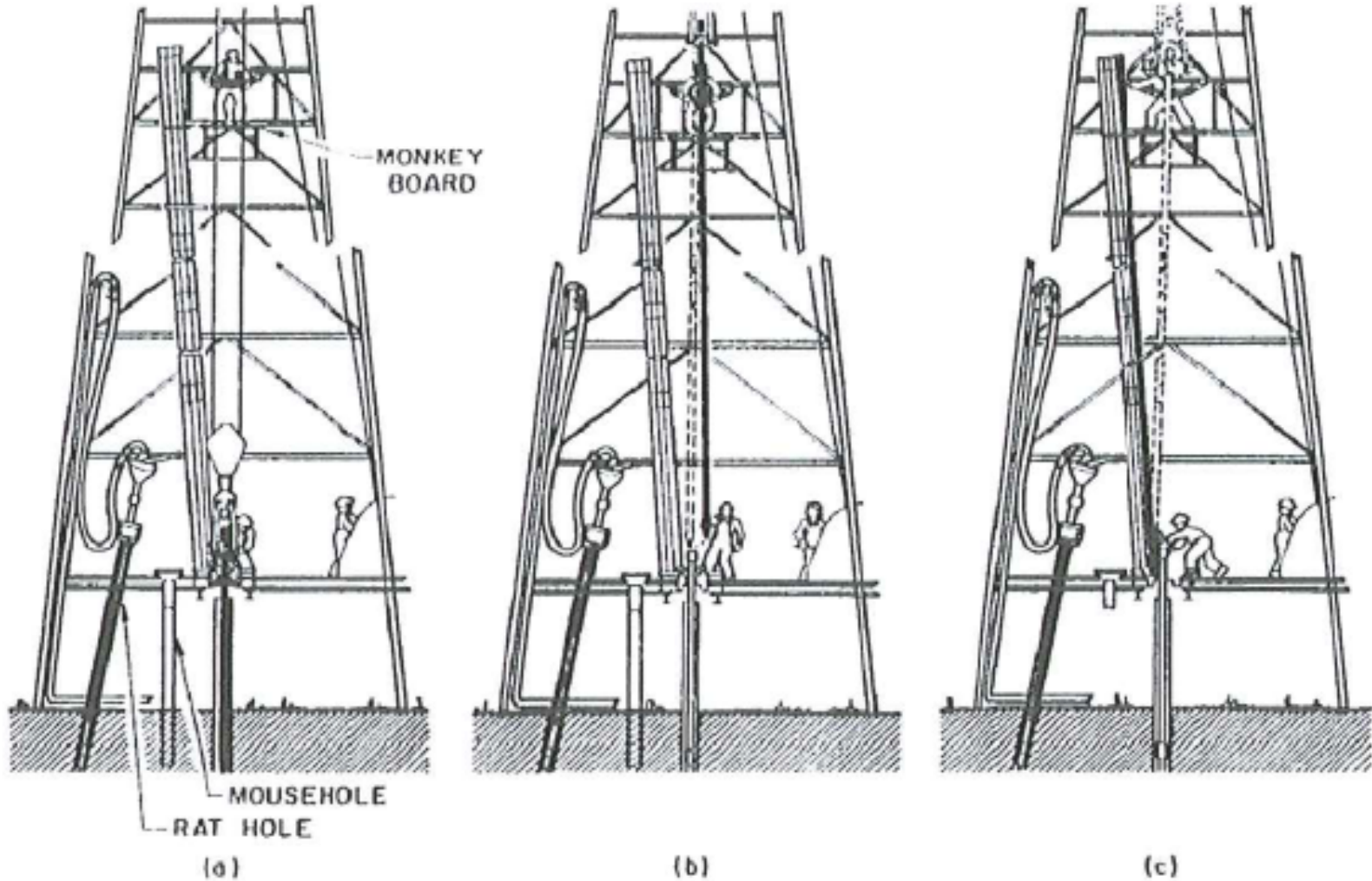
- **It provides both the necessary equipment and work areas**
 - The support structure consists in the following parts:
 - The substructure
 - Rig floor
 - Derrick
 - The hoisting and lifting equipment is composed by :
 1. Draftwork
 2. Crown block
 3. Travelling block
 4. Drilling hook
 5. Fast line and dead line
 6. “Drilling Line” (Wire Rope)

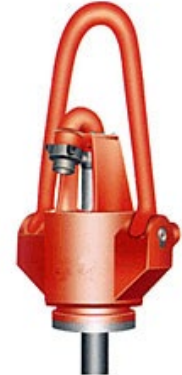
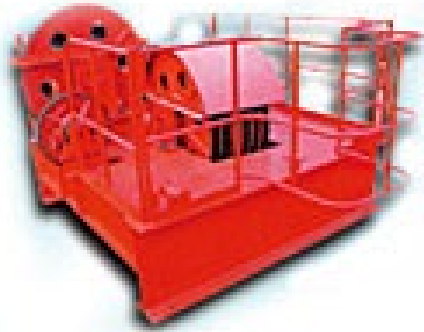
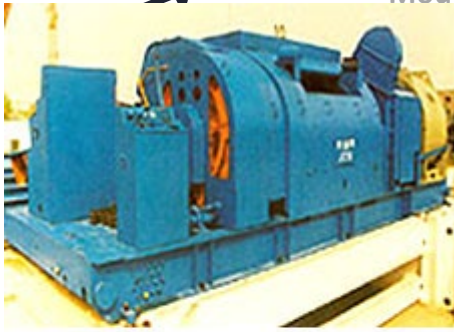




Making a connection







Bloque Corona

Bloque Viajero

Grifo de perforación (Swivell)



Malacate



Motor superior o TDS



Asas de izado



Cabrestante neumático

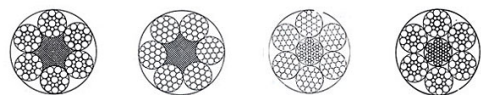


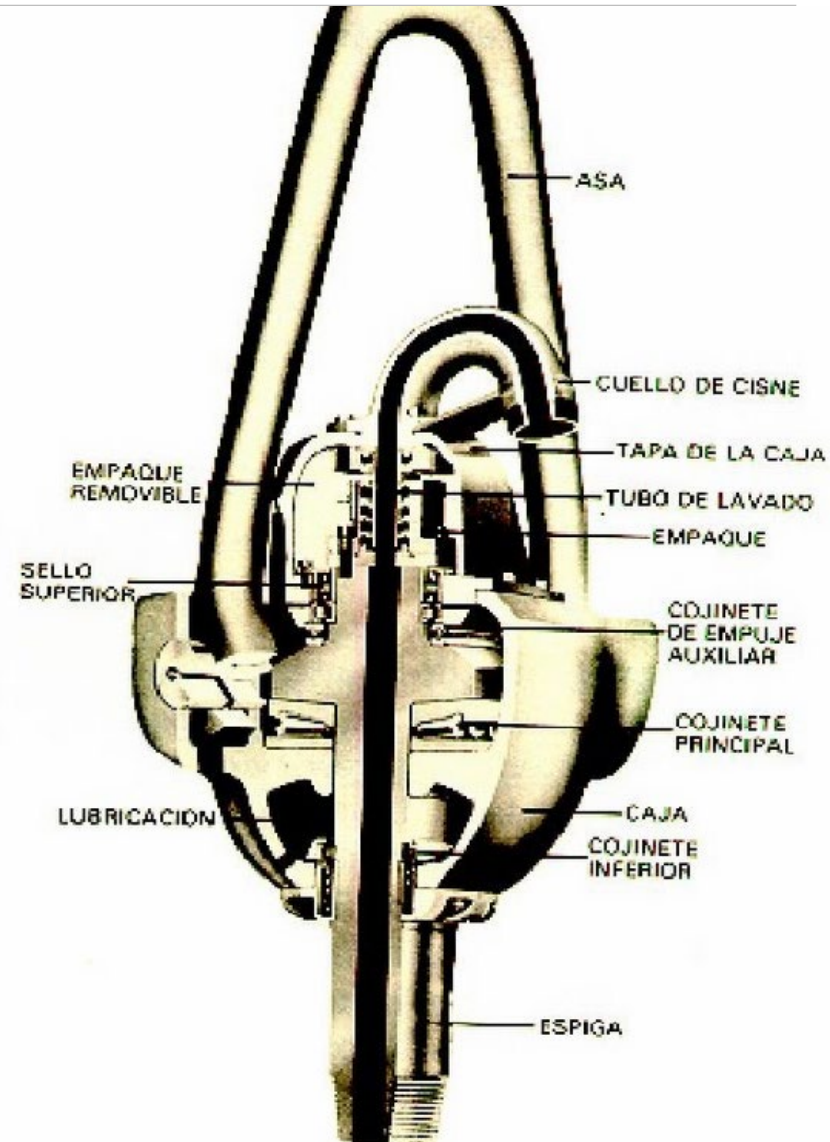
Mesa giratoria



Ancla de línea muerta

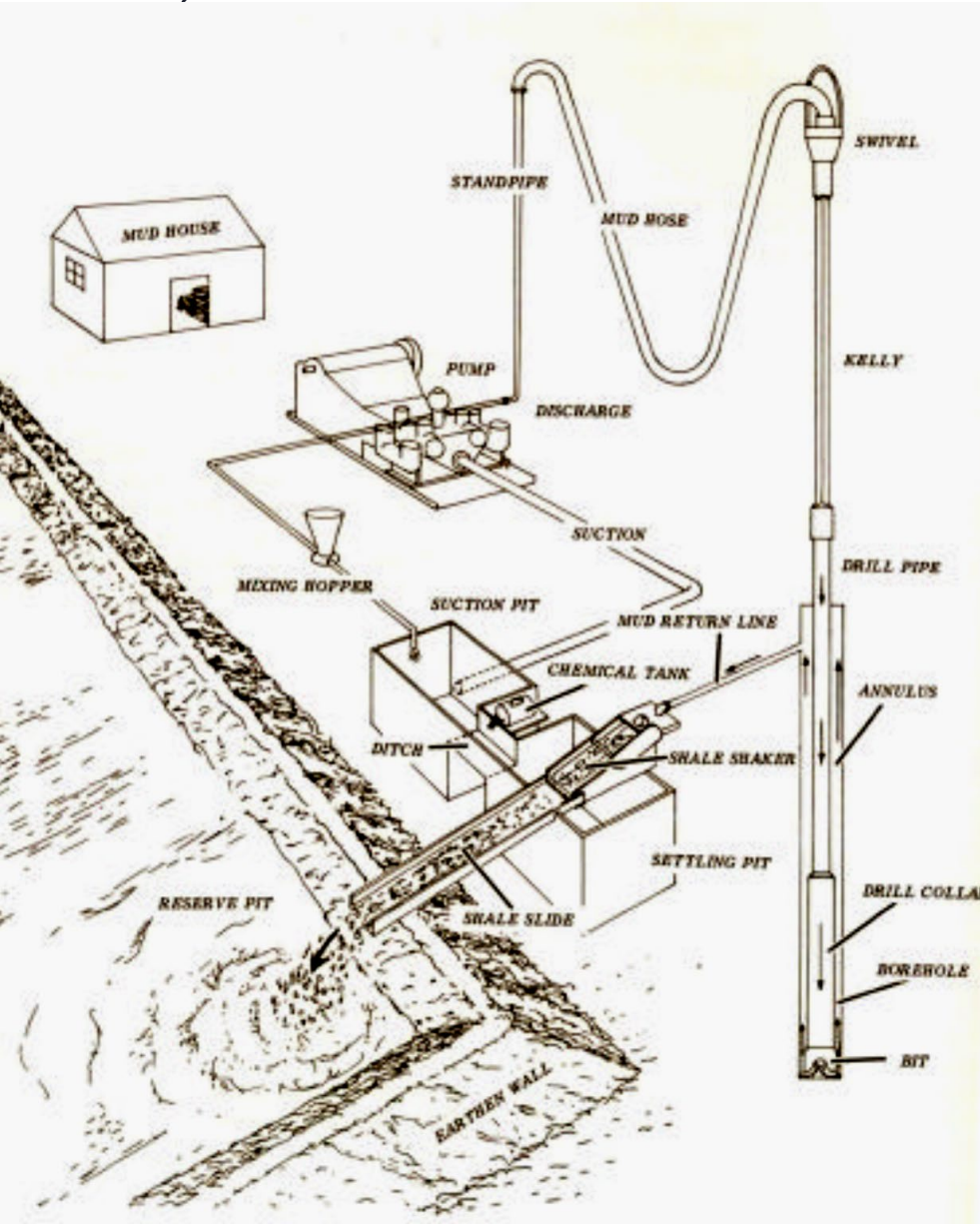
Cable de acero





4. Drilling fluid circulation system

- This system consists of four main components:
 1. The drilling fluid
 2. The preparation and storage area
 3. The equipment for pumping and fluid circulation
 4. The area and equipment for preparation



Bomba de lodos



Criba vibrante



Centrifugadora



Desarenador



Guardabarro



Bomba centrífuga



Separador de gas



Bomba de corte



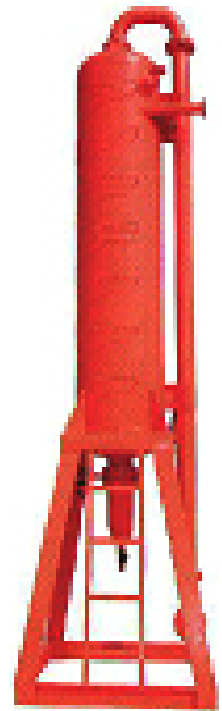
Limpiador de fluido de perforación



Mezclador de fluido de perforación



Agitador de fluido de perforación



Separador de perforación

Solids contained in fluid control equipment



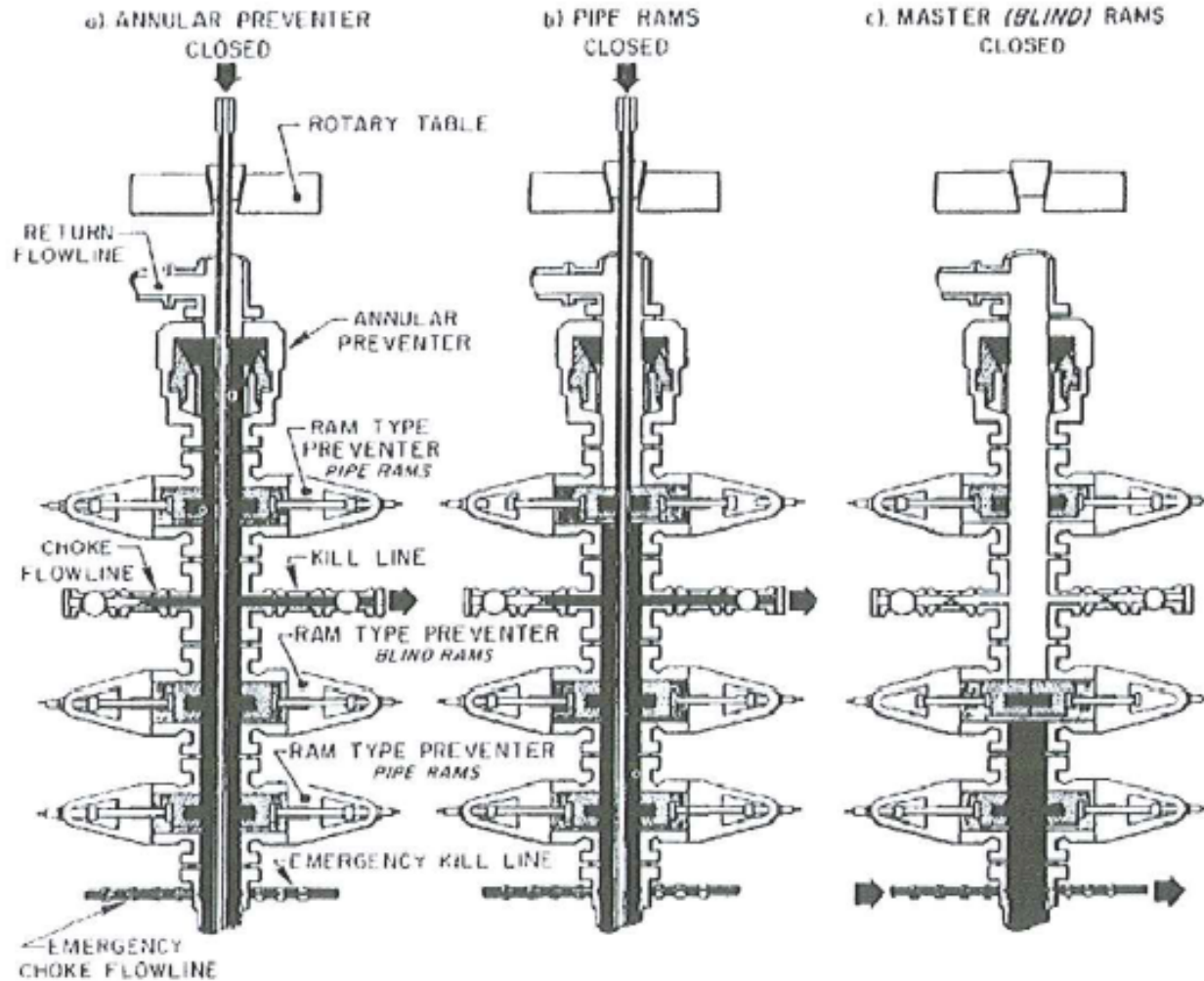
El conocido como "Lucas Gusher" en Spindletop, Texas (1901)



5. BOP – Blow Out Prevention system

- A blow out is an uncontrolled flow of fluids (crude oil or natural gas) from the formation to the surface when the pressure control systems have failed.
- Before the appearance of the control equipment of pressure in the 1920's, the uncontrolled release of oil and gas from a well during drilling was common and was known as "oil gusher", "gusher" o "wild well".
- A Blow out begins with an "outbreak" or "pitch" which is an unexpected flow of fluid from the formation towards the inside of the well, which, if not handled properly, it becomes a blow out.
- The system for the well control has three functions:
 1. Close the well in the event of an unexpected influx.
 2. Put in place a sufficient counter-pressure on the formation.
 3. Retrieve the primary control of the well.

Components of a BOP system





mip

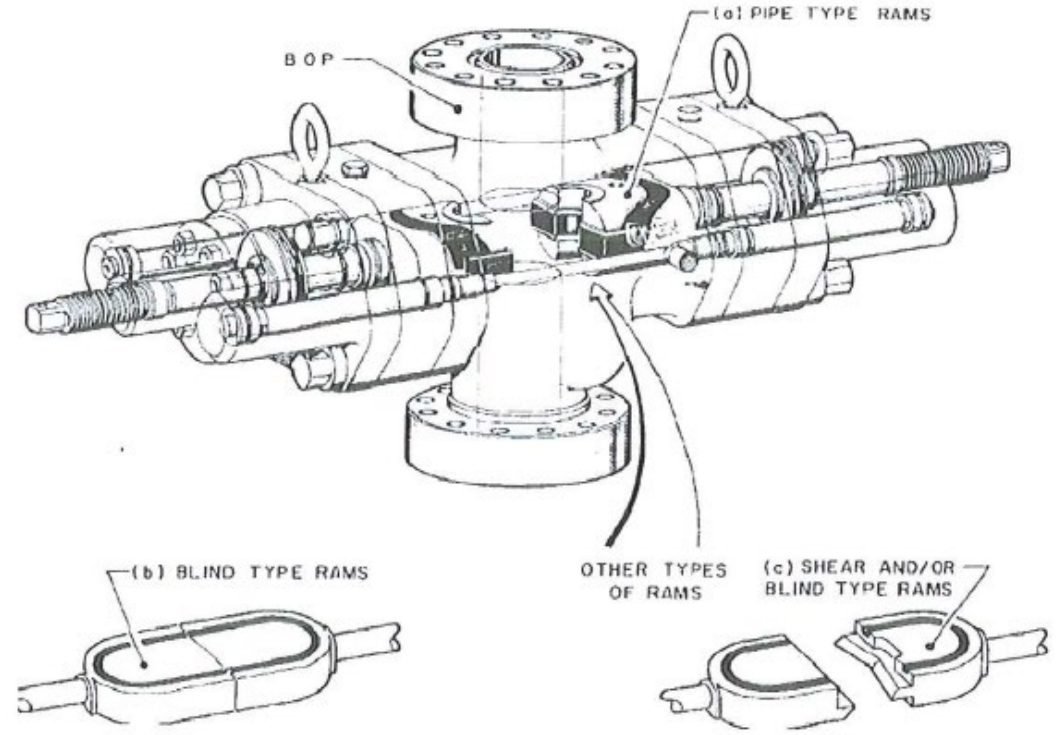
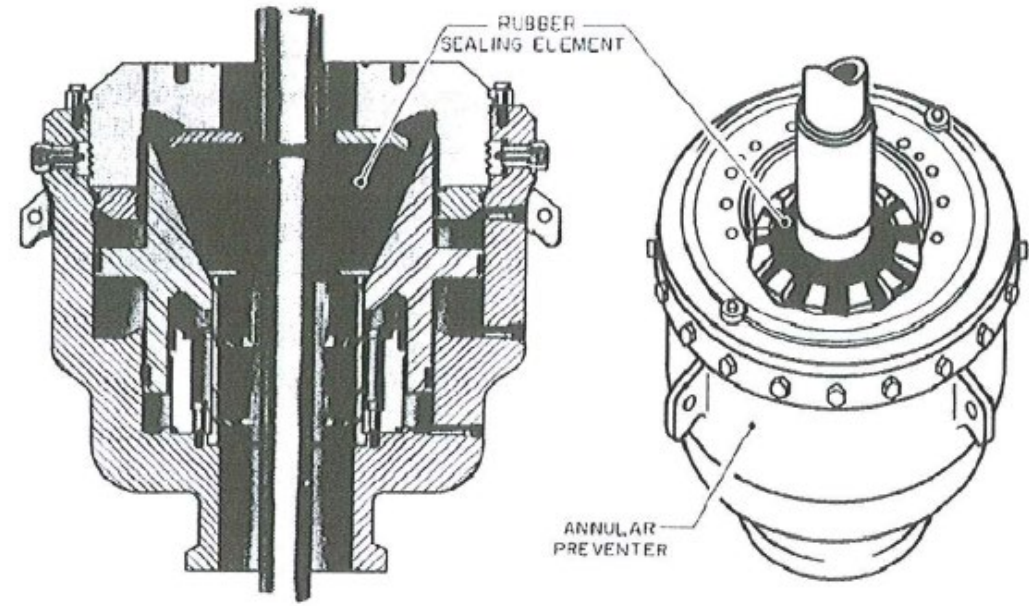
**MÁSTER EN INGENIERÍA
DE PETRÓLEO Y GAS**
OIL & GAS ENGINEERING MASTER'S DEGREE



POLITÉCNICA



ESCUELA TÉCNICA SUPERIOR
DE INGENIEROS DE MINAS Y ENERGÍA
DE MADRID



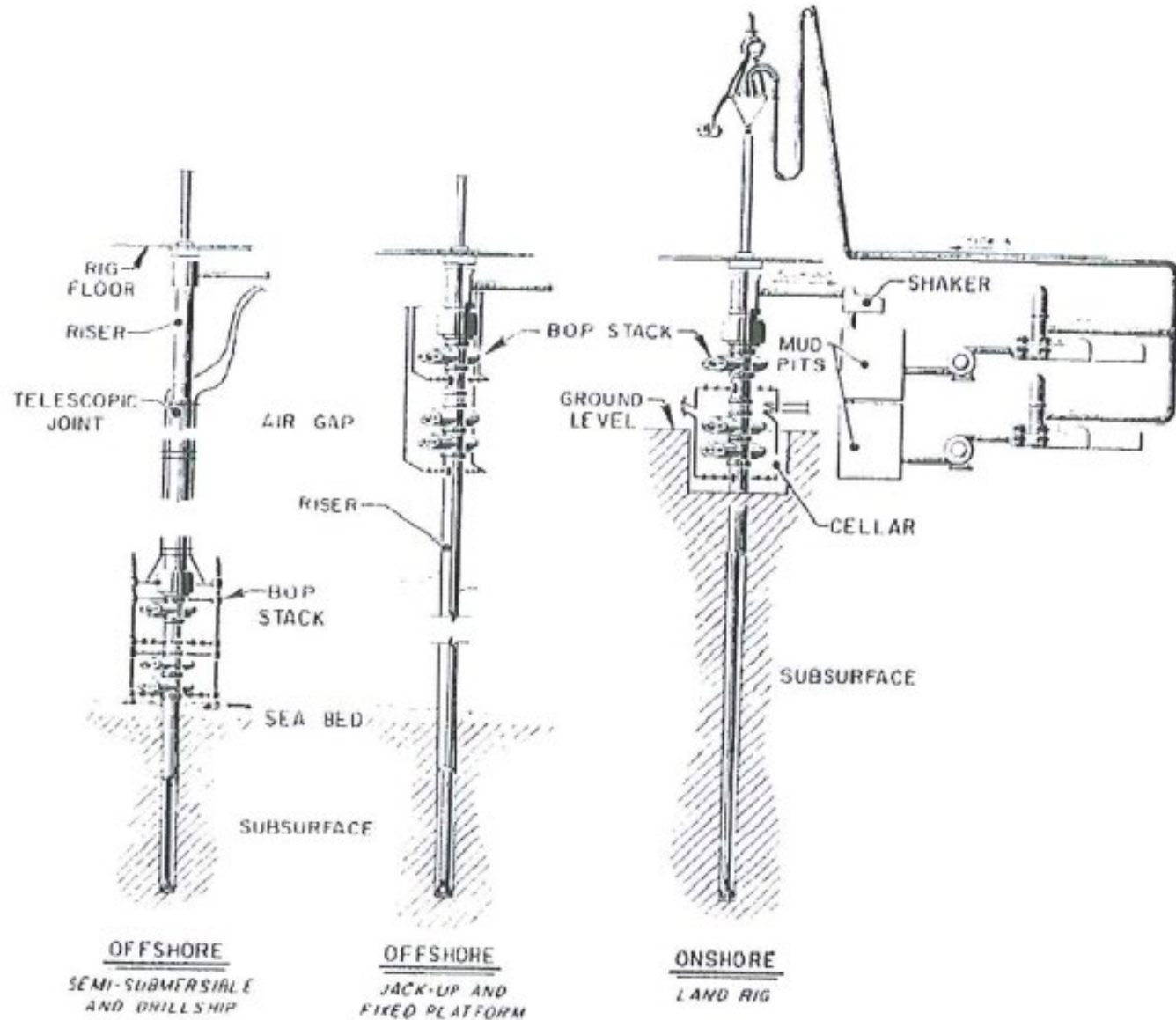


BOP de tipo ariete



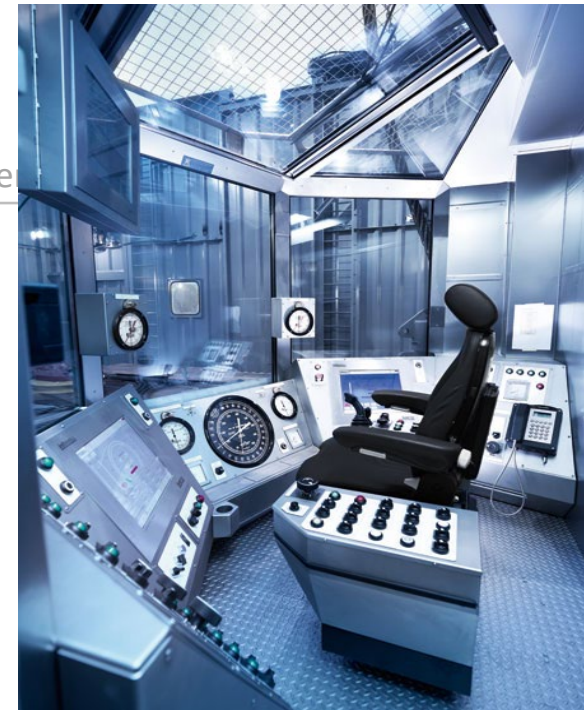
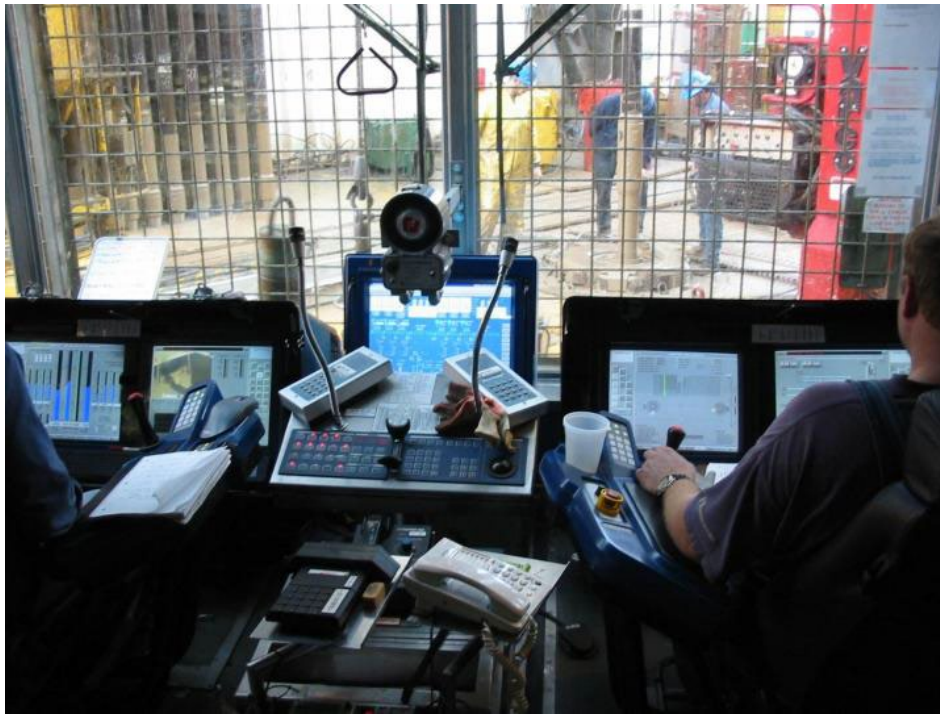


Deepwater Horizon offshore drilling unit on fire in 2010

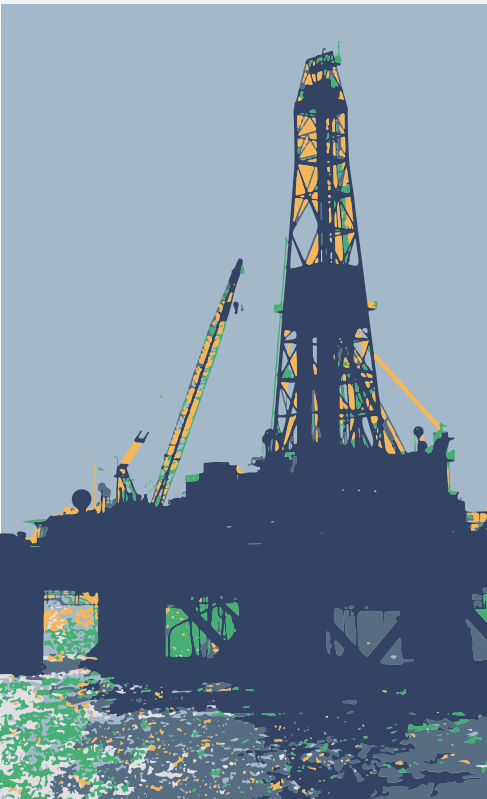


6. The Drillers console







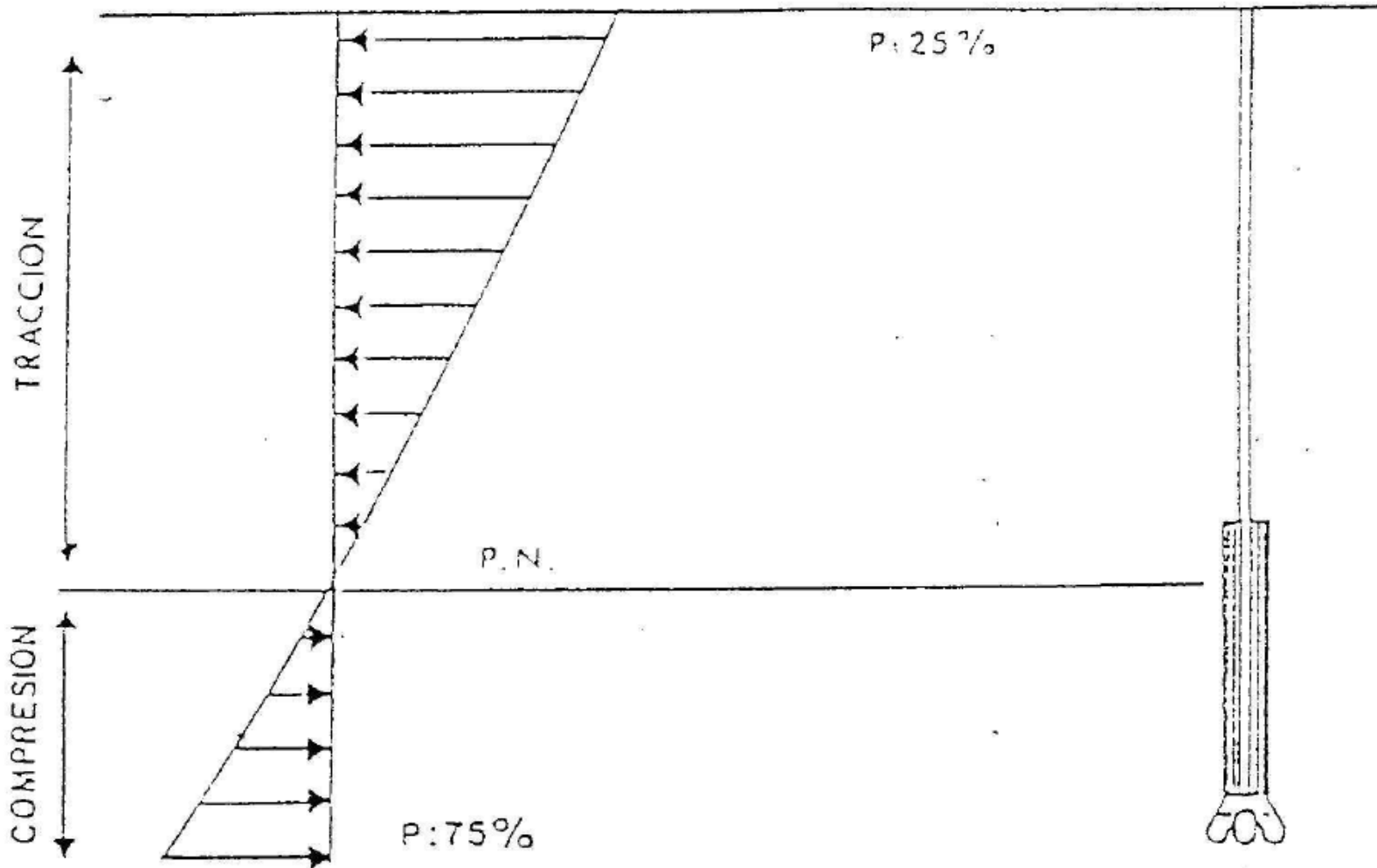


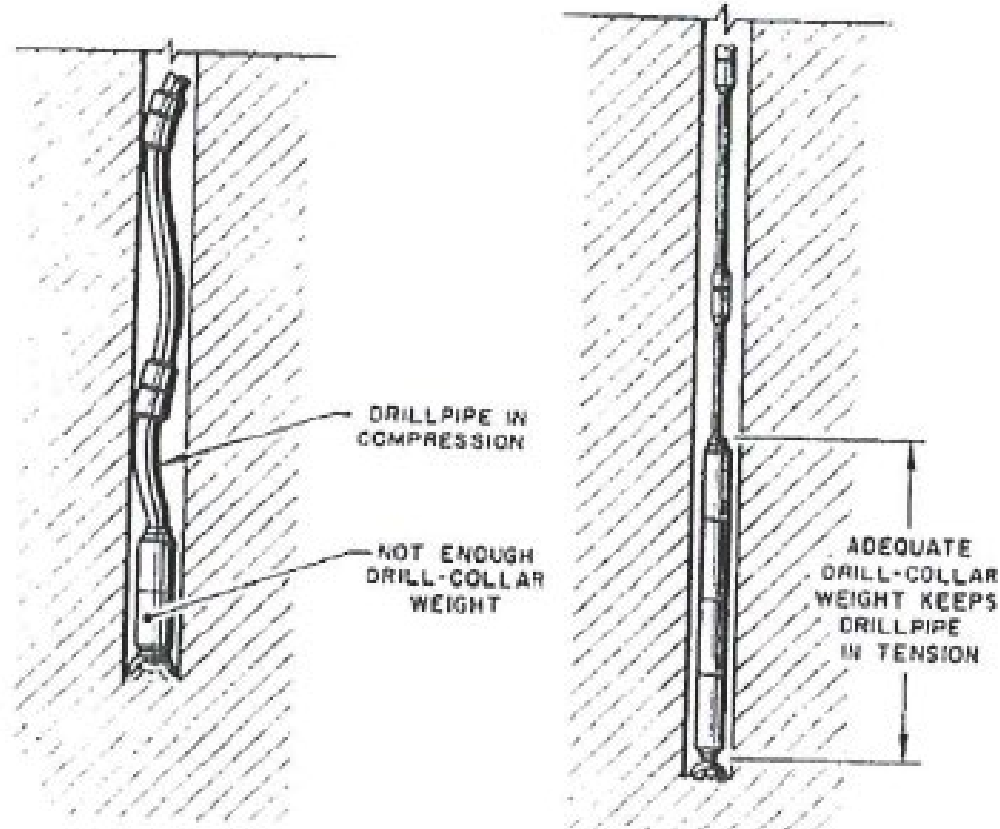
4. Components of the drilling string.

Components of the drilling string

- In general terms, the drilling string has the following components:
 - Drilling bit
 - (Mud motor)
 - Drilling Collars (DC)
 - Heavy Weight Drill Pipe (HWDP)
 - Drill pipe (DP)
 - Accessories:
 - Stabilizers,
 - Reamers,
 - Substitutes of coupling,
 - Drilling bit connectors,
 - Etc.

Distribución de esfuerzos en la sarta de perforación

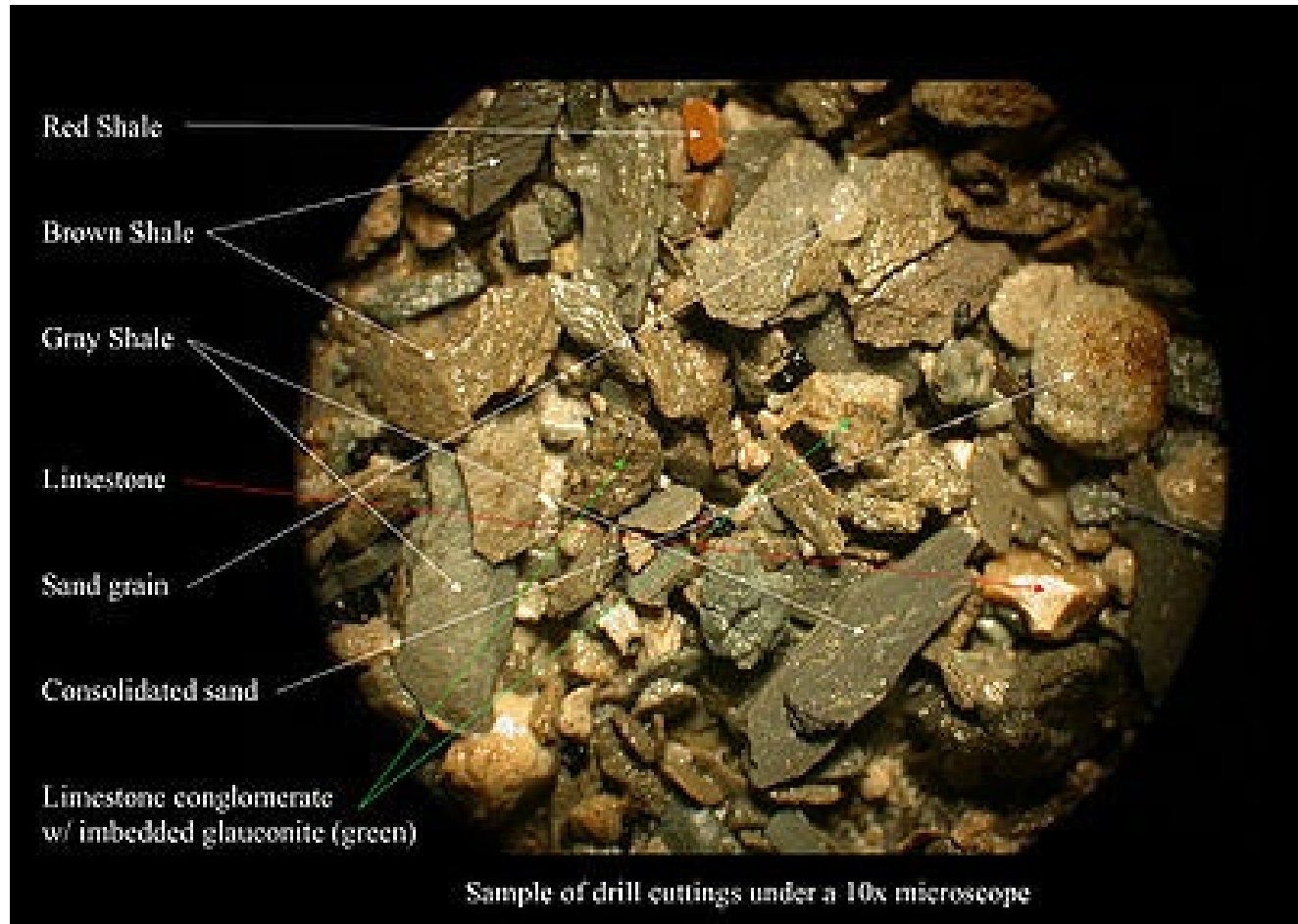




Drill bit selection

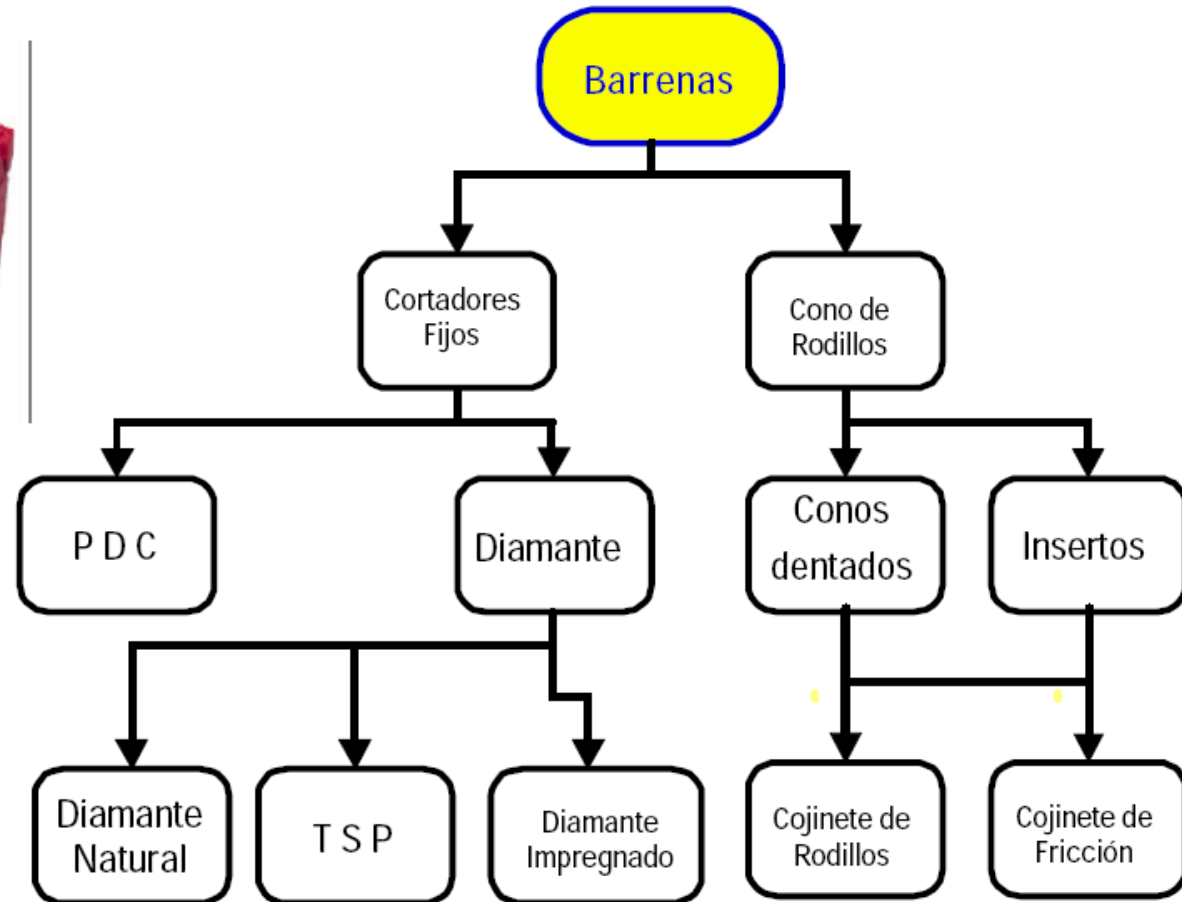
- The selection of the drilling bits is a crucial aspect for the operation of all drilling projects.
- **Understanding the different types of drill bits and their respective applications is a prerequisite for their selection.**
- Drilling involves not only the **correct bit selection** in the correct application, but also its **operation with the correct operating parameters.**
- Given that drilling technology continues to improve at a rapid pace, the engineers in charge of the supervision of a well must be updated about the latest advances to ensure making the optimum selection of drilling bits.



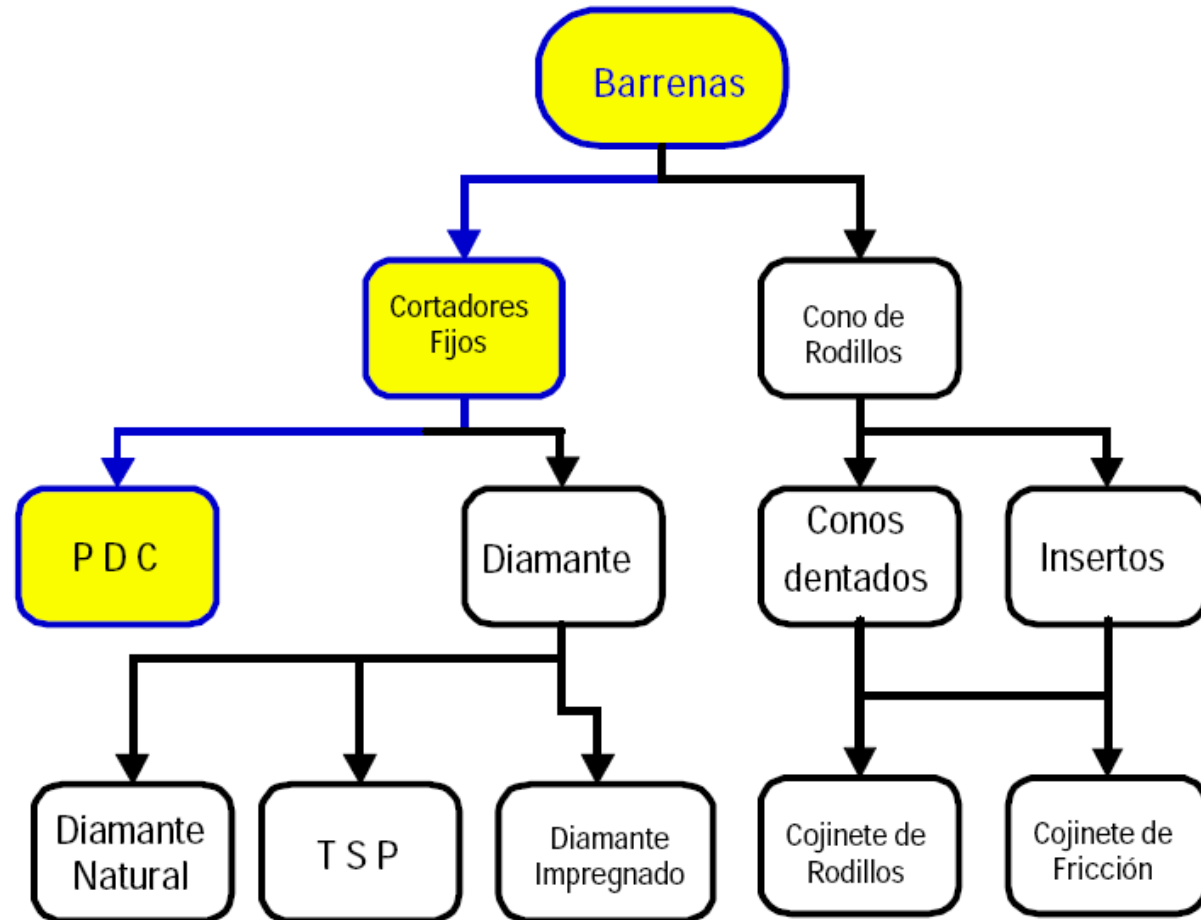


Fuente: http://en.wikipedia.org/wiki/Drill_cuttings

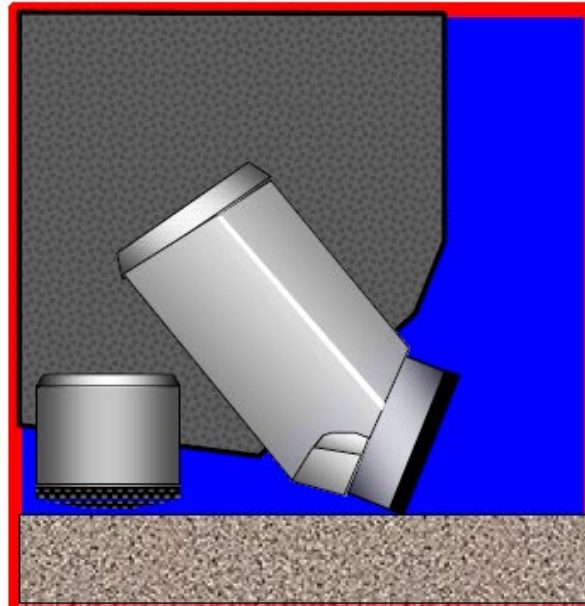
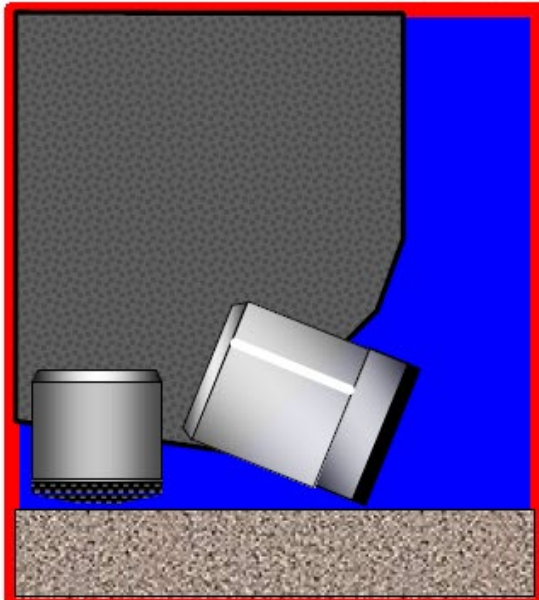
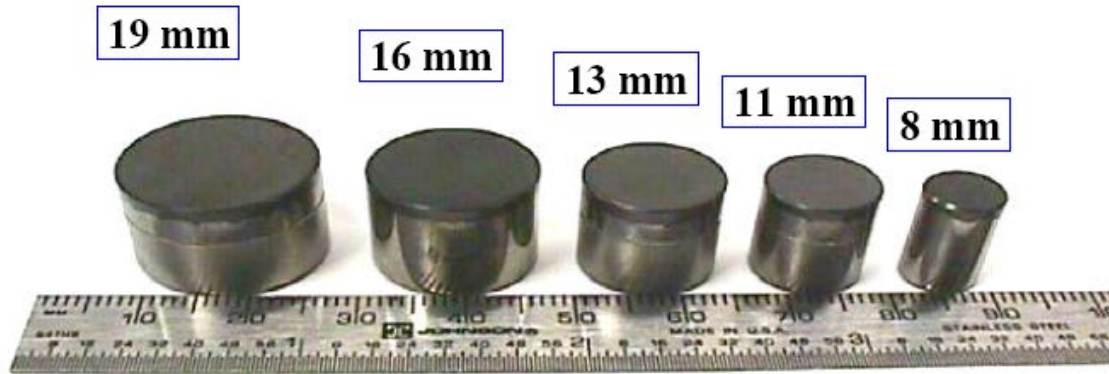
Drill bit types



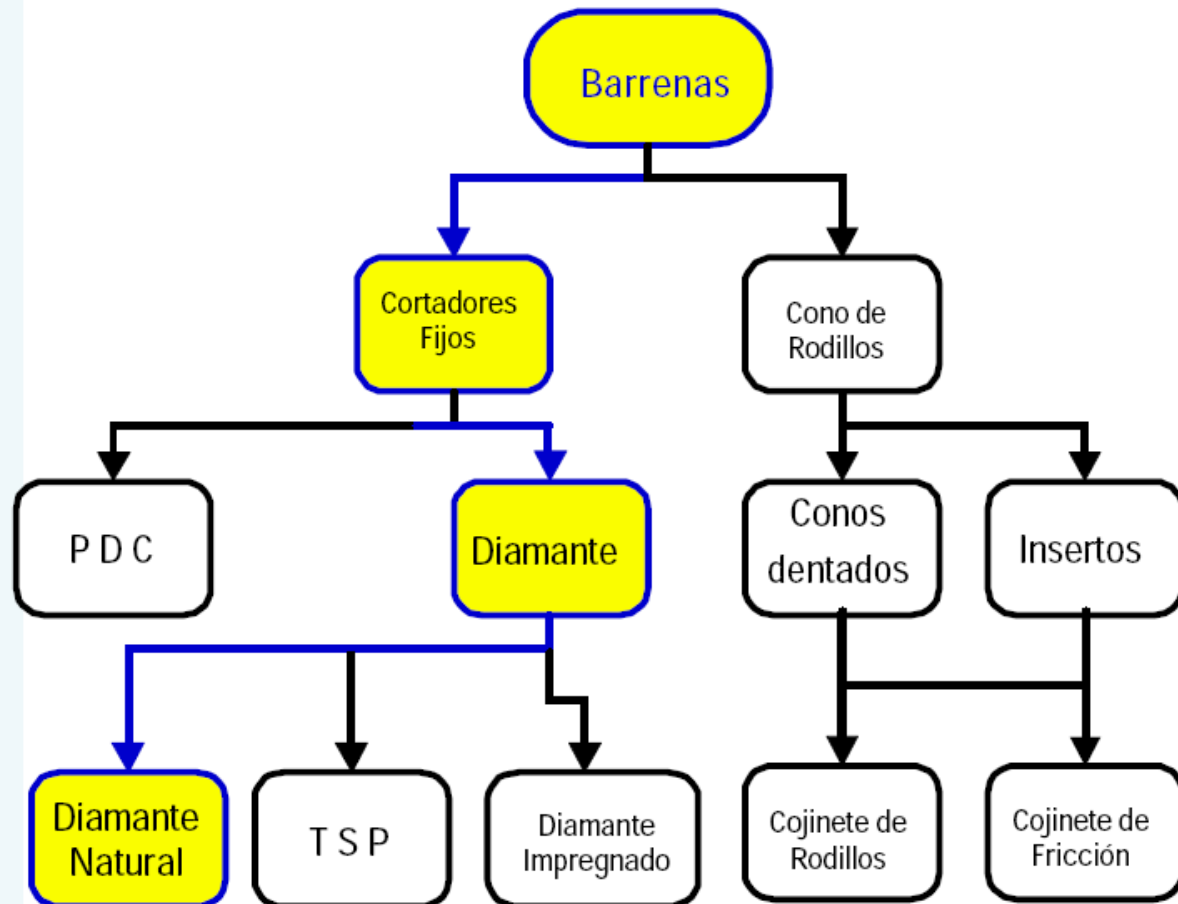
Polycrystalline diamond compact (PDC) drill bits

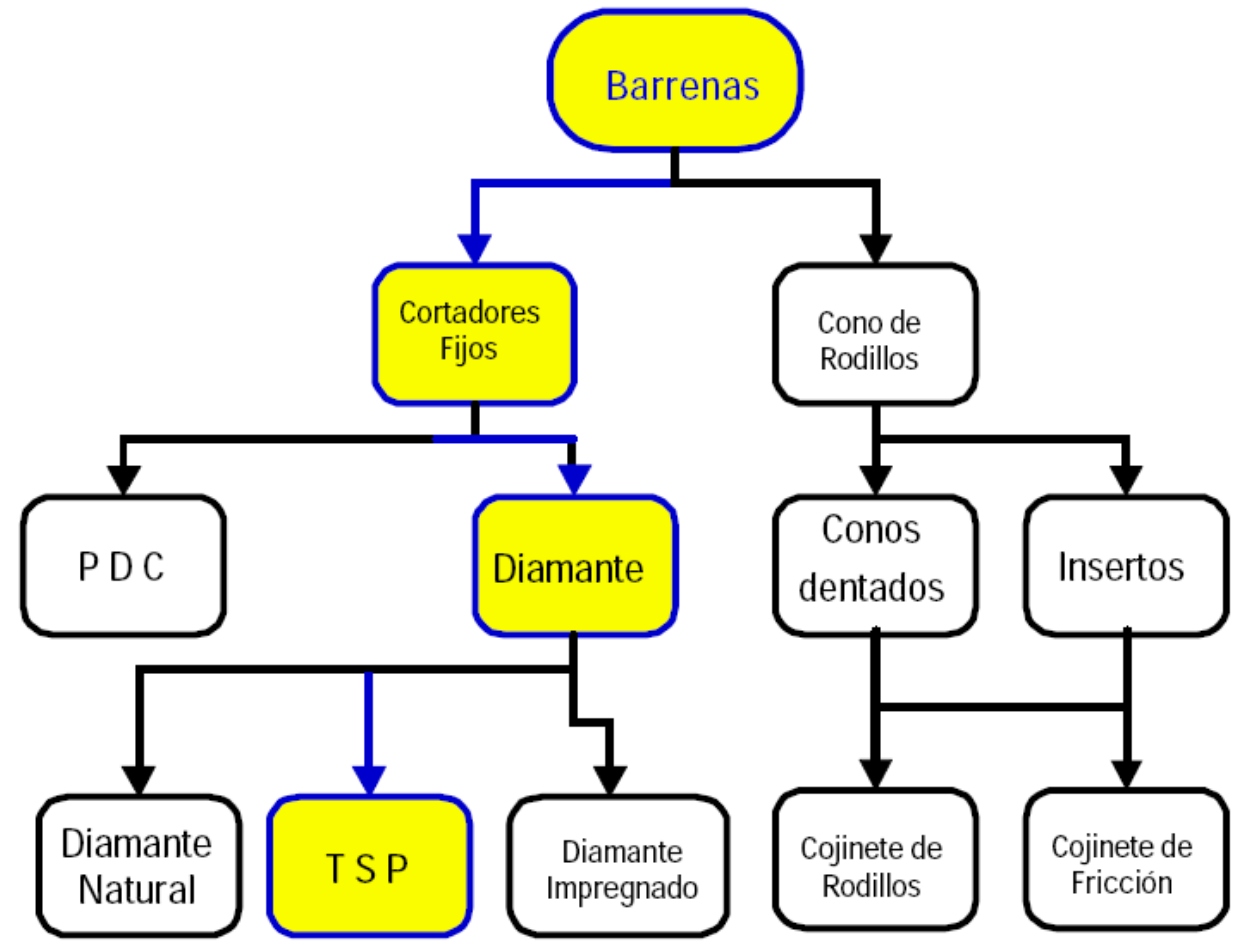


PDC cutting elements

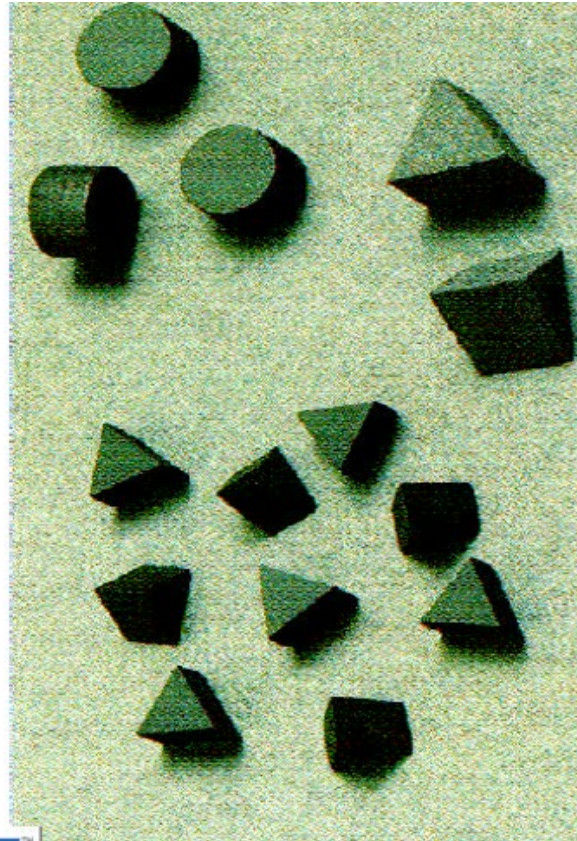


Natural Diamonds

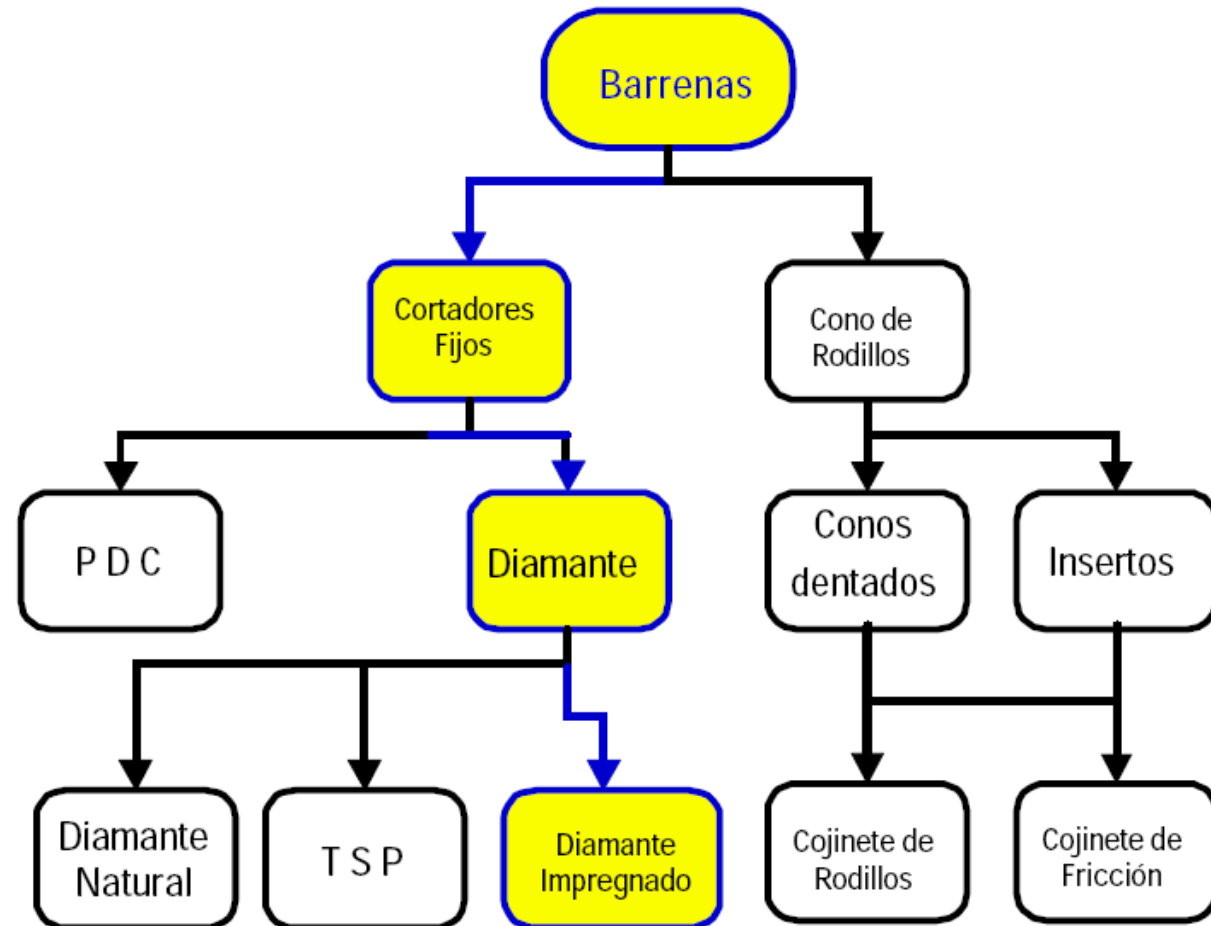




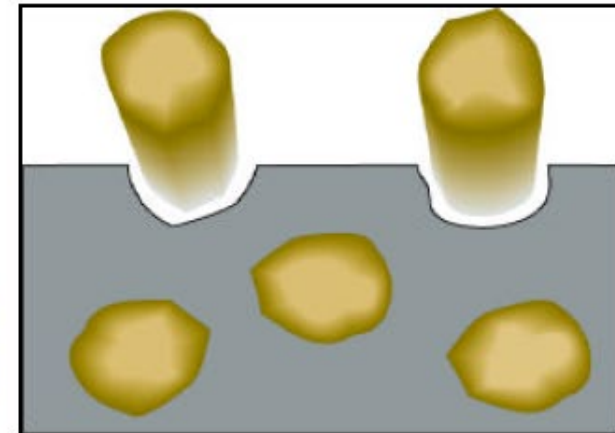
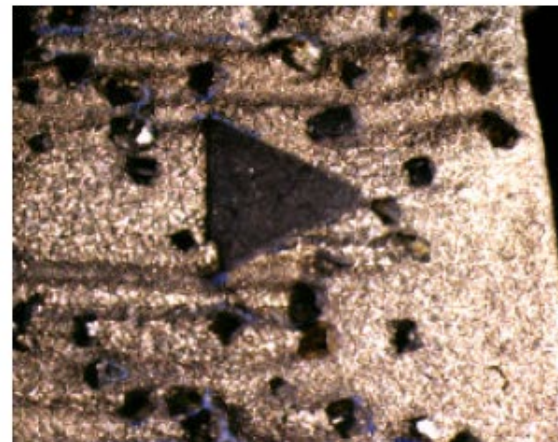
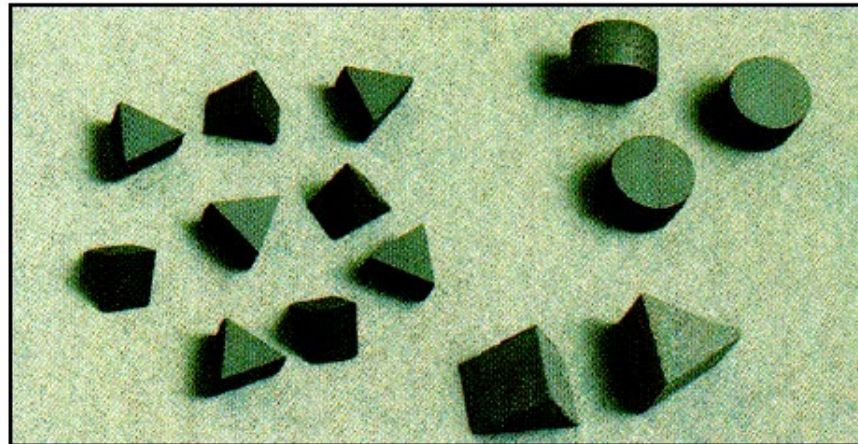
TSP cutting elements



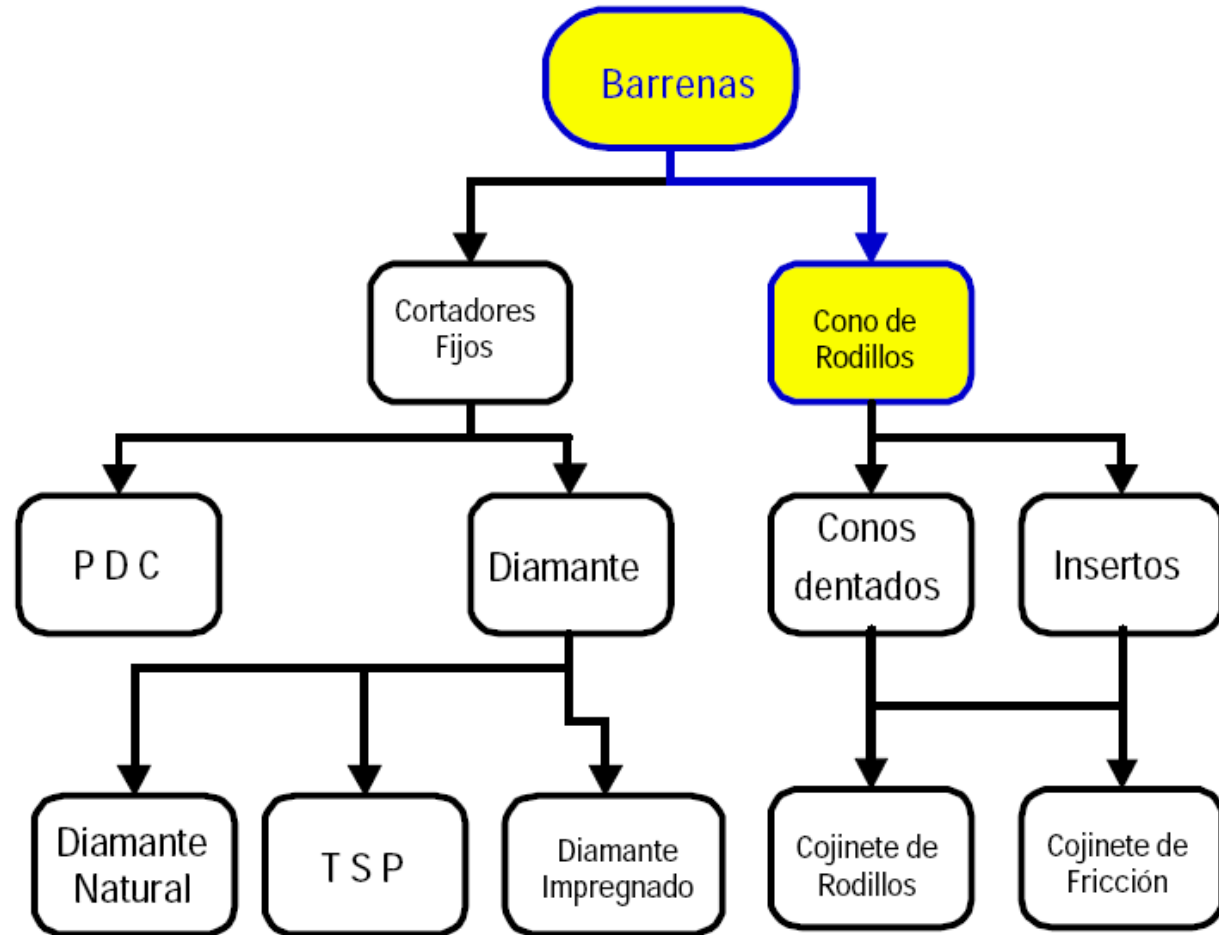
Diamond powder impregnated drill bit



Diamond powder impregnated cutting elements



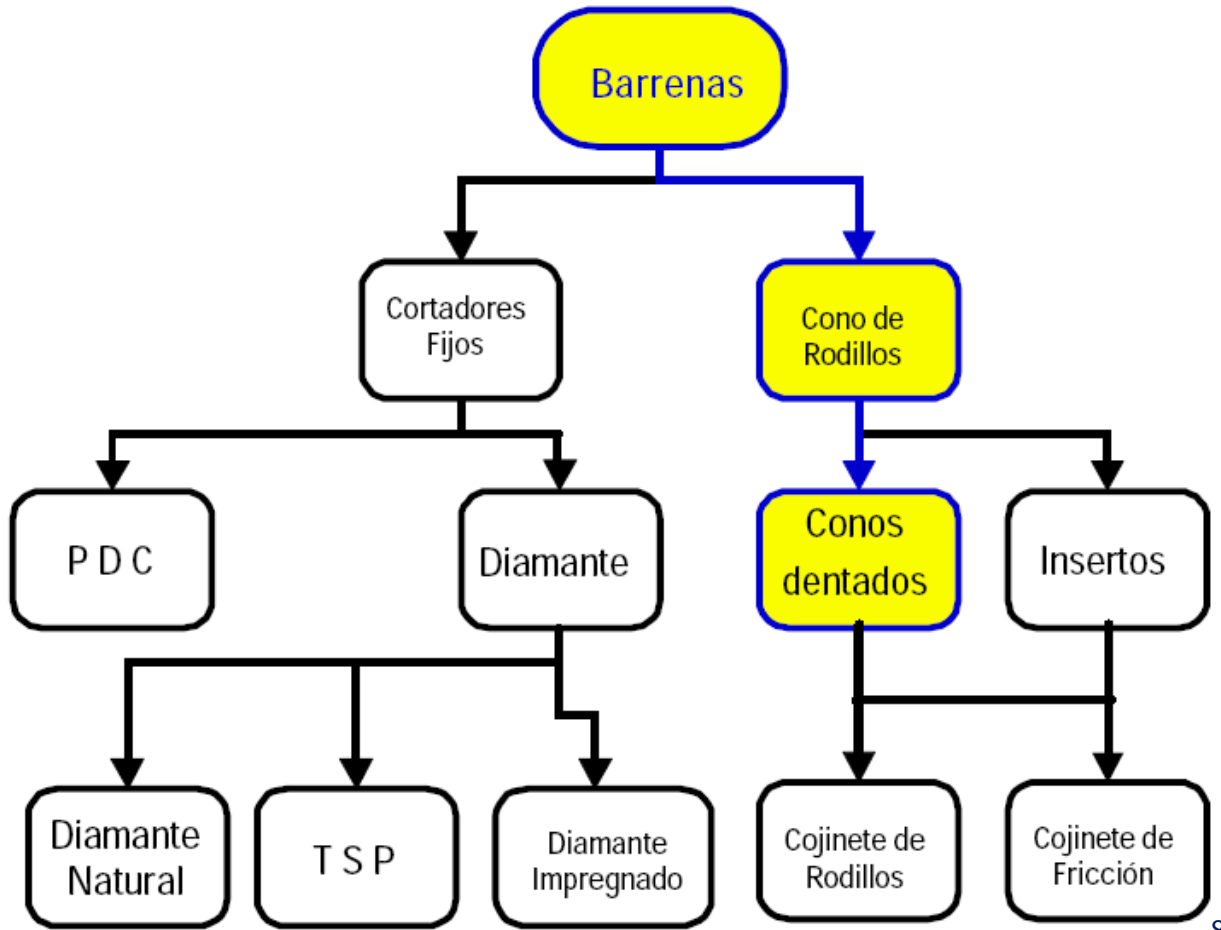
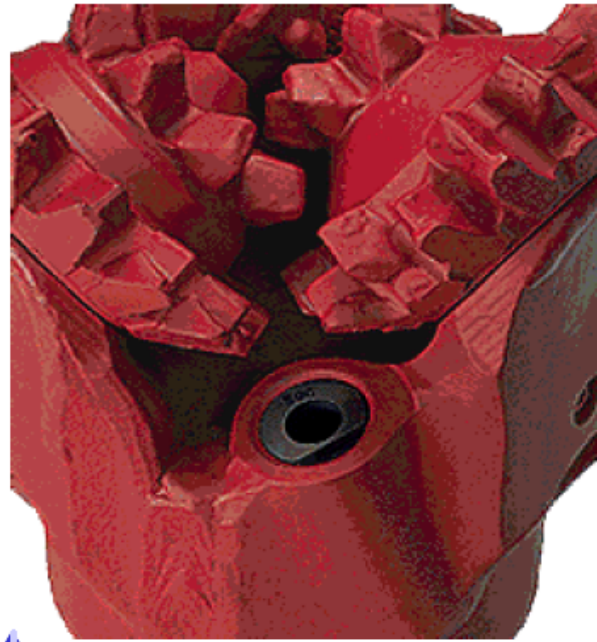
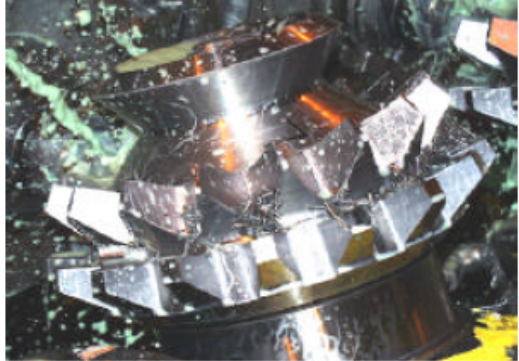
Drill bit types



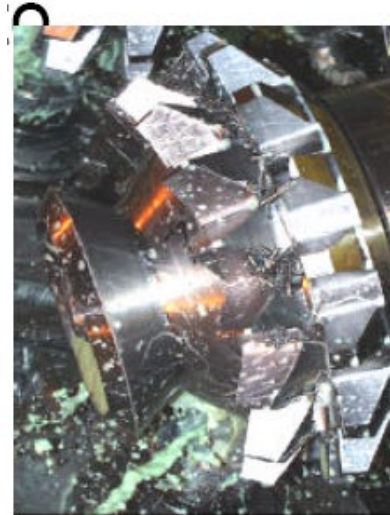
Tri-Cone™



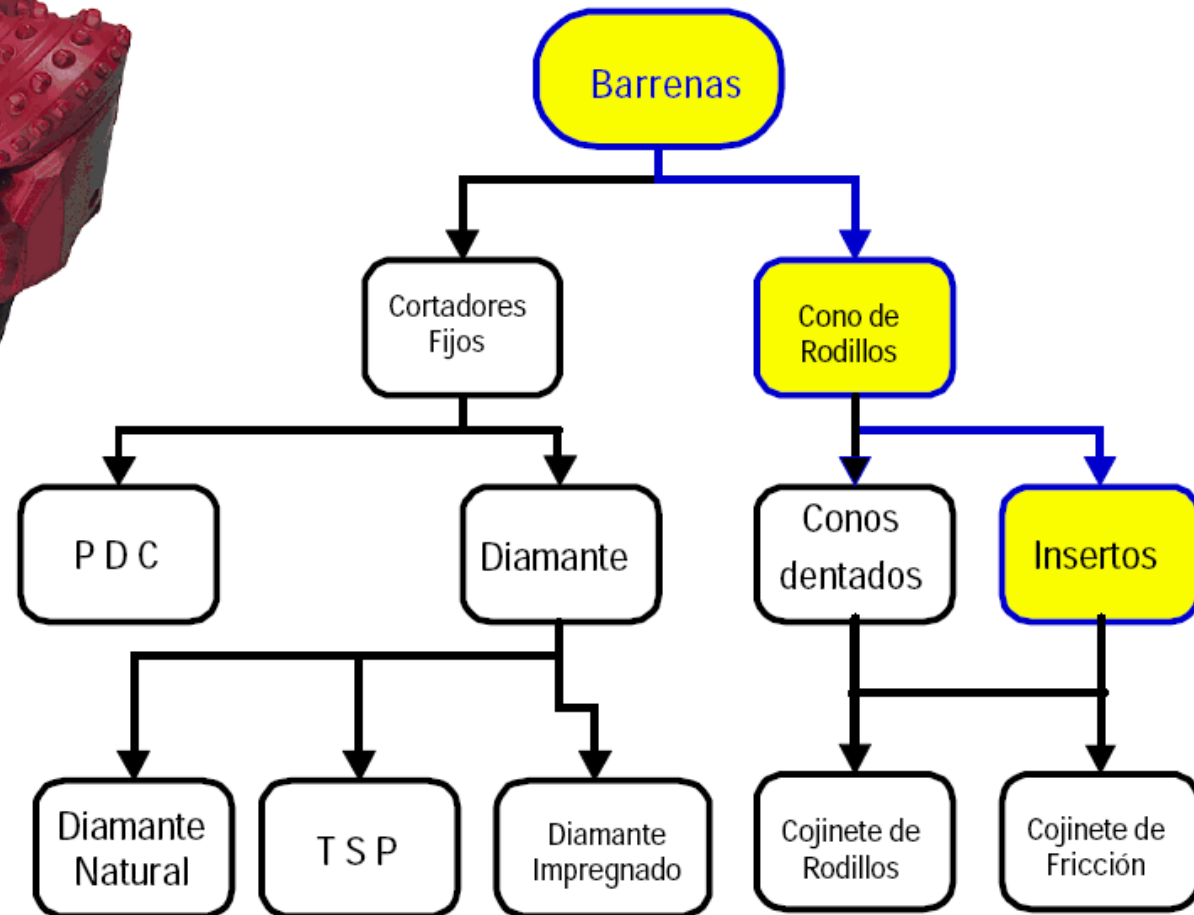
Tri-cone drill bit



Tri-cone drill bit cutting elements

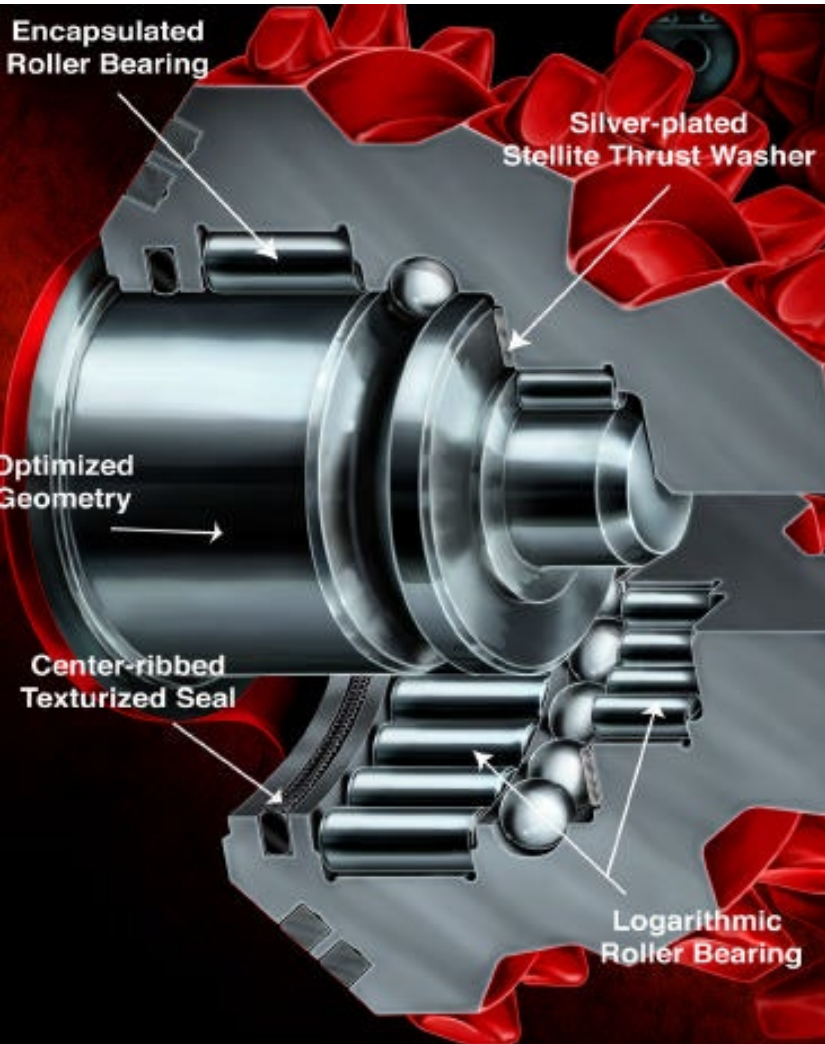


Inserts drill bits

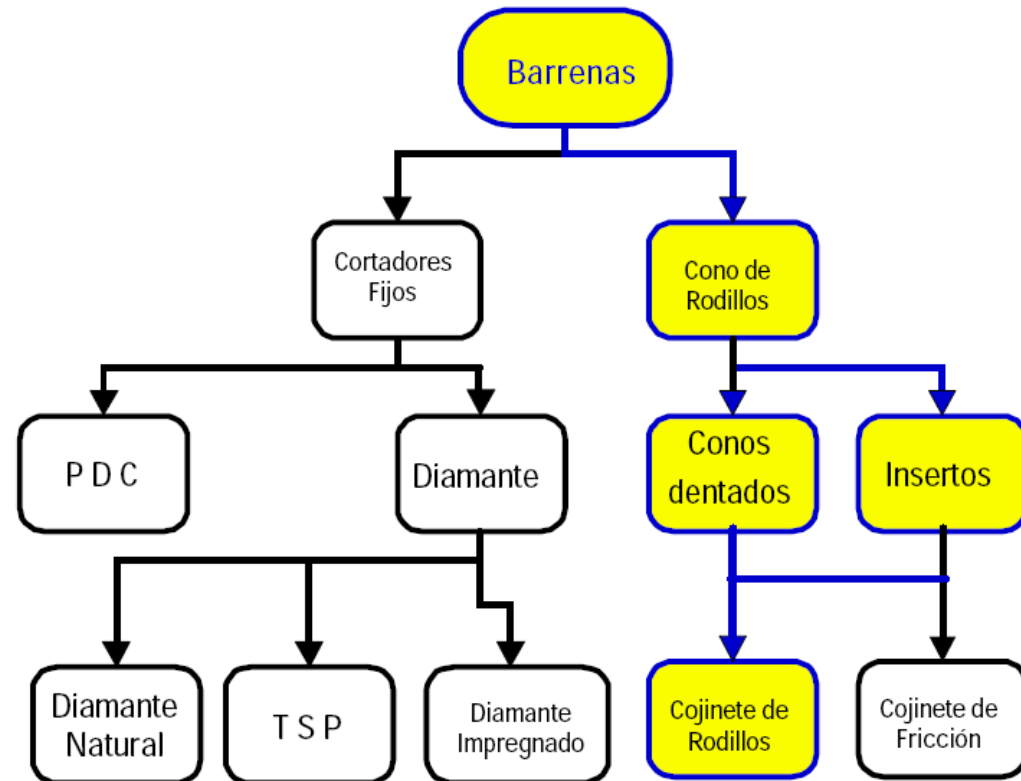


Tungsten carbide insert elements

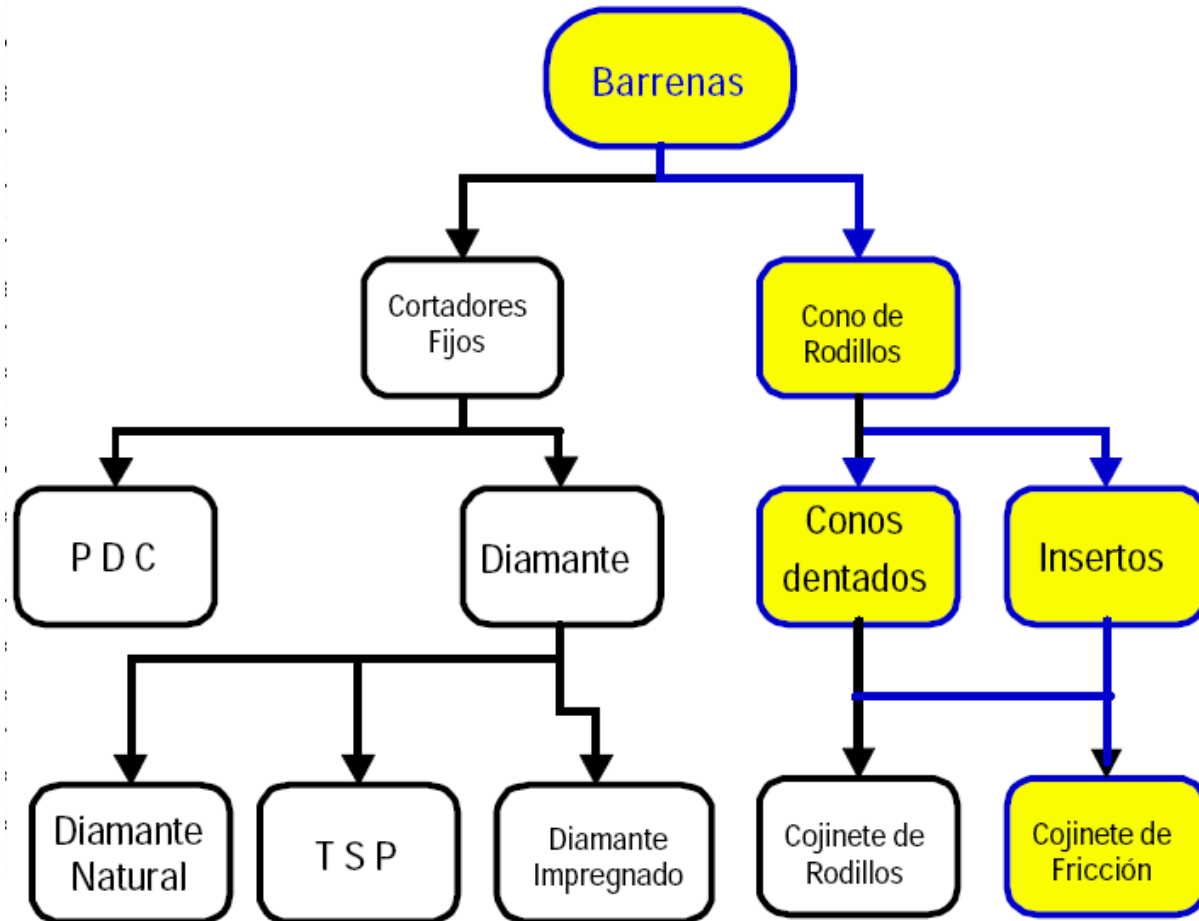




Cones - roller bearing



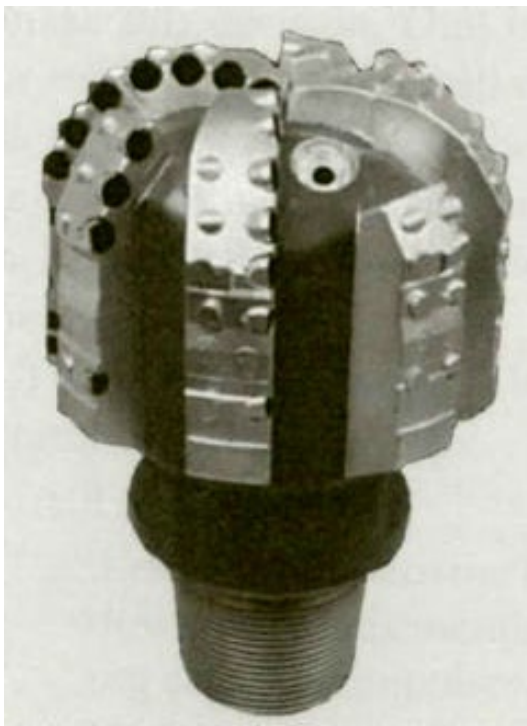
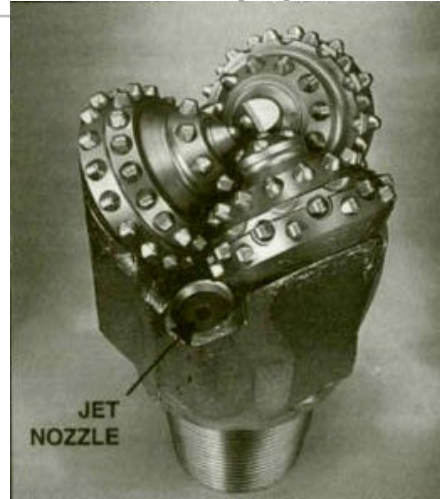
Jagged/Insert Cone – Trunnion bearing



Drill bits

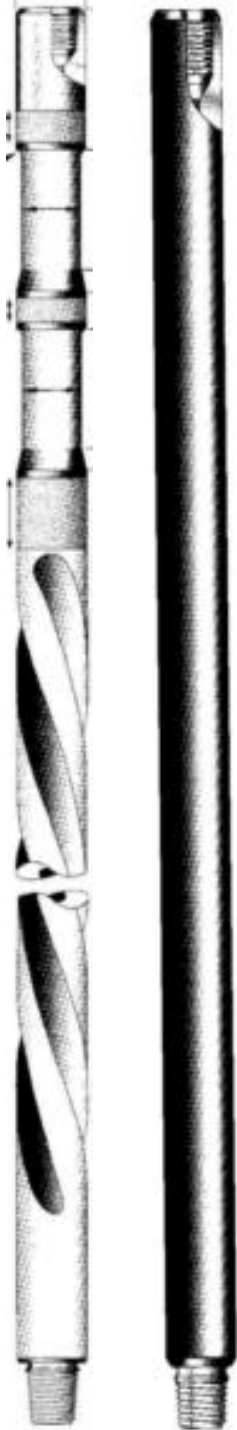
Tri cone bits (Rock Bits)

Fixed cutters bits (Drag Bits)



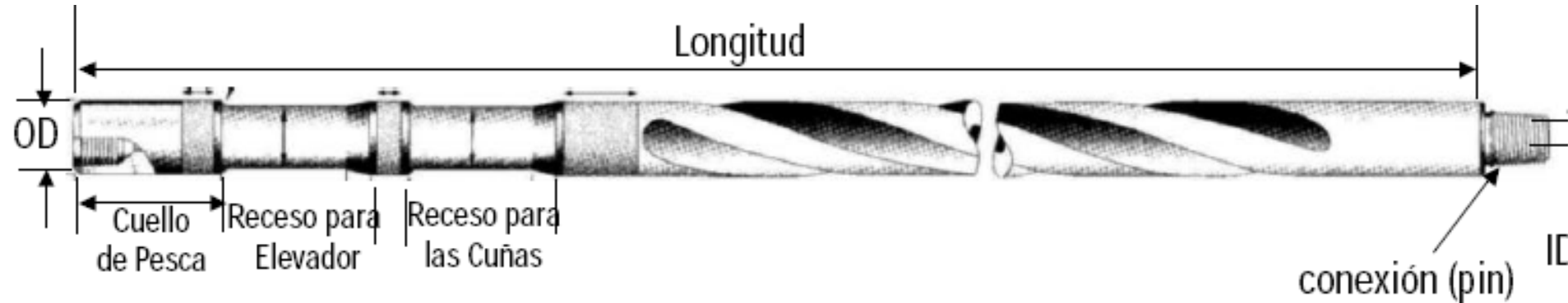
Drilling Collars

- Description:
 - They are metal tubes with walls of a great thickness.
 - The ends of the tube have threads machined (box and pin)
- Functions:
 - Provide the weight applied to the bit (WOB)
 - Keep the drill pipe in tension and prevent (avoid) the cupping or buckling of drill pipe.
 - Provide the pendulum effect for drilling straight holes
- Types:
 - They are manufactured in a wide variety of sizes of inner and outer diameter: normal external diameter OD runs from 4 ¾" to 9 ½"
 - Usually the length goes from 30 to 31 feet
 - They can have the form of a square bar to drill in areas with high natural tendency to the deviation of the hole.
 - The form of spiral is suited to drill in areas prone to entrapment of the string
 - They may have recessions to install elevators and Rotary wedges



A

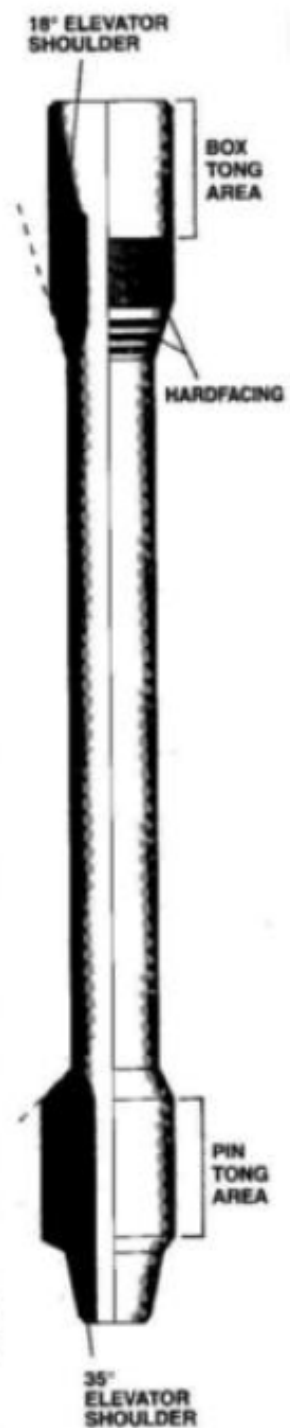
Measure of the drilling collars



Well# TRG 1		Schlumberger					Bit # 1	
Date: 28-Jul-03							SI # 1234	
Rig: IDPT							Type atm 234	
BHA#: 1							Manuf Hughes	
Hole Size 26"							Jets 20-20-20	
Item	SI #	ID	OD	FN	Pin	Box	Length	Remarks
Bit	1234		26"		7 5/8" R		0.75	New
Bit Sub	SL 235	3 1/8"	9 1/2"			7 5/8 R	1.01	
9 1/2" Drill Collar	9546	3 1/8"	9 1/2"	0.67	7 5/8" R	7 5/8 R	8.96	
Stab	237689	3 1/8"	9 1/2"	0.93	7 5/8" R	7 5/8 R	2.36	
9 1/2" Drill Collar	9503	3 1/8"	9 1/2"	0.78	7 5/8" R	7 5/8 R	9.01	
9 1/2" Drill Collar	9521	3 1/8"	9 1/2"	0.95	7 5/8" R	7 5/8 R	9.04	
9 1/2" Drill Collar	9520	3 1/8"	9 1/2"	1.03	7 5/8" R	7 5/8 R	8.99	

Drilling pipes

- Functions:
 - Serve as a conduit for the circulation of the drilling fluid
 - Transmit rotation from the surface down to the bit at the bottom
- Components:
 - A cylindrical outer seam and central duct made of cast steel or extruded aluminum pipe.
 - Threaded connectors welded at the ends of the tubular body without sewing
- Screw connectors:
 - Provide the connection between the components of the drill pipe.
 - They are metal parts welded to a seamless tubular body
 - They are sufficiently thick and strong to have cutted in them the thread of pin and the box.

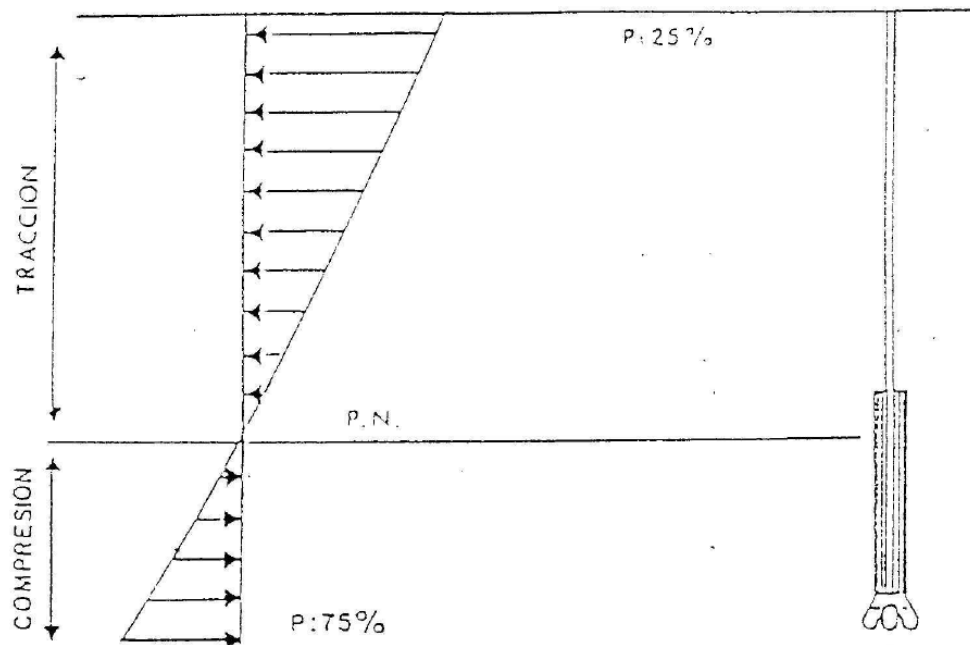




- The tubes to be assembled have a length of 30 meters (100 feet).
- As the well goes deeper, the weight of the drill pipe increases significantly and can weigh about 500 metric tons for a well of 3,000 meters deep.
- The control of the weight on the bit must be very careful, in order to prevent it becomes damaged or destroyed.
- Typical values of the efforts on the bit are as follows: a force of 50 kN on the drill bit and a twist of 1 or 1.5 kNm at 40 - 80 rpm for an 8 inch cone.
- The ROP (Rate of Penetration) depends of the depth and can be as much of 20 m per hour for sandstone or a dolomite, and as low as 1 m/hour for a deep schist or a granite.

Drill string neutral point

- Definition:
 - It is the point in the drillstring where the stress goes from compression to tension.
 - Such a point should always be within the Drilling Collars
 - Drill pipe should always be in tension condition

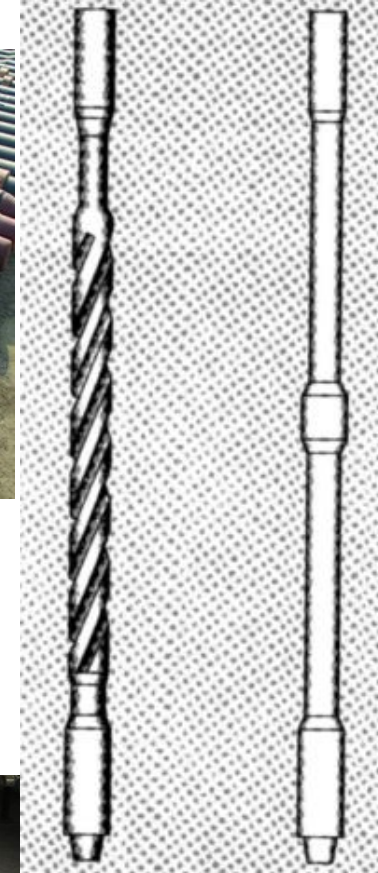


Classification of the drill pipe

- 1. Size:
 - from 2-3/8" to 6-5/8" (external diameter of the body)
- 2. Length ranges:
 - R-1 from 18 to 22 feet,
 - R-2 from 27 to 30,
 - R-3 from 38 to 45
- 3. Steel grade:
 - E – 75, X – 95, G – 105, S – 135 (Nota: los números indican la mínima resistencia a la cedencia en 1000 libras)
- 4. Nominal weight:
 - It depends on the different ranges of size and weight
- Example: a DP can be: 5", R-2, G-105, 19.5Lpp (Libras por pie)

Heavy Weight Drill Pipe (HWDP)

- Design:
 - With higher wall thickness and fasteners longer than the regular DP
 - With external metal reinforcement in the center of the tube body
 - Also available with exterior spiraled design
- Functions:
 - Works as a transition between the drill collars (DC) and the drilling pipe (DP)
 - This prevents buckling or the cupping of the DP
 - It can work in compression without damage in attachments
 - Widely used in directional drilling
 - Sometimes used instead of the DC (drilling collars).
 - It keeps the drill pipe rotating in tension
 - It should not be used to provide weight on the bit under normal conditions



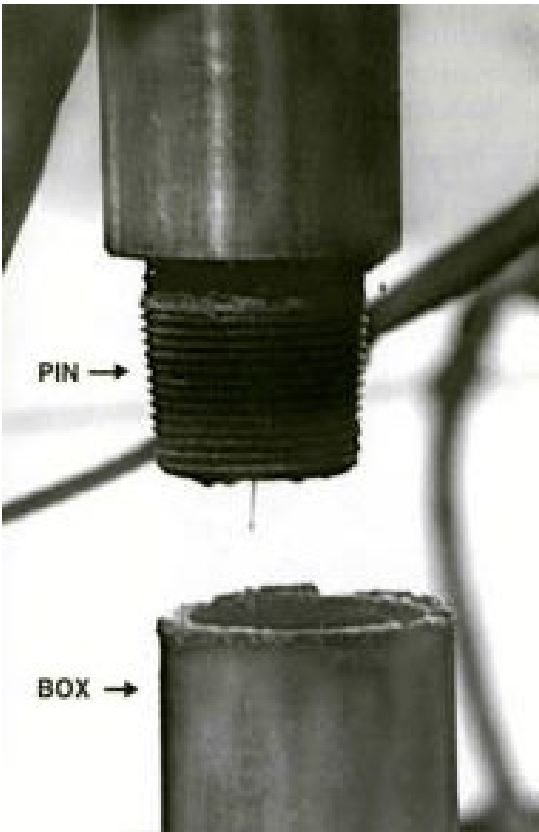
Drillstring Weight

- Nominal Weight (in pounds per foot) for tube body
 - Example: 19.5 lbs / ft for drill pipe of 5" y 15.5 lb/pie for DP of 3 ½"
- Approximate Weight (Adjusted) Including Coupling Mass
 - For the above DP, will be 22 lb/pie para TP de 5" y 17.0 lb/pie para TP de 3 ½"
- Floated or Submerged Weight:
 - It is found by multiplying the weight in the air by the Buoyance Factor, BF, which depends on the density of the fluid inside the well.
- BF is calculated as:

$$BF = \frac{\text{Peso de Acero (lb/gal)} - \text{Peso del lodo (lb/gal)}}{\text{Peso del Acero (lbs/gal)}} = \frac{65.44 - MW}{65.44}$$

Tubes coupling:

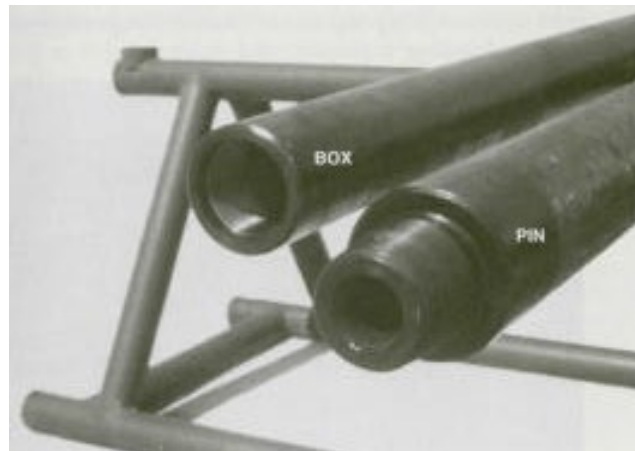
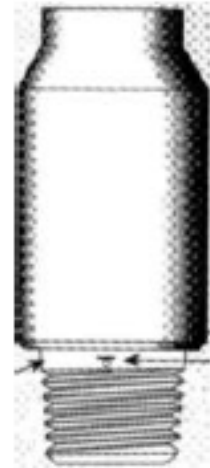
- They are manufactured in many sizes and in a variety of forms of thread:



Caja (Box)

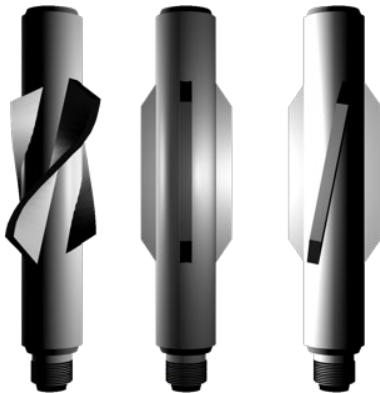


**Perno
(Pin, macho)**

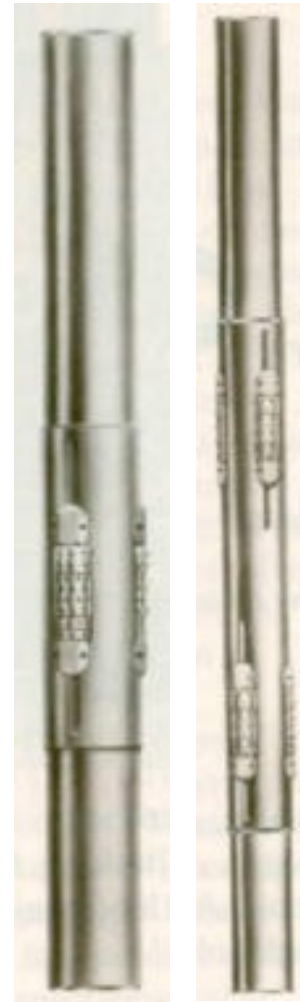


Auxiliary elements / Accessories of the drilling string

Bit connector



String stabilizer



Roller reamer



Auxiliary elements / Accessories of the drilling string

Thread Combination Substitutes

(Sustitutos de Combinación de Roscas)

Stretcher



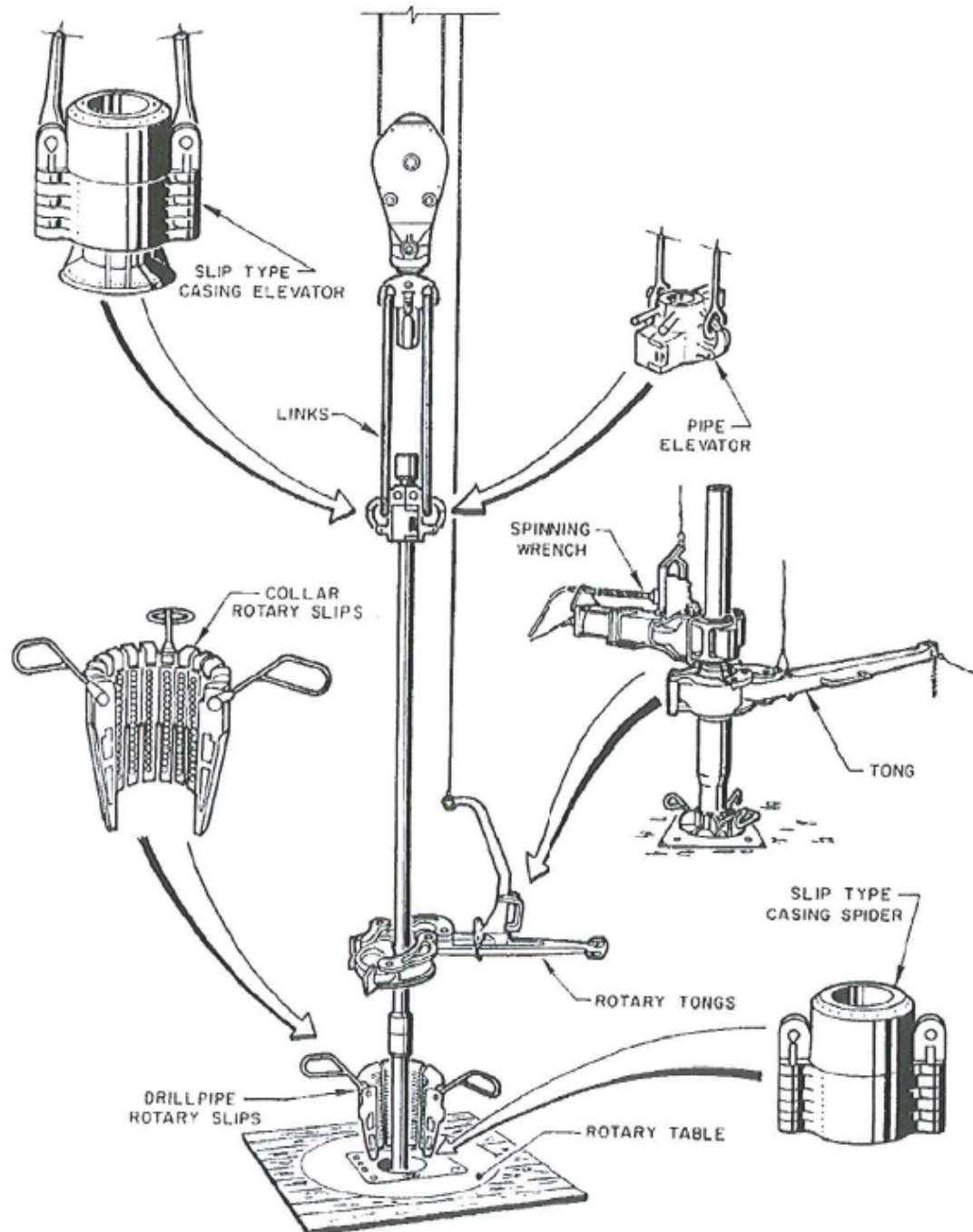
Box x Pin



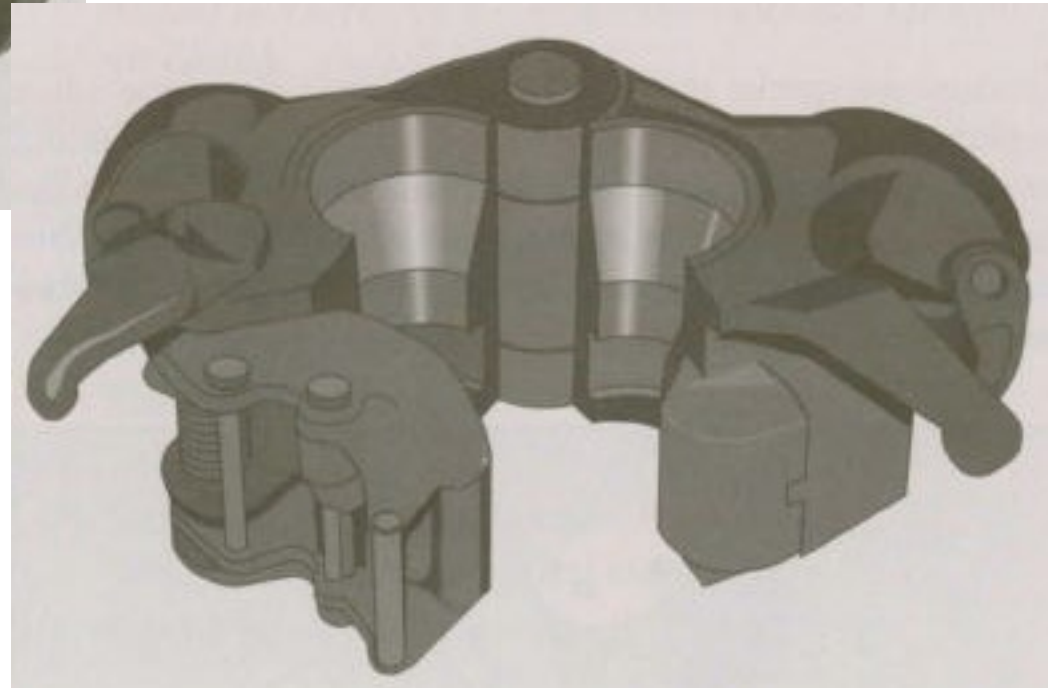
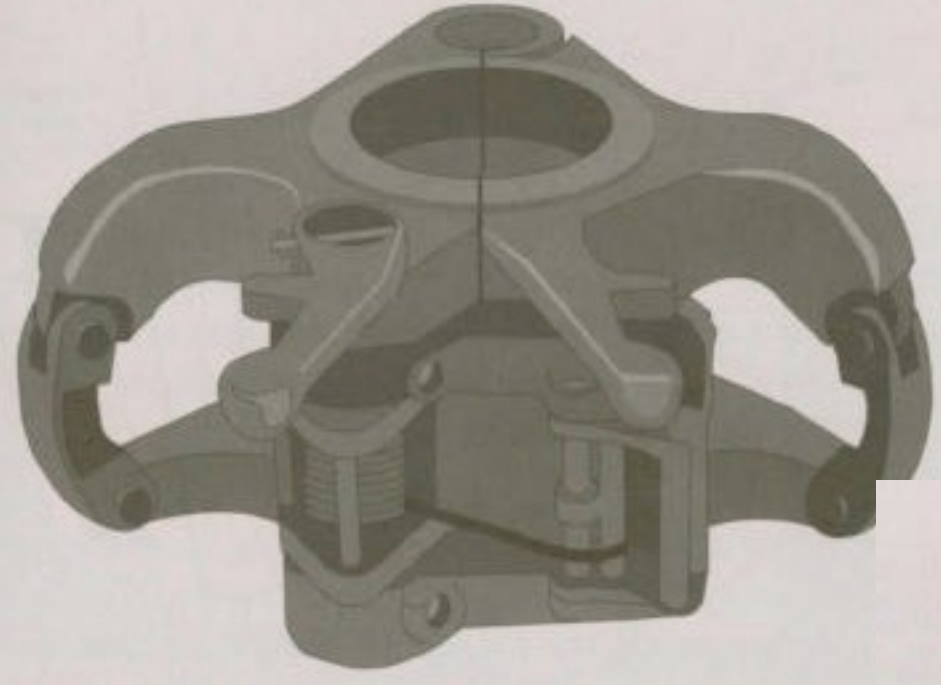
Pin x Pin



Box x Box



Manipulation tools. Elevators





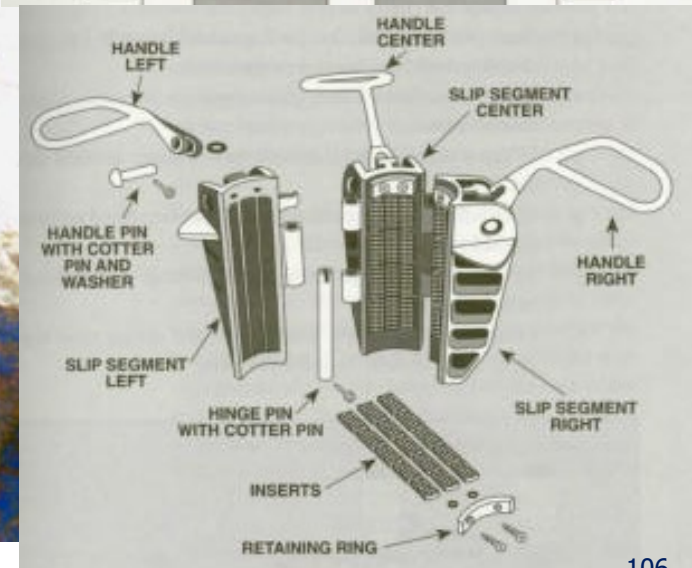
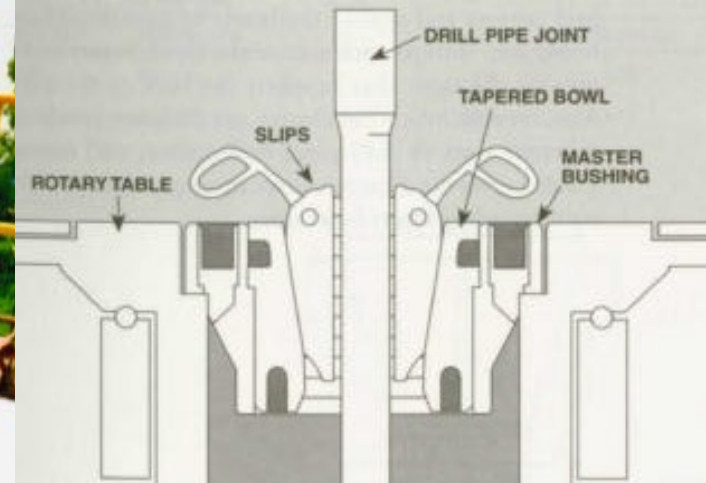
DRILLING ENGINEERING
E3.1: BASIC DRILLING TECHNIQUES
General Description of the Drilling
Process and Equipment

Dr. Juan Herrera Herbert (2024)



Manual drill pipe slips

el acople

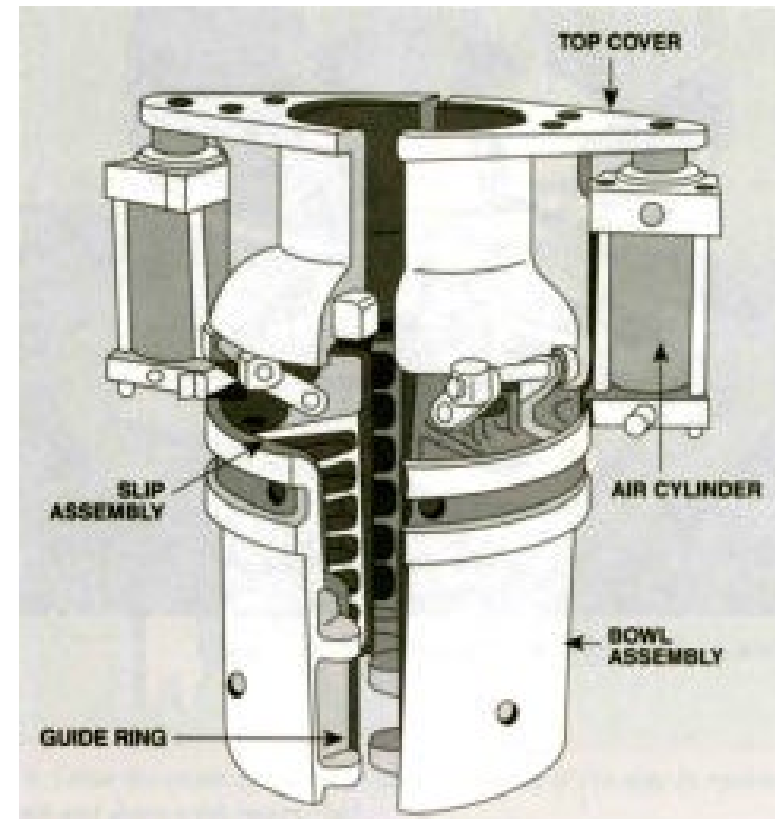




Drill pipe slips

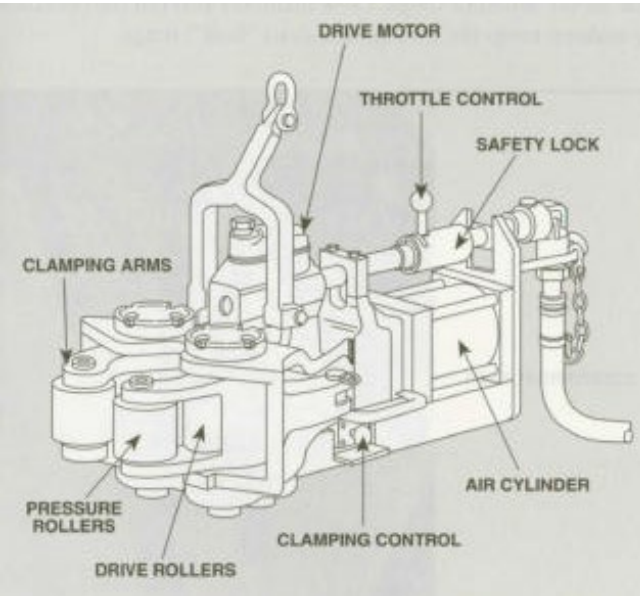


Cuñas de Pié

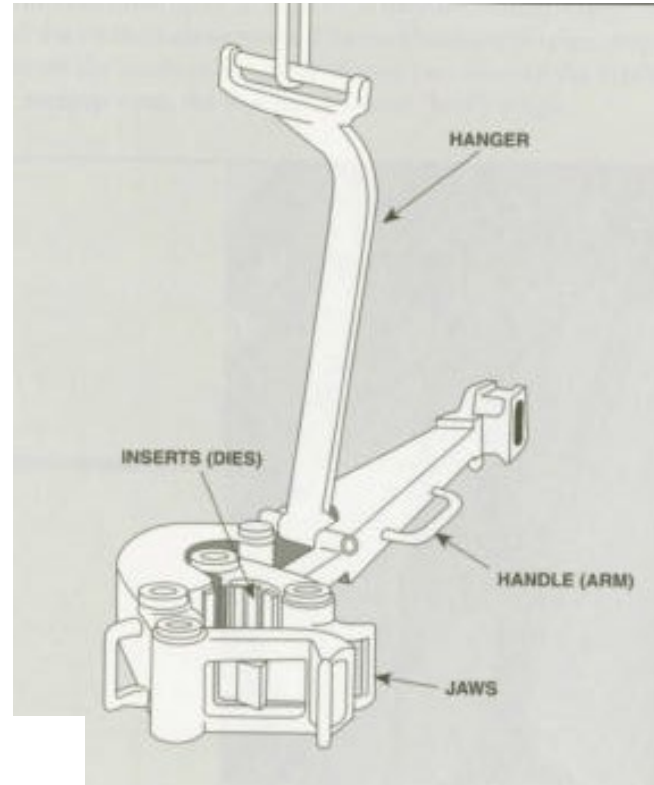


Cuñas operadas con aire

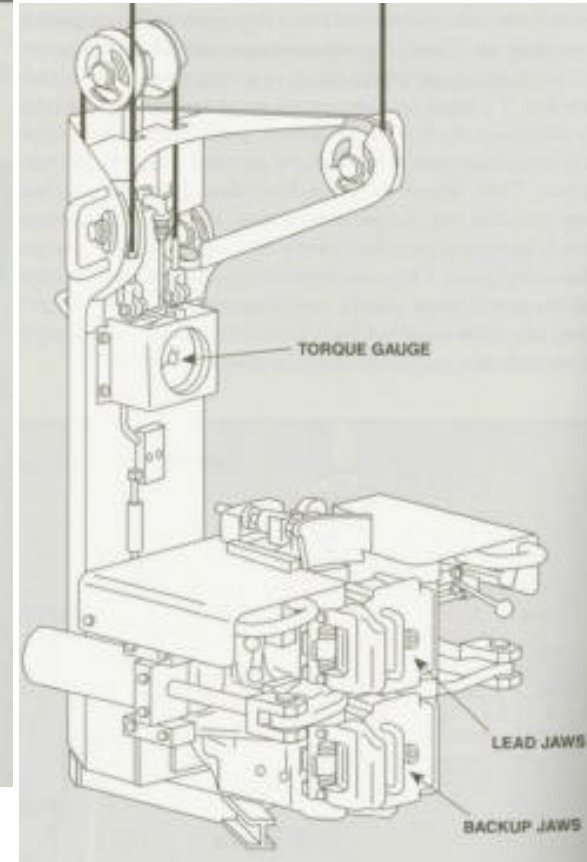
Drilling Manual Tongs



**Enrosgador Rápido
de Tubería**



Llaves Manuales



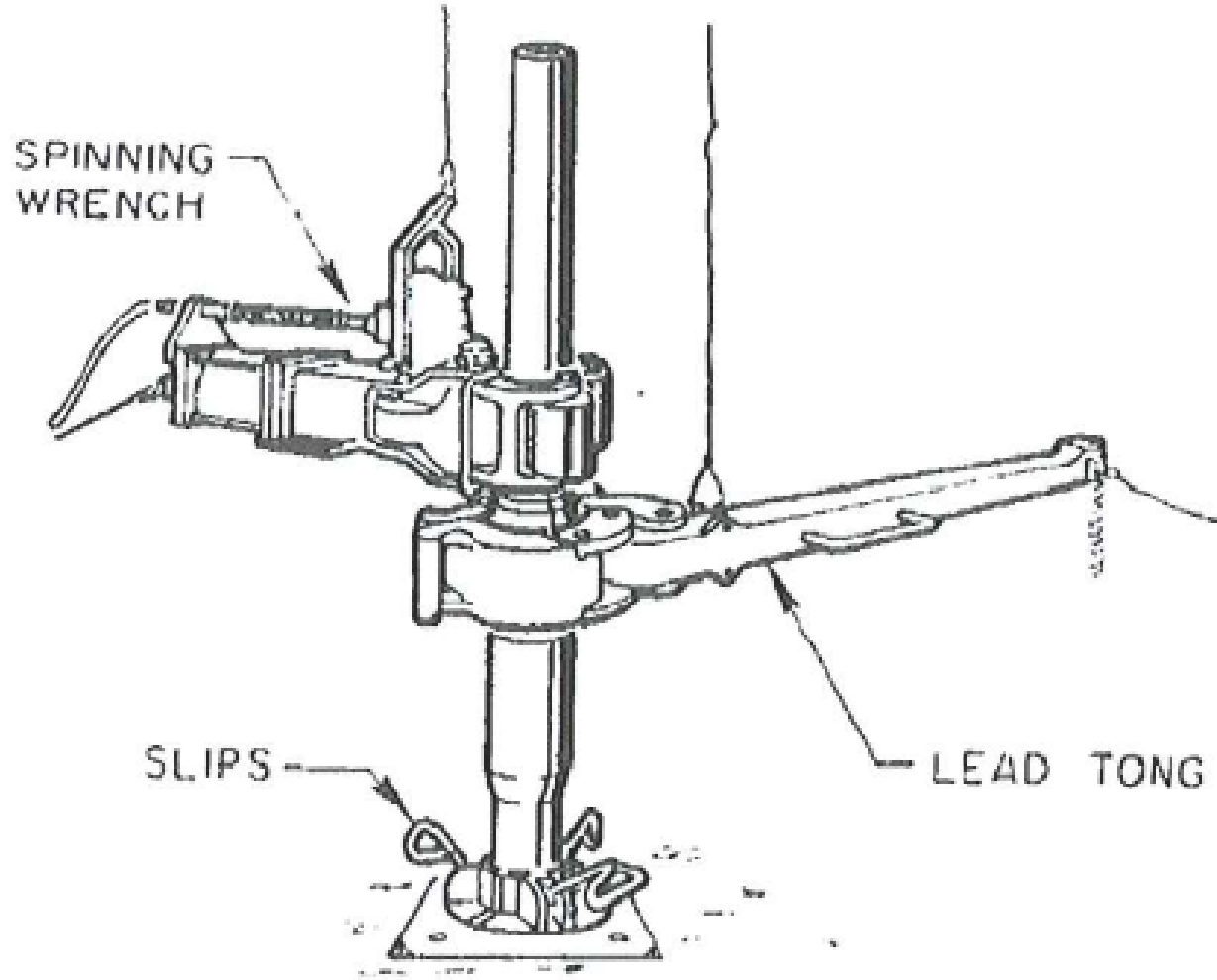
**Llave Hidráulica
de Torque y Ruptura**



Lined “lunge” twist (Enrosque de “estocada” alineada)



Position of the hand wrenches to tighten the threaded joint

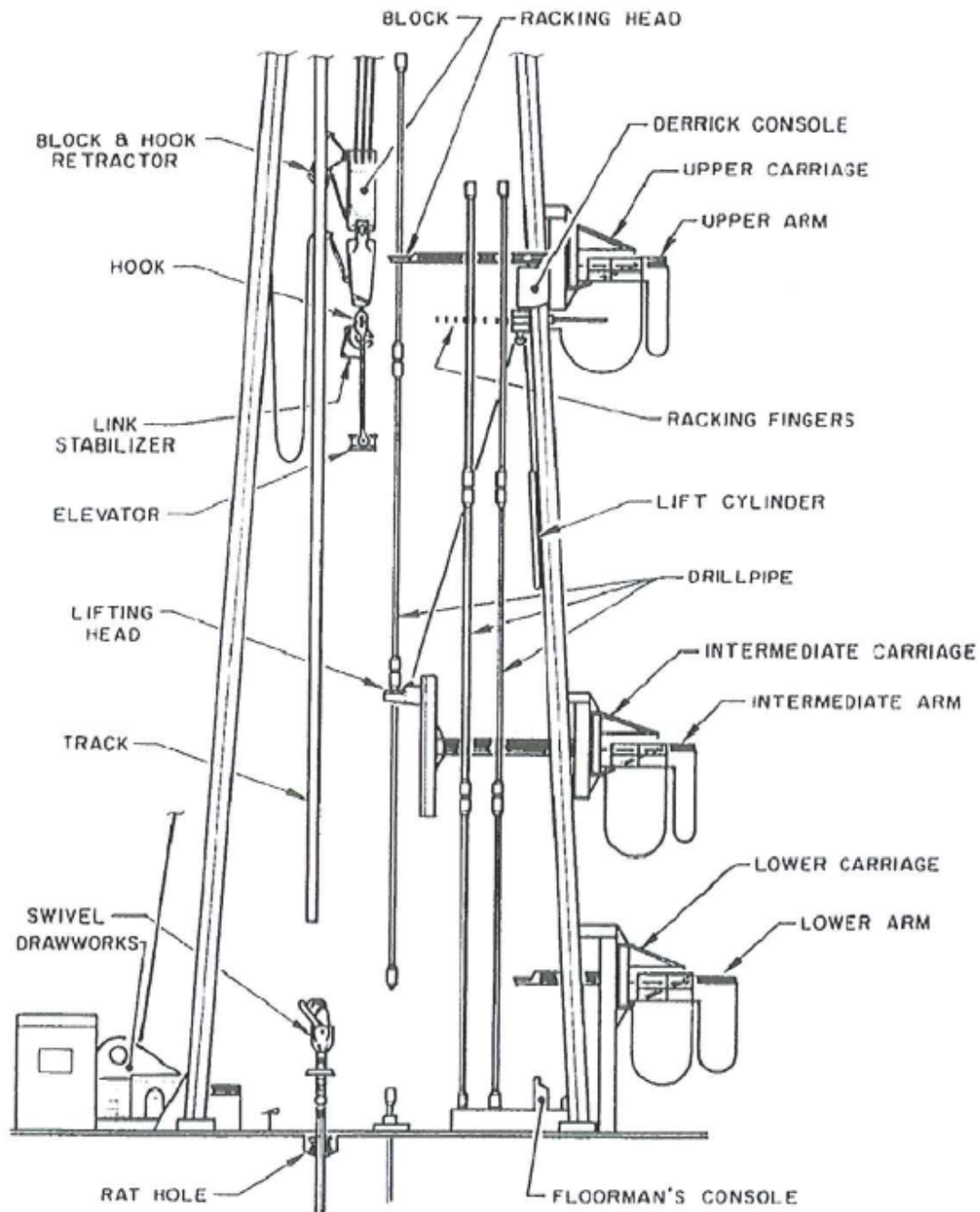




Applying the torque to the joint

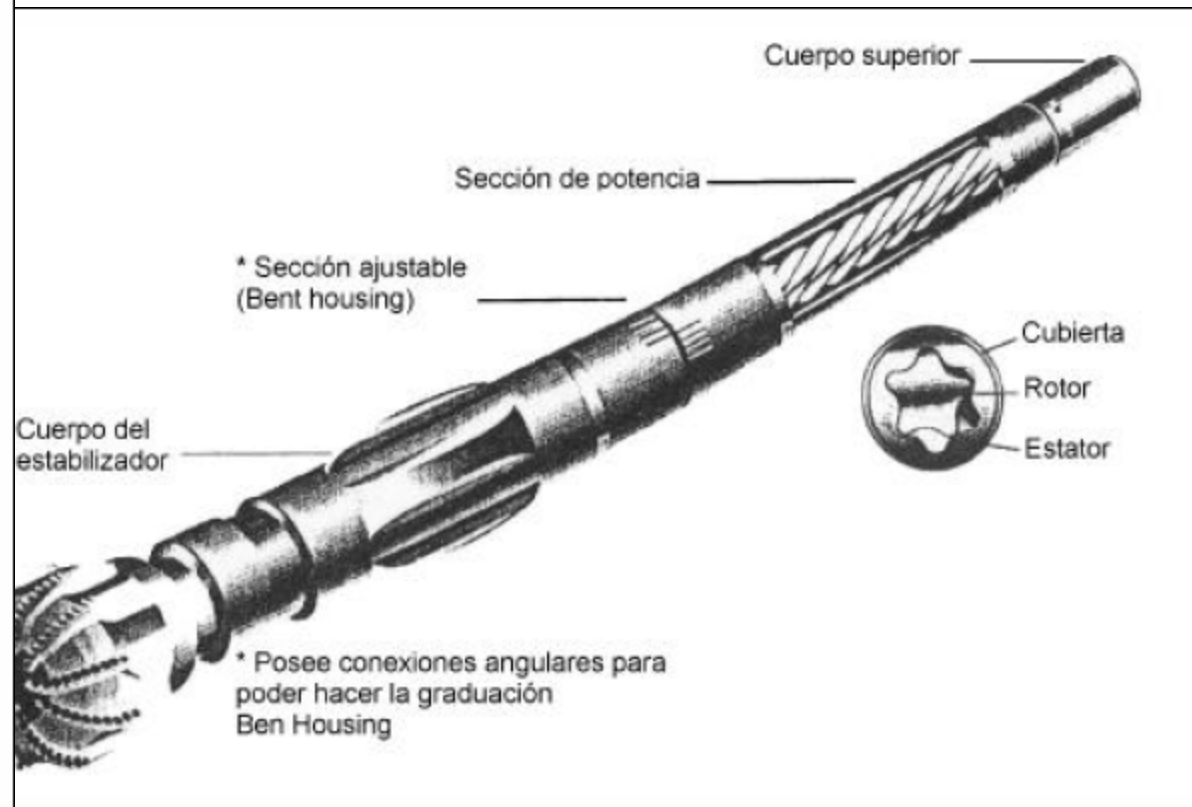
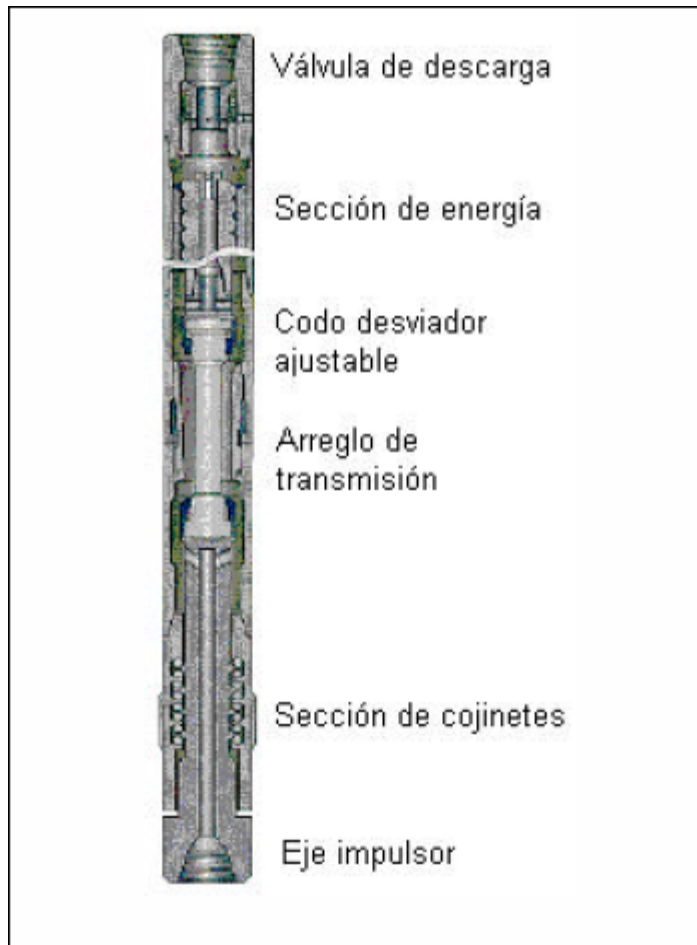


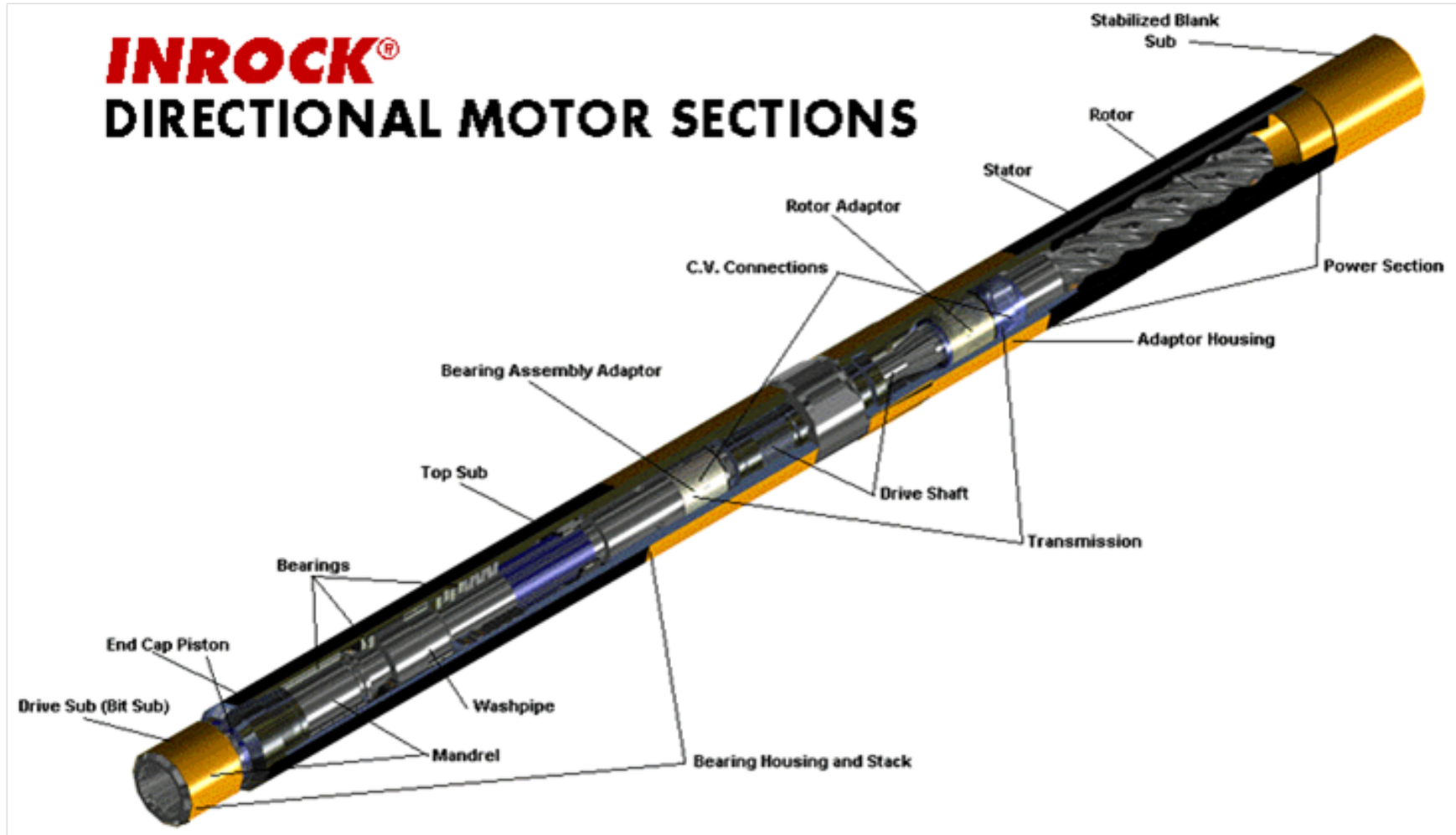
Applying the torque to the joint

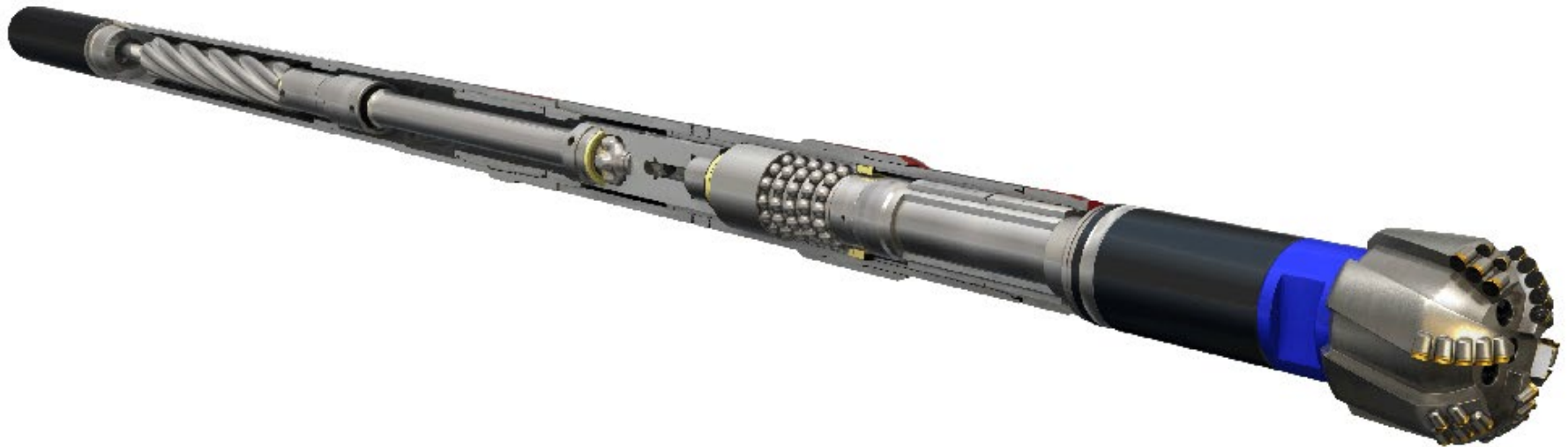


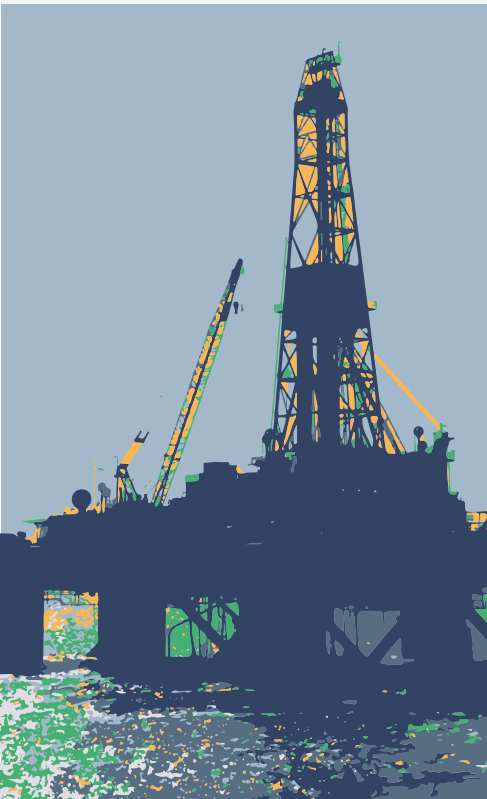
Mud motor









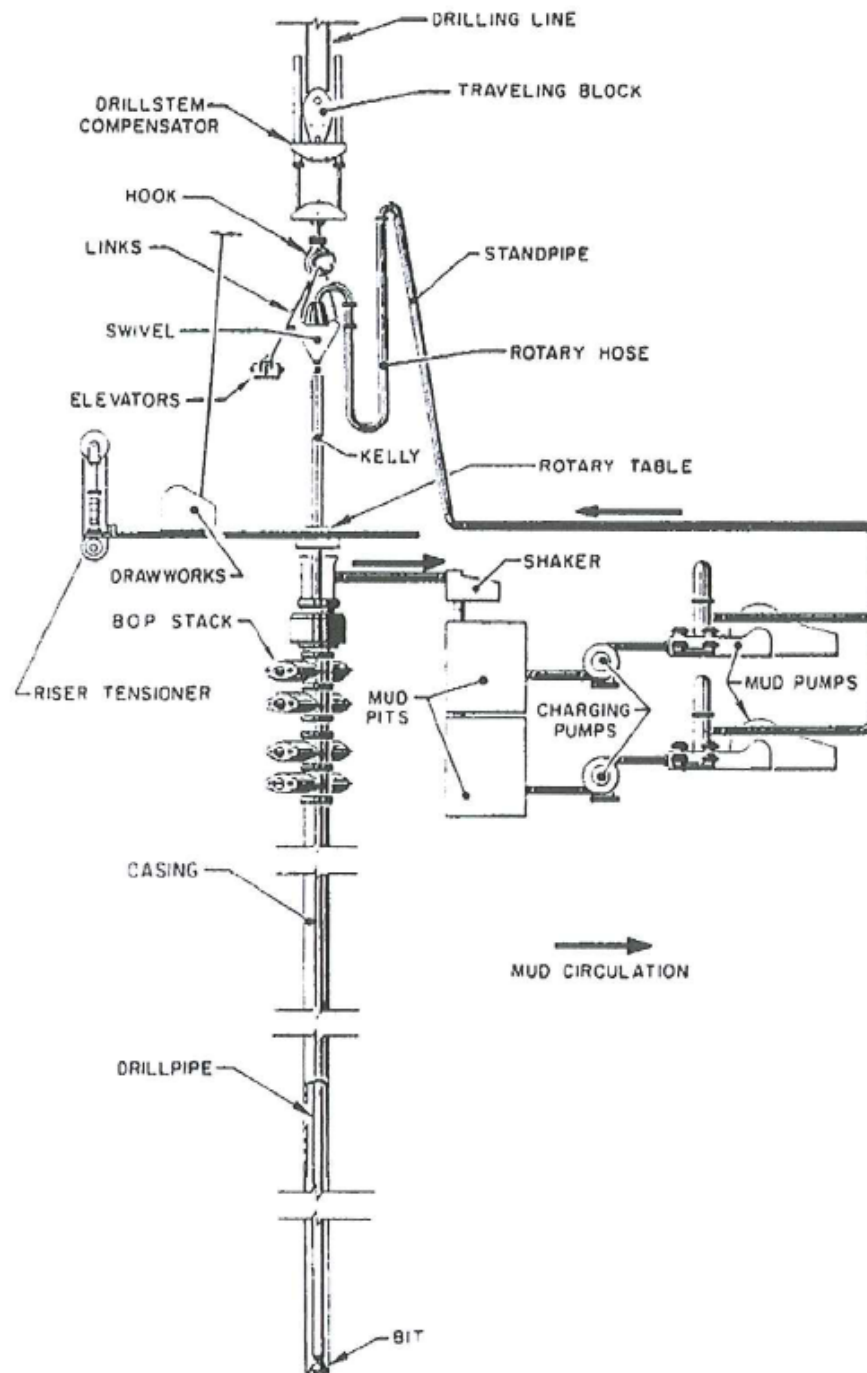


5. The drilling-fluid system ("mud system").

Introduction

- The drilling-fluid system is also commonly known as the “mud system”.
- It is the single component of the well-construction process that remains in contact with the wellbore throughout the entire drilling operation.
- Drilling-fluid systems are designed and formulated to perform efficiently under expected wellbore conditions.
- Advances in drilling-fluid technology have made it possible to implement a cost-effective, fit-for-purpose system for each interval in the well-construction process.

- The active drilling-fluid system comprises a volume of fluid that is pumped with specially designed mud pumps from the surface pits, through the drillstring exiting at the bit, up the annular space in the wellbore, and back to the surface for solids removal and maintenance treatments as needed.
- The capacity of the surface system usually is determined by the rig size, and rig selection is determined by the well design. Examples:
 - The active drilling-fluid volume on a deepwater well might be several thousand barrels. Much of that volume is required to fill the long drilling riser that connects the rig floor to the seafloor.
 - A shallow well on land might only require a few hundred barrels of fluid to reach its objective.



Drilling fluids

- The drilling fluid is a mix of different components:
 - Base (water in the vast majority of occasions)
 - Mud and mineral additives
 - Chemical Additives
- **Basic function of the drilling fluids:**
 1. To provide hydraulic power to the drilling string
 2. To transport of the crushed rock chips outside of the well
 3. To support the walls of the drilled well
 4. To prevent the entrance of formation fluids into the drilled well
 5. To help to the heat dissipation and to lubricate the bit and the drilling string
- **Main fluid types:**
 1. Water/Clay muds
 2. Oil/Clay muds
 3. Compressed gases

- The cost of the drilling fluid averages around the 10% of the total tangible costs of well construction.
- However, drilling-fluid performance can affect overall well-construction costs in several ways.
- A correctly formulated and well-maintained drilling system can contribute to cost containment throughout the drilling operation by:
 - Enhancing the rate of penetration (ROP)
 - Protecting the reservoir from unnecessary damage
 - Minimizing the potential for loss of circulation
 - Stabilizing the wellbore during static intervals
 - Helping the operator remain in compliance with environmental and safety regulations.

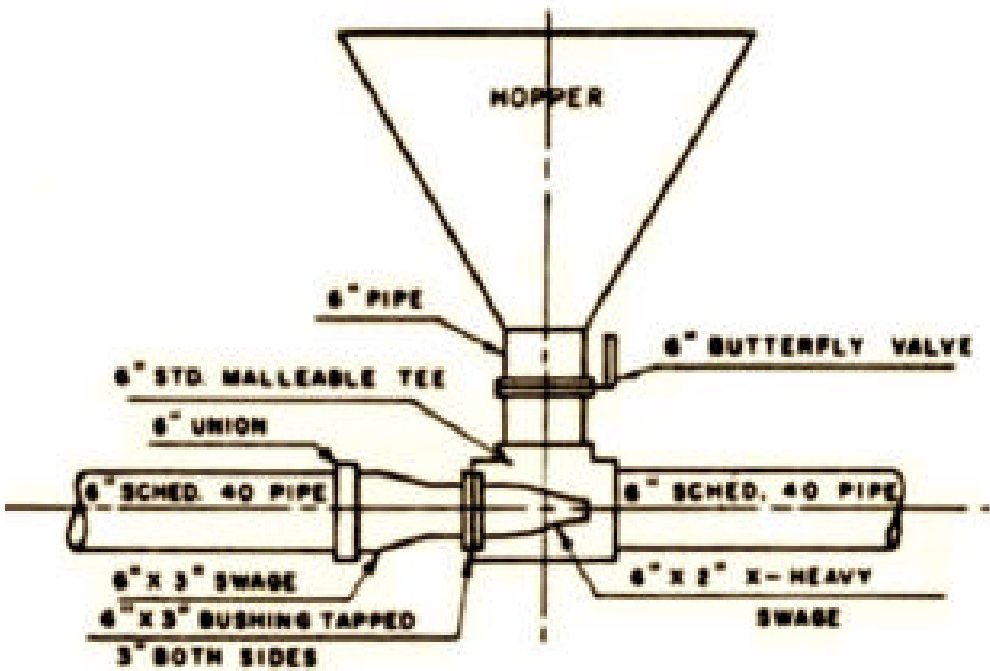
- Today, many drilling-fluid systems can be reused from well to well, thereby reducing waste volumes and costs incurred for building new mud.



- To the extent possible, the drilling-fluid system should help preserve the productive potential of the hydrocarbon-bearing zone(s).
- Minimizing fluid and solids invasion into the zones of interest is critical to achieving desired productivity rates.
- The drilling fluid also should comply with established health, safety, and environmental (HSE) requirements so that personnel are not endangered and environmentally sensitive areas are protected from contamination.
- Drilling-fluid companies work closely with oil-and-gas operating companies to attain these mutual goals.

Preparation and treatment of the drilling fluid

- The four main routines for the fluid system are:
 1. Initial preparation
 2. Densification (increase in weight or density of the mud)
 3. Dilution (reduction in weight or density of the mud)
 4. Treatment conditioning (changes in the chemistry of the mud)
- A device looking like a funnel is used to add quickly solid materials to the mud using the principle of the vacuum created by the choked flow (venturi principle of Joule tube)
- The two main properties which are continuously monitored are:
 - Weight of the sludge, measured with the "sludge balance" (Fig A)
 - Viscosity, measured using a "Marsh funnel" (Fig B)



Embudo de mezcla con chorro de lodo

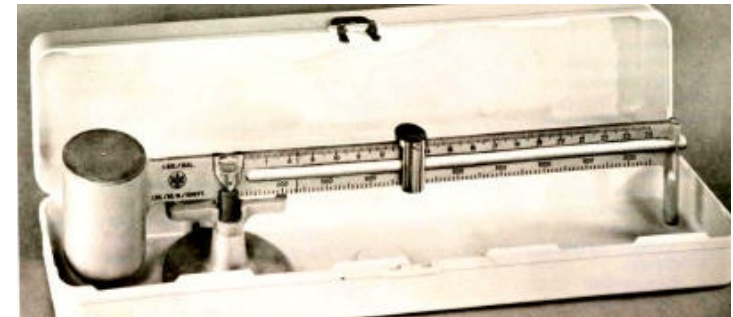


Fig A

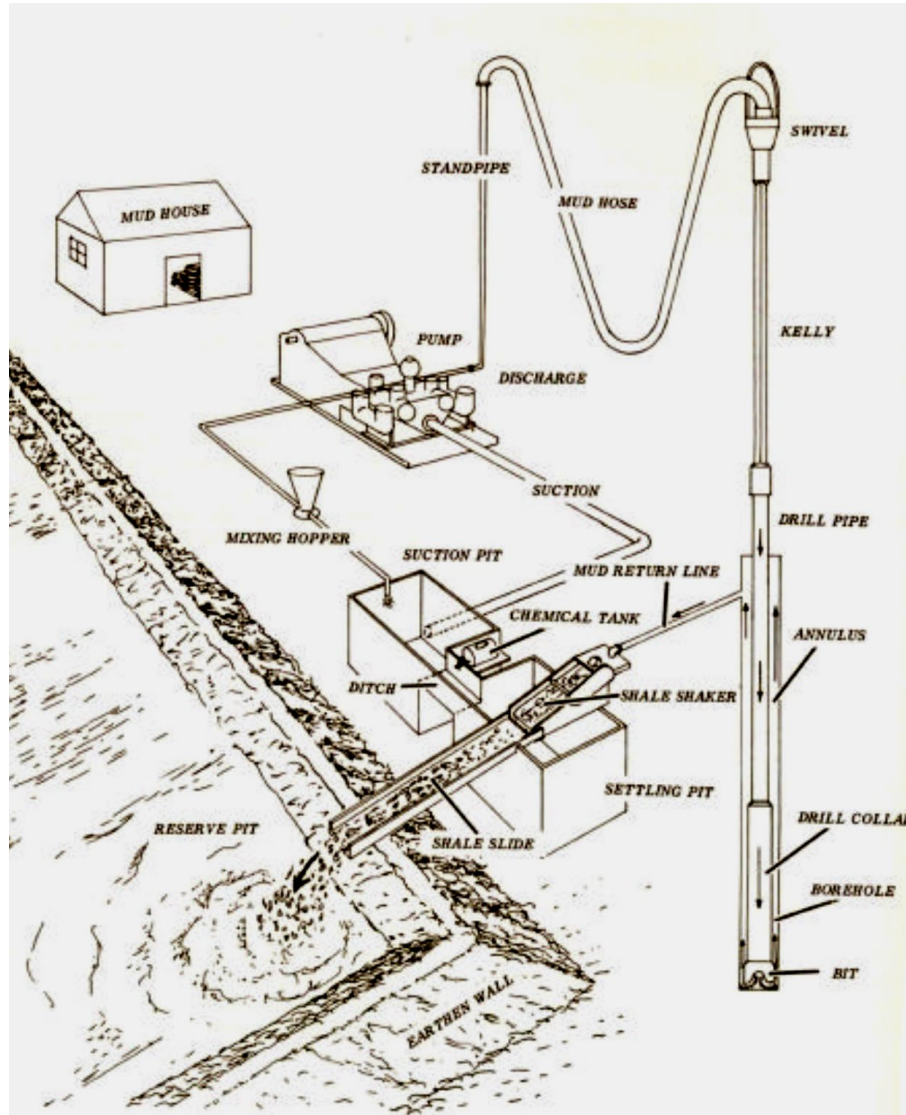


Fig B

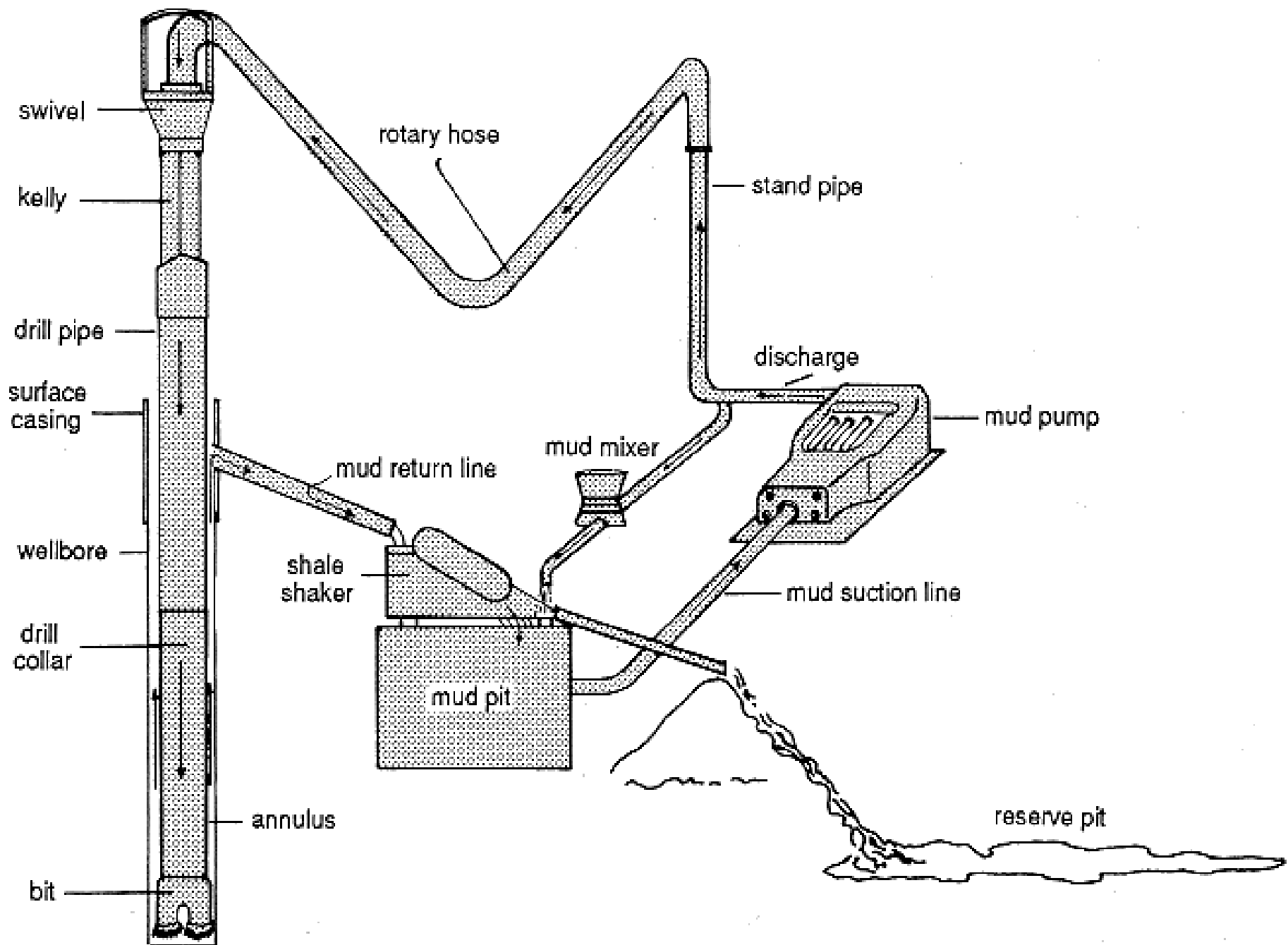


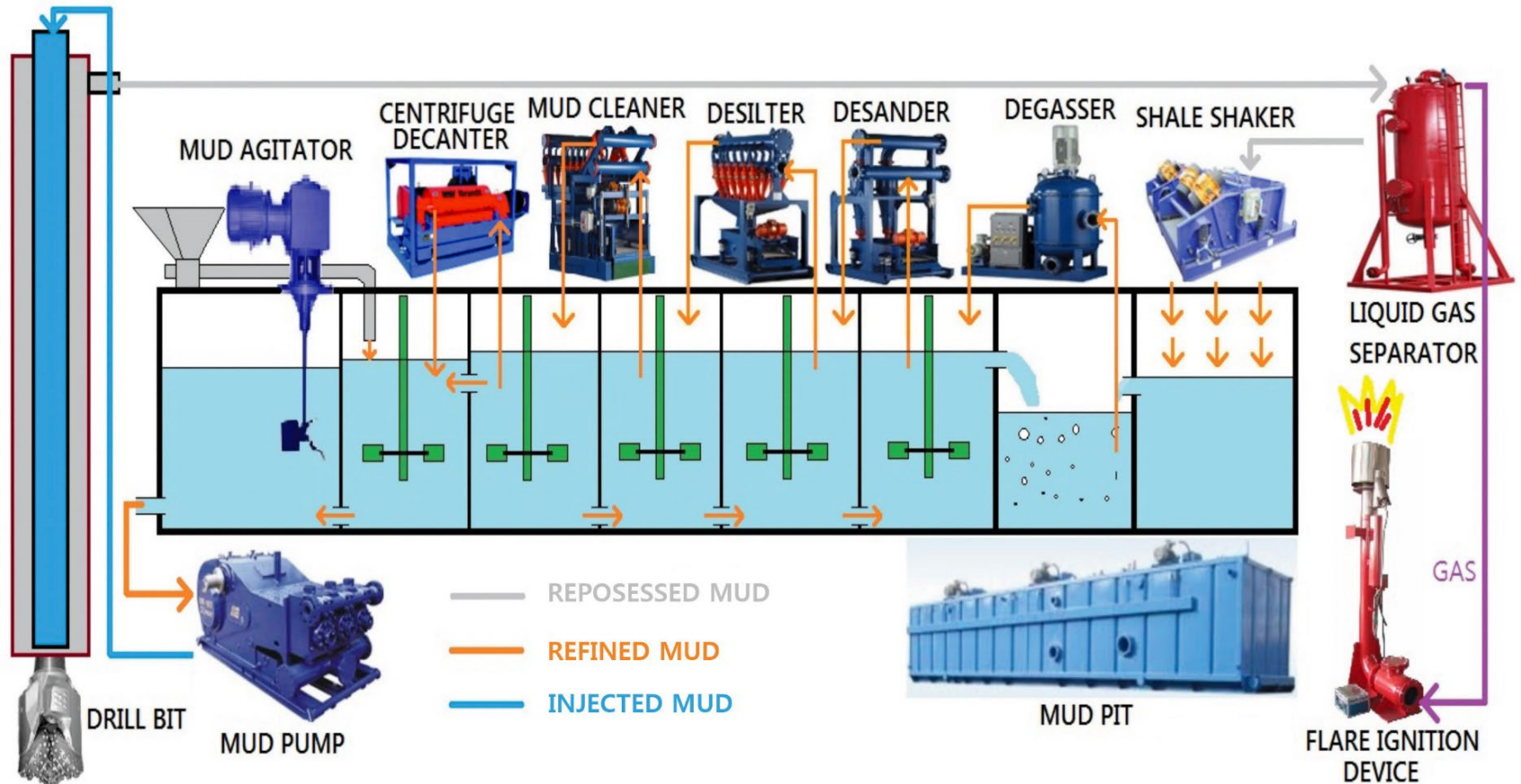


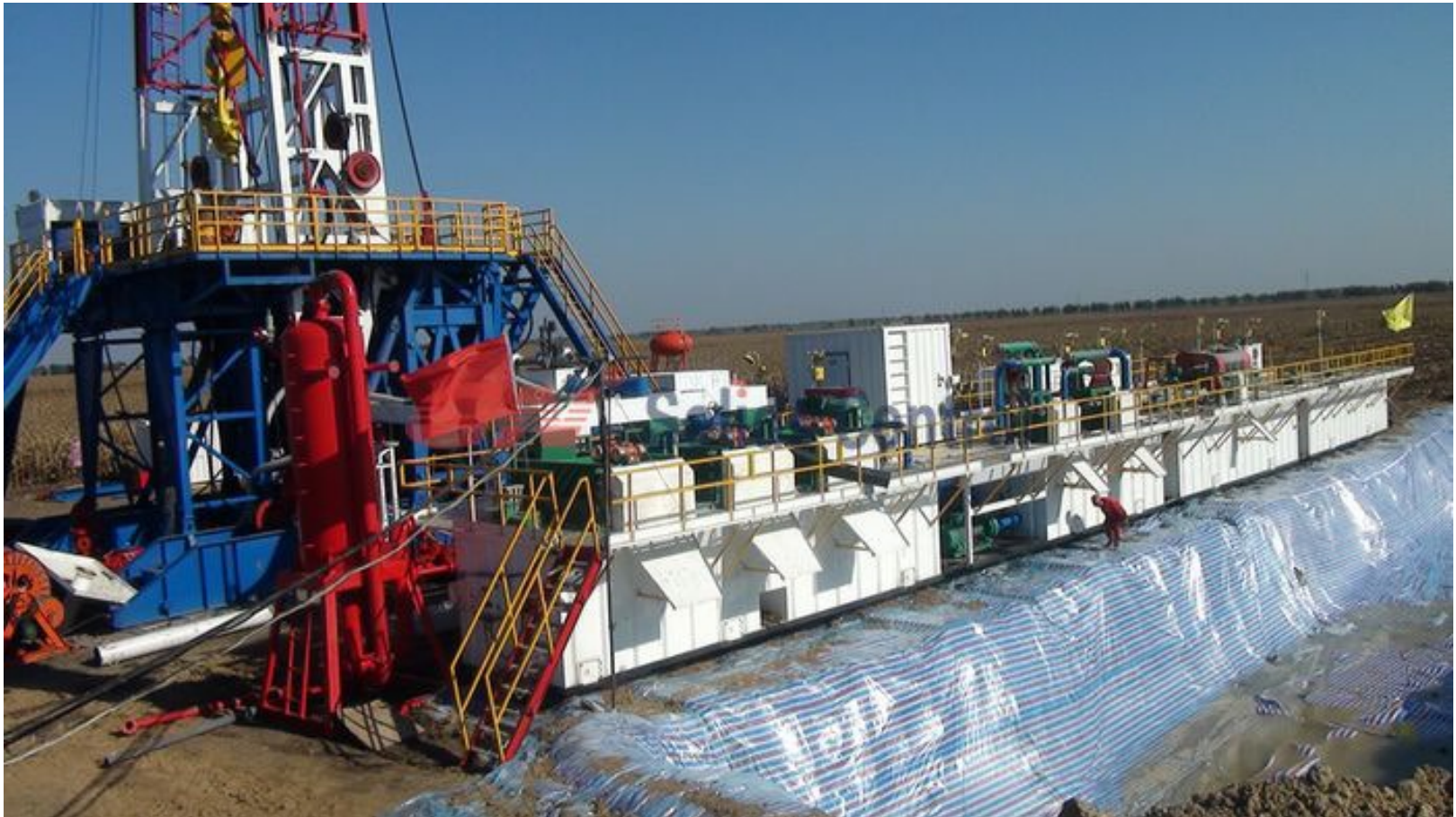
Components of drilling mud circulation system



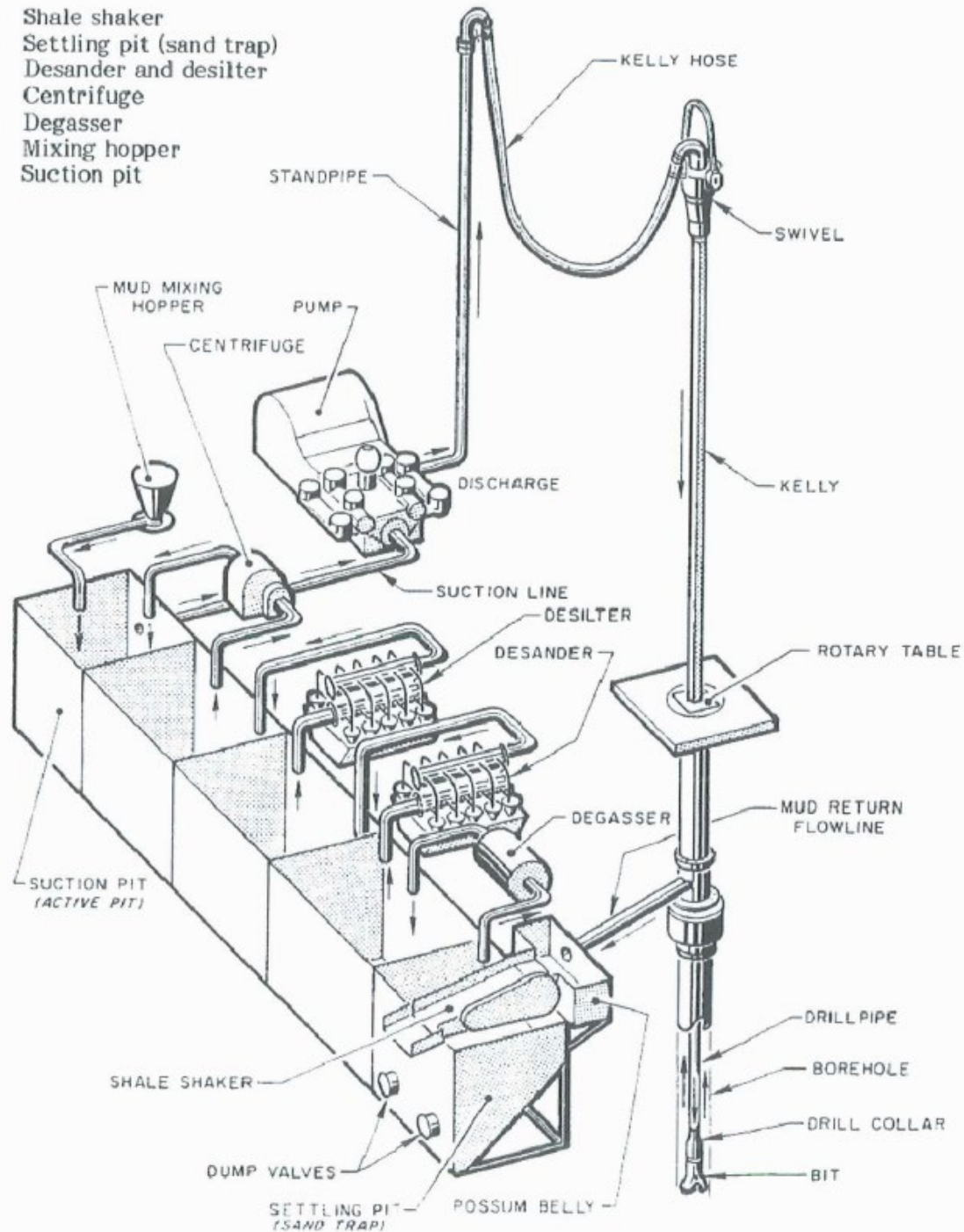
1. Suction tanks or dams
2. Suction line
3. Mud pumps
4. Pump discharge line
5. Driveline to the Tower
6. Rotary hose
7. Drill pipe
8. Anular space of the well - string
9. Return (flow or float line) line
10. Settlement tanks
11. Area for drilling mud conditioning







- Shale shaker
- Settling pit (sand trap)
- Desander and desilter
- Centrifuge
- Degasser
- Mixing hopper
- Suction pit

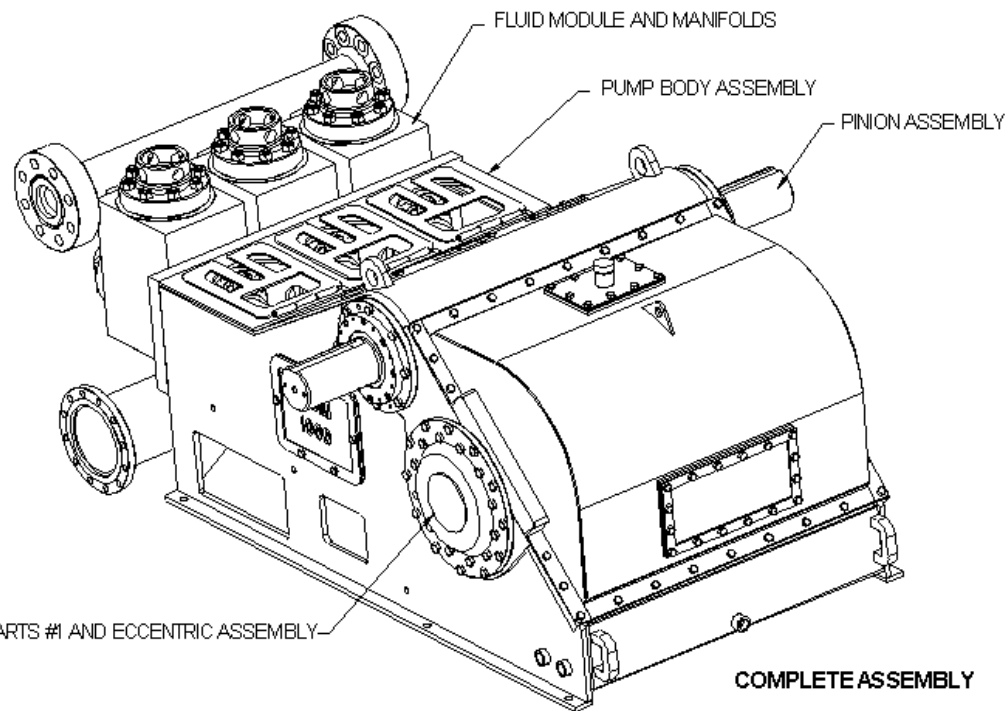
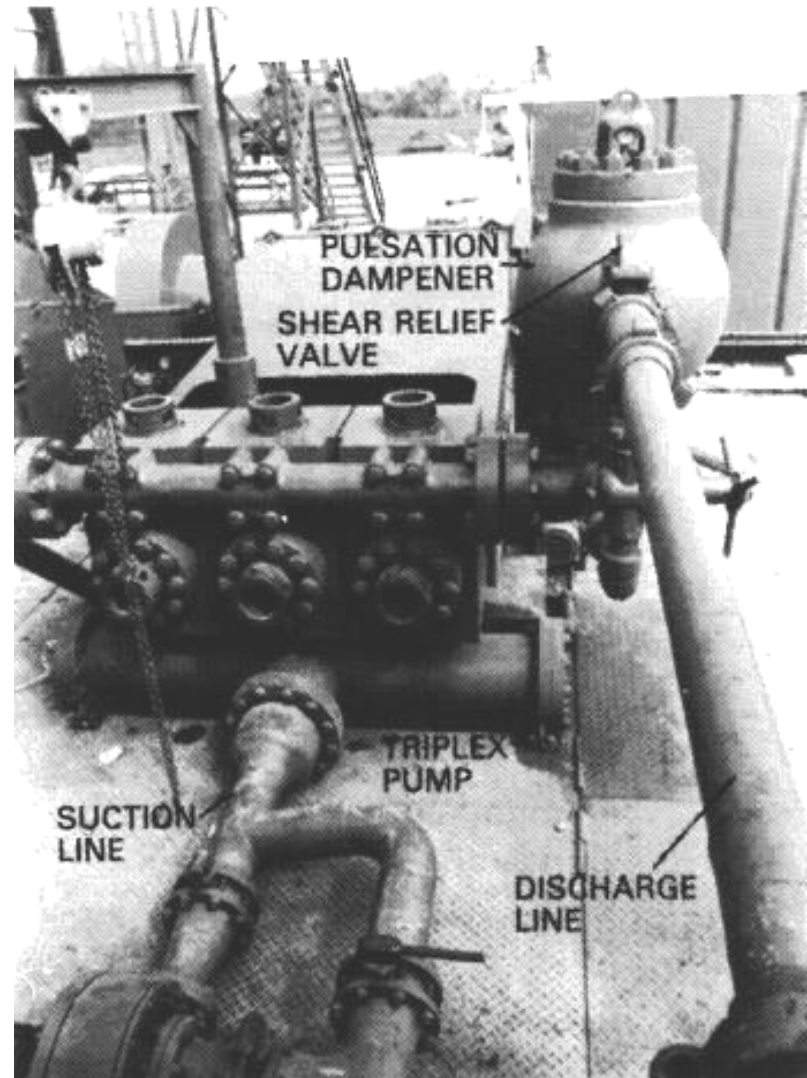


TECHNIQUES

Drilling

Dr. Juan Herrera Herbert (2024)

Alba de lodos tipo Triplex





Solids control equipment

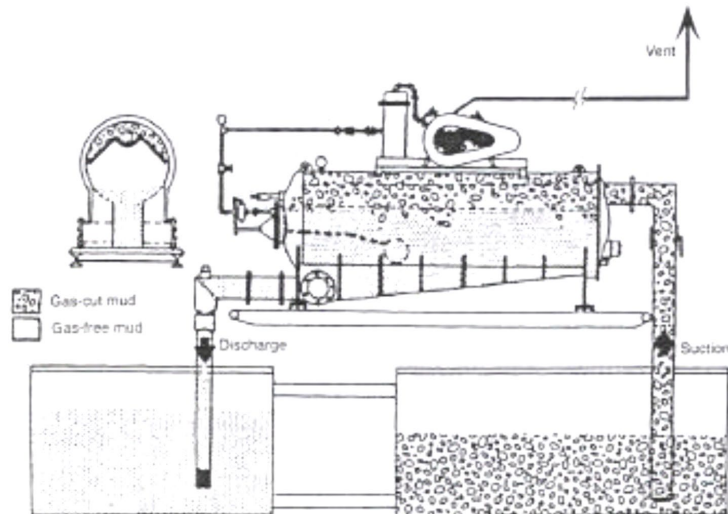
- Screening:
 - It is the primary cleaning device of the mud.
 - It promotes the separation of the larger drilling detritus dragged with the mud, separating them by means of vibratory screens.
- Desander and Disilter:
 - The remove very fine particles by means of a centrifugal force when the mud passes through the interconnected Hydrocyclones with a lateral entrance of the flux and a solids discharge by the vortex.



B

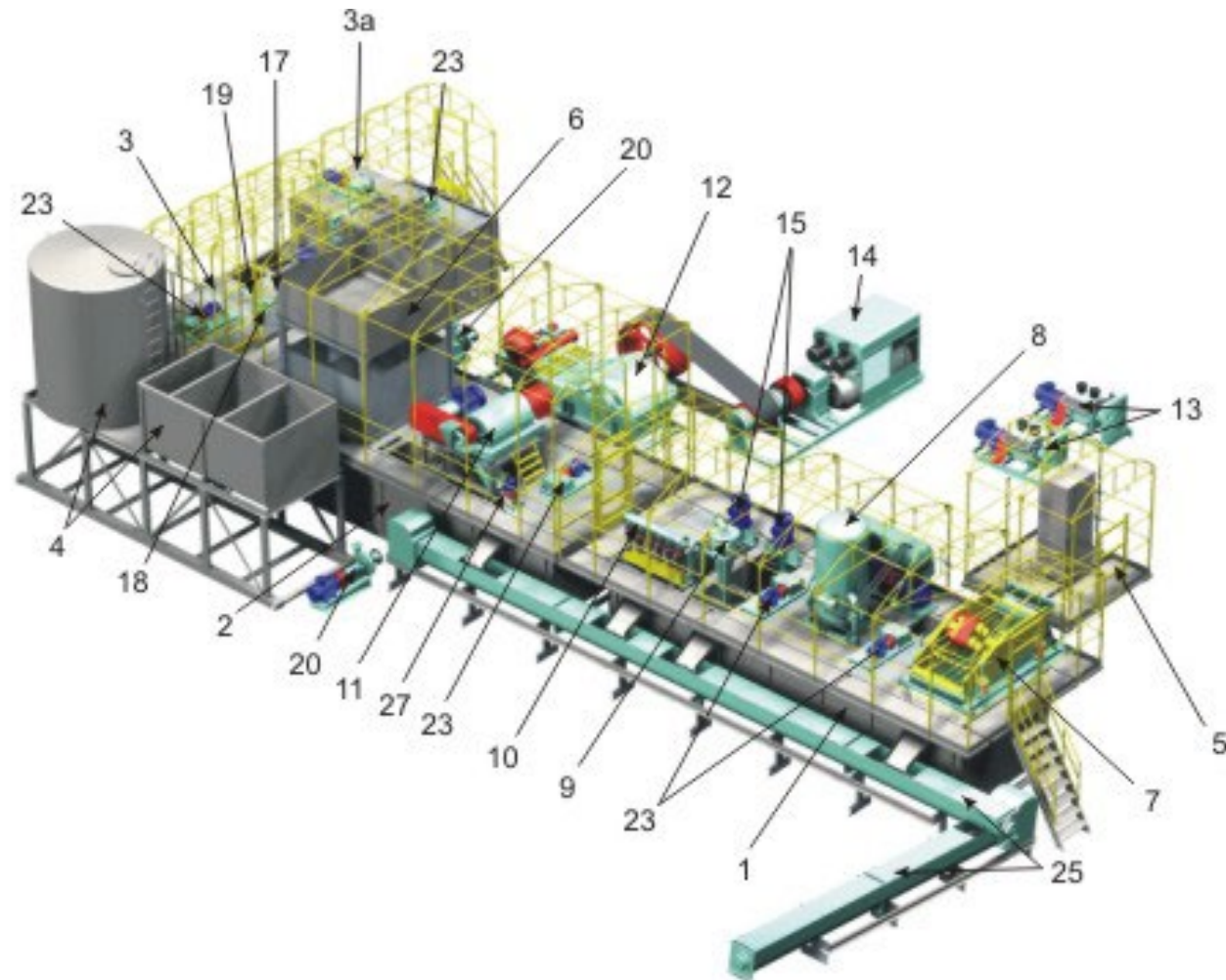
Degassers

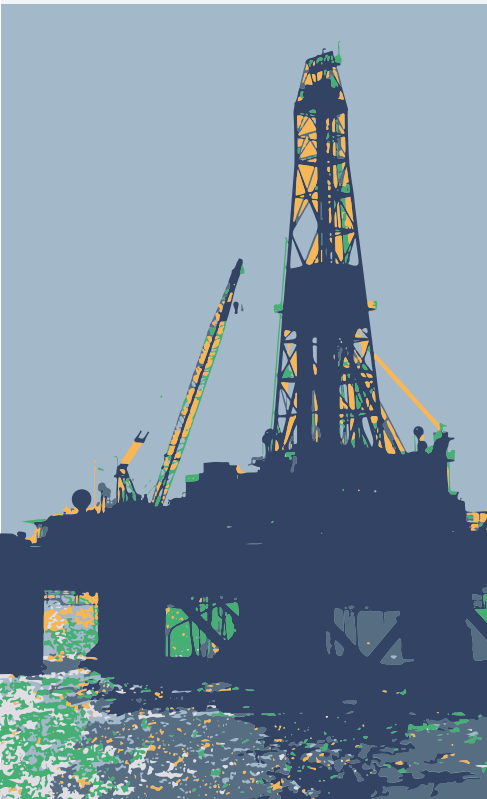
- The gas that has entered the well and is brought up with the drilling mud, must be removed because:
 1. It reduces the density of the mud
 2. It reduces the volumetric efficiency of the pump
 3. The hydrostatic fluid column pressure decreases
 4. It increases the volume of the drilling fluid
- The equipment used for removal of the gas is:
 - Vacuum degassers (A)
 - Mud / gas separator (B)



A

1. Cleaning unit
2. Intermediaty unit
3. Acceptance unit
- 3a. Chemical reagent preparation unit
4. Chemical reagent treatment unit
5. Electric drive control panel –
6. Coagulation and flocculation unit
7. Linear shale shaker
8. Degasser
9. Desander
10. Desilter
11. Centrifuge
12. Mud pump
13. Compressor
14. Diesel engine
15. Vertical sludge pump
16. Mixer
17. Hydraulic dispersant
18. Dispersant
19. Hydraulic mixer
20. Sludge pump
21. Sludge container
22. Electric drive control panel
23. Mud agitator
24. Hydraulic mixer
25. Screw conveyer
26. Mud agitator
27. Submersible pump
28. Cover



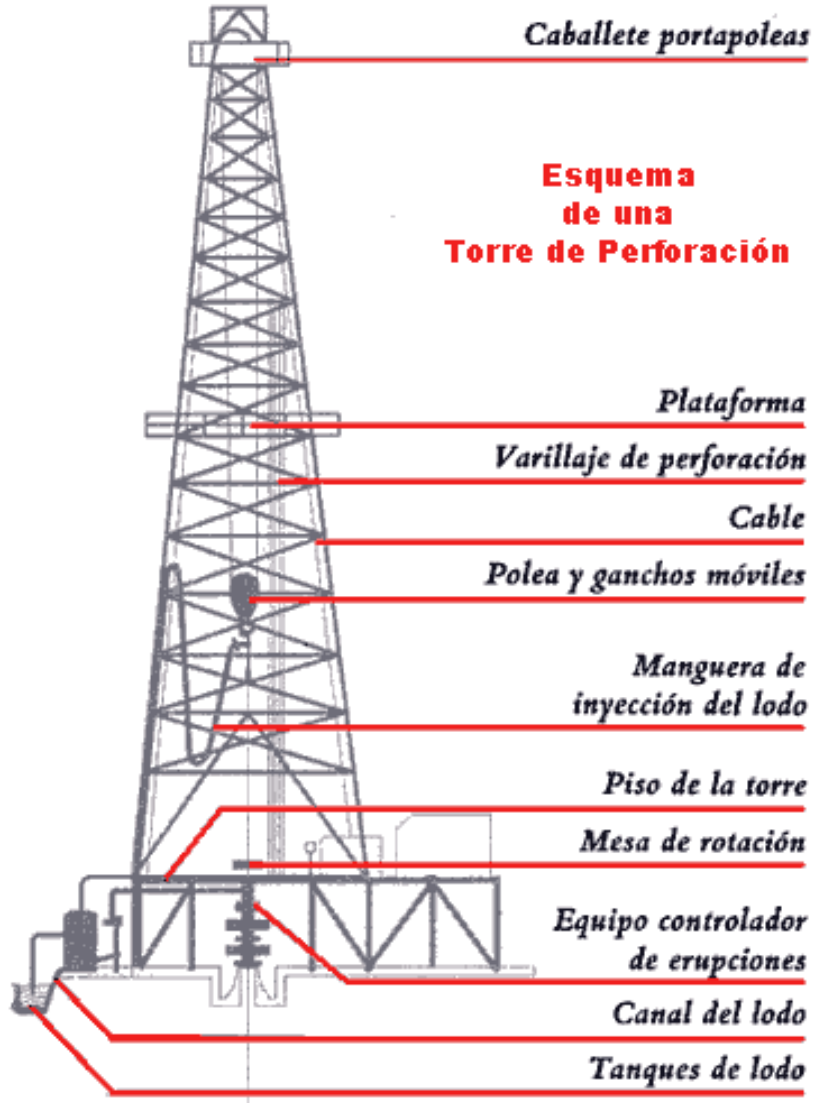


6. Support structure and hoist system.

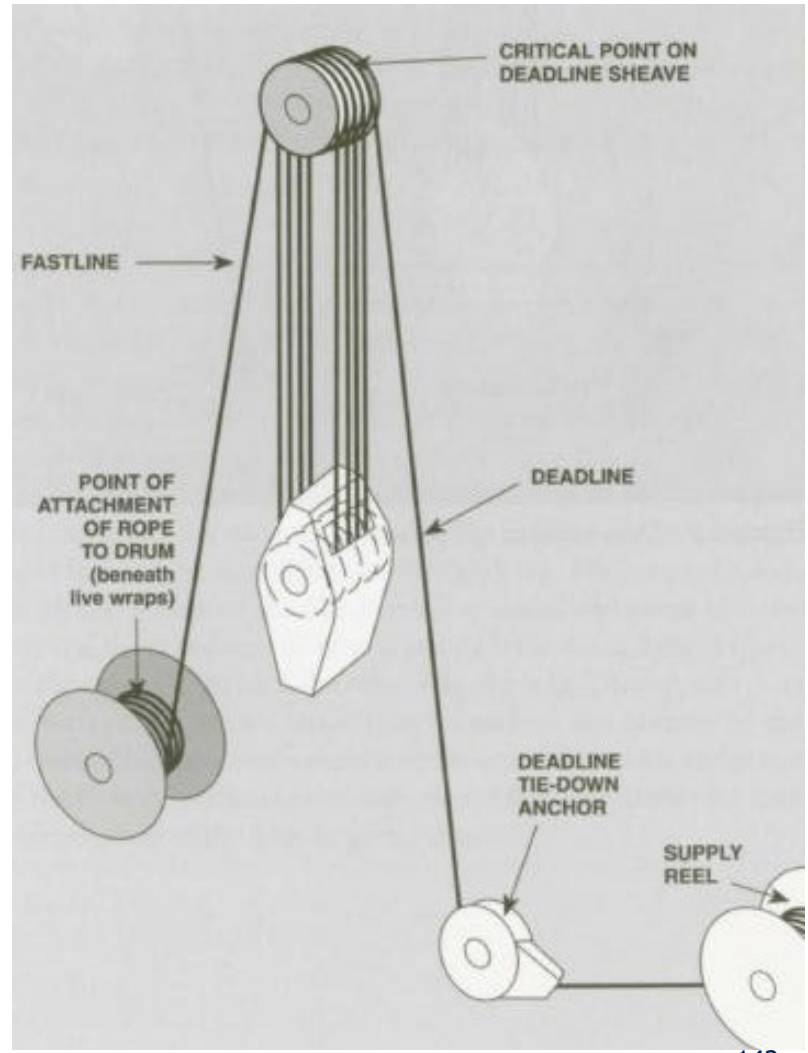
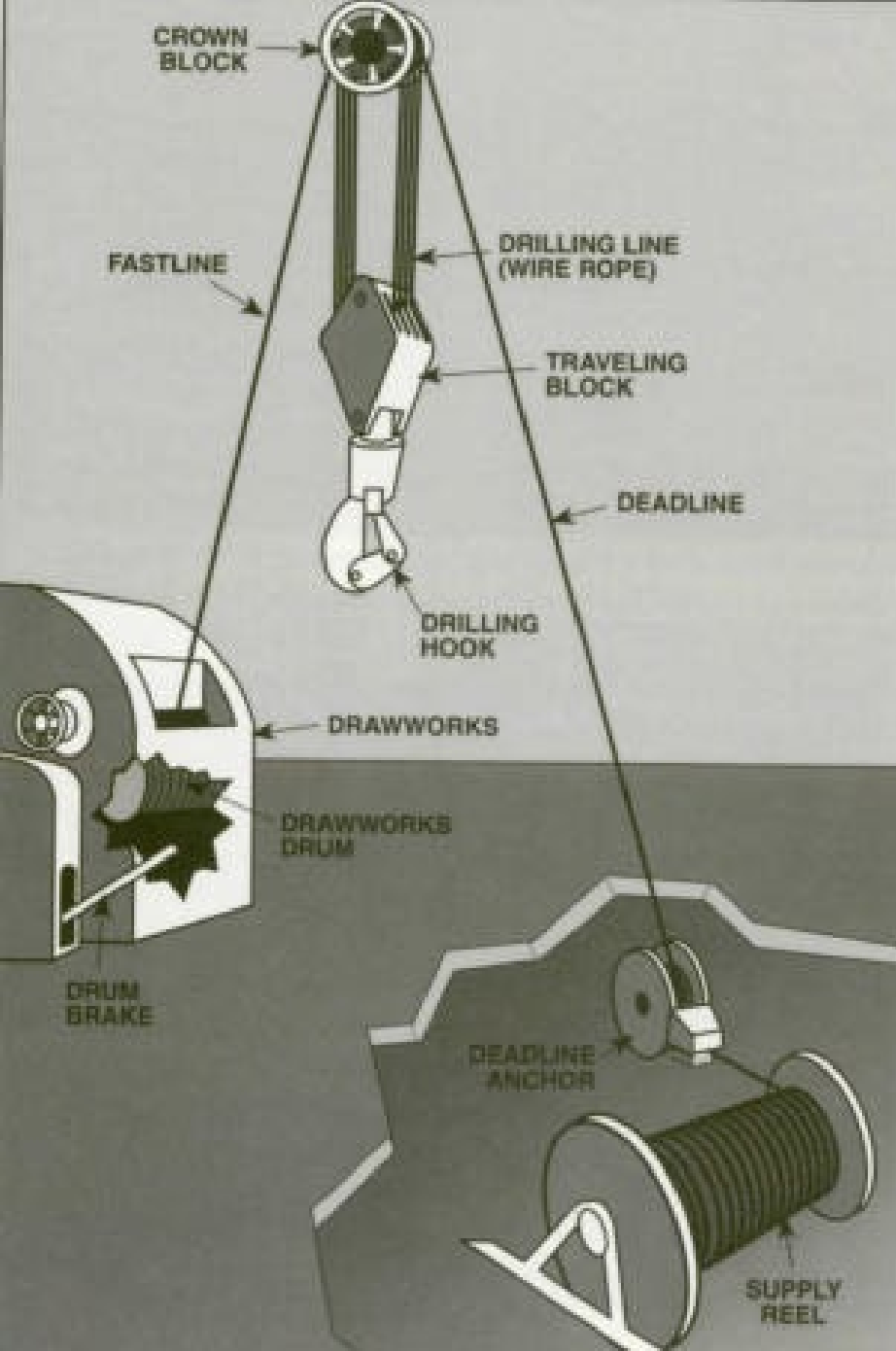
Supporting structure

It is composed by:

- The support structure
- The floor of the platform
- Derrick
- The substructure



Hoisting system



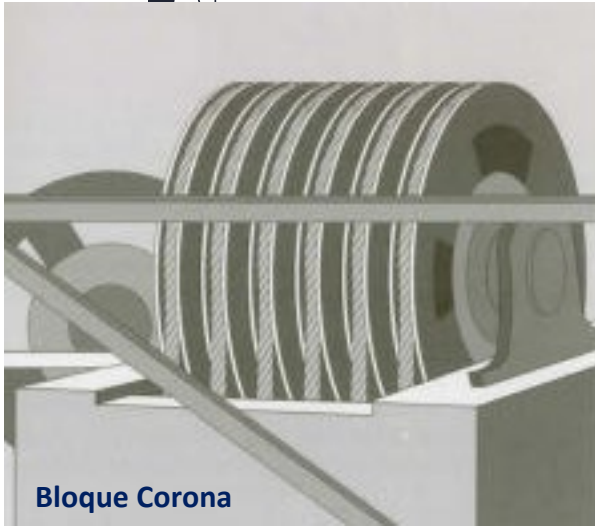


General Description of the Drilling

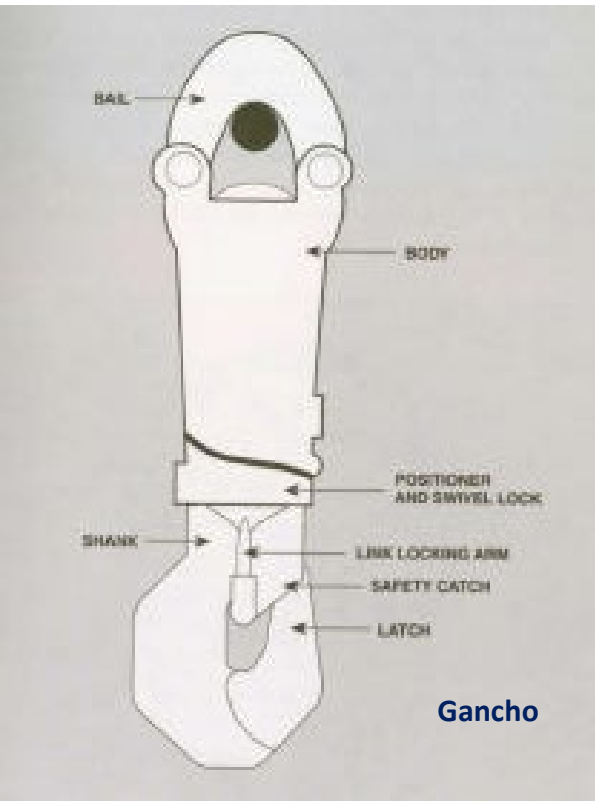
Process and Equipment

Dr. Juan Herrera Herbert (2024)

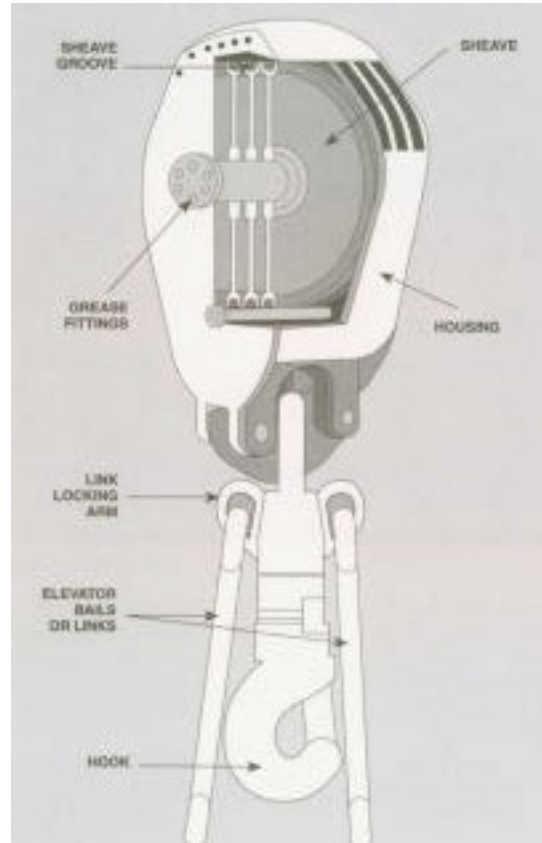
Lifting system



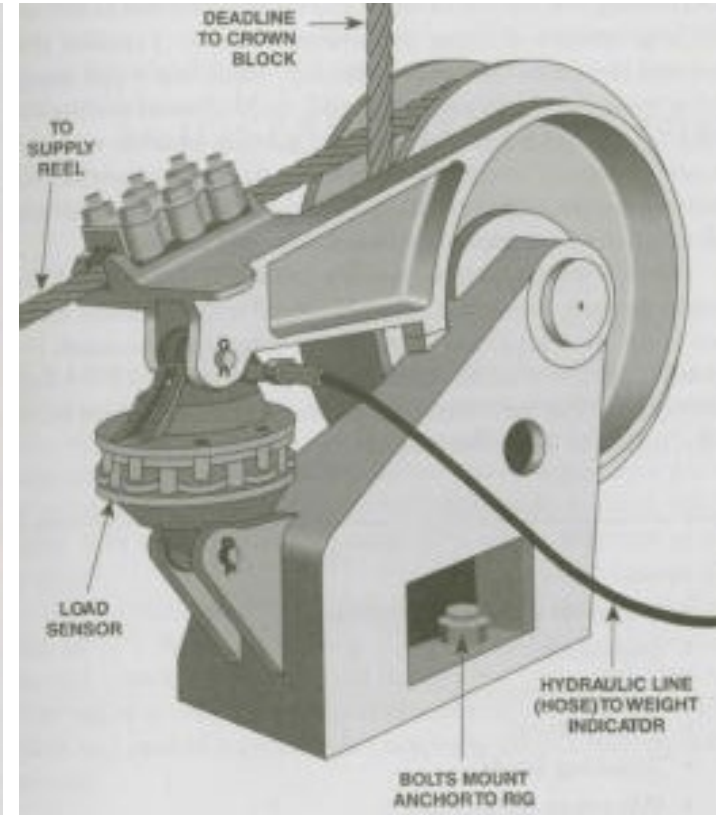
Bloque Corona



Gancho

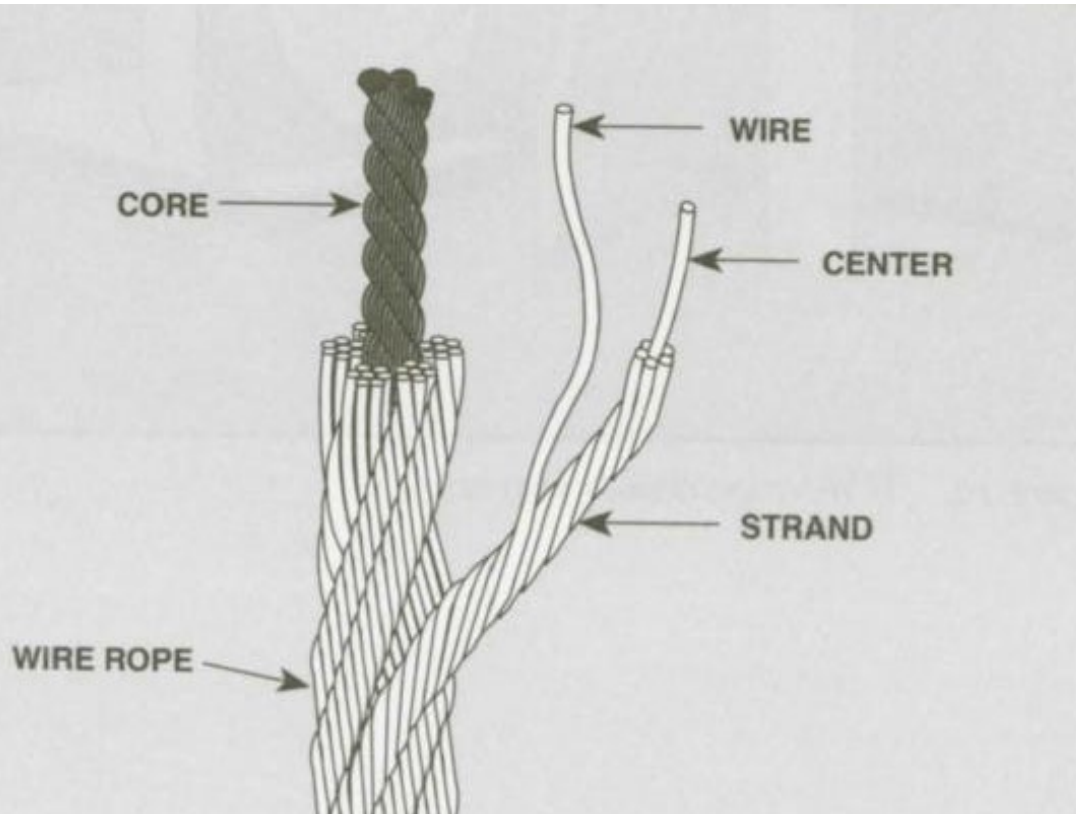


Bloque viajero

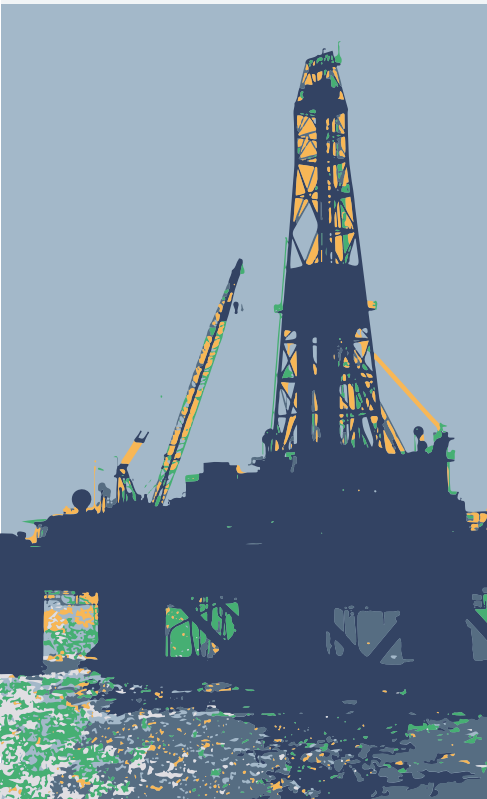


Anclaje de la línea muerta

Wire rope



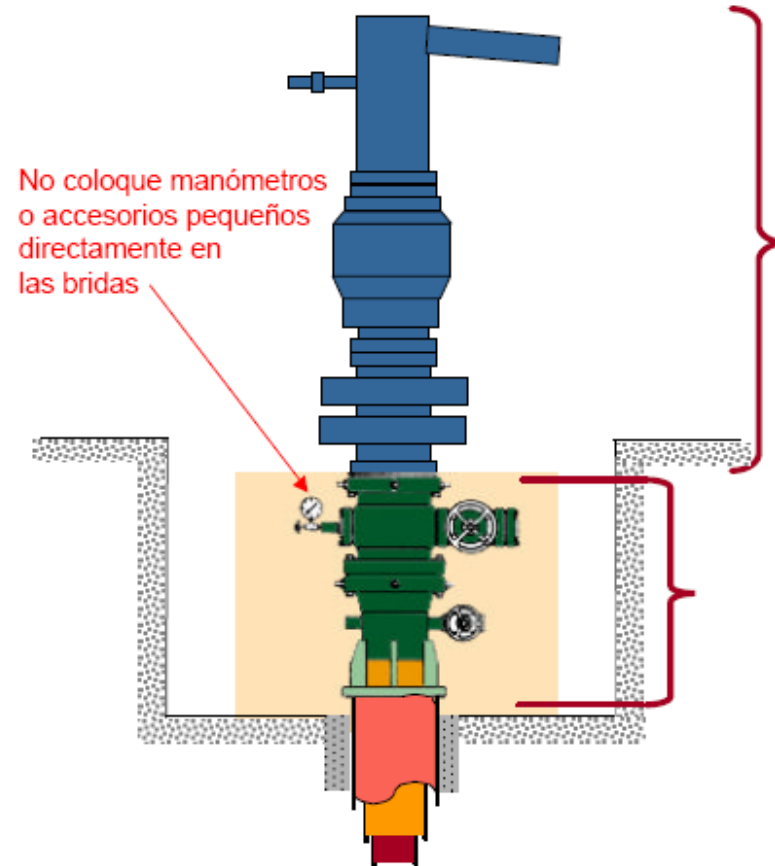
- Size: from 1" to 1 ¾"
- Design: braided 6 x19
- Core: IWRC (Independent Wire Rope Core)
- Steel grade: EIPS (Extra Improved Plow Steel).



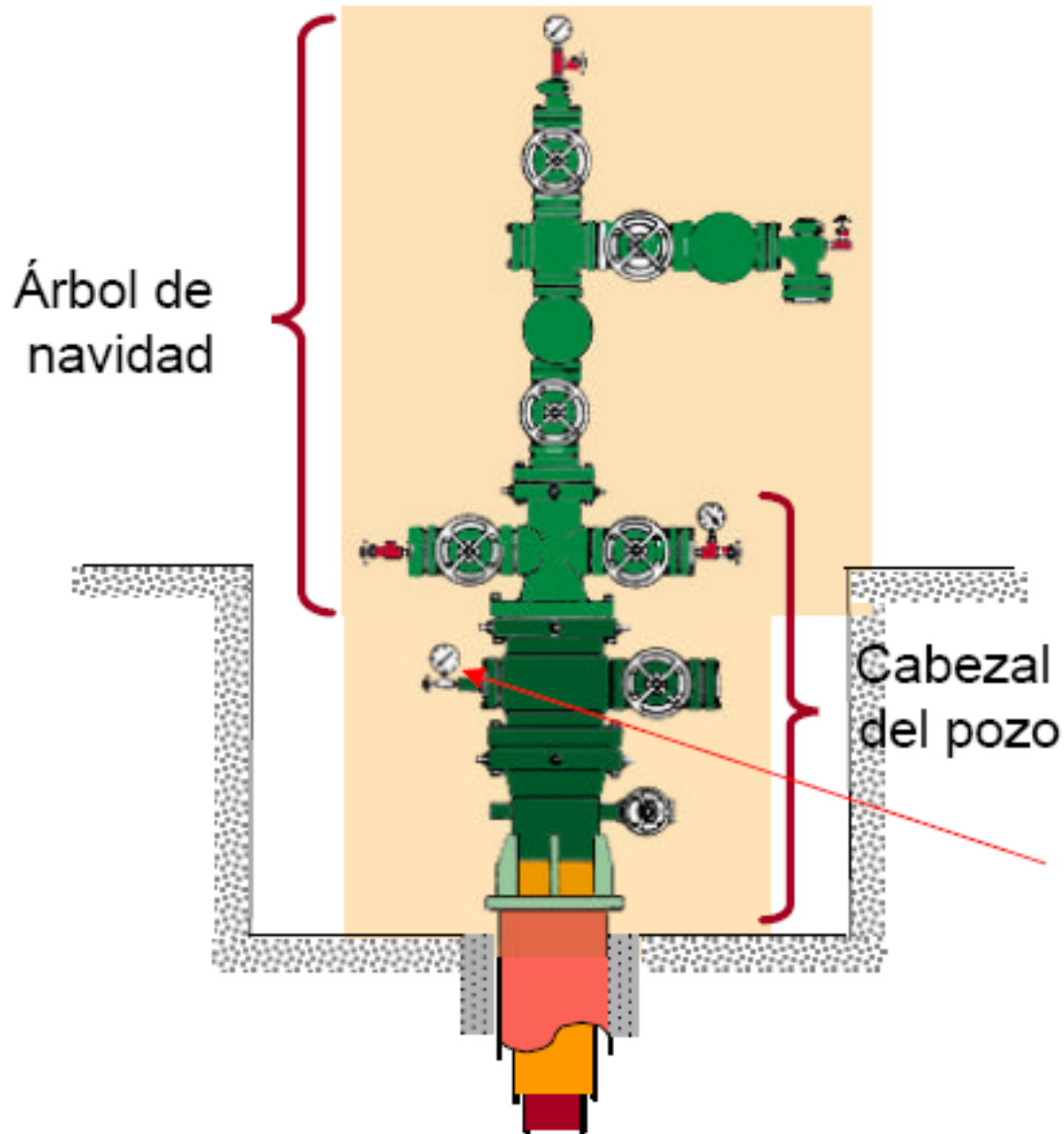
7. Well head and Christmas tree.

Wellhead

- Well head is base on the surface on which the well is built during the drilling operations.
- During the drilling operation the well is controlled by a BOP – Blow Out Preventor and a “multiple flow and strangulation device”.
- While the well is drilled, each annulus space is sealed by the wellhead.
- Once the well is finished and the pipe installed,
 - The BOP is withdrawn
 - The Christmas tree is installed to control the flow of the well



- The well head:
 - Enables the regulation and monitoring of the hydrocarbons extraction.
 - It prevents the leakage of oil or natural gas from the well.
 - It prevents the blowouts due to the high pressures of the formation.
- It is not uncommon that they must withstand pressures exceeding the 140 Mpa (1400 Bar).
- The well heads are composed of three parts:
 - The casing head.
 - The tubing head.
 - The «Christmas tree»



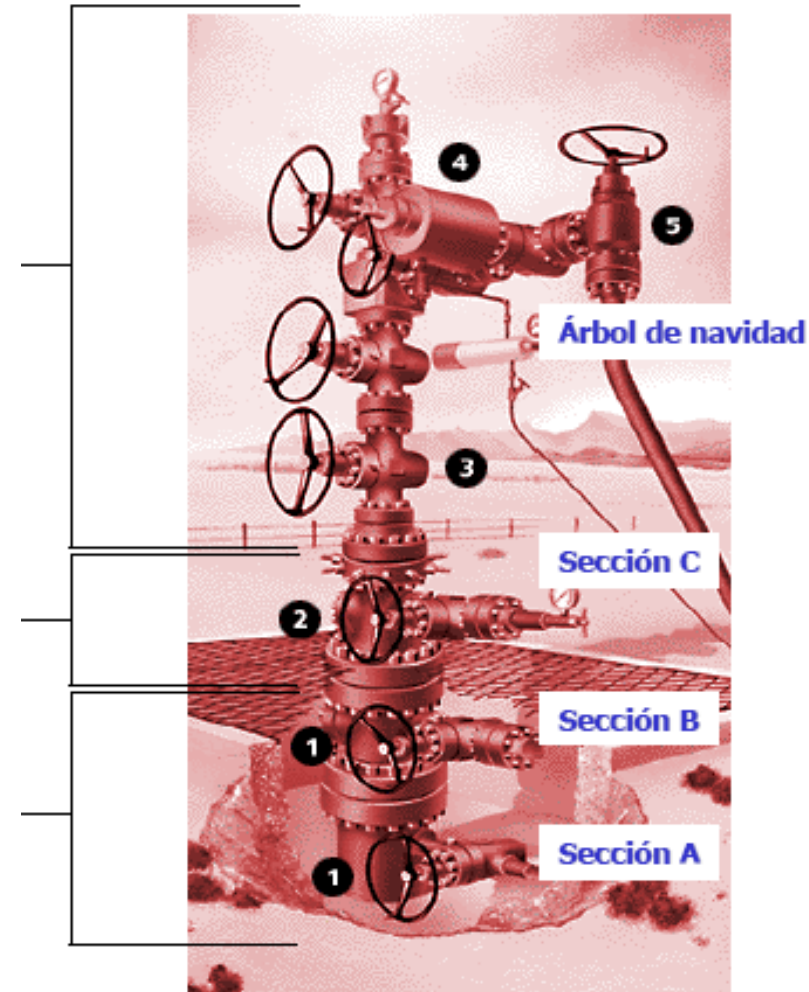
No se deben colocar manómetros o accesorios pequeños directamente en las bridas

- Well life cycle:
 - Drilling
 - Production
 - Rehabilitation
 - Suspension
 - Abandonment
- Well head systems must be designed to:
 - Support the tension load of the suspended pipelines
 - Be able to seal the pressure
 - ISOLATE the well from the outside environment
 - ISOLATE formations down the well
 - MAINTAIN the pressure during the control operations of the well, well tests or lockout operations.

- There are three main groups of conventional wells:
 - The most common is oil well with associated gas.
 - Natural gas wells are drilled specifically for this purpose and often give little or no oil.
 - Wells for condensate give natural gas and condensates that are separated from natural gas in the well head or in the further processing of natural gas.
- Depending on the well that is being drilled, its completion will differ from some others in greater or lesser extent.
- As being lighter than the air, the natural gas will rise naturally to the surface by the well. Is for this reason that pumping equipment is not needed, while they tend to require a wide variety of systems for their impulsion towards the surface, especially when after years of production of the oil well, the oil pressure of the well decreases.

What makes a well head

- Hang weight
- Contain the pressure
- Monitor the safety of the well
- Provide a base for the Christmas tree

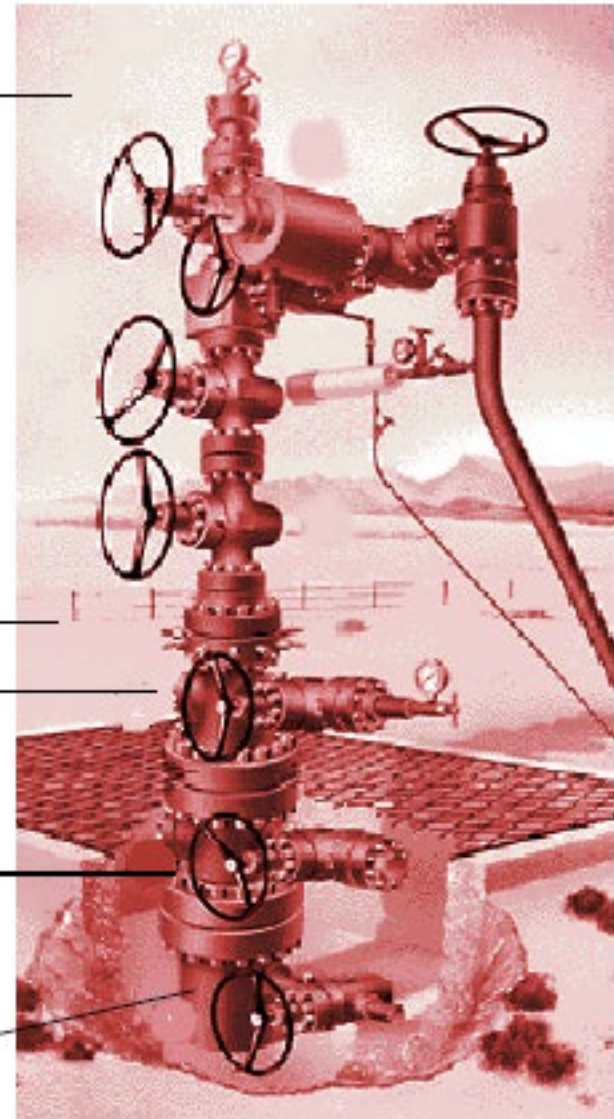


Árbol de navidad

Cabeza Carrete de Tubería

Cabeza Carrete del Revestidor

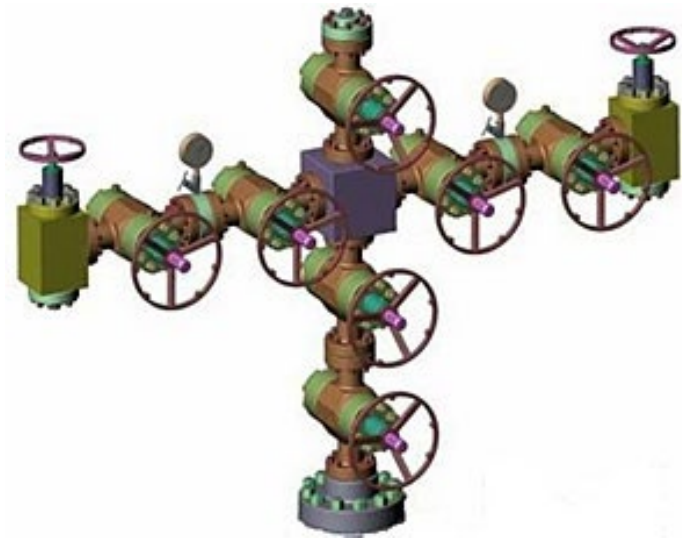
Cubierta del cabezal del Revestidor



entes

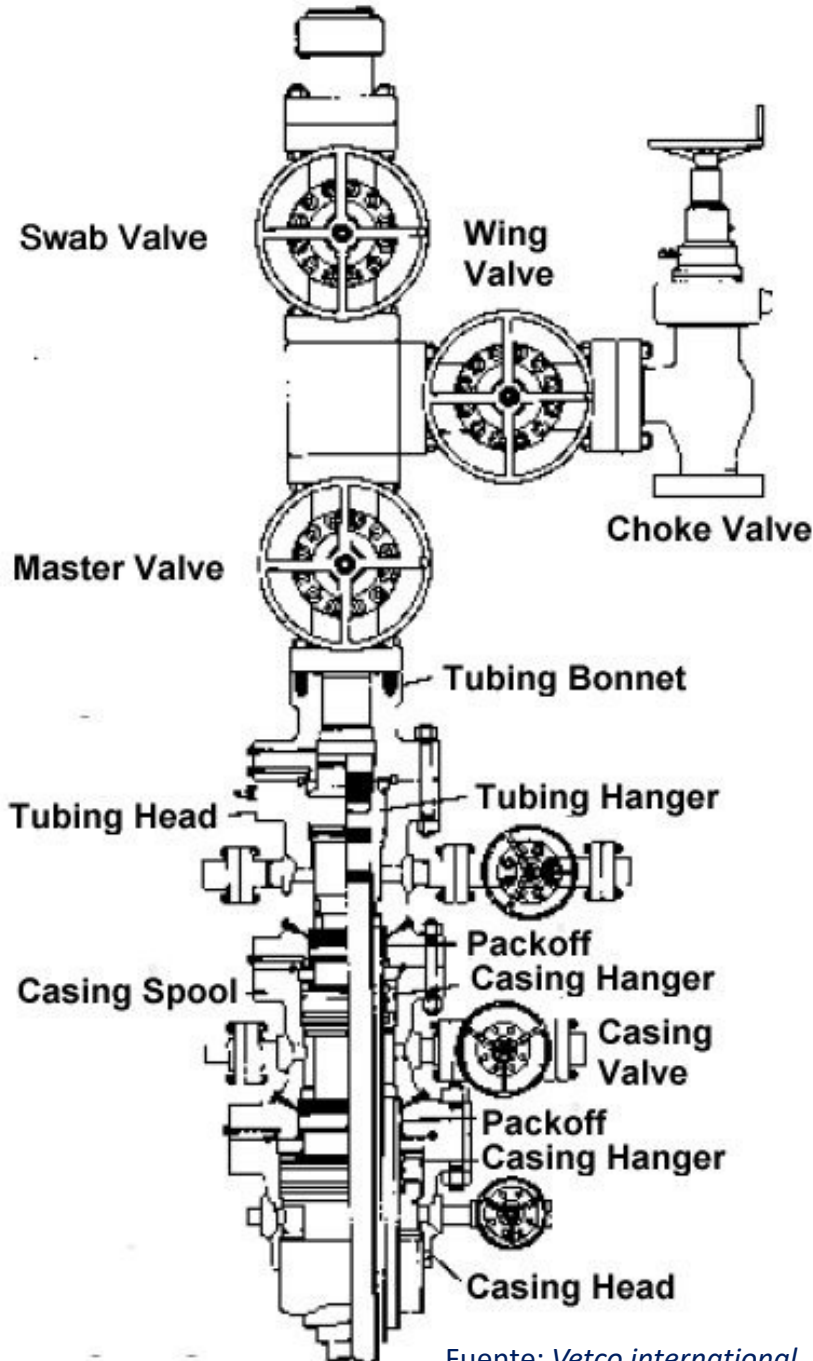


Árbol de Navidad



Árbol de Navidad

Christmas tree



Fuente: *Vetco international*

- A Christmas tree is composed by a master gate valve, a pressure gauge, a wing valve, a swab valve and a choke.
- It can also have a set of control valves.
- In the lower part is the Casing Head and the Casing Hangers.
- The casing can be screwed, bolted or welded to the support.
- There should be also provided various valves and fittings that should allow the access to the casing to open it, close it, inspect it and, if necessary, allow the circulation of fluids by the casing at the same time as in the tubing.

- The valves can also determine the existence of a leak in the tubing, casing or the packer.
- Support of the tubing (also called donut), is used to place it correctly in the well.
- Closures also allow to proceed with the withdrawal of the Christmas tree if necessary when there is pressure on the casing.
- The main valve allows inspection tools to pass through the tubing.