Rotary drill rig components

A drilling rig is a machine that creates holes in the earth's subsurface. Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and such are called augers. Drilling rigs can sample subsurface mineral deposits, test rock, soil and groundwater physical properties, and also can be used to install sub-surface fabrications, such as underground utilities, instrumentation, tunnels or wells. Drilling rigs can be mobile equipment mounted on trucks, tracks or trailers, or more permanent land or marine-based structures (such as oil platforms, commonly called 'offshore oil rigs' even if they don't contain a drilling rig). The term "rig" therefore generally refers to the complex equipment that is used to penetrate the surface of the Earth's crust.

Small to medium-sized drilling rigs are mobile, such as those used in mineral exploration drilling, blast-hole, water wells and environmental investigations. Larger rigs are capable of drilling through thousands of metres of the Earth's crust, using large "mud pumps" to circulate drilling mud (slurry) through the drill bit and up the casing annulus, for cooling and removing the "cuttings" while a well is drilled. Hoists in the rig can lift hundreds of tons of pipe. Other equipment can force acid or sand into reservoirs to facilitate extraction of the oil or natural gas. Marine rigs may operate thousands of miles distant from the supply base with infrequent crew rotation or cycle.

Oil well drilling utilises tri-cone roller, carbide embedded, fixed-cutter diamond, or diamond-impregnated drill bits to wear away at the cutting face. This is preferred because there is no need to return intact samples to surface for assay as the objective is to reach a formation containing oil or natural gas. Sizable machinery is used, enabling depths of several kilometres to be penetrated. Rotating hollow drill pipes carry down bentonite and barite infused drilling muds to lubricate, cool, and clean the drilling bit, control downhole pressures, stabilize the wall of the borehole and remove drill cuttings. The mud travels back to the surface around the outside of the drill pipe, called the annulus. Examining rock chips extracted from the mud is known as mud logging. Another form of well logging is electronic and is commonly employed to evaluate the existence of possible oil and gas deposits in the borehole. This can take place while the well is being drilled, using Measurement While Drilling tools, or after drilling, by lowering measurement tools into the newly drilled hole.

Hydraulic rotary drilling

The most common drilling rigs in use today are rotary drilling rigs. Their main tasks are to create rotation of the drillstring and facilities to advance and lift the drillstring as well as casings and special equiptment into and out of the hole drilled. In general, rotary rigs can be distinguished into:

Land rigs (onshore):

- Conventional rigs: Small, medium and large land rigs.
- Mobile rigs: Portable mast, jacknife.

Offshore rigs:

- Bottom anchored rigs: artificial island, TLP, submersible, jackup, concrete-structured, etc.
- Floating rigs: drillship, semi-sumersible, barge.

For offshore rigs, factors like water depth, expected sea states, winds and currents as well as location (duppy time) have to be considered as well. It should be understood that rig rates are not only influenced by the rig type but they are also strongly dependent on by the current market situation (oil price, drilling activity, rig availabilities, location, etc). Therefore for the rig selection basic rig requirements are determined first. Then drilling contractors are contacted for offers for a proposed spud date (date at which drilling operation commences) as well as for alternative spud dates.

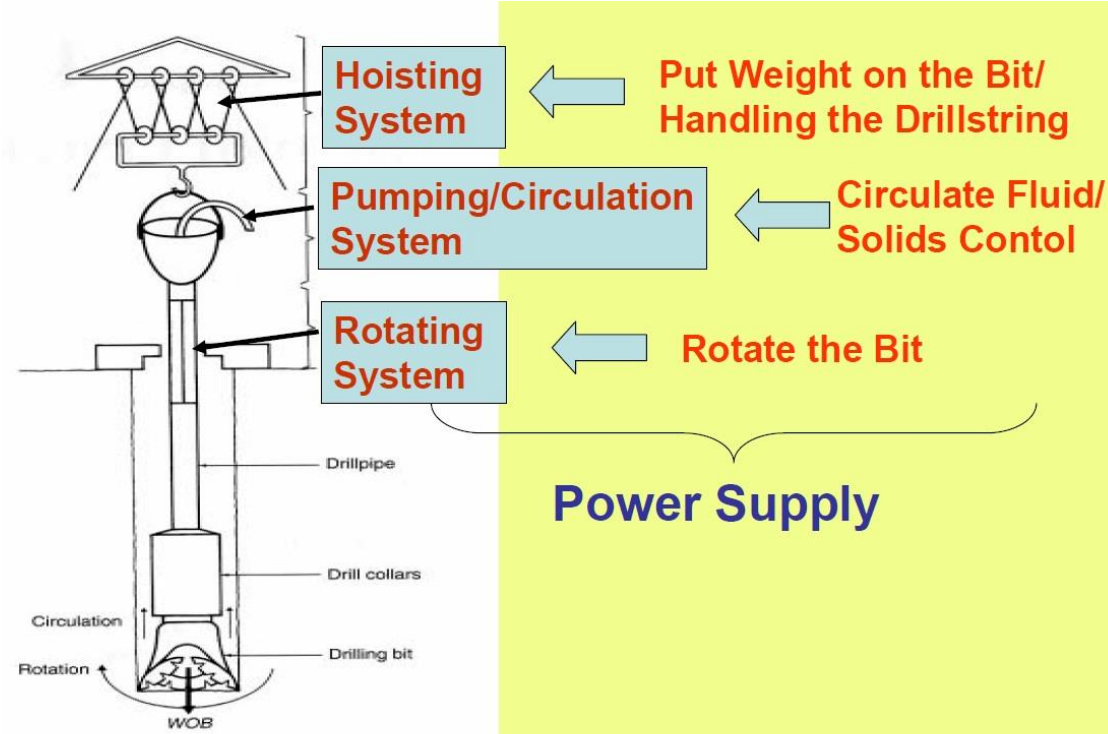
Rig Power System

The power system of a rotary drilling rig has to supply the following main components:

-Rotary system

-Hoisting system

-Drilling fluid circulation system.

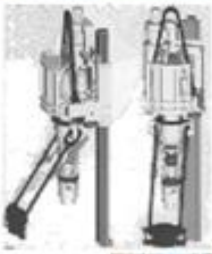


In addition, auxiliares like the blowout preventer, boiler-feed water pumps, rig lighting system, etc. have to be powered. Since the largest power consumers on a rotary drilling rig are the hoisting and the circulation system, these components determine mainly the total power requirements. At ordinary drilling operations, the hoisting (lifting and lowering of the drillstring, casing, etc.) and the circulation system are not operated at the same time. For that reason the same engines can be engaged to perform both functions. The power itself is either generated at the rig site using internal-combustion diesel engines as electric power supply from existing power lines.

Rotary System

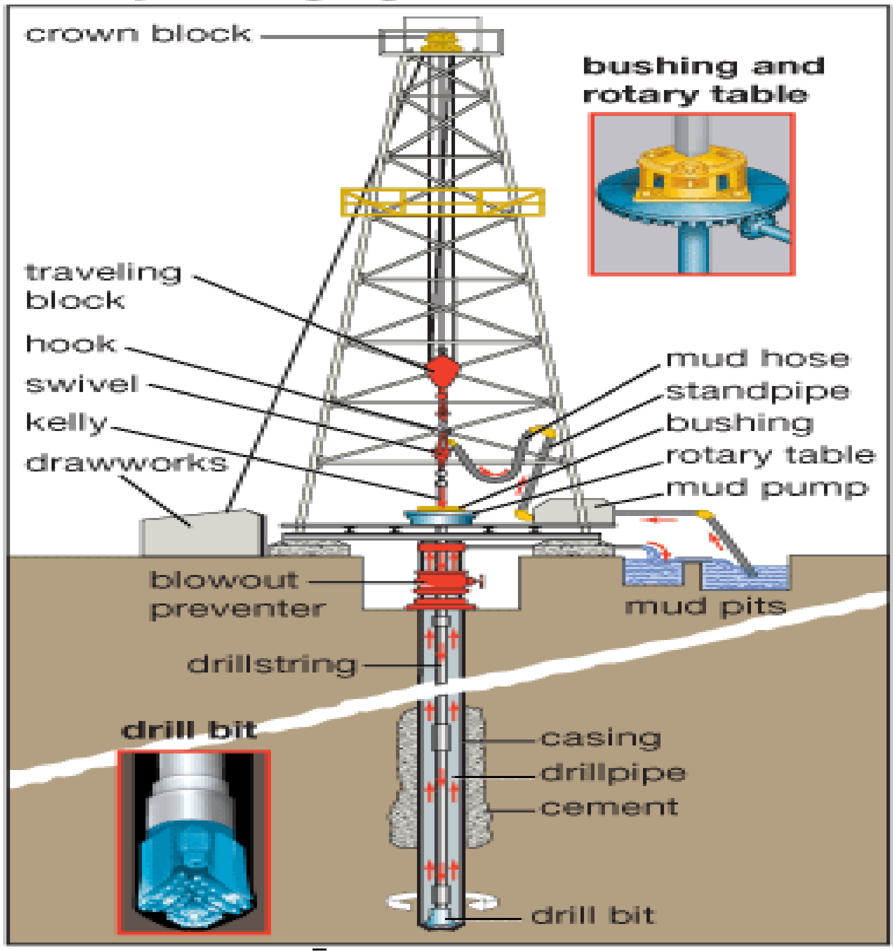
The function of the rotary system is to transmit rotation to the drillingstring and consequently rotate the bit. During drilling operation, this rotation is to the right. The main part of the rotary system are as follows: Swivel, Rotary hose, Kelly, Rotary drive (master pushing, kelly pushing), Rotary table and Drilling string.

The main components of rotating equipment



- ✓The main components are:
  - Rotary table
  - Kelly
  - Top Drive
    - equivalent to the Kelly and rotary table, i.e. either top drive or Kelly/rotary table
  - Swivel
  - Rotary hose
- ✓The rotary horse power requirement is usually between 1.5 to 2 times the rotary speed, depending on hole depth.
  - Hence for rotary speed of 200 rpm, the power requirement is about 400 HP.

Rotary drilling rig



Swivel:

The swivel which established a connection among hook and kelly, has to be constructed or built extremely robust since or because it has to carry the total drillstring weight and simultaneously, provide a high pressure seal (connection between flexible, non-rotating rotary hose and the rotation kelly).

Kelly:

The kelly has a square or hexagonal cross-section and provides the rotation of the drillstring. Because the kelly is made of high quality, treated steel, it is a flashy part of the drillstring. Thus to prevent the kelly from excessive wear caused by making and breaking connections, a kelly sub is mounted at the bottom end of it. To prevent backward flow of the mud in case of a kick, a kewlly cock providing a backflow restriction valve is often mounted between kelly and swivel.

Rotary Drive:

The rotary drive consists of master pushing and kelly pushing. The master pushing receives its rotational momentum from the compound and drives the kelly pushing which in turn transfers the rotation to the kelly.

Hoisting System

The main task of the hoisting system is to lower and raise the drillstring, casings, and other subsurface equiptment into or out of the well. The hoisting equiptment itself consists of: Draworks, Fast Line, Crown Block, Traveling Block, Deadline, Deal line anchor, Storage reel, Hook, Derrick.

Making a connection” is defined as the periodic process of adding a new joint of drillpipe to the drillstring as the hole deepends is referred.

Making a trip is the process of moving the drillstring out of the hole, change the bit or alter the bottom-hole assembly (BHA), and lower the drillstring again into the hole is referred.

Derrick:

Derricks are classified (or rated) by The American Petroleum Institute (API) according to their heigh as well as their ability to withstand wind and compressive loads.

Block and Tackle:

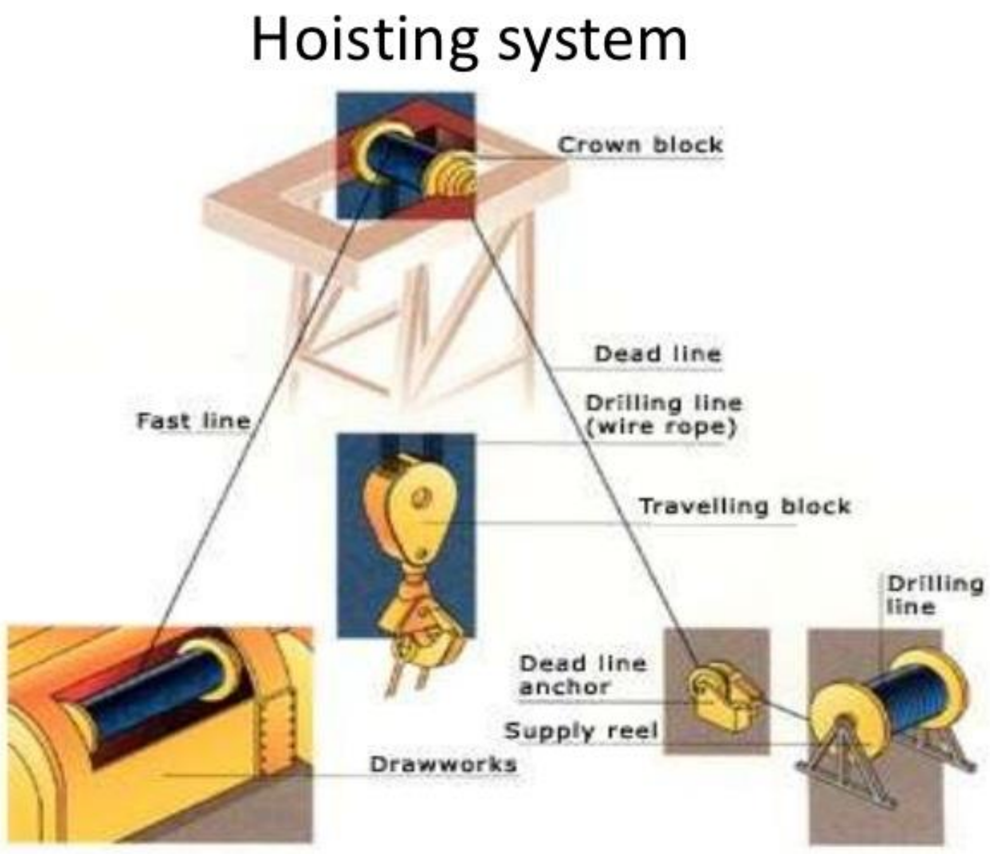
The crown block, the travelling block and the drilling line comprise the block and tackle which permits the handling of large loads. To lift and lower the heavy loads into and out of the borehole, the drillling is strung multiple times among the crown and the travelling block.

Drilling Line:

The drilling line is a wire rope that is made of strands wounded around a steel core. Its classification is based on the type of core.

Drawwork:

The purpose of the drawworks is to provide the hoisting and breaking power to lift and lower the heavy weights of drillstring and casings. The drawwork itself cosists of: Drum (which provides the movement of the drilling line), Brakes, Transmission and Catheads.



Circulation System

The principle components of the mud circulation system are as follows: Mud pumps, flowlines, drillpipe, nozzles, mud pids and tanks (settling tank, mixing tank, suction tank), ,ud mixing equipment (mud mixing hopper) and contaminant removal equipment (shale shaker, desander, desilter, degasser).

The flow of circulated drilling mud can be described as from the mud pit (storage mud) via the mud mixing hopper. Where various additives like weghting material erc. can be mixed into the mud, or the suction line to the mud pumps. At the mud pumps the mud is pressure up to the required mud pressure value.

From the mud pumps the mud is pushed through the stand pipe (a pipe fixed mounted at the derrick), the rotary hose (flexible connection that allows the fed of the mud into the vertically moving drillstring), via the swivel into the drillstring. Inside the drillstring (kelly, drillpipe, drill collar) the mud flows down to the bit where it is forced through the nozzles to act against the bottom of the hole. From the bottom of the well the mud rises up the annuli (drill collar, drillpipe) and the mud line (mud return line) which is located above the BOP.

From the mud line the mud is fed to the mud cleaning system consisting of shale shaker, settlement tank, de-sander and de-silte. After cleaning the mud, the circulation circle is closed when the mud returns to the mud pit.

Mud Pumps:

Nowadays there are two types of mud pumps in use **(**Duplex pump which consists of two cylinders and is double-acting, triplex pump which consists of three cylinders and is single-acting), both equipped with reciprocating positive-displacement pistons. The amount of mud and the pressure the mud pumps release the mud to the circulation system are controlled via changing of pump liners and pistons as well as control of the speed (stroke/minute) the pump is moving.

When the mud returns to the surface, it is lead over shale shakers that are composed of one or more vibrating screens over which the mud passes before it is feed to the mud pits.

The mud pits are required to hold an excess mud volume at the surface. Here fine cuttings can settle and gas, that was not mechanically separated can be released further. In addition, in the event of lost circulation, the lost mud can be replaced by mud from the surface pits.

Drilling rig classification

There are many types and designs of drilling rigs, with many drilling rigs capable of switching or combining different drilling technologies as needed. Drilling rigs can be described using any of the following attributes:

By power used

- Mechanical — the rig uses torque converters, clutches, and transmissions powered by its own engines, often diesel.
- Electric — the major items of machinery are driven by electric motors, usually with power generated on-site using internal combustion engines.
- Hydraulic — the rig primarily uses hydraulic power.
- Pneumatic — the rig is primarily powered by pressurized air.
- Steam — the rig uses steam-powered engines and pumps (obsolete after middle of 20th Century).

By pipe used

- Cable — a cable is used to raise and drop the drill bit.
- Conventional — uses metal or plastic drill pipe of varying types.
- Coil tubing — uses a giant coil of tube and a downhole drilling motor.

By height

Rigs are differentiated by height based on how many connected pipe they are able to "stand" in the derrick when needing to temporarily remove the drill pipe from the hole. Typically this is done when changing a drill bit or when "logging" the well.

- Single — can pull only single drill pipes. The presence or absence of vertical pipe racking "fingers" varies from rig to rig.
- Double — can hold a stand of pipe in the derrick consisting of two connected drill pipes, called a "double stand".

- Triple — can hold a stand of pipe in the derrick consisting of three connected drill pipes, called a "triple stand".
- Quadri — can store stand of pipe in the derrick composed of four connected drill pipes, called a "quadri stand".

By method of rotation or drilling method

- No-rotation includes direct push rigs and most service rigs.
- Rotary table — rotation is achieved by turning a square or hexagonal pipe (the "Kelly") at drill floor level.
- Top drive — rotation and circulation is done at the top of the drill string, on a motor that moves in a track along the derrick.
- Sonic — uses primarily vibratory energy to advance the drill string.
- Hammer — uses rotation and percussive force.

By position of derrick

- Conventional — derrick is vertical
- Slant — derrick is slanted at a 45 degree angle to facilitate horizontal drilling.

Earth boring apparatus

In machining, boring is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a boring head containing several such tools), such as in boring a gun barrel or an engine cylinder. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal-diameter counterpart to turning, which cuts external diameters.

There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end (which works for both, through holes and blind holes). Lineboring (line boring, line-boring) implies the former. Backboring (back boring, back-boring) is the process of reaching through an existing hole and then boring on the "back" side of the workpiece (relative to the machine headstock).

Because of the limitations on tooling design imposed by the fact that the workpiece mostly surrounds the tool, boring is inherently somewhat more challenging than turning, in terms of decreased toolholding rigidity, increased clearance angle requirements (limiting the amount of support that can be given to the cutting edge), and difficulty of inspection of the resulting surface (size, form, surface roughness). These are the reasons why boring is viewed as an area of machining practice in its own right, separate from turning, with its own tips, tricks, challenges, and body of expertise, despite the fact that they are in some ways identical. The first boring machine tool was invented by John Wilkinson in 1775. Boring and turning have abrasive counterparts in internal and external cylindrical grinding. Each process is chosen based on the requirements and parameter values of a particular application.

The boring process can be executed on various machine tools, including (1) general-purpose or universal machines, such as lathes (/turning centers) or milling machines (/machining centers), and (2) machines designed to specialize in boring as a primary function, such as jig borers and boring machines or boring mills, which include vertical boring mills (workpiece rotates around a vertical axis while boring bar/head moves linearly; essentially a vertical lathe) and horizontal boring mills (workpiece sits on a table while the boring bar rotates around a horizontal axis; essentially a specialized horizontal milling machine).

Because boring is meant to decrease the product tolerances on pre-existing holes, several design considerations apply. First, large length-to-bore-diameters are not preferred due to cutting tool deflection. Next, through holes are preferred over blind holes (holes that do not traverse the thickness of the workpiece). Interrupted internal working surfaces—where the cutting tool and surface have discontinuous contact—are preferably avoided. The boring bar is the protruding arm of the machine that holds the cutting tool(s), and must be very rigid.

Because of the factors just mentioned, deep-hole drilling and deep-hole boring are inherently challenging areas of practice that demand special tooling and techniques. Nevertheless, technologies have been developed that produce deep holes with impressive accuracy. In most cases they involve multiple cutting points, diametrically opposed, whose deflection forces cancel each other out. They also usually involve delivery of cutting fluid pumped under pressure through the tool to orifices near the cutting edges. Gun drilling and cannon boring are classic examples. First developed to make the barrels of firearms and artillery, these machining techniques find wide use today for manufacturing in many industries.