COST/TIME SAVING BENEFITS OF USING A GYRO MWD TOOL FOR TOP HOLE NAVIGATION ON MULTIWELL STRUCTURES

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Historically, multi well platform directional drilling has been challenging especially in the initial drilling phase. Wells have to be carefully navigated through a maze of other wells and eventually steered clear of all interfering wells to the desired target. (ref #1)

To avoid drilling into another well, ellipses of uncertainty and well proximities are calculated as part of the well planning program so that each well can be monitored relative to the others wells around it and collisions avoided. (Ref # 2)

As well as an appropriate well plan, the survey tools used for the drilling phase must be modeled and any errors taken into account when the drilling phase is underway. All navigation orientation systems used on modem multi well structures will be either gyroscopic for the top hole, or magnetic systems, once the interference section of the hole has been overcome.

Because of the proximity of other wells it is impossible to use any magnetic based survey system in the initial part of the well so gyro survey tools are normally used to give the directional driller the required azimuth and toolface data he requires to orient and steer the motor assembly through this hole section. A typical bottom hole assembly for this initial top hole phase consists of a bit, motor, bent sub,or a bent housing motor, orienting sub, non magnetic drill collar, heavyweight drillpipe and drill collars.

The orientation of the bent sub and motor is facilitated by the alignment of a key in the orienting sub with the highside scribeline of the bent sub (Ref # 3). The bottom of the gyro tool is dressed with a muleshoe which will locate the key in the sub and force the gyro tool to seat with the muleshoe properly aligned in the keyway. (Ref # 4). This means that any toolface reading from the gyro will indicate the direction in which the motor/bent sub is “pointing”.

By placing weight to this assembly, the bent sub becomes the fulcrum and the bit is forced to the highside of the hole thereby initiating a building of hole angle. The severity of the bent sub angle will determine the rate of build.

SURVEY SYSTEMS - GYRO

The gyro tools used in the past have gone through several technology changes.
In the earlier days, film systems were used (ref # 4). These involved photo mechanical tools that took small photographs of the gyro compass and had to be developed after the tool was pulled out of hole. The drawbacks were accuracy, single shot mode only(no realtime readout) and time taken in hole for each run. These early systems had to be oriented to an external fixed point of a known azimuth and this tended to lead to many errors. (Ref # *5)*

These were later replaced with surface readout gyros which allowed the directional driller to get a realtime readout at surface of the orientation of the motor. (ref # 14). These systems used the same basic “free gyroscopes” but were the first to use accelerometers (ref # 6) for inclination and high side instead of mechanical plumb bobs. They also used a resolver to track the orientation of the gyrocompass. The advantages of these systems were accuracy, speed of operation and a realtime surface readout of toolface.

The next move forward came in the early eighties when North Seeking “Rate Gyros” were first used for a downhole survey instrument instead of the typical older “free gyroscopes” North Seeking gyros use a rate gyro instrument which can detect the earth’s spin rate very accurately and compute North for a given latitude, (Ref # 7-8). These instruments gave survey and orientation service much more accuracy and removed a major source of error, gyro orientation (Ref # 5)

Subsequent developments have seen increased accuracies by means of further enhanced North Seeking systems employing multiple gyros to allow "continuous mode" of operation. This mode sees the tools run in a continuous navigation mode sending up larger quantities of data than before and also higher accuracies at higher angles. (Ref # 9-10)

As per the above, much progress has been made in the capabilities of gyro tools used for directional drilling but the same scenario still prevailed that being, the tools were still run on an electric wireline every time a surveylorientation was required. These runs can be as many as 20 or more during a complex kick off and run time can average 60mins I run.

SURVEY SYSTEMS – MWD

The first commercial MWD systems appeared in the late seventies to allow for insitu surveying in the long open hole sections of Directional wells. The MWD tools are a magnetic survey instrument housed inside a 30ft non magnetic drill collar. The sensor portion of the tool is based on triaxis magnetometer, accelerometer device capable of providing inclination, magnetic toolface, highside and magnetic azimuth. The tools re powered by either a battery pack or a downhole generator or turbine.(Ref # 12)

These tools can transmit the survey data up the mud column in the form of a pulse sequence. These systems are generally used on all directional wells from the point where magnetic interference is no longer a problem all the way to the bottom of the well.

Wouldn't it be nice to have an MWD tool with a gyro built into it ?

The gMWD system was developed in late 2000 using already field proven gyro and magnetic steering modules which when combined into one system in a mud pulse mwd configuration, represents a huge time saving for top hole multiwell platform drilling.

Gyro MWD was developed so the directional driller could benefit from having the gyro sensor in place at the bottom the MWD tool string and have the ability to get fast gyro orientation/survey data in minutes. Gyro toolface is realtime with gamma and a survey can be pumped to surface after 3 mins. still time. The added benefit of the system is being to ascertain the exact point at which drilling is clear of magnetic interference from other wells. The data from both the gyro and magnetic probes can now be obtained simultaneously from one tool.

The system consists of 3 main components. (Ref #18-20)

1) The pulser and driver,
2) The magnetic mwd sensor and battery pack (3 – axis 16bit magnetometer and 3 – axis accelerometer sensors)
3) The gyro sensor and battery pack (2 gyroscopes and 3 accelerometers) (Ref # 16)

The tool string measures approx. 30ft in length and diameter of 1.75" The gyro module is placed at the bottom of the tool string to be as close to the bit as possible. The gyro and magnetic sensor points are 15ft apart. The entire toolstring is seated in a pulser sub and non magnetic drill collar much like a conventional mwd tool. (Ref #13)

OPERATING METHOD

The control module in the system detects the pumps being turned on and will start up the Gyro module. The gyro probe will be initialized and initial QA parameters checked. The tool will then be set into a continuous navigation mode to give realtime gyro toolface and gamma. Drilling commences using gyro toolface and when a gyro survey is required, the pumps are shut off and after 3 mins of still time, the gyro survey can be pumped to surface.

Approaching the expected magnetic interference limit, the tool is set to pump up both a gyro survey and a magnetic survey for comparison purposes. Assuming the correlation is consistent between the 2 data sets, the gyro probe can be shutdown and drilling can continue using only the magnetic probe in the gmwd tool.

Utilizing power saving techniques, the system capability allows for approx. 7 days drilling.

Additional benefits from this system are :

1) Safer drilling operations in top hole by removing wireline.
2) Reduced personnel and equipment on board during top hole phase.
3) Ability to switch between magnetic and gyro probes as required.

4) Optional gyro multishot stored in memory as tool is pulled out of hole.

Case study
Location: **Multi Well N.Sea Platform.**
Well No: XXXXX

Description of work performed:
gMWD in the 17 ½" section.

Objective:
To run Scientific Drilling's **gMWD** tool during the drilling of the 17 ½" open hole section, from the 20" conductor shoe at 1619.00ft to the section T.D at 6080.00ft.

gMWD Analysis:
The section was drilled with 'Gyro' surveys down to a depth of 3109.00ft and then with 'Magnetic' surveys. All surveys were within specification but due to the proximities of other wells it was decided to run a 'Keeper' Gyro multishot. The multishot confirmed the **gMWD** data.

The decision to drill ahead was made with a successful talk down to the tool made to switch off the Gyro. Drilling continued till section T.D where concern was raised over inclination loss. At this point, the gMWD talkdown was done to power up the gyro module which had been shut off prior to this and cross check the inclination data from the magnetic sensor with the data from the gyro module accelerometers. Checks were made using both Magnetic and Gyro surveys and the inclination confiied.

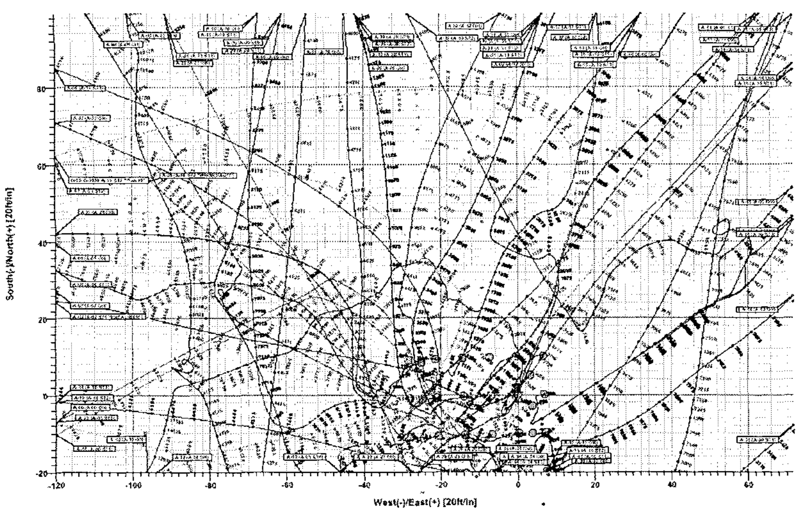
A wiper trip back to the shoe was performed and then the B.H.A ran back to T.D where two check shots were taken. The B.H.A was then pulled out of hole and the tool retrieved back at surface.

CONCLUSIONS
The system proved to be a time saver and very versatile in the data it could provide the directional driller throughout the kick off section. The ability to shut down and power up the modules with talkdown is a distinct benefit. By removing the wireline aspect of the job, significant time savings were seen over conventional wireline conveyed gyro tools averaging 45 – 60 min. per run. Typically we would reach casing point 1 – 2 ½ days ahead of the time curve using this method after a complex kick off. (Ref #25-26)

Job Information:
Inclination range from 5 Degrees to 65 Degrees.

Circulating Hours 100, Tripping Hours 10.

Avg. PeakG 2.543g
Max PeakG 45.000g



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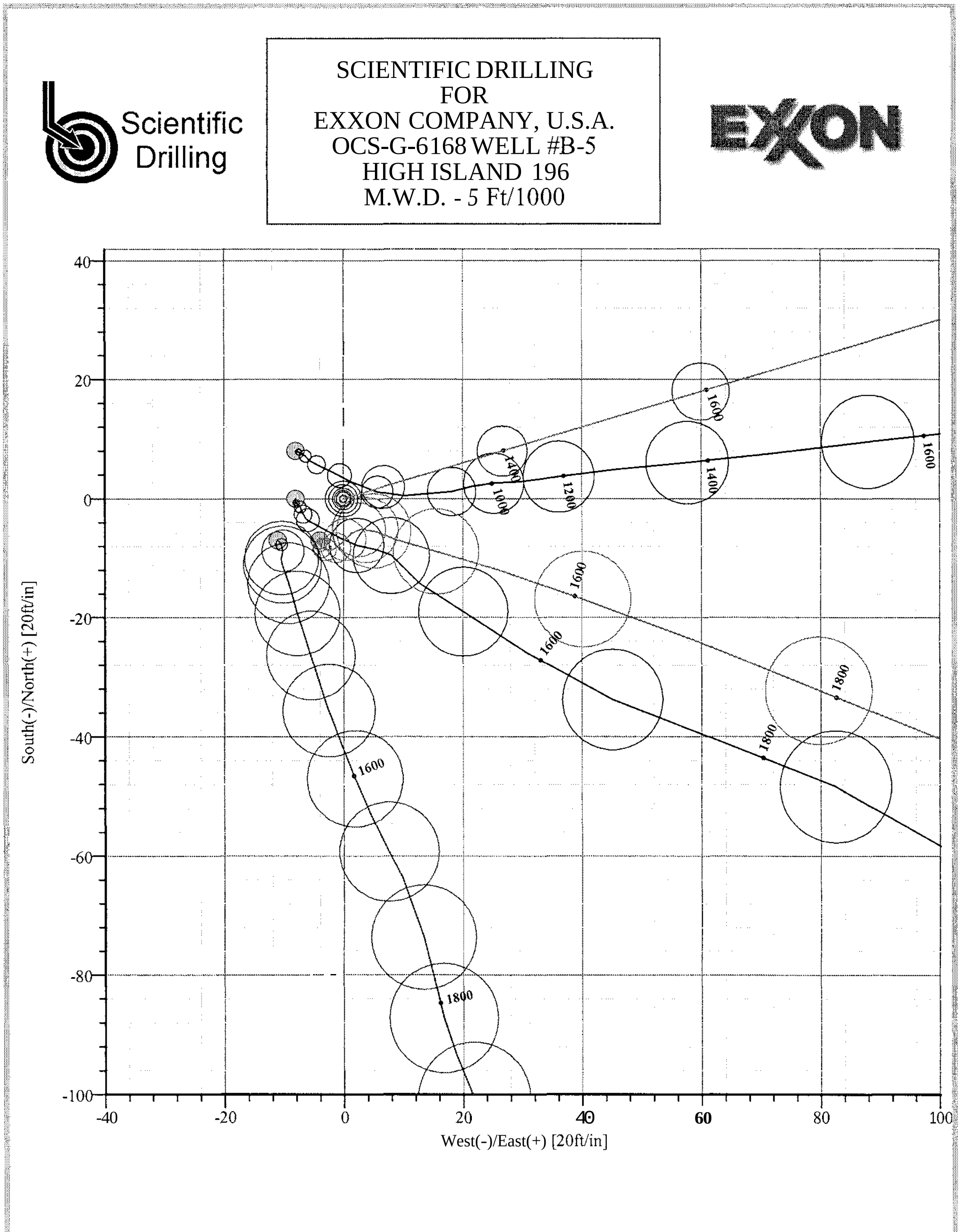
Scientific Drilling
SCIENTIFIC DRILLING
FOR
EXXON COMPANY, U.S.A.
OCS-G-6168 WELL #B-5
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EXXON
South(-)/North(+) [20ft/in]
West(-)/East(+) [20ft/in]

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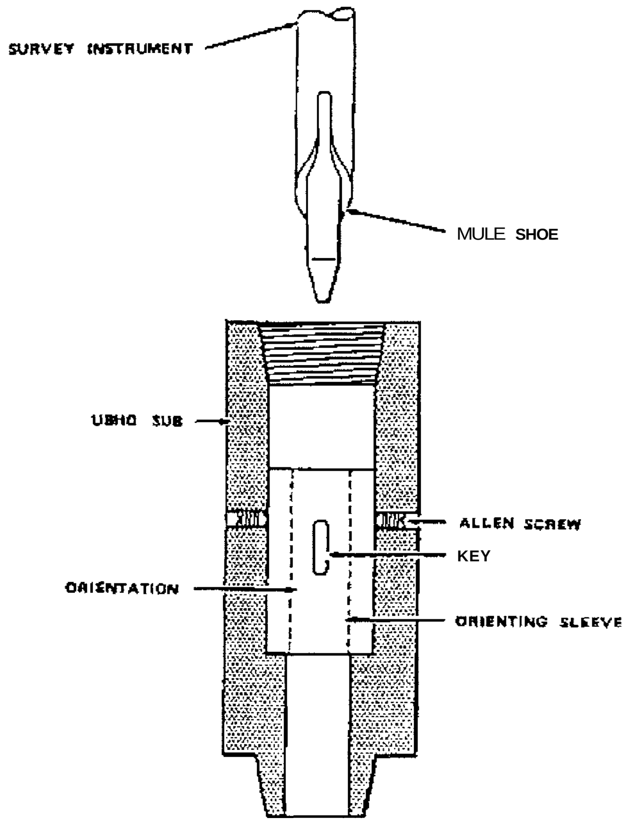

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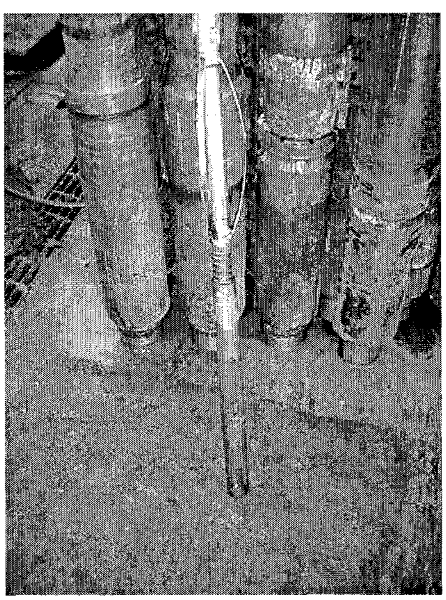

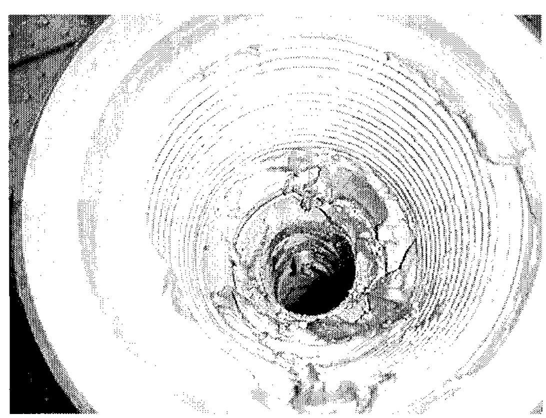

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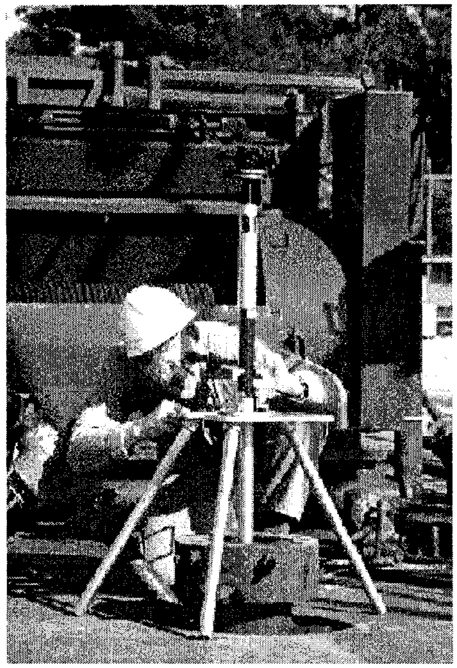
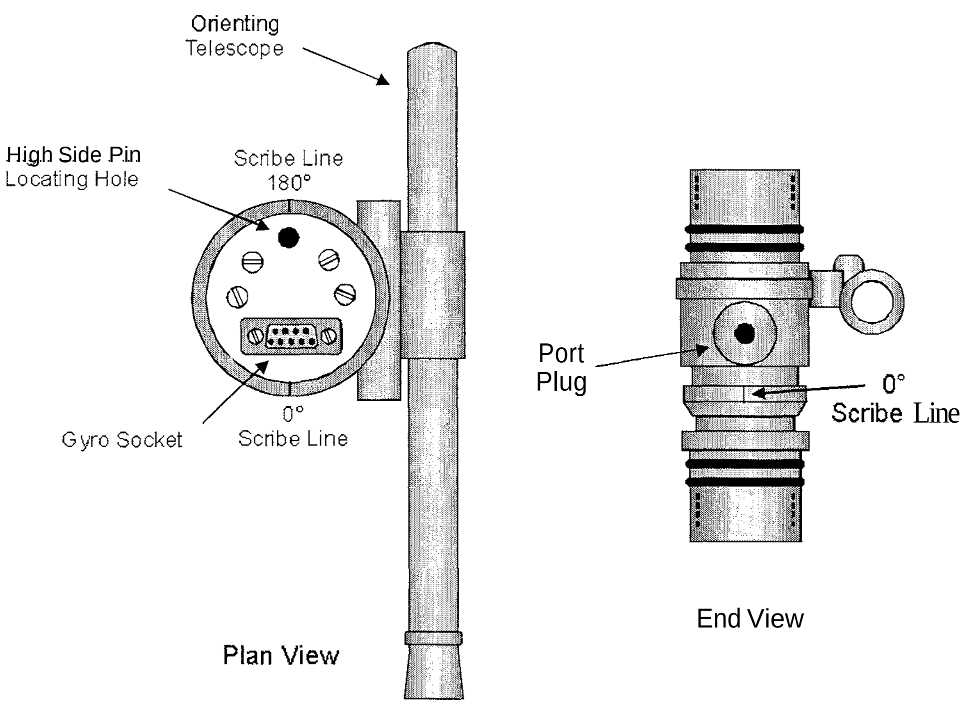
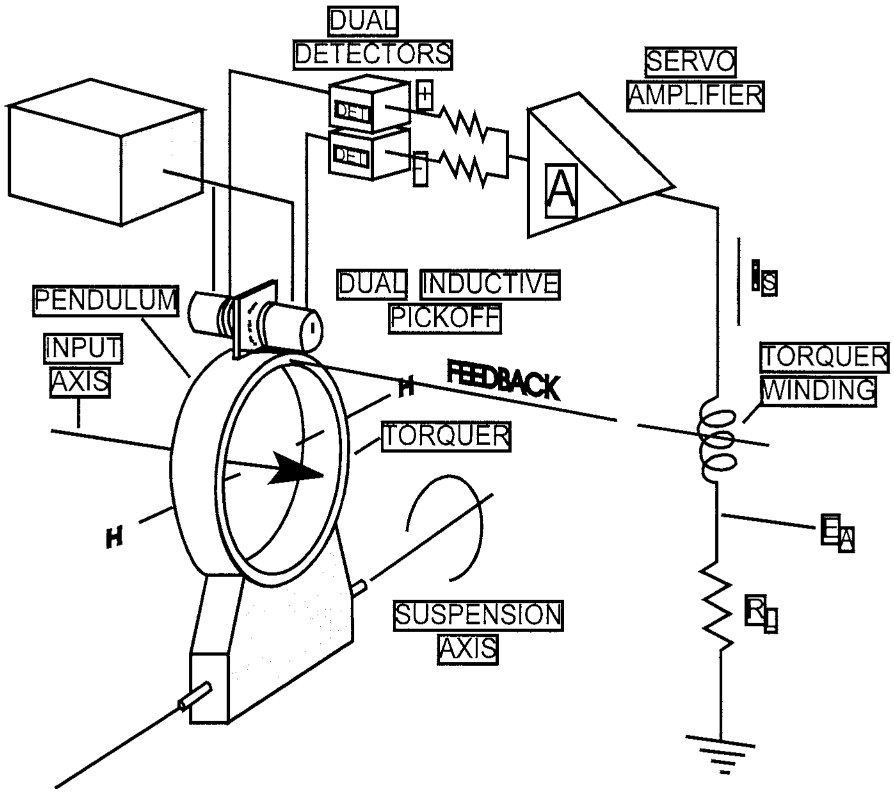




Orienting
Telescope
High Side Pin
Locating Hole
Scribe Line
180°
Gyro Socket
0°
Scribe Line
Plan View
Port
Plug
0°
Scribe Line
End View

Reference 5



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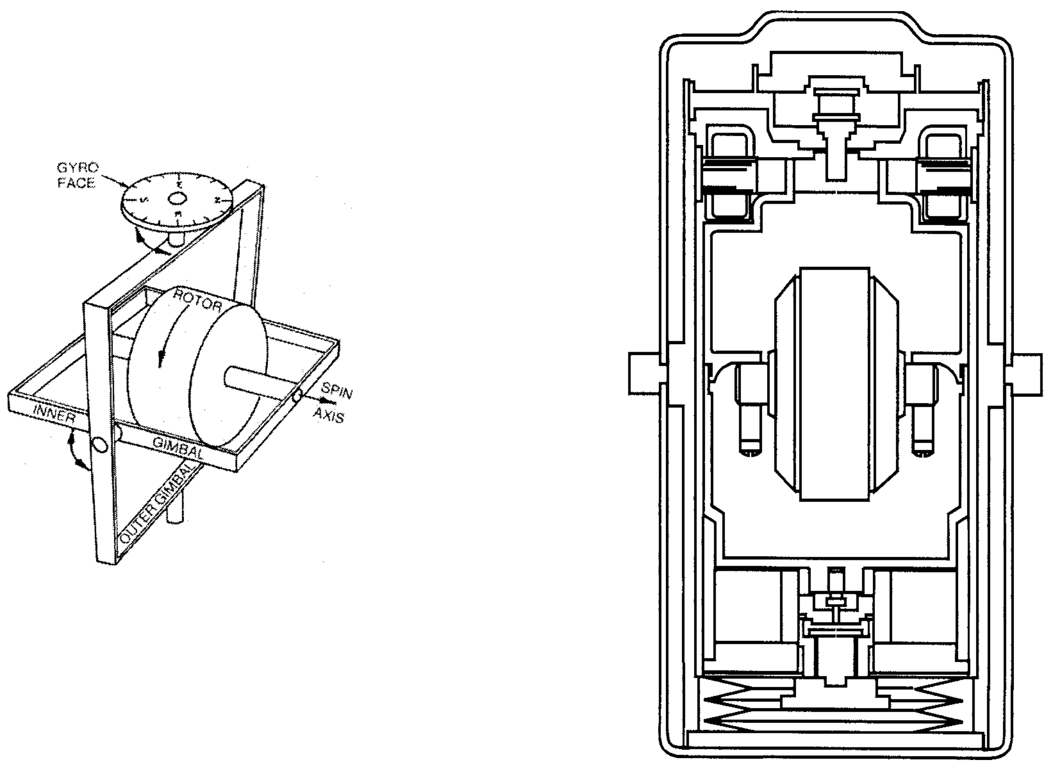

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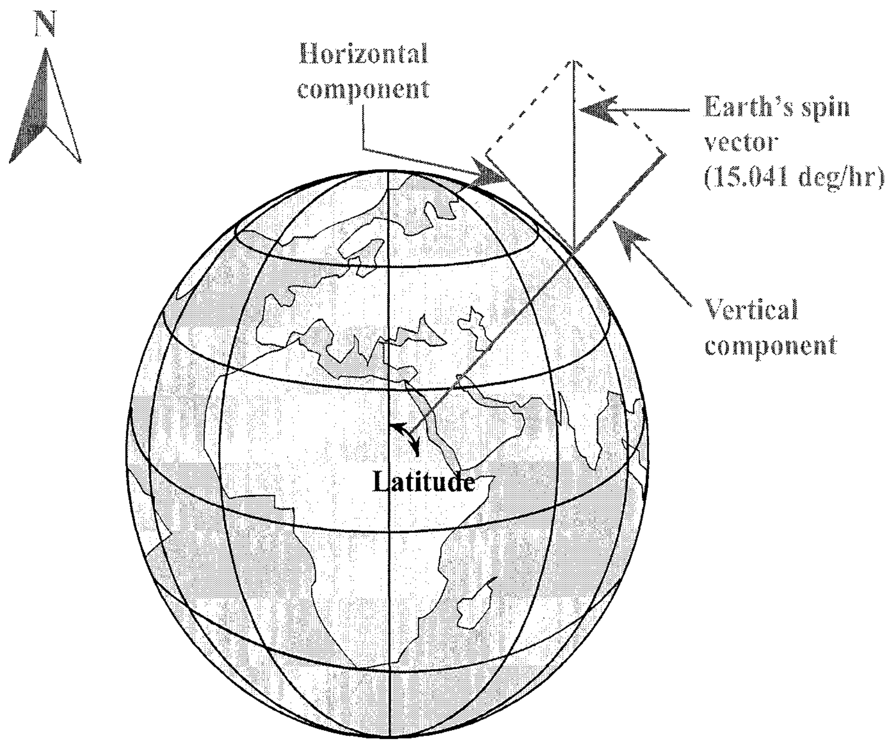
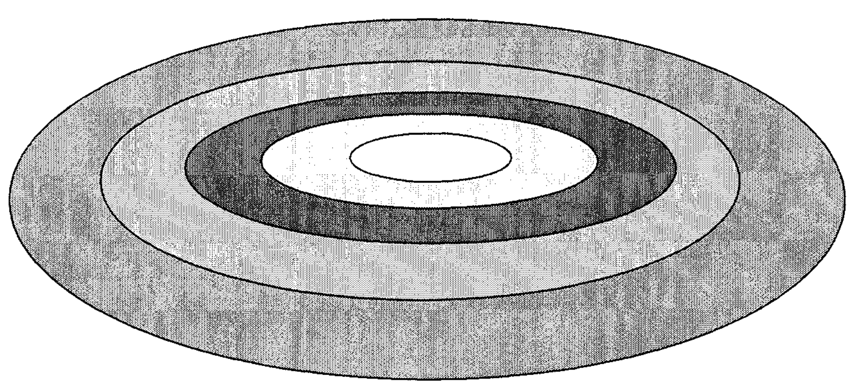


Reference 8

Gyro film system	5
Generic MWD	4
Typical Modern MWD	3
Film Mag.MS	4
Enhanced EMS	3
Keeper	1.5
Surface Readout Gvro	3.5



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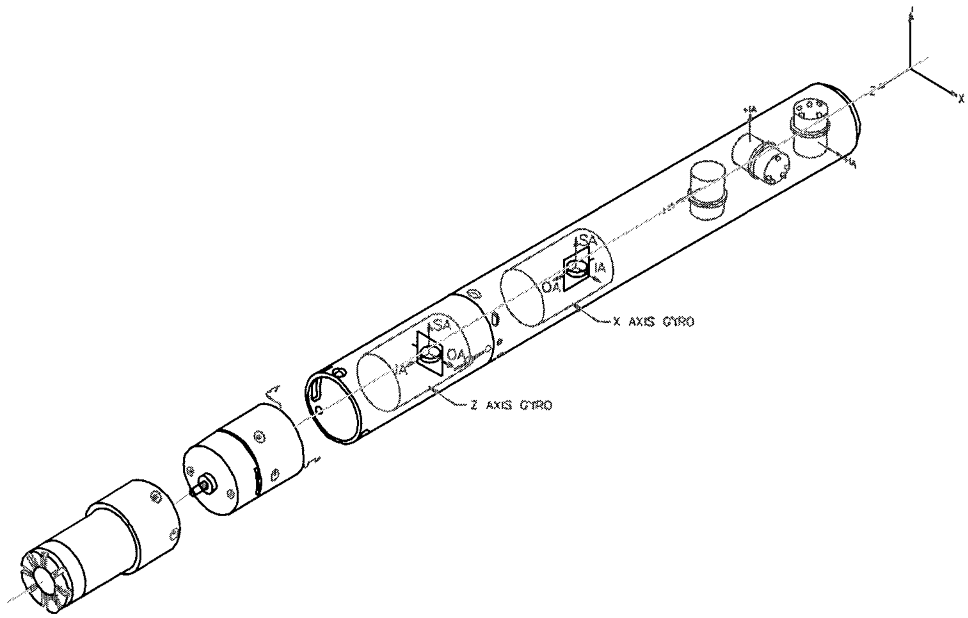

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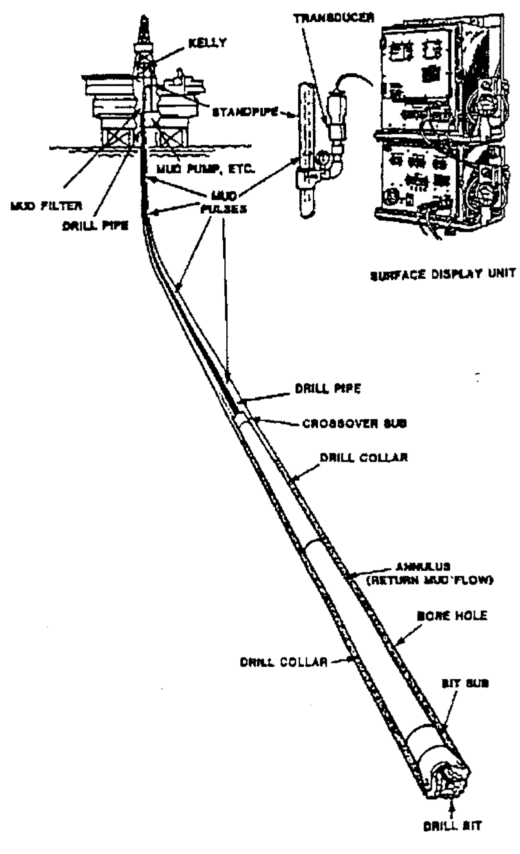

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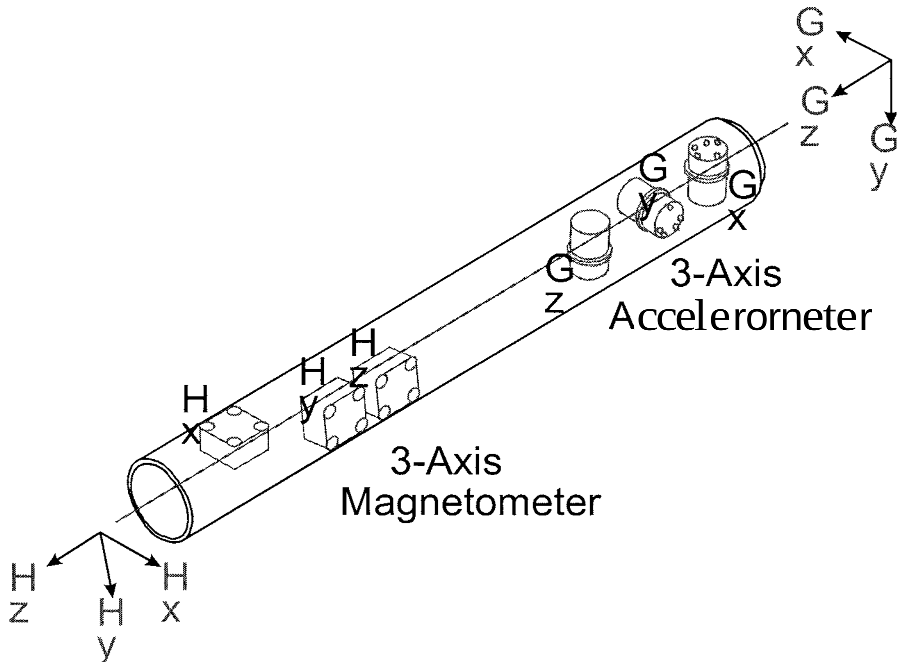

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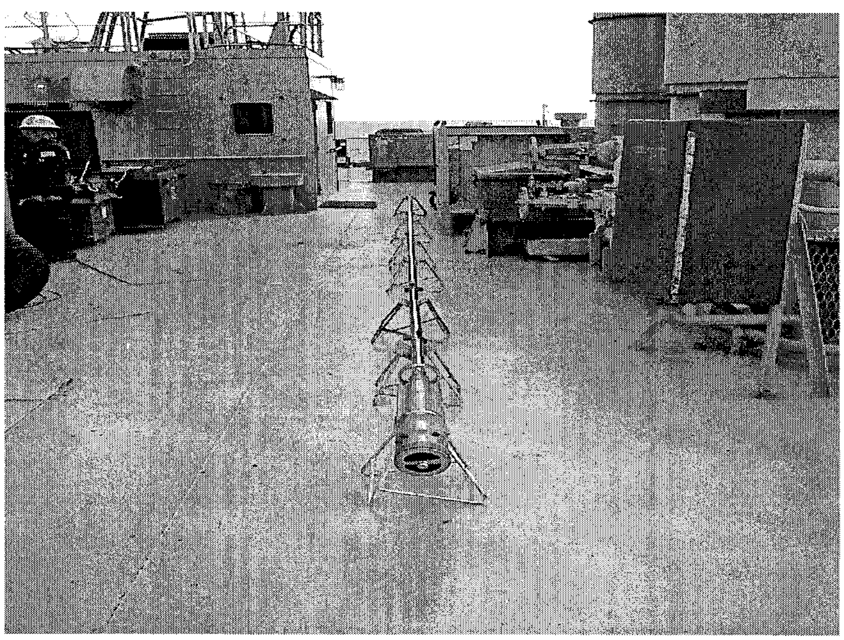

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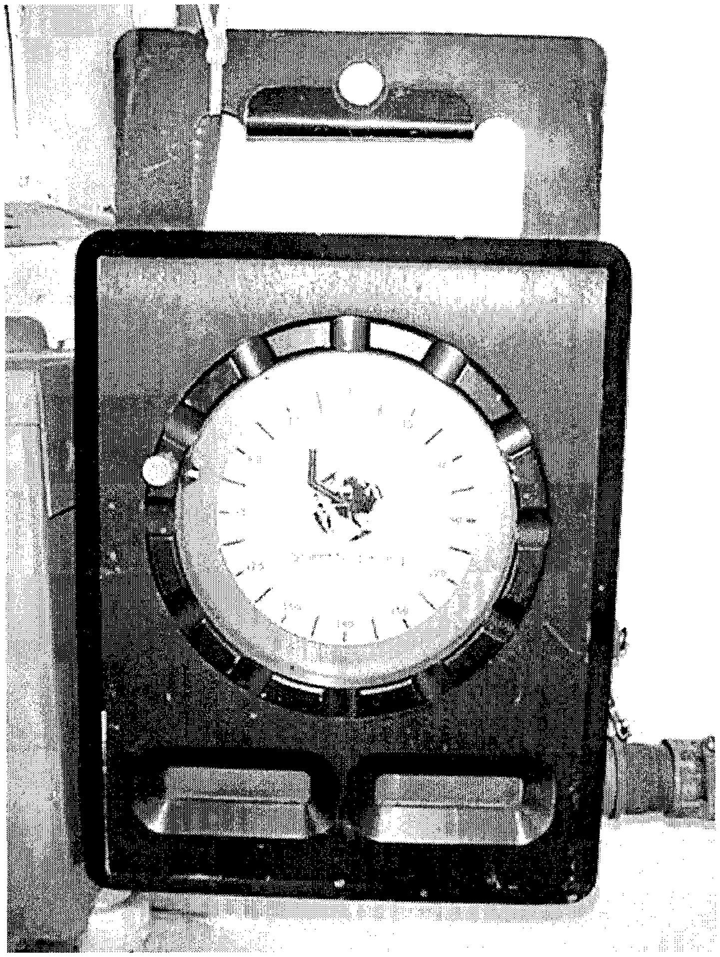

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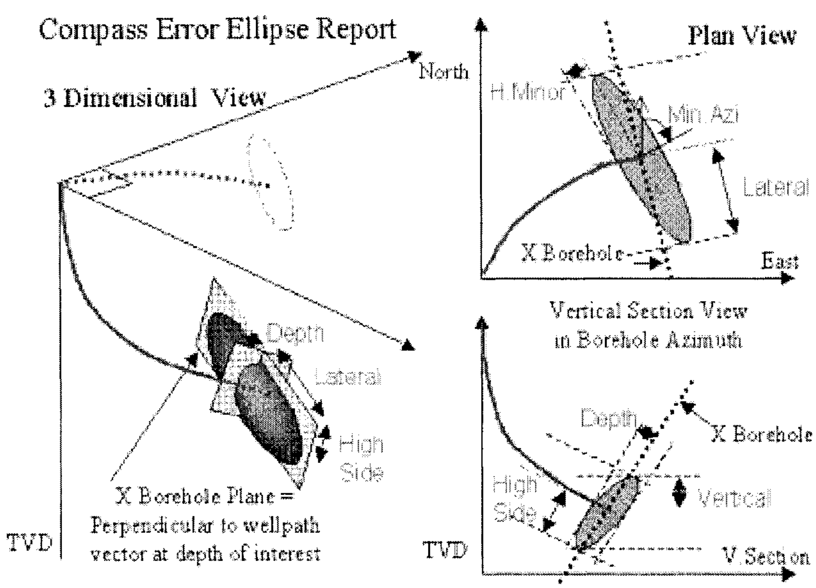

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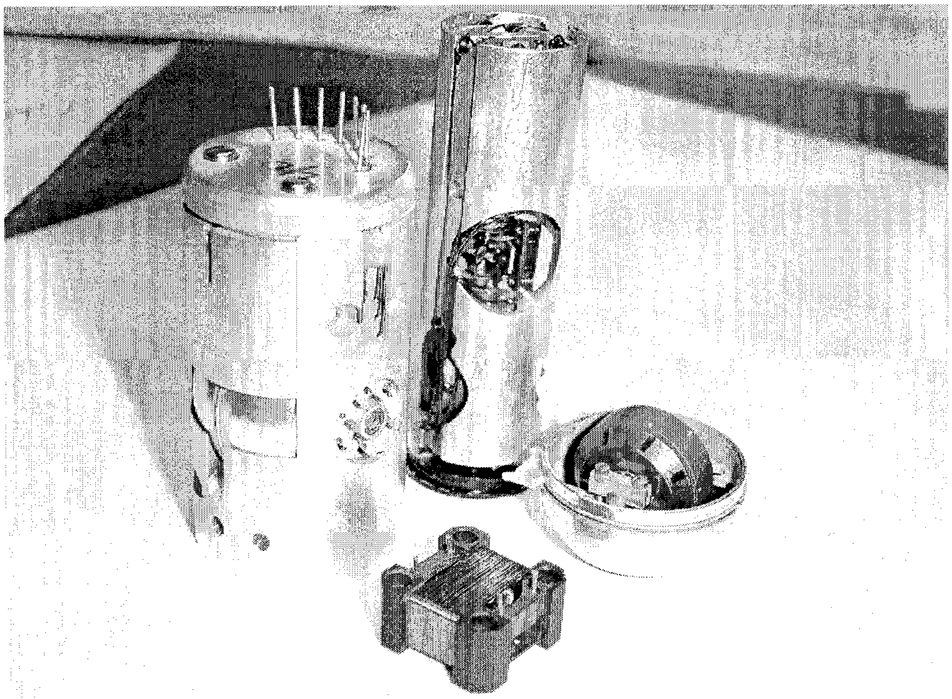

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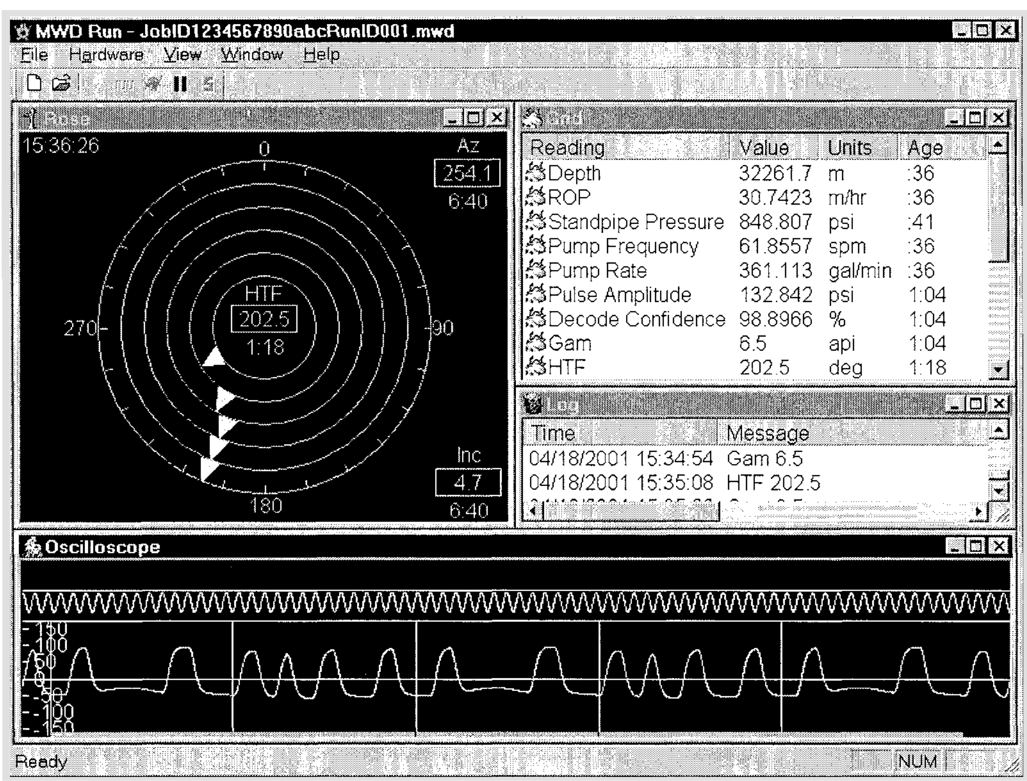

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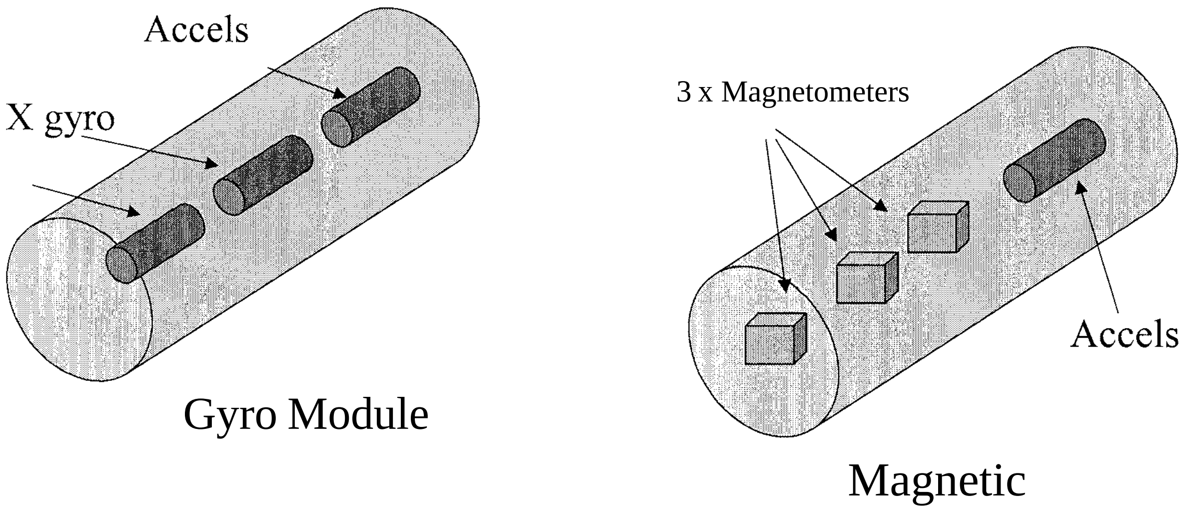

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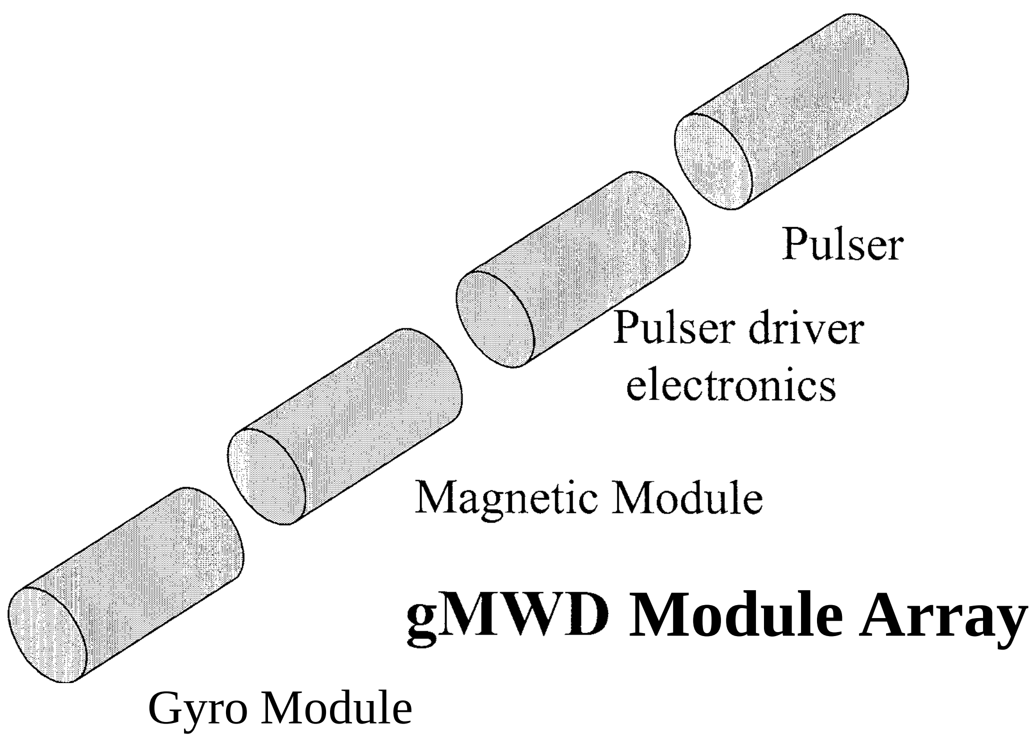

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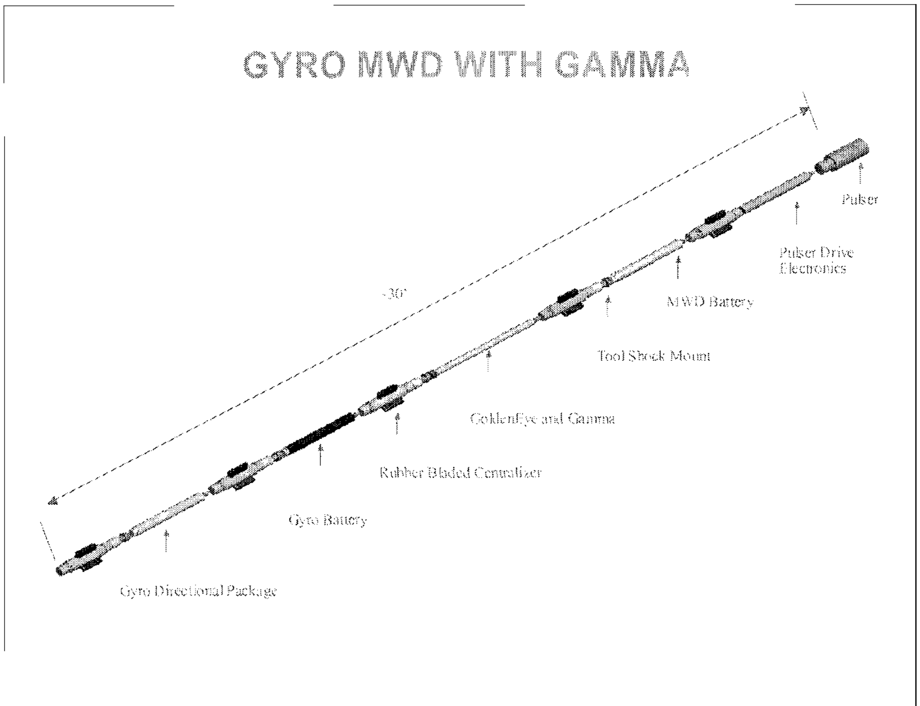

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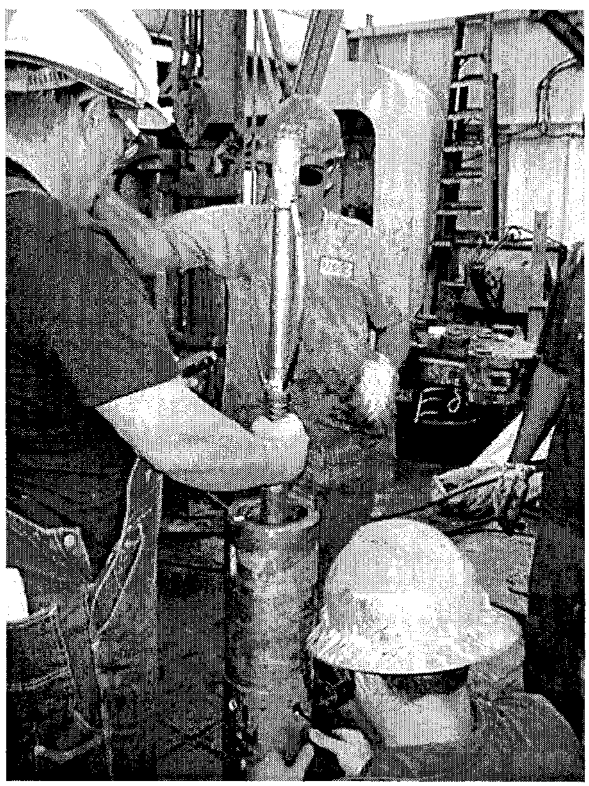

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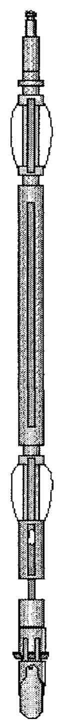

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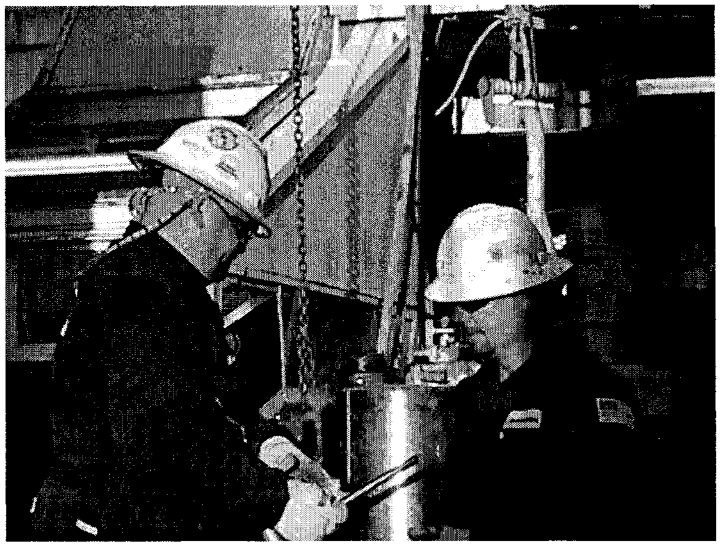

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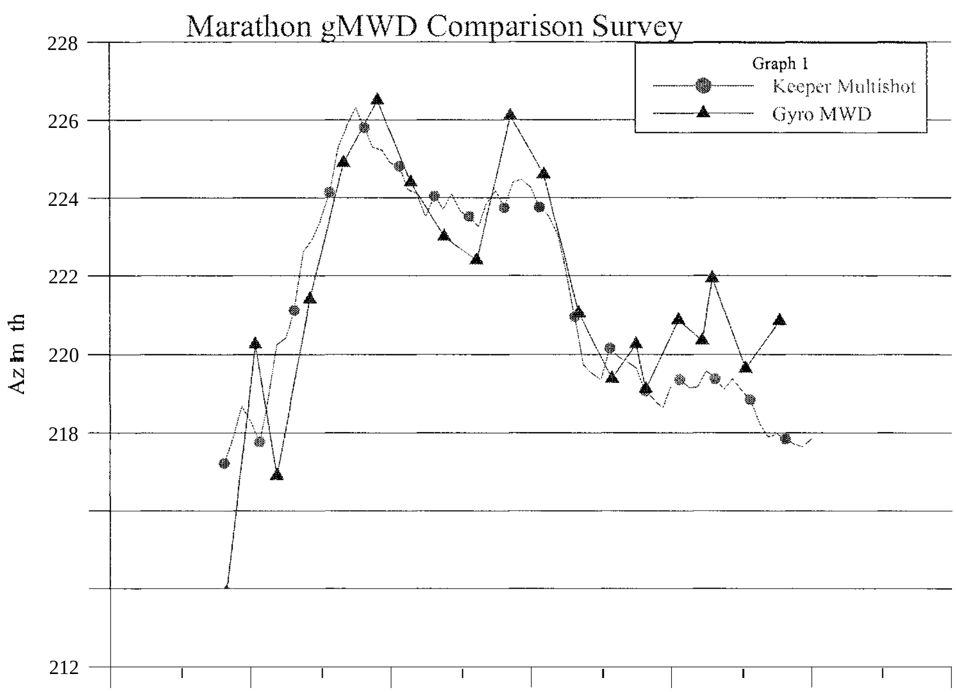

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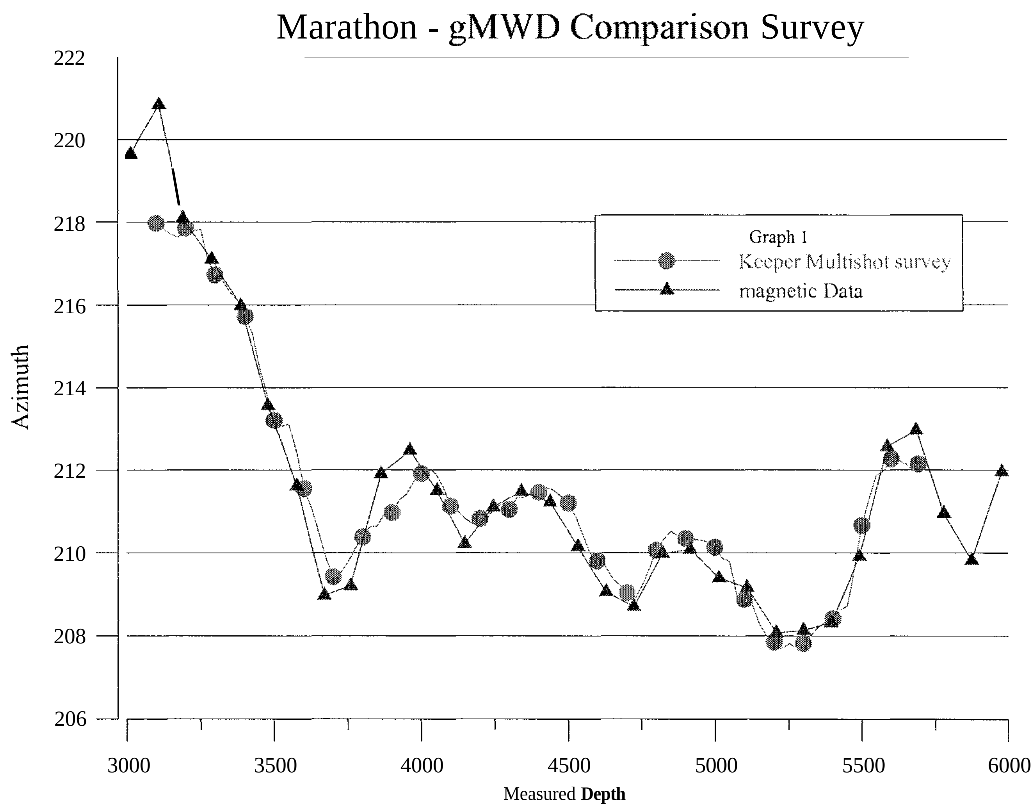

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