Gyrocompass

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How did early sailors find their direction in waters where land could not be seen?

Before the invention of the compass, early sailors could look for the North Star (Polaris), and by knowing which way was north, they were able to calculate their heading.

When was the first compass invented?

More than 2,000 years ago, the Chinese would hang a piece of lodestone on a string, and they would ask the Spirit World a yes-no question to be answered by *yes* or *no*, much like a Ouija board. It was not a compass, but it did show that the Chinese had an awareness of Earth's magnetic field.

How did this knowledge lead to the creation of a compass?

For a millennium, people experimented with lodestone's mysterious properties, until one day they discovered that, if you rub a steel needle over lodestone, the needle would become magnetized, and if the magnetized needle were placed on a friction-free surface, it would always point to Polaris, and this practice would work on a cloudy day, or even at night.

Why were maps drawn in the 1500s not always accurate even though they had a compass?

Early cartographers did not know the difference between *true north* and *magnetic north.* They did not understand that the magnetic North Pole changes over time in response to changes in the earth's magnetic core.

Do compasses work the same on iron ships as they did on wooden ships?

The Earth's magnetic field is the same, but the compass reading on the iron ship is distorted by the presence of iron. This distortion is called *deviation.* Deviation is also caused by the ship's proximity to the North Pole.

What was used on ships to compensate for deviation?

Navigator's balls are iron spheres attached to both sides of the compass to neutralize the ship's deviation. The port ball was usually painted red, and the starboard ball was painted green.

Is there any kind of compass which can identify true north, and not magnetic north?

A gyroscope can identify true north because it works on the principal of *gyroscopic effect* , not magnetism. Gyroscopic effect is the force that makes a rotating disk maintain a steady orientation of its axis of rotation, even if the base it is resting on moves erratically.

When was the gyroscope invented?

It was invented in 1852 by a French physicist named J.B. Foucault. He created a wheel rotating on a vertical axis, and proved that, if you started a wheel spinning, it would maintain its vertical position and would continue to spin on a plane parallel to the ground and would not be influenced by erratic movements at its base. Furthermore, once the spinning motion was started, it would maintain its momentum until friction would eventually slow it down. He proved that Earth will never slow down, because in outer space with no gravity, there is no friction to slow it down. Mr. Foucault's discovery is called *the law of conservation of angular momentum.*

In addition to telling you which way is north, can a gyroscope tell you where you are on Earth?

For thousands of years, sailors used an *astrolabe* to calculate their latitude by measuring how far south they were from Polaris. To measure longitude, you have to know two things: you need to know what star you are looking at, and you need to know what time it is. Because Earth is spinning at 1,000 MPH, you need to have a star chart, and you have to know the exact time. Then, you pick a star in the eastern sky, and you measure the angle between that star and the horizon. If you know exactly what time it is, you can calculate where you need to be to see that star, at that angle, at that exact time.

Why was it so difficult to know the time? Noon is when the sun is the highest point in the sky.

To make a clock that could give you exact time all day and night, the clocks were powered by a swinging pendulum mounted on a stable surface. It was in the middle 1700s, that John Harrison invented the first marine chronometer. It ran by spring power instead of the swinging pendulum, and could function accurately on a ship at sea.

A spinning disk can show an east-west axis, but how do you get a north-south axis?

To get a true image of Earth, you need to have a gyroscope frame with two axes, (a horizontal one and a vertical one). This allows your spinning disk to move in all directions. You will have one disk spinning on a horizontal plane, and within it, you

will have another disk spinning on a vertical plane. These reciprocating disks are called *gimbals,* and the entire unit is called a *gyroscope.*

Which one of the two disks is more important?

They are both important because one is of no value without the other. You get a gyroscope reading from the vertical disk, because that's the one which gives you a north-south reading. For navigation, the only reading that's important is *true north.* Accurate navigation is contingent upon a precise reading of true north, just like our ancestors navigated by studying Polaris.

What is a gyro repeater?

A gyro repeater is the instrument which indicates the heading of the ship. It shows the precise direction the ship is going, relative to true north.

What does a radar repeater show?

A radar repeater shows where objects are, relative to true north. On a radar screen, north will always be at the top of the screen.

When is it necessary to use both a radar repeater and a gyro repeater?

In Combat Information Center, when you look at the air-picture status board, you are looking at information from the radar repeater. When you see an enemy aircraft coming from the top of the screen toward you, you know that he is coming from the north. Next, you look at the little dial in the upper right corner of the status board. It shows heading, and if the gyro repeater reads 180 degrees, this means that you are going south. So, if the enemy is going south, and you are also going south, you had better look over your shoulder, because you are being attacked from behind.

How many gyro rooms are there on the Hornet?

There are two gyro rooms on the Hornet. The forward room is on Deck Seven near Special Weapons. The after room is on Deck Four near the Sidewinder Missile Shop.

Can we take visitors to see these rooms?

Only the aft gyro room is available to the public. The easiest way to find it is to go to the berthing room on Second Deck, between the Torpedo Shop and Sick Bay. In the forward area of this room, find the down ladder. Go down the ladder to Third Deck, (you will find a light panel on the port bulkhead). Go down the next ladder to Fourth Deck, (this time the light panel will be on the starboard bulkhead). The three rooms down there are the Nitrogen Supply Room, the Sidewinder Shop, and the Gyrocompass Room.

When we enter this room full of electronic equipment, where is the gyrocompass?

The gyrocompass is the unit in the center of the room. To understand what it does, look at the model in this Plexiglas box. When brought up to full speed, the orientation of the gyroscope will align perfectly with the orientation of the earth. The Earth spins at 1,000 MPH, and the gyroscope spins at 1,000 MPH. The equator of the earth rests at a 23^{o} angle to the sun, and the flywheel rests at a 23^{o} angle to the sun. The earth spins on a north-south axis perpendicular to the equator, and the gyroscope spins on a north-south axis perpendicular to the equator.

How does it work?

When the gyroscope is turned off, it will rest on its side with its center axle in contact with a swivel base. When electric power is supplied, the outer wheel will start to spin, and the unit will rise up slowly. As the speed increases, the horizontal wheel will wander a bit while it is trying to replicate the equator of the earth. The smaller disk is inside the larger disk, and it is spinning faster and faster trying to replicate the polar axis of the earth. The two disks will wander until finally, after about two hours, both gimbals are aligned perfectly. At this point, the electric motor will speed up to 11,000 rpm, and the gyroscope will be immovably locked onto the setting of true north.

How can the electric motor spin that fast?

There is a power panel on the starboard bulkhead that is called **400-cycle motor generator.** This generator produces an electric current at 400 cycles per second, instead of the 50 cycles used throughout the ship. This rapid cycling of the alternating current is what allows the motor to spin very fast. Remember that law called **conservation of angular momentum**? The faster the gyroscope spins, the more power it has to conserve its angular position. If you took the front wheel off your bicycle, and you held the wheel by its axle, and you spun that wheel up to 11,000 rpm, no matter how hard you tried to change the angle of that axle, you would not be able to move it. Both gimbals are locked into position, and they will remain in that position until they stop spinning.

What does the 400-cycle-motor generator do?

The gyro motor is a high-power induction motor that has three-phase capacity so it can run at different speeds. It has dual-stator windings where the input terminals are supplied with power separately to eliminate magnetic coupling between the two windings. The control panel has three gauges : frequency meter, volt meter, and ammeter. This device not only generates the electricity for the gyro motor, it also monitors and regulates the electricity.

After the gyrocompass is locked into position, how is this information transmitted to other parts of the ship?

The control panel to the left of the switchboard processes the data coming from the gyroscope . So far, the gyro information has been gathered mechanically, and it has to be converted to a digital format to be distributed throughout the ship. The data is analyzed and separated according to the department that needs the data. After the data has been digitized and compartmentalized, it goes to one of those five electronic boxes on the port side of the room. These are called *synchro signal amplifiers.* Their function is to boost the signal, format the data so it is appropriate for each receiver, and transmit it to the places where it is needed.

How many divisions need this information?

The Navigation Department needs this data for keeping the ship on course and keeping the DRTs coordinated and accurate. Keeping the ship on an even keel, and monitoring roll and pitch is also important, especially during storms. Fire control needs this information to accurately aim all ordinance fired from the deck of the ship and to program rockets and missiles efficiently . Primary Flight Control needs this information to guide pilots in making a safe landing. CIC needs this information to keep all radar screens accurate and coordinated. Engineering uses this information in the engine rooms to allow the engines to run at different speeds and aid the helmsman in keeping the ship on course.

What does the gyro switchboard do?

The switchboard can distribute gyro information to any gyro repeater on the ship. Captain's Bridge, Flag Bridge, CIC, After Steering, and Secondary Con have two repeaters, (fore and aft). All other stations receive a gyro signal from only one gyro, but can be switched to the alternate gyro in an emergency.

What does the switchboard with the earphones do?

This is one of the switchboards used for sound-powered telephones. These phones use a direct wire to connect two workers who have to be in constant communication with each other. The phones do not use an electric current to amplify the sound. Once a line has been set up to connect two workers, that connection never has to change. But, if one worker wants to communicate with someone else, the change is done at this switchboard. Or, if you want to include two or more people on the same line, this too is possible through this switchboard. There is no need for an amplifier to boost the signal. The only one who needs an amplifier is CIC, when communicating with gun mounts.