Static Electricity

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Who first discovered a method to manipulate electricity?

In 1752, a Philadelphian named Benjamin Franklin discovered a way to manipulate electricity. Mr. Franklin flew a kite carrying a metal wire from the ground up to a storm cloud. The bottom end of the wire ran to the ground. In one hand, Mr. Franklin held a *Leyden jar*, (primitive form of dry-cell battery). In the other hand, he held an iron key that was attached to the metal wire. The key was to tap off some electricity coming from the storm cloud, and direct it into the Leyden jar. The key was wrapped in a heavy handkerchief to insulate his hand from the key. To see if the experiment was working, he touched the iron key with the knuckle of his hand, and when he felt a tingle on his knuckle, he knew that he had discovered a way to capture electricity and to store it in a Leyden jar for future experiments.

Why wasn't Mr. Franklin killed by the lightning?

Mr. Franklin knew that pulses of electric energy were prevalent in storm clouds, and his only intention was to capture a little of this energy and save it to use experimentally. Fortunately, he was never struck by lightning, otherwise his kite experiment would have been deemed a failure.

How is electricity made inside the storm cloud?

Atoms are held together by electromagnetic attraction of their tiny particles. Atoms are normally neutral because they contain equal numbers of positive particles (protons), and negative particles (electrons). When atoms are rubbed together, this can cause an imbalance of positive or negative particles, and a tiny electrical spark will jump between the atoms as it neutralizes this imbalance. If it does not find a way to neutralize itself, it will continue to accumulate more energy until it is grounded. When it finally grounds itself, the spark is called *static electricity.*

Can automobiles generate static electricity when driving down the highway?

Yes, motor vehicles build up static electricity driving down the highway, because rubber tires act as an insulator between the vehicle and the ground. Grounding happens when a metallic part of the car touches a metallic conduit on the ground, for example a gas pump hose nozzle touching the car's filler tube.

Can airplanes generate static electricity when flying through the air?

Airplanes can generate tremendous amounts of static electricity when flying through the air. If this static charge isn't neutralized when landing, refueling the plane could result in a huge explosion and ensuing conflagration.

Can ships generate static electricity when traveling in the ocean?

Ships can accumulate large amounts of static electricity in the ocean, because there is nowhere to ground out the static buildup. Tanker ships need to be constantly aware of static buildup on ships carrying flammable liquids. Any type of fire or explosion is bound to have disastrous results.

Other than causing a fire, can static electricity endanger the ship in any way?

Traveling through salt water, a ship will develop a weak magnetic field within its iron hull. This magnetic energy does not really damage the ship, but it can make the ship subject to detection by enemy submarines, undersea mines, and magnetic-sensitive torpedoes.

What could the ship do to protect itself from detection?

The Hornet is equipped with an elaborate anti-magnetic system called a **degausser.** The entire circumference of the hull is wrapped with heavy electric cables, and an electrical current is passed through them to neutralize the magnetic field. The difference between an electrical field and an electrical current is that a field is static electricity floating in the air, and an electrical current is controlled electricity contained within a wire. The **degausser** converts the static electricity into an electric current, which can be easily controlled.

Where on the ship was this system monitored?

The degaussing control station is found in the Pilot House, on a bulkhead aft of the ship's helm. The gauge displays the electrical current level being applied to the degaussing coils. A higher reading means a stronger electric current is being applied to minimize the ship's detectability. Adjustments are made to compensate for changes in the ship's heading, local geomagnetic field reading, and proximity to the North or South Pole. Minor adjustments can be made in the Pilot House, but major changes are made on the master degaussing unit which is in the Damage Control Center on Deck 5.

If the Hornet passing through salt water can generate electricity, why can't we power the ship with it?

The electricity generated in the water is very weak, it is static and not contained in a wire, and it does not have an alternating current. Static electricity is of very little value to a ship, and it is generally considered a nuisance.

Does anything else on the ship use electromagnetic energy to operate?

On the Hangar Deck, near the security desk, you will see the Hornet's actual **pit sword**. The exhibit also gives you a brief description of how a pit sword works.

*What is a **pit sword?***

A pit sword is a metal blade, about 3 feet long, that protrudes from the bottom of the ship. Inside the blade there are two hollow tubes. A sensor measures the rate of water flowing past the blade from two different directions to calculate the ship's speed through the water. This information is sent to various departments on the ship that need this information.

Which departments have need for this information?

The Navigation Department needs this data for keeping the ship on course and keeping the DRTs coordinated and accurate. Fire control needs this information to accurately aim all ordnance fired from the deck of the ship and to manage rockets and missiles efficiently. Primary Flight Control needs this information to ensure safe takeoffs and landings. CIC needs this information to keep all radar screens accurate and coordinated. Engineering uses this information in the engine rooms to ensure that the ship is sailing in accordance with the captain's orders. Secondary and Tertiary Control Stations need this information as a backup redundancy for emergency situations.

When I look at the pit sword, why can't I see holes on the side to let water in?

Although everyone calls it a pit sword, what you are looking at is technically called an **Electromagnetic Log.** People like to call it an **EM Log,** for short. On the outside, it looks just like a pit sword, but inside it is very different.

How does an EM Log work?

A ship moving in salt water through a magnetic field will induce voltage into a circuit. When a ship passes through this field, the voltage rises. The faster the ship moves through the water, the greater the electromagnetic field is induced in the water. This rise in voltage is measured to determine the speed the ship is travelling, relative to the Earth.

What are the differences between a Pit Sword and an EM Log?

The EM log is more accurate than the pit sword. It is also capable of measuring transverse as well as longitudinal speeds. An EM log is not affected by seaweed or other debris in the water. It measures speed relative to the Earth, not relative to the water. A pit sword is three feet tall, while our EM Log is five feet tall; the extra length is because magnetism in the ship's hull can interfere with an accurate meter reading. Also, a pit sword is made of steel, and the EM log is made of fiberglass and contains no steel to interfere with the electric signal. The only deficiency that the EM Log has is: it doesn't work in fresh water.

When I board the ship on the visitor's ramp, over the handrail at the top of the ramp, I see a cable that runs down the side of the ship. What is that for?

That cable has nothing to do with either the pit sword or the degausser. The cables you see dropping from the Hangar Deck to below the waterline, are called **cathodic protection** cables. They are there to protect the ship against corrosion and oxidation (rust).

How can metal attached to the end of an electrical cable protect the ship?

As the ship passes through the water, it collects positive electrons (cathodes), which must eventually discharge with negative electrons (anodes). With **cathodic protection,** some direct current electricity (positive electrons), is passed between the iron of the ship and an **anode** (negative electrons). This will create corrosion and oxidation. But, if this contact point is made out of a soft metal, this metal will experience the corrosion and not the hull of the ship. The ship is the **cathode,** and is protected from the corrosion. The soft metal is called the **sacrificial anode,** and it sacrifices its life to protect the ship.