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Electric Gyroscopic Stabilizer for Ships and Aeroplanes

FOR many years the problem of reducing or preventing the rolling of ships has occupied the attention of prominent engineers and scientists in all parts of the world. Among them, and probably the first to make practical experiments in this direction, was Sir Philip Watts, who in the '80's placed damping tanks on English battleships.

Somewhat later Sir John I. Thornycroft, an Englishman, devised a stabilizer consisting of a large weight equal to about 5% of the ship's total displacement. By means of hydraulic control actuated by the ship's rolling, this weight, mounted in the hold of the ship, was shifted from side to side, partly counteracting the tendency to roll from side to side.

Recently Herr Frahm reinvented the damping tanks and installed some of them on several large ships. These tanks were shaped somewhat like a horseshoe and were partly filled with water, which surged back and forth as the ship rocked. This surging of the water tended to reduce the natural roll of the ship.

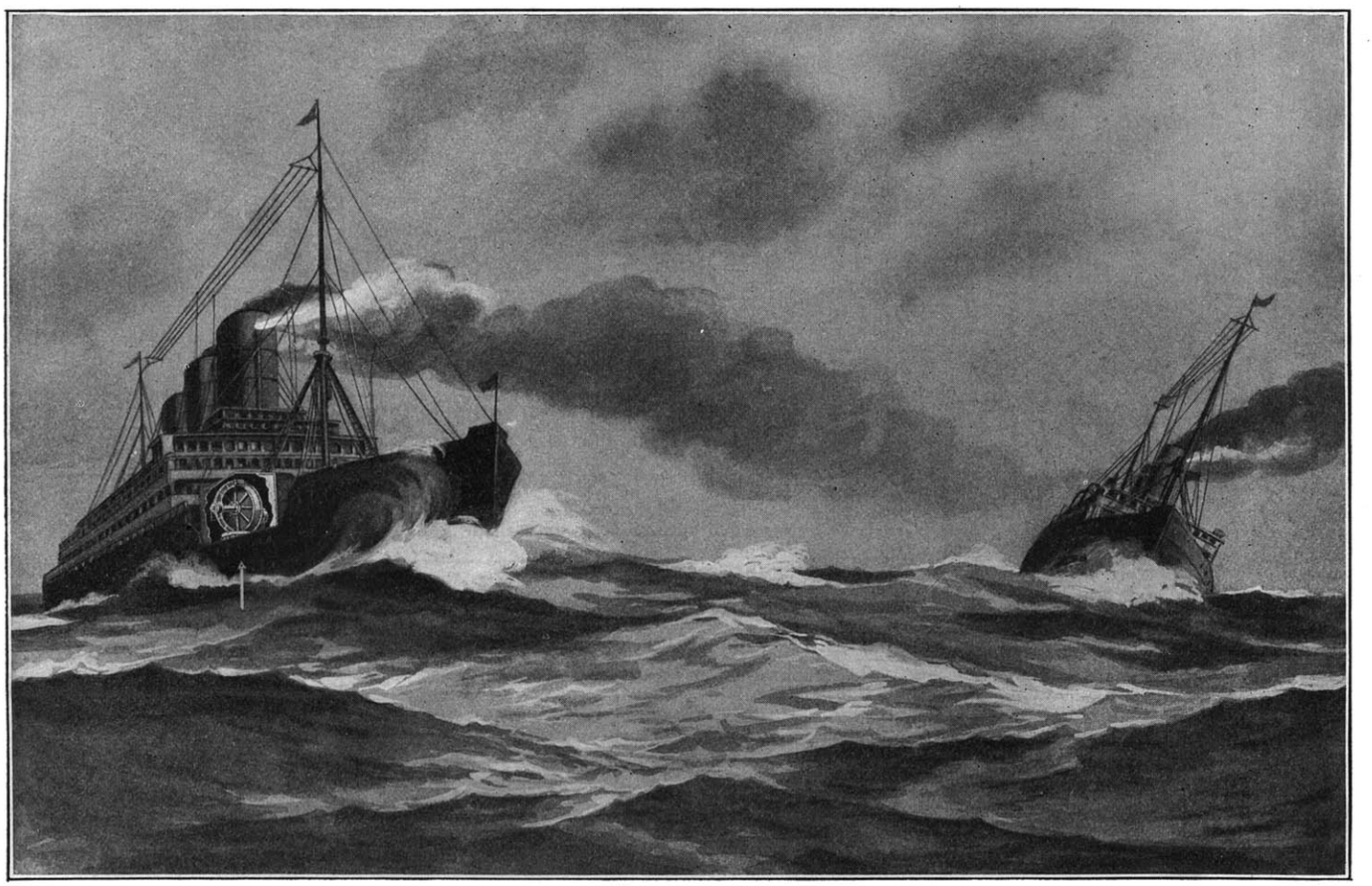
The gyroscope was first employed to stabilize a ship by Dr. Schlick, a German engineer, who mounted a large gyroscope wheel horizontally in the ship in a position to swing freely, with its shaft vertical. This constituted a "passive" gyroscope. The rolling of the ship tended to tilt the gyroscope out of its horizontal plane but the inertia of the spinning wheel opposed the motion with a reaction which tended to check the motion of the ship.

There were, however, weak points in these various systems, inasmuch as they were only partially effective in heavy seas.

It was left to Mr. Elmer A. Sperry, an American engineer, to perfect a stabilizer that will *actually prevent* a ship from rolling.

This has been accomplished by means of an "active" type of stabilizing gyroscope; that is, one in which the motions of an unassisted or "passive" gyroscope are simulated and greatly augmented by a precision (i.e. advance motion) motor. This motor is controlled by a small auxiliary gyroscope, equal to a pendulum some six miles in length. It will instantly detect the slightest roll of the ship and actuates the control of the precession motor, which, in turn, controls the large gyroscope. The inertia of the gyroscope prevents the rolling of the ship.

The principle upon which the gyroscope is employed in stabilizing such a vessel is that remarkable inherent quality of the gyroscope to create dynamic forces from pure static energy.



The Vessel at the Left Is Equipped with Stabilizing Gyroscope; Ship at Right Without Gyroscope is Floundering Through the Heavy Seas at All Angles.

This is easily illustrated by the little toy gyroscope, which, when spinning at high velocity, shows this reaction effect perfectly. The phenomenon of precessional movement passes through the whole range of 180 degrees by pure static pressure applied to the outer ring. Upon careful observation it will be found that this static pressure is almost free motion. When all of the joints are free and lubricated almost no motion whatsoever is taken on by the outer ring during the full 180 degrees precessional (i.e. advance motion) movement of the inner ring. Now, applying this to the ship, we find that while stabilizing it against heavy seas, the gyro-equipment is very active, as the dynamic forces of the gyro are opposing the dynamic effects of the sea. But as we have seen in our toy gyro, the greatest movements result entirely from static pressure transmitted to the device from the sea, through the structure of the ship, without the slightest necessity of motion on the part of the ship itself. The transmission is from the dynamic disturbance to the dynamic resistance through pure statics and for this reason it becomes entirely unnecessary for the ship itself to take on motion; it is only necessary for the ship to act as a medium for the transfer of static stresses of comparatively small magnitude and without motion.

The first gyroscopic stabilizing plant was placed on the U.S. Destroyer *Worden* (Fig. 1), for experimental purposes in 1911. The gyroscope was studied carefully for its ability to roll the ship as well as for its stabilizing characteristics. Fig. 2 shows clearly the *Worden* heeled over to port by the gyros. The gyroscope installed on this boat is depicted in Fig. 3. The rapidly revolving wheel is enclosed in a sealed case and the air is entirely exhausted in order to remove all possible friction that the wheel may produce when it is revolving. It is turned by an electric motor located on the left side of the gyro, as depicted, and the transmission between the wheel and motor is frictional.

The gyroscope is controlled by an advance timing gear and is governed by a small auxiliary gyro (Fig. 4) which, when acted upon by the rolling of the ship, closes the proper electrical contacts. As soon as the ship rolls a fraction of a degree one way or the other, this instrument directs the precession of the main gyro which stabilizes the ship. Unless the main gyro precesses it gives no stabilizing stresses to the ship, so that by breaking and making the circuit between the control gyro and the precession motor, the ship is either free to roll or is held stable.

The operation of the whole apparatus is practically silent, except for the slight humming which is a characteristic of all high speed motors. The connecting gear and control necessarily work at such low speed as to make very little disturbance.

As a commercial device, the stabilizer has considerable value. The owner of a yacht on which a stabilizer is employed does not need to think of seasickness, and knows, therefore, that his guests will be comfortable at all times. He is independent of weather conditions, and can negotiate trips in rough seas, which he would otherwise postpone or avoid.

For passenger and merchant ships which are obliged to sail regardless of weather conditions, and which are likely to encounter heavy storms on long voyages, the stabilizer is of most vital importance. Many await with keen anticipation the day not far distant, when the largest ocean liners will be stabilized, and those affected by the constant rolling of the ship will be able to travel with ease and comfort.

The advantages which the stabilizer will bring to this type of ship are: Saving in power and consequent economy in fuel owing to the ability to maintain the shortest course between two points in bad weather, since the ship will be in no danger from excessive rolling even when steaming in a trough of the sea. The vessel can save a considerable amount of fuel by the resultant elimination of rolling when under way, and also by elimination of the stresses in the structure of the ship and of severe strains in the engines and auxiliaries of the ship, that are caused by the pitching about of the vessel. Deterioration of the cargo caused by the constant rolling is prevented. This would be particularly applicable to ships carrying live stock. It would also increase the seaworthiness of the ship by doing away with the shipping of seas.

One of the greatest advantages of the

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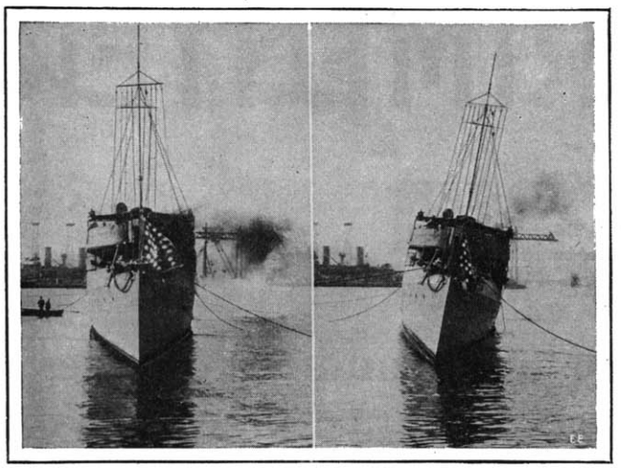
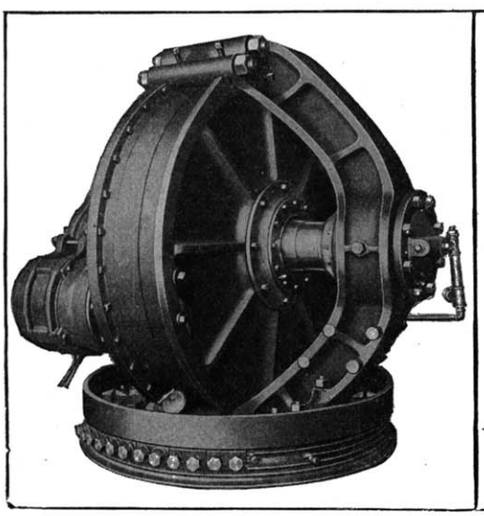
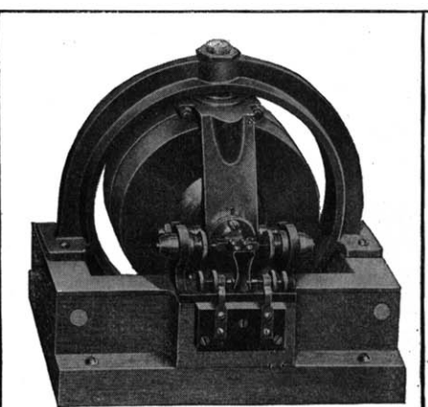


Fig. 1 (Left): Normal Position of U. S. S. Worden. Fig. 2 (Right): Heeled Over by Action of Gyroscope.





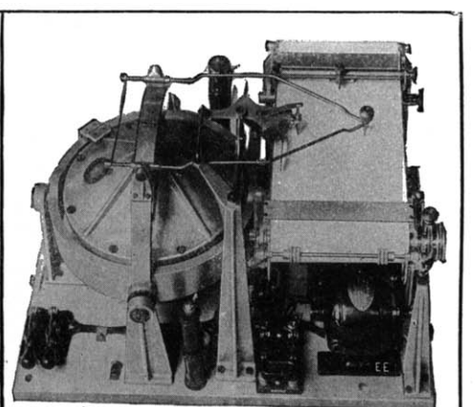


Fig. 3 (Left): Type of Stabilizing Gyroscope Installed on U. S. S. Worden. Fig. 4 (Centre): Small Auxiliary Gyro Used to Control Larger One Seen at Left. Fig. 5 (Right): Latest Type of Gyroscopic Pitch Period and Amplitude Recorder. Produces Graphic Chart Accurately Timed.

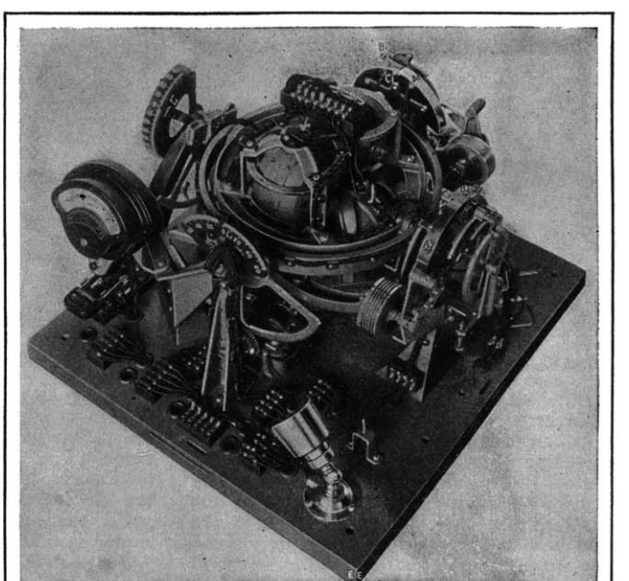


Fig. 6. Automatic Gyroscopic Stabilizing Set for Aeroplanes.

CAN ELECTRICITY PRODUCE RAIN?

(*Continued from page 7*)

fied and the remainder negatively. Again, the fine drops were always negatively charged while the large ones were found to be positively charged. Several snow squalls occurred while these tests were being conducted and falling snow was invariably found to be negatively electrified or charged. Hail was always positively charged.

The magnitude of the electric charge per cubic centimeter in falling rain was accurately measured and fine rain exhibited a negative value of .24 to .06 electrostatic units per cubic centimeter; rain consisting of large drops indicated an average positive charge of 1.5 electrostatic units per one cubic centimeter.

It is often popularly imagined that the atmosphere reverses or changes its electric charge from positive to negative and vice versa during or directly after rain storms. In the tests conducted by Prof. McClelland and J. J. Nolan, the potential gradient of the atmosphere in several instances was measured. In one interesting test the potential gradient measured 100 volts *positive* charge just before a snow fall occurred. Shortly after it began to snow the potential gradient changed to a *negative* value and the electrometer measured a voltage of 2,500 maximum, which held to this value throughout the storm. On its cessation, however, the potential gradient suddenly changed back again to a normal positive value with a potential equivalent to that existing before the storm.

Normally the earth is negatively charged and the atmosphere positively; thus it seems that there is some hope for an electrical rain precipitator, properly employed, but from the wealth of scientific literature and opinions available on the subject to-day, it does not seem at all probable that such apparatus or arrangements will ever be perfected in so far as we now know; in other words, we apparently can never hope to actually cause rain to fall unless Dame Nature is suitably disposed to such an effect.

ELECTRIC GYROSCOPIC STABILIZERS.

(*Continued from page 6*)

gyroscope stabilizer is its ability to cause the ship to roll for the purpose of freeing it from, or rolling it off, sand and mud banks.

When used on a battleship the stabilizer will insure all the advantages mentioned before in connection with a passenger liner and also these benefits. It will decrease the amount of underwater armor necessary on men-of-war in order to protect that portion of the hull which might be exposed to the enemy by rolling. It will improve conditions for the crew and officers by reducing the fatigue and other effects incurred from the incessant motion and will make it possible to go into action in any sea or upon any course in rough waters. Moreover it will make the gun-firing more accurate. Thus it can be seen that a "stabilized" navy would be superior, even in moderate weather, to an "unstabilized" fleet. The sole object of a fleet is to strike the mark, and if the number of hits can be doubled, it means the virtual doubling of the navy. Although there are other advantages which might be mentioned in connection with this device, yet those which have been enumerated are sufficient to clearly bring out the value of this remarkable product of the human mind.

Not only has the gyroscope been utilized on ships for stabilization, but is also being used for recording the magnitude of rolling. Several have been built in the past, but the one depicted in Fig. 5 is the latest and most improved form of gyroscopic and pitch recorder. The gyro of this recorder, which is observed at the left of Fig. 5, is equivalent to a pendulum some six miles in length and weighing about six tons. This forms an absolute base line to which two recording pencils are attached and about which the ship recording chart rolls and pitches. A clock electrically marks off the time period, and the amplitude is measured by a graduated rule. Thus, the period and amplitude of both roll and pitch are recorded continuously in a graphic manner.

Aeroplanes that are being operated at present are not reasonably safe because of their unstable condition when the machine is caught in a gale, or when the operator becomes nervous and loses control of the machine. Most accidents which have occurred up to the present have been due to this cause, although there have been others. Various schemes have been developed from time to time to eliminate the disastrous effects engendered when flying an aeroplane, but none has proved very successful.

The wonderful properties of the gyroscope have been used advantageously in building a suitable stabilizer for aeroplanes. Such a device is illustrated in Fig. 6. The two gyros control various electrical circuits which operate suitable drums as depicted, which are connected to the different rudders, ailerons, etc., by means of steel wires. With this means of stabilizing, the aeroplane is rendered perfectly safe, in so far as it can be. The gyroscope stabilizer is the most perfect device ever brought before the aeronaut to keep his machine in perfect equilibrium while he is flying.

When fully developed, the gyroscope should be an important factor in making safer than ever before all ocean and aerial travel. Thus, once again, a product (once a toy) of the scientists' laboratory bids fair to become one of the greatest blessings ever bestowed upon mankind.

Seventy per cent. of the people use electricity in some form every day.

Ten per cent. of the population derive their living, directly or indirectly, from the electrical industry; $7,999,862,157 invested in electrical industry, including telephone and telegraph.

MARVELS OF MODERN PHYSICS

(*Continued from page 23*)

plain developments of the future as it has those of the past.

Such theories give us, too, a working basis for further search after the answer to that question of the ages as to what really constitutes matter. It seems probable that the electron may be only an electric atom with no material body, but with reference to the positive particle we are completely in the dark. If we assume that there is such a thing as matter besides the unit of electricity, then we are up against another riddle as to what it may be. The simplest suggestion we can make is that the *atom is the volume of ether cut out by electrons rotating about a nucleus.* It is interesting to note what a scientist of 2,500 years ago thought. Nearly 500 years B.C. Anaximenes advanced the theory shown in Fig. 3 that all matter was composed of one fundamental substance which he believed to be air. The air, he said, if condensed, would form water and if still further condensed would form the denser materials such as those composing the earth. He added that a rarefication of air would produce fire, but unfortunately for himself he was never able to prove his contentions. Laughable as this theory now seems to us, yet it is worthy of note that even then there was the idea that some "one" element was