PRACTICAL TESTS OF THE SCHLICK GYROSTAT FOR SHIPS.

The Schlick gyrostat, or device to diminish the rolling of ships, which was first described about two and a half years ago, was suggested by certain curious phenomena which the inventor had observed in paddle-wheel steamers. One of these is the violent list caused by putting the helm about, which is much greater than can be explained by the centrifugal force due to the turning. In general, paddle steamers roll less than screw steamers and their period of oscillation is longer when the wheels are revolving than when they are at rest. In a seaway a paddle steamer follows a sinuous course which is generally attributed to the alternate raising and lowering of the wheels in rolling. On this theory the depression of the starboard wheel should deflect the bow to port, but, as a matter of fact, the bow turns to starboard.

Schlick came to the conclusion, long ago, that these phenomena are caused by the gyroscopic action of the revolving paddle wheels. When the axis of a rotating wheel is turned by external forces about an axis perpendicular to itself there is produced a couple which tends to cause rotation about a third axis, perpendicular to both of the axes above specified. For example, when the shaft of a paddle steamer is turned in a horizontal plane, by moving the helm and changing the course, a couple comes into play which acts to turn the shaft about a horizontal axis running fore and aft and thus to careen the vessel toward the outside of its curved path.

Conversely, when the shaft is turned about a horizontal axis by the rolling of the ship a couple is produced which acts to twist the vessel around a vertical axis and cause it to deviate from the straight course. But this deviation in turn produces a couple which tends to turn the vessel about its longitudinal axis in a direction opposite to the rolling, which is therefore diminished.

Schlick's gyrostat is a heavy wheel revolving rapidly about a vertical shaft mounted in a frame supported on trunnions which allow it to turn about a horizontal transverse axis so that the shaft of the wheel swings in the vessel's plane of symmetry. As the common center of gravity of the wheel, shaft, and frame is lower than the trunnions the shaft hangs vertical while the vessel is at rest, but it swings fore and aft like a pendulum when the vessel rolls.

The arrangement above described, however, would only lengthen the period of rolling, because part of the energy derived from the waves would be consumed in raising the center of gravity of the apparatus as the shaft is deflected from the vertical position. But when the ship had completed its roll to one side and begun to right itself the potential energy of the raised center of gravity would be expended in increasing the rolling motion from which it had been derived, so that the amplitude of rolling would not be affected by the revolving wheel. The addition of a hydraulic brake makes it possible to check the oscillations of the apparatus and indirectly, through reaction, those of the ship. In other words, the energy taken from the rolling motion during one phase is not restored to it during another, but is converted into heat by the brake, so that the energy of rolling is diminished.

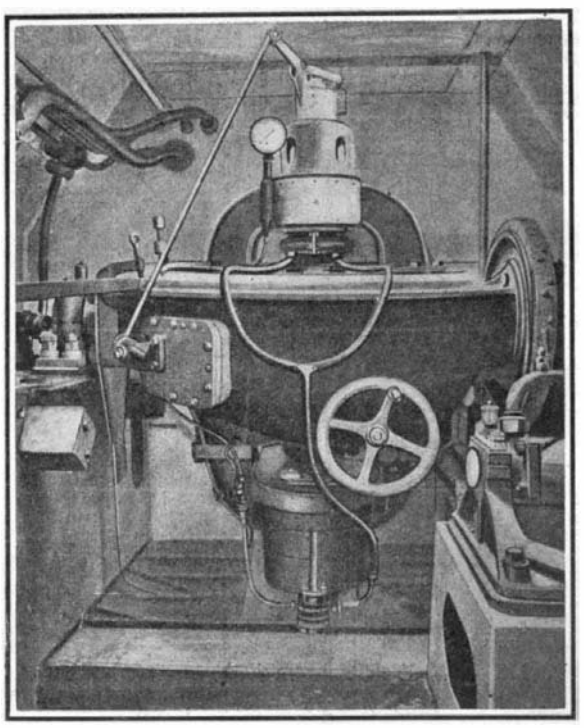
Experiments made with small models were surprisingly successful, yet the inventor hesitated to test the invention on a ship until Prof. Foeppl had reduced the mathematical theory to practical form and proved that an effective gyrostat need not be of impracticable size.

In view of the great expense of the experiment and of the increase in practical difficulties with the size of the vessel, the apparatus was installed on the little "See-Baer," formerly a torpedo boat of the German navy. Her approximate dimensions are as follows:

Length of water line, 35 meters or 115 feet.
Greatest breadth, 3.6 meters or 12 feet.
Draft, 1 meter or 3.3 feet.
Displacement, 57 metric or 63 short tons.
Metacentric height, 0.5 meter or 1.6 feet.
Period of rolling, 4.14 seconds.

The comparatively high metacenter increased the size of the gyrostat needed to check rolling and hence the severity of the test and the value of the results. In order to avoid unknown practical difficulties the gyrostat was designed to run at comparatively low speed and made correspondingly large, according to the following:

Outer diameter of wheel, 1 meter or 3.3 feet.
Weight of wheel, without shaft, 500 kilos or 1,100 pounds.
Velocity of rim, 84 meters or 275 feet per second.
Revolutions per minute, 1,600.



The Schlick Gyrostat in the "See-Baer."

The wheel was a solid block of forged steel. It would have been most convenient, both for installation and for operation, if the wheel had been driven by an electric motor, but as the boat had no electric plant and none could be added without great expense and difficulty Schlick decided to convert the wheel itself into a steam turbine by attaching to its rim rings of reaction surfaces and inclosing it in a shell of cast iron to which were attached the trunnions which permitted it to swing in the median plane of the ship. These trunnions, which rest on ball bearings, are hollow and serve respectively as an inlet and an outlet for steam, like the trunnions of an oscillating reciprocating engine. The lower end of the shaft also rests on ball bearings, which as well as the bearing or guide at the upper end are kept constantly supplied with oil by a chain pump, and cooled by a blast of air from a centrifugal blower. At the upper end is a centrifugal governor which cuts off the steam when the speed exceeds 1,600 revolutions per minute. There is also a device which strikes a gong after each 10 revolutions and thus gives warning of any irregularity in speed. Finally, there are brakes by which the wheel can be stopped quickly in emergencies.

The brakes which control the oscillations of the apparatus are on the port side. They include a band brake connected with a wheel on deck by which the oscillation can be entirely stopped, and a hydraulic cylinder brake. The piston rod of the latter is connected to a tongue on the side of the gyrostat case and its resistance is regulated by a valve which can be operated either from the gyrostat room or the deck.

In the first experiments the vessel was towed. The performance of the gyrostat was satisfactory in every respect. Not the slightest vibration or jar was felt and the lubricating and braking devices proved their excellence. Occasionally the speed was increased to 3,000 revolutions per minute. No ill effects followed.

Next, the boat was caused to roll by moving the crew from one side to the other. The time occupied by a double oscillation (from starboard to port and back to starboard) was 4.14 seconds when the gyrostat was at rest and about 6 seconds when it was making 1,600 revolutions per minute. In the latter case the smallness of the oscillations made the observations very difficult.

Then experiments were made to determine the number of oscillations that took place while the amplitude of oscillation decreased from an arbitrary initial value to ½ degree. For this purpose the boat was inclined about 15 degrees by raising one side with a crane and suddenly released. The amplitude was measured with a simple instrument consisting essentially of a heavy wheel, 60 centimeters (2 feet) in diameter, with its axle horizontal and parallel to the axis of the ship, at the level of the center of gravity in the latter, and mounted on ball bearings. The center of gravity of the wheel was a little below the axle and the period of oscillation 20 seconds. The rim of the wheel was graduated in degrees and turned under a fixed pointer, which indicated zero when both the ship and the wheel were at rest. When the ship rolled, the wheel remained at rest, so that the pointer marked the amplitude of the oscillation. The results of the experiments show that the gyrostat has a great damping effect on the oscillations.

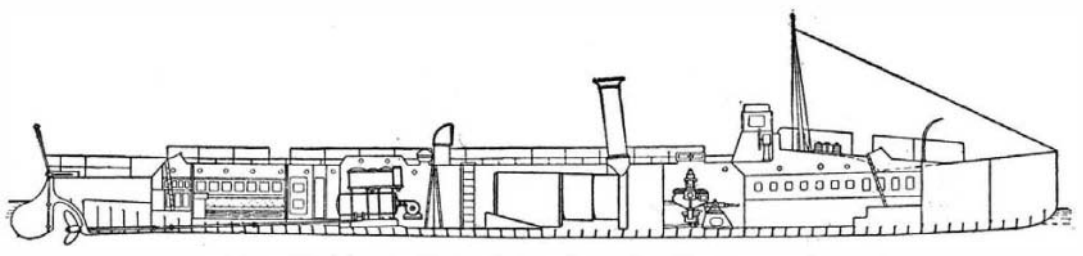
The main experiment was the test of the apparatus with the vessel steaming at sea. After several trips which gave no results of value because of the calmness of the sea, experiments were made in the delta of the Elbe, in the following manner:

The gyrostat was driven at normal speed, 1,600 revolutions per minute, but at first its shaft was held vertical (or rather, perpendicular to the deck) by the band brake attached to its case. The rotation of the wheel in this fixed position has no effect on the rolling of the ship. The vessel steamed slowly at right angles to the direction of progression of the waves in order to make the rolling as great as possible, and the amplitude of oscillation was measured with the small graduated wheel described above. On one occasion there was a maximum weather roll of 15 deg. and a maximum lee roll of 25 deg.; on others there were maxima of 15 deg. in each direction. This is pretty violent rolling.

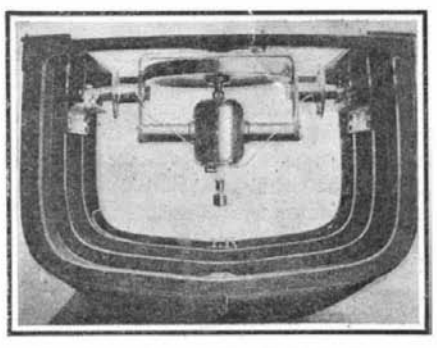
After the rolling had been observed and measured for several minutes the band-brake was cast loose. The gyrostat and its case began to swing violently and the rolling of the vessel was at once reduced to an average amplitude of ½ deg. with an occasional roll of 1 deg. The boat behaved very well, much better, indeed, than when the gyrostat was not acting. The waves appeared to pass under the hull, gently lifting and lowering it without even throwing much spray on the deck. The prediction of nautical experts that the boat would ship heavy seas under the influence of the gyrostat was not fulfilled.

In order to study the effect of lower speeds the revolutions of the gyrostat were reduced to 1,200 per minute. No difference in the effect was observed, but at 1,100 revolutions the damping effect was slightly lessened, and at 800 revolutions the maximum amplitude of rolling attained was 3 deg. With the gyrostat made ineffective by braking deflections of 12 deg. were observed. From this it appears that the gyrostat of the "See-Baer" was much larger than it need have been for a speed of 1,600 revolutions.

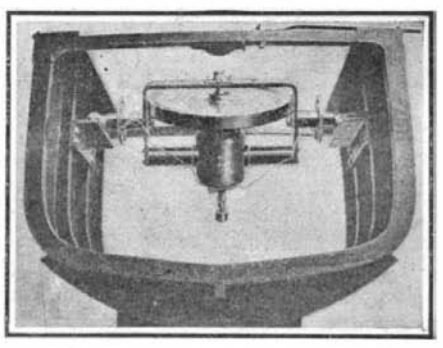
The material for this article is taken from a paper by Dr. Schlick in the Zeitschrift des Vereines deutscher Ingenieure, and the pictures from the Illustrirte Zeitung.



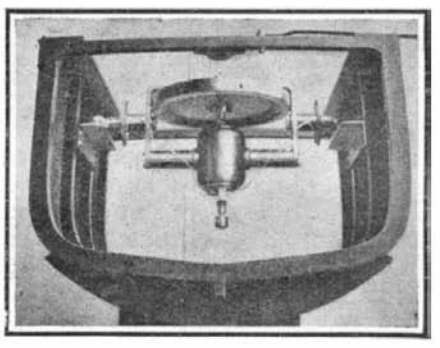
Longitudinal Section of the "See-Baer," Showing Gyrostat Forward.



The Gyrostat in Vertical Position.



The Gyrostat Tilted Forward.



The Gyrostat Tilted Backward.

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