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ESSO OIL-WAYS

IT'S THE SPERRYS

THE trifling purchase of a toy gyroscope for his young sons, Elmer, Jr., Edward, and Lawrence, in 1904, started Elmer Ambrose Sperry on years of experiments and tests that resulted in the development of some of the most remarkable and revolutionizing mechanisms in existence.

Among these, in order of time and importance, are the Sperry gyroscopic compass which provides a true north indication in ships, gyroscopic stabilizers which prevent ships rolling excessively, gyroscopic pilots which automatically keep ships and airplanes on fixed courses, and a host of other gyroscopic instruments and appliances that have made the name Sperry almost a synonym for gyroscope.

Many successful years as an inventor, however, preceded Sperry's interest in gyroscopes. Even had he allowed the gyroscope to remain a scientific toy — as it had been from the time of the ancient Greeks — his name would stand high on the roster of American inventors.

From the moment the uncanny balancing properties of the gyroscope first piqued his interest while he watched his sons at play with it, he became absorbed in the possibility of practical application and worked unceasingly to develop it.

A toy gyroscope gave Elmer Ambrose Sperry the idea which eventually resulted in the invention of many valuable instruments, including the gyroscopic compass and gyroscopic pilot.

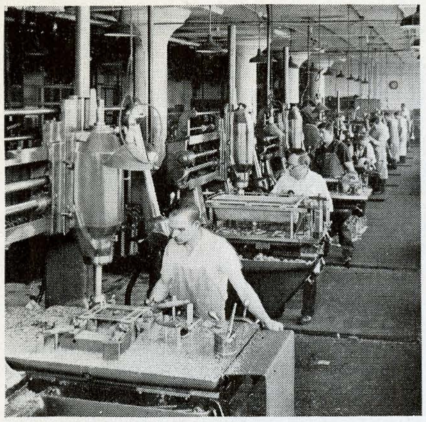
The Gyro-Compass. While the principles governing the behavior of the gyroscopes had been determined before Sperry began his experiments, no successful application to useful work had been made. The French scientist, Foucault, had proved that the axis of the wheel of the gyro can be set in any position, and regardless of gravity or magnetic attraction, the wheel will remain in that position as long as it maintains its spinning speed. The American, Hopkins, had built a gyroscope in which the wheel was revolved by electric power.

Sperry checked the experiments of others and made innumerable experiments and calculations of his own. It occurred to him that the gyro characteristic of "staying put" while spinning could be utilized as the north-south indicator of a compass. The maintenance of a certain spinning speed, however, was necessary to make his idea practical. So he decided to make the rotating element or rotor of the gyroscope in the form of an electric motor.

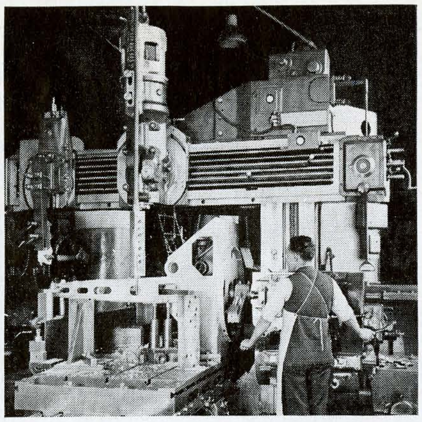
After countless experiments with various types of motors, and with the difficulties of suspension and other problems, he finally perfected a rotor which gave the desired results and put the earth's rotation to work for man. Regardless of changes in position of the mounting in which the gyroscope was suspended, its axis pointed north and south.

In 1910 Mr. Sperry had built his first gyro-compass and could convincingly demonstrate its superiority over the magnetic compass. The turning and tossing of a ship and the presence of magnetic materials, both of which sometimes led to serious deviation in magnetic compasses, had not the slightest effect on the gyro-compass. His invention had a further advantage in that as many repeater compasses as desired could be connected to the master compass and be distributed throughout the ship as easily as additional loud speakers can be connected to a radio.

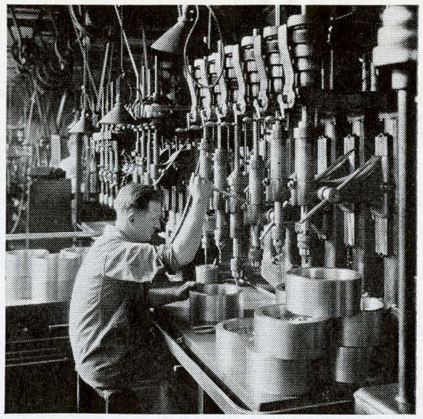
But Sperry found it impossible to secure financial backing for the commercial development and manufacture of his remarkable device. Accordingly, in 1910, he mortgaged everything he owned and established the Sperry Gyroscope Com-



These specially designed, high-speed vertical milling machines make possible accurate work in instrument manufacture.



One of the many expensive machines in the Sperry plant. It drills, bores, mills, and planes parts to close tolerances.

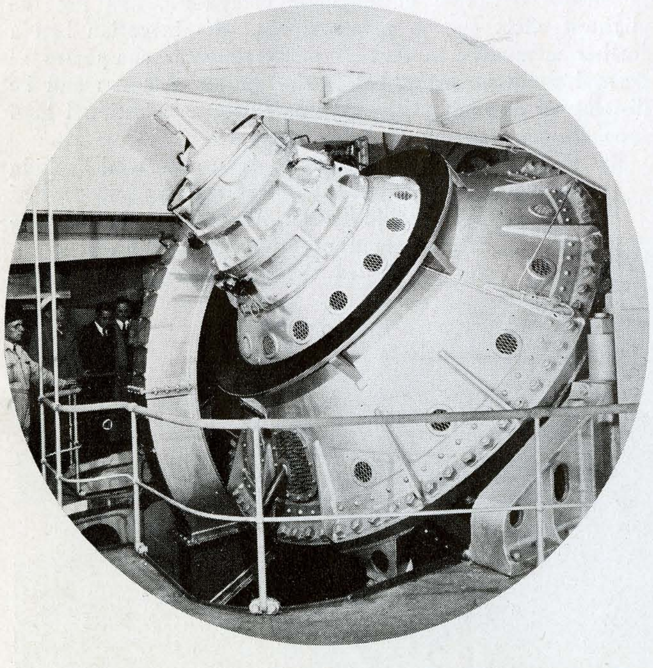


Drilling and tapping compass rotors. Machines are lubricated by products of the Esso Marketers.

pany. At that time, or very soon thereafter, there went into the company Thomas A. Morgan, today chairman of the board of the Sperry Gyroscope Company; Reginald E. Gillmor, now president and general manager; Preston R. Bassett, now vice-president in charge of engineering; and Robert B. Lea, vice-president in charge of sales. These early associates of Sperry are guiding the company today, pursuing aims and policies which they established when working with Mr. Sperry.

Within its first year the original company installed its first gyro-compass on the U.S.S. Delaware. It proved successful, and within a short time the navies of the Allies and neutral countries were installing gyro-compasses on their ships. After the war, merchant ships began to adopt the gyro-compass, among the first being ships of the Esso Marketers.

Sperry Stabilizers. With the gyro-compass well on its way to commercial adoption, Sperry applied himself to reducing the roll of ships with big gyros. His experiments ultimately



One of the six stabilizers used in the Conte di Savoia. The rotor weighs about 100 tons and revolves at 900 r.p.m.

proved that the force exerted by the heavy, spinning gyros could be applied to lessen the movement of a ship when its center of buoyancy was changed by waves.

In these gyroscopes each spinning wheel has to be large and heavy, sometimes 100 tons or more, with a sufficient number of them to equal about $1\frac{1}{2}$ per cent of the ship's weight.

Sperry stabilizers are successfully operating today in a score of yachts, an ocean liner, airplane carriers, and navy fighting ships. The Sperry stabilizer in the crack Italian liner, Conte di Savoia, greatly reduces the rolling of the ship.

Gyro-Pilots. Other Sperry instruments, utilizing the controlling abilities of the gyroscope, quickly followed the development of the stabilizer and the compass. Perhaps the most amazing of these is the gyro-pilot, or automatic control, used on both ships and airplanes.

Lawrence Sperry, who played with the toy gyro in 1904, demonstrated it for the first time at the Grand Prix air meet at Paris in 1914. He flew a plane without touching the controls, standing up in the cockpit during the demonstration flight. The war delayed the development of this device, so it was not until 1926 that the first gyro-pilot was installed in a commercial transport plane.

Up to this time the only gyroscopic flight instrument in general use was the turn and bank indicator developed by the Sperrys toward the end of the war. It is still in use in most planes. This one instrument indicates the rate of turn of the plane and the direction (left or right) in which it is banked or tilted.

Toward the end of 1927 there was a crying need for an instrument that would tell an airplane pilot, first, the position of his plane with respect to the horizon, and, second, give him an accurate measurement of turn or departure from his course, so that he could tell exactly, in degrees, how much he was off his course. The accurate measurement also would permit him to make a precise turn without waiting for the magnetic compass to settle down.

It was reasoned that if these needs could be fulfilled, pilots would be able to fly blind — operate their planes by instruments alone. In developing blind flying instruments, the Sperrys went back to their original gyro-pilot which Lawrence Sperry demonstrated in 1914. In 1927 they gave aviation the directional gyro and the artificial or gyro horizon. The artificial horizon tells the pilot the position of his plane in relation to the natural horizon, and the directional gyro tells him the degree of turn or departure from his course.

With the development of blind flying instruments, the demand for automatic flying increased. Pilots wanted to be relieved of the manual labor of flying planes. They needed more time for navigation, engineering duties, calculations, and reports, listening to radio signals, and generally paying closer attention to other duties, especially in nasty weather. The Sperrys answered this need by producing the gyro-pilot, which is a combination of the artificial horizon and the directional gyro connected by hydraulic controls to the ailerons, rudder, and elevators of the plane. Today an airplane equipped with a gyro-pilot can fly through fog and storm to any point in the world where gasoline will take it, without human hands once touching the controls until it lands.

The gyro-pilot, in combination with the gyro-compass, simplified sea navigation, too, and helped to lessen the captain's worries. His course can be set, the gyro-pilot put into operation, and the ship held to that fixed course from then on with an accuracy human hands cannot duplicate. And with a Sperry rudder indicator, rudder recorder, and course recorder in operation besides, the captain is supplied, at any time desired during the voyage, with a complete, automatic record of all rudder and ship movements. The first merchant ship on which experiments were conducted with a gyro-pilot was the John D. Archbold, one of the Esso Marketers fleet of tankers. Today a great many ships of this fleet are so equipped.

Some Other Sperrys. Although Sperry formed the Sperry Gyroscope Company with the intention of concentrating on gyroscopes, his inventive talent carried him into additional fields. Some of his other inventions and improvements include gunfire control apparatus, naval, military, and commercial search-lights — some with beam intensities of 800,000,000 candlepower — engine speed indicators for ships, and apparatus for indicating water salinity. Sperry sold his company in 1929. In 1932 he died. Lawrence had died many years before. Edward and Elmer, Jr., survive, the latter being consultant to the Sperry Gyroscope Company, and vice-president of an unrelated concern, the Sperry Products Company.

Making and Lubricating Sperrys. Sperry gyroscopes and other products demand the utmost accuracy in finished parts, whether for the tiny 15-ounce air-operated rotor in an airplane instrument gyro that makes 13,000 r.p.m. or a hundred ton gyro stabilizer spinning at 900 r.p.m. Tolerance is frequently but one ten-thousandth of an inch.

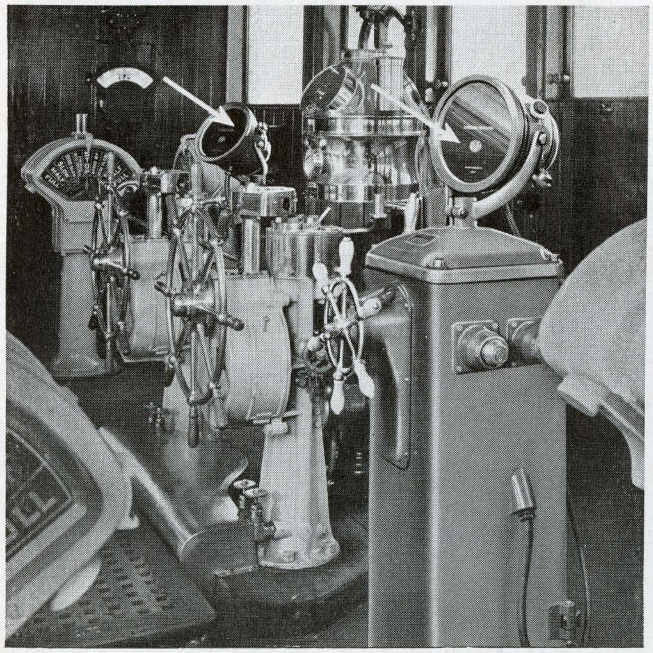
Ball bearings with specks of rust that can be detected only by a microscope must be rejected. To prevent rust, bearings to be shipped from the bearing manufacturer are first cleaned by immersion in Varsol and then coated with Teresso 120. The previous slushing compound used was not a good rust preventive, and a considerable number of bearings had to be rejected. Since Teresso 120 has been used, rejections have been cut to a minimum.

The success of the gyro-pilot was aided by Gyro Aircraft Instrument Oil No. 3 and Stanavo Servo Oil because of their high viscosity indexes and extremely low pour points. These qualities made perfect lubrication possible at ground temperatures as well as in the frigid cold, miles above the earth's surface. Because of the characteristics of these two oils, which were developed by the Esso Marketers, they have been adopted by the U. S. Army and Navy for Sperry instruments.

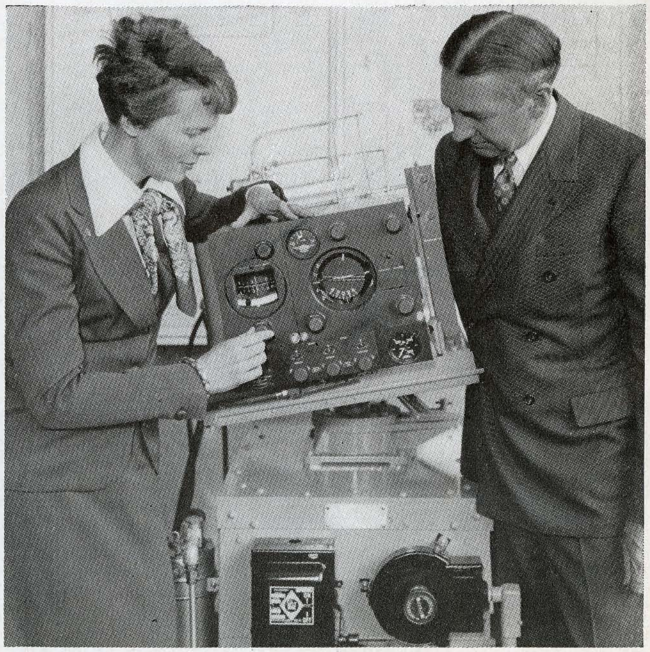
The extreme accuracy required in finished parts is obtained only by machines capable of the finest adjustment and maintained in the most perfect condition. Many of the machines in the Sperry plants are of special design and construction and represent a large investment.

The individual lubrication requirements of many of these fine machines call for extremely careful attention. Throughout the highly specialized shop, products of the Esso Marketers are used for lubrication. Esso Marketers cutting oils, Pennex 48 and 53, and soluble oils, Kutwell 40 and 50, protect the many fine cutting tools.

The Esso Marketers are proud of the part their products play in protecting so vast an investment in shop equipment, in assuring the manufacturing accuracy of this machinery, and the subsequent efficient operation of the products.



The arrows point to repeater compasses on the Queen Mary. The one at the right is mounted on the gyro-pilot.



Amelia Earhart inspecting Sperry gyro-pilot for use in her new Lockheed Electra, to be used as a flying laboratory.

ALL'S WELL that's OILED WELL in the PAPER INDUSTRY

PAPER rates fifth among the industries of the United States. Twenty-five billion pounds of paper — two hundred pounds per person—is the yearly output of over eight hundred American paper plants. The value of paper products exceeds a billion and a quarter dollars annually. Of this total, from 8 to 15 per cent is power cost—$3 to $9 per ton. Buried in these power costs is an insignificant lubricant cost of somewhere between 5 and 20 cents per ton of paper—insignificant, but easily responsible for an increase in manufacturing cost that cuts the heart out of profits.

Lubricating a Million Dollars. A modern paper making machine costs from a quarter of a million to over a million dollars. Anything that interferes with the smooth and efficient operation of any part, from the wire belt upon which the pulp and water mixture is poured to the calender rolls which give the paper a smooth hard finish, costs a lot of money. The failure of one bearing may not only shut down this million dollar piece of machinery, but halt production in the entire plant.

Just how expensive this can be is illustrated by the experience of one large mill. The wrong type of lubricant on roller bearings of drier rolls was causing as many as five or six bearings to be made worthless through pitting and wear in a single day due to the coking of the lubricant under operating temperatures as high as 300°F. The cost of new bearings alone ran to approximately $20,000 for one year. How this condition was remedied by the application of the correct Esso Marketers lubricants is told briefly on page 19 of the May, 1936, issue of Esso OIL-WAYS.

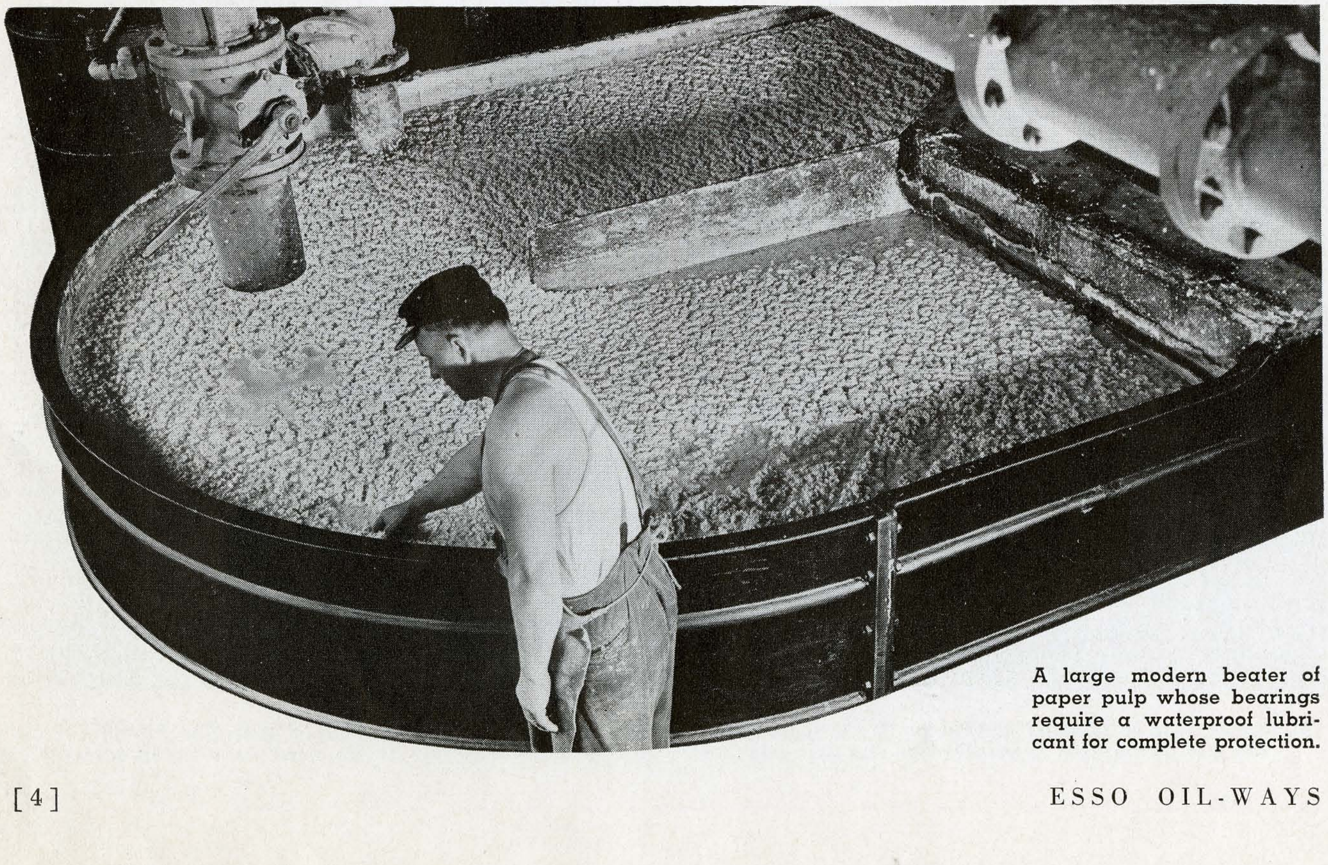
In another mill, formation of deposits due to high carbon content of the lubricant had made necessary frequent cleaning of the bearings and replacement of many bearings that had burned out. The condition was not only corrected when an Esso Marketers oil of high viscosity index and low carbon content was substituted, but the cost of lubrication per ton of paper dropped from 8 cents to 6½ cents.

Cheap or improper lubricants will nearly always prove costly to the paper manufacturer. Mill operators will be repaid many times over by a thorough understanding of operating conditions and lubrication requirements of paper mill machinery. Following are examples of lubrication practice that have proved highly effective in many paper mills.

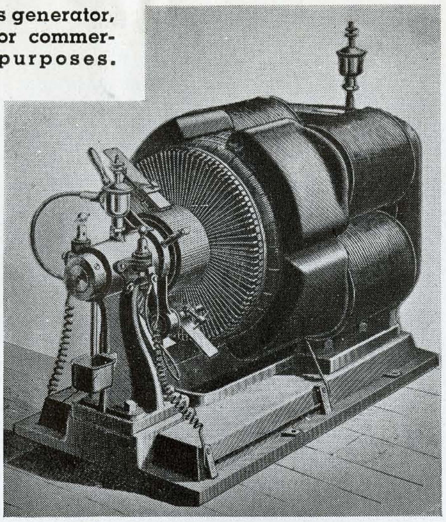
Log Conveyor to Paper Machine. The first operation in making pulp and paper is the hauling of logs and cutting them to size. Then comes debarking, log cleaning, chipping, or grinding the wood to pulp, and the cleaning and sizing of chips or pulp. The pulp, mixed with about 99 per cent water —and in this form called slush or stock—is made into paper in a paper machine.

It is first deposited on the wire screen of the Fourdrinier, or wet end of the paper machine. After some water drains off, there remains a water-soaked blanket of pulp, like wet blotting paper. The water in this is removed by suction, pressure, and heat, and the pulp becomes paper. The paper is then ready for calendering, or ironing, to give its surface the required smoothness. Successful lubrication of the machines which perform these operations depends on fitting the lubricant to individual lubricating conditions.

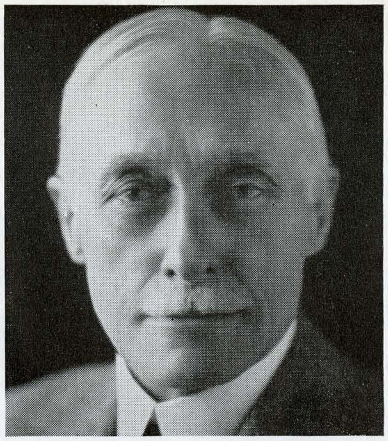
Conveyors. The endless chain conveyor that carries the logs from the pond to the saw mill operates partially in



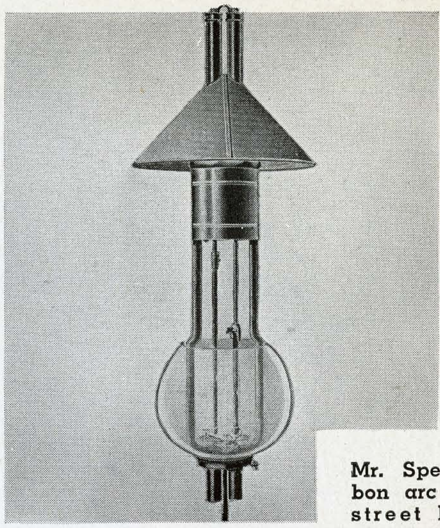
A large modern beater of paper pulp whose bearings require a waterproof lubricant for complete protection.



Sperry's generator, made for commercial purposes.



Elmer Ambrose Sperry.



Mr. Sperry's carbon arc lamp for street lighting.

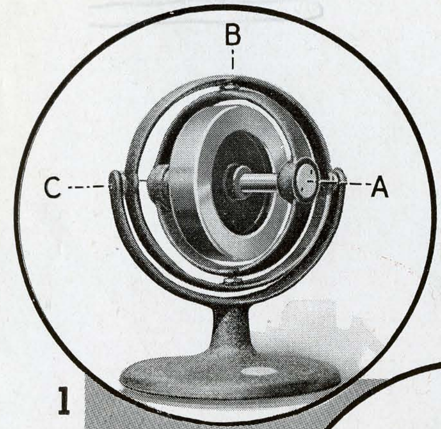
What SPERRY Learned from a TOY GYROSCOPE

A GYROSCOPE is a spinning flywheel. In practical use, the flywheel is actually the rotor of an electric or an air-driven motor, and is so mounted in supporting rings that it is free to turn in any direction. Figure 1 below shows (A) the spinning axis, (B) the vertical axis, (C) the horizontal axis, of a demonstration model of the gyroscope. These embrace three angular degrees of freedom, and when all three are present, as they are in the model illustrated, the flywheel is said to be universally mounted.

Gyroscopic devices rely upon two important properties which are unique to a spinning gyroscope—gyroscopic inertia and precession. By definition gyroscopic inertia is the tendency of the gyroscope to resist any force tending to turn its spinning axis in a new direction. Precession is the name given to the movement of the axis that occurs when a force is applied to it. A very important and unusual characteristic which must be considered is that precessional movement takes place, not around the axis of the applied force, but at right angles to that force, and also at right angles to the axis of the spinning wheel. This is explained as follows:

Gyroscopic Inertia. Fig. 2 illustrates gyroscopic inertia. Assume that the gyroscope, conveniently mounted in a support or frame, is spinning, and the frame is grasped as shown. The original direction of the axis of the flywheel is not changed, in spite of the fact that the frame has been turned. If the gyroscope were not spinning around, the friction in its supporting bearings would have a tendency to make it turn with the frame, but because the wheel is spinning, it opposes any tendency to move it out of its plane of motion. Thus, in a gyro compass, inertia keeps its axis in a fixed position regardless of movement of ship or airplane with relation to it.

Precession. Suppose a force is applied in the direction "T" shown in Fig. 3. Instead of the spinning wheel and its supporting ring moving in the direction of arrow "T," it strangely enough moves in the direction of arrow "P" at right angles to "T." Similarly, if a force "T" is applied, as shown in Fig. 4, the wheel and its ring will move in direction "P," or at right angles to "T." This movement about an axis at right angles to the axis of the applied force is called precession. Advantage of it is taken in a ship's stabilizer and causes the gyroscope and its housing to move fore and aft when pressure is applied sideways due to rolling of the ship. These opposing forces balance each other and reduce rolling.



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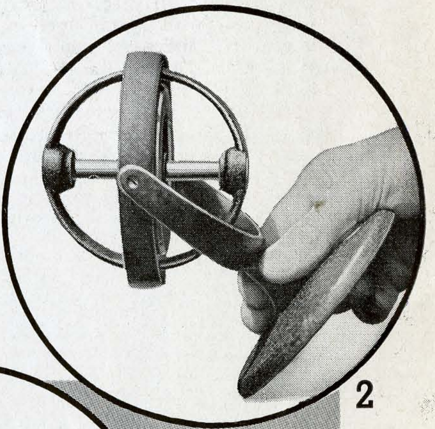

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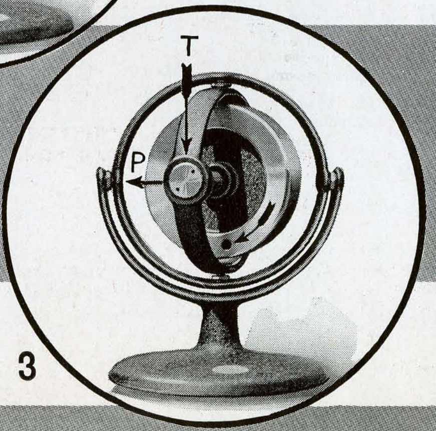

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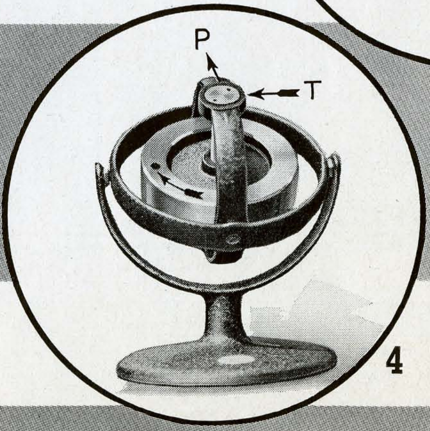

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EVERYTHING
UNDER
CONTROL
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THE GOVERNOR