

1 THE FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA

2 For the Promotion of the Mechanic Arts.

3
4 Committee on Science and
5 the Arts Case No. 2524.

6
7 Report of Subcommittee, dated January 7, 1914, investi-
8 gating Elmer Ambrose Sperry's Gyro Compass.

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10 Subcommittee: Mr. Hugo Bilgram, Chairman,
11 Prof. James Barnes,
12 Dr. A. W. Goodspeed.

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14 To the Committee on Science and the Arts:

15 Your subcommittee appointed to investigate the above
16 application reports as follows:

17 With the introduction of iron in the construction of
18 steam ships the magnetic compass has become less reliable, being
19 subject to local influences which cannot be eliminated entirely.
20 A compass that shall be free from these disturbances has become
21 a desideratum of great importance, and this has been supplied by
22 the invention submitted to your committee for investigation.

23 The Sperry Gyro Compass is founded on a peculiar prop-
24 erty of the gyroscope, which may be briefly described as follows:

25 If a fly wheel is suspended in such a way that it is

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1 free to rotate not only on its own axis, but also in every other direct-
2 ion, and this wheel is rapidly rotating on its own axis while the
3 axis itself is rotated in a plane passing through it, forces are
4 developed tending to rotate the axis of the wheel in a plane at
5 right angles to the said plane. This peculiar property is made
6 use of in the gyro compass in the following way:

7 A fly wheel is suspended in a universal joint, but
8 through a weight its axis is constrained to maintain a horizontal
9 position. Suppose the axis of this wheel is set due east and west
10 with the wheel rotating to the right when viewed from the west.
11 The axis, in partaking of the motion of the earth will rotate in a
12 plane parallel to the equator, the east end of the axis moving
13 downward, the west end rising. This produces a tendency of the
14 wheel axis to move out of this plane, the east end tending toward
15 north. The wheel, being free to rotate in this direction, will
16 yield to this force until it comes to lie in the meridian and so
17 point due north.

18 The rotation of the axis of the earth being slow, the
19 forces so developed are very feeble. It is therefore essential
20 to make the instrument sufficiently sensitive to allow the small
21 forces to adjust the heavy body of the fly wheel with sufficient
22 accuracy to make the instrument answer the purpose of a mariners'
23 compass.

24 The frictionless suspension of the sensitive part of the
25 instrument is accomplished in a very ingenious manner.

1 The body of the instrument is suspended in a compass
2 gimbal joint. On this body is carried a vertical ring adapted
3 to be rotated in either direction on a vertical axis passing through
4 its center by a small electric motor. A second, somewhat smaller
5 ring is suspended within this outer ring, rotatable on the same
6 vertical axis, being supported by an untwisted cable of steel
7 wires and held central by means of two ball bearings. When the in-
8 ner ring is in one plane with the outer ring, the supporting steel
9 cable is adjusted to be without torsional strain. The inner ring
10 supports on a horizontal axis the housing of the gyro wheel. The
11 wheel itself is the field magnet of a three phase induction motor
12 of which the armature is held fast while the field magnet rotates.
13 The housing is made air tight and the air is exhausted so as to
14 reduce the resistance to the movement of the wheel to a minimum.
15 The currents are conducted to the motor by suitable connections
16 which permit the free movements of the several parts of the instru-
17 ment. By a pendulum suspended on the outer ring on a horizontal
18 axis and connected to the lower end of the housing the axis of the
19 gyro wheel is maintained in a practically horizontal position.

20 Between the inner and the outer ring is located an elec-
21 tric switch so arranged that whenever the inner ring swings out of
22 the plane of the outer ring, an electric circuit is closed which
23 actuates the small motor above referred to, through which the out-
24 er ring is moved in the direction in which the inner ring had
25 moved. The outer ring thus follows up every movement which the in-

1 ner ring may make. As a matter of fact, this following up is al-
2 ways overdone, so that a reverse adjustment immediately follows.
3 It is for this reason that the outer ring constantly oscillates
4 on its vertical axis within a small angle, and in doing so, fol-
5 lows in the main the movements of the inner ring. The suspending
6 cable therefore remains without torsion and the inner ring can
7 follow the slightest impulse without encountering any resistance
8 besides that of its own inertia.

9 The point where the pendulum engages the lower end of
10 the housing for the purpose of holding the gyro axis in a horizon-
11 tal position is not precisely in the vertical centre line, but is
12 located a short distance towards the east. This, it is claimed,
13 has the effect of damping the oscillations that arise when for
14 some reason the axis of the gyro wheel is not precisely in the pos-
15 ition of its static equilibrium and proceeds to swing towards that
16 position. The philosophy of this claim is fully discussed in an
17 appendix to this report, kept apart because it involves mathema-
18 tics.

19 For two reasons elaborated in the appendix, the axis of
20 the gyro wheel is usually deflected to one side or the other of
21 the meridian. The reading of the instrument must accordingly be
22 corrected by the extent of these deflections. But the Sperry in-
23 strument is provided with a device through which these two cor-
24 rections are made on the instrument by merely setting two dials.
25 These affect the position of the index by which the position of

1 the compass is read, thus accomplishing the correction automatical-
2 ly. One of the dials is to be set to the latitude, while the other
3 is to be set to the speed of the ship. The one tendency to deflect
4 the gyro wheel results from the one-sided attachment of the pend-
5 ulum to the housing, the deflection being proportional to the
6 tangent of the latitude. This is corrected through the operation
7 of the dial set to the latitude. The other tendency to deflect
8 the instrument from the meridian results from the motion of the
9 ship on which the instrument is installed, if that motion has a
10 component in the direction of south-north. The effect of this ten-
11 dency is corrected by the adjustment of the speed dial, in con-
12 junction with a cam attached to the head of the outer ring.
13 Through this cam the effect of the dial is so modified that only
14 the south-north component of the speed to which the dial is set be-
15 comes operative in shifting the position of the index on which the
16 position of the compass is read.

17 The usefulness of the Sperry compass is materially in-
18 creased by the use of repeating instruments. Any number of these
19 instruments can be connected with the compass, in each of which an
20 index is made to follow the movements of the compass by means of
21 small electric motors of special construction. This makes it pos-
22 sible to locate the master compass in any suitable part of the ship
23 and have a repeater at the helm, another in the captain's room, and
24 one or more in other parts of the ship if desired. These repeat-
25 ers need not be held in a horizontal position, but may be placed at
any angle convenient to read, which is a decided advantage to the
helmsman.

