



MARITIME UNIVERSITY IN SZCZECIN

ORGANIZATIONAL UNIT:

FACULTY OF NAVIGATION - DEPARTMENT OF NAVIGATION DEVICES

Instruction

2

CONSTRUCTION AND MAINTENANCE OF THE GYROCOMPASS

Lab

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EXCERCISE NO 2

Subject: CONSTRUCTION AND MAINTENANCE OF THE GYROCOMPASS

1. Purpose of exercise

The purpose of the exercise is to familiarize students with the construction of the Master Gyrocompass and its operation. Particular attention should be paid to the co-operation of individual parts and assemblies gyrocompass which have a decisive influence on the accuracy of the determination (setting) of the course.

2. Theoretical preparation

Before beginning classes, students should read theoretical exercises.

- The basic construction of the gyrocompass,
- Construction of the Master Gyrocompass,,
- Construction of the Gyrosphere
- Power Supply to the Gyrosphere,
- Electric Pick-off and Follow-up Course Transmission
- Alarm system
- Maintenances and International regulations acc. SOLAS

3. Exercise course and raport

Refer to the main construction of the compass and the original units and parts gyrocompass accumulated in the room. Collect the information you need **to report**. The report should be a relation of the course activities with the purpose of the exercise and according to the instructor's instructions.

4. Control questions:

- Construction diagram of the Gyrocompass and description,
- Gyrosphere description and construction,
- Outer Sphere description
- A method for the power supply to the Gyrosphere,
- Hydrostatic, Dynamic Suspension and Centering of the Gyrosphere in the Outer Sphere

- Influence of fluid temperature on the work of the Gyrocompass.
- Hydrostatic, Dynamic Suspension and Centering of the Gyrosphere in the Outer Sphere
- The chemical composition of the fluid, what role each component plays

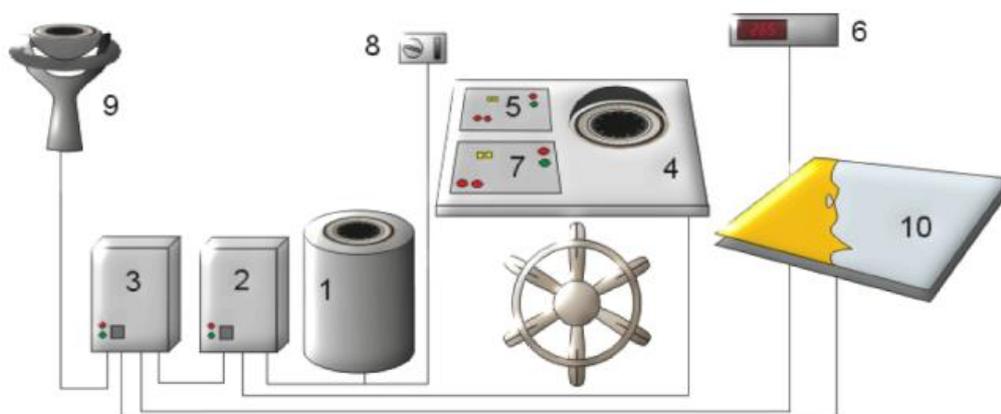
Biography:

1. E. Krajczyński, Urządzenia nawigacji technicznej, Fundacja Rozwoju Wyższej Szkoły Morskiej w Gdyni, Gdynia 1995.
2. E. Krajczyński, Okrętowe kompasy żyroskopowe, Wydawnictwo Morskie, Gdańsk 1987.
3. M. Mięsikowski, Współczesne kompasy żyroskopowe, Przegląd Morski 1999 nr 7-8.
4. Polski Rejestr Statków, Przepisy klasyfikacji i budowy statków morskich, Gdańsk 1999.
5. Zeszyt Naukowy WSM Szczecin, Kryteria dokładności żyrokompasów, 1998 nr 55
6. Podręcznik techniczny żyrokompasu CMZ 300X, wydanie angielskie
7. Instrukcja obsługi żyrokompasu CMZ 300X, wydanie polskie skrócone
8. Podręcznik techniczny Plath żyrokompas Navigat, Hamburg
9. Strona internetowa: <http://www.sperry.com>
10. Strona internetowa: <http://www.plath.com>

5. Theory

5.1. The basic construction of the gyrocompass

At present there are many models of gyrocompass on the market. The most popular company are: Sperry, Anschutz, Furuno. A gyrocompass is a set of devices that allow you to establish the course that a ship sailing. This course is transmitted to analogue or digital repeaters, autopilot, satellite receivers, radars and course recorder - a tracer. *The gyrocompasses are using the properties of the gyroscope, which has the ability to self-align the main axis of the gyroscope along of the meridian real.*



Rys.1. Gyrocompass

Basic devices, which are equipped with a gyrocompass:

- 1** Master Compass: Discovers and maintains the true north reading with the help of gyroscope.
- 2** Voltage Regulator: Maintains constant supply of the ship to the motor-generator.
- 3** Course Transmitter: a device for connecting different types of analogue, digital, stepper motors to Gyrocompass,
- 4** Repeater Compasses: Receive and indicate the true direction transmitted electrically from the Master Compass.
- 5** Autopilot
- 6** Digital Repeater
- 7** Alarm Unit: Indicates failure of the ship's supply
- 8** Time base generator
- 9** Bearings Repeater
- 10** Plotter for plotting lines on navigation charts
- 11** Course Recorder: Makes a continuous record of the manoeuvring on a moving strip of paper.
- 12** Namiernik,
- 13** Additional devices

5.2. Construction of the Gyrocompass

The most important device of the Gyrocompass is Master Gyrocompass. This includes the north-seeking element, its housing, and a follow-up mechanism. Components of the master compass are:

Binnacle stand, which supports and encloses the whole master compass, is made in 3 sections. The center section is cylindrical and connects the upper and lower sections. The bottom of the lower section is bolted to the binnacle base. The midsection carries the gimbal rings. **Gimbal rings** provide a relatively stable support for the compass, the frame, consisting of bowl and spider, is supported on gimbal rings within the binnacle stand. The outer ring is insulating the rings from the binnacle. The inner ring is prevent the compass frame from swinging excessively in the rings when the ship rolls, the inner ring carries on its upper surface 3 steel damping tanks partially filled with mercury.

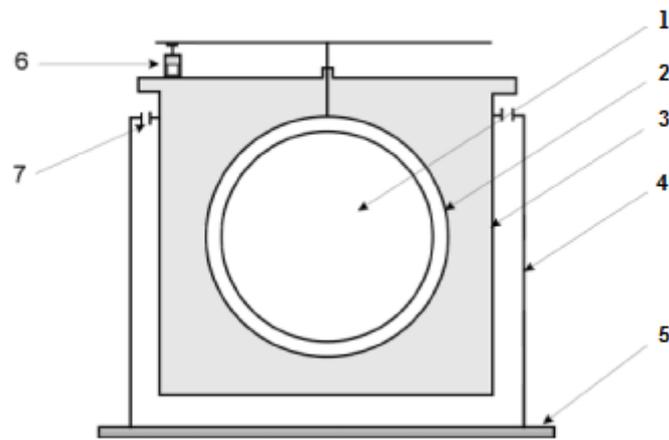


Fig.2 Implied diagram of the main constituent parts of the compass.

- 1. Gyrosphere - sensitive element
- 2. Outersphere, phantom
- 3. Tank
- 4. Cover
- 5. Base
- 6. Azimut fallow up motor
- 7. Gimbal rings

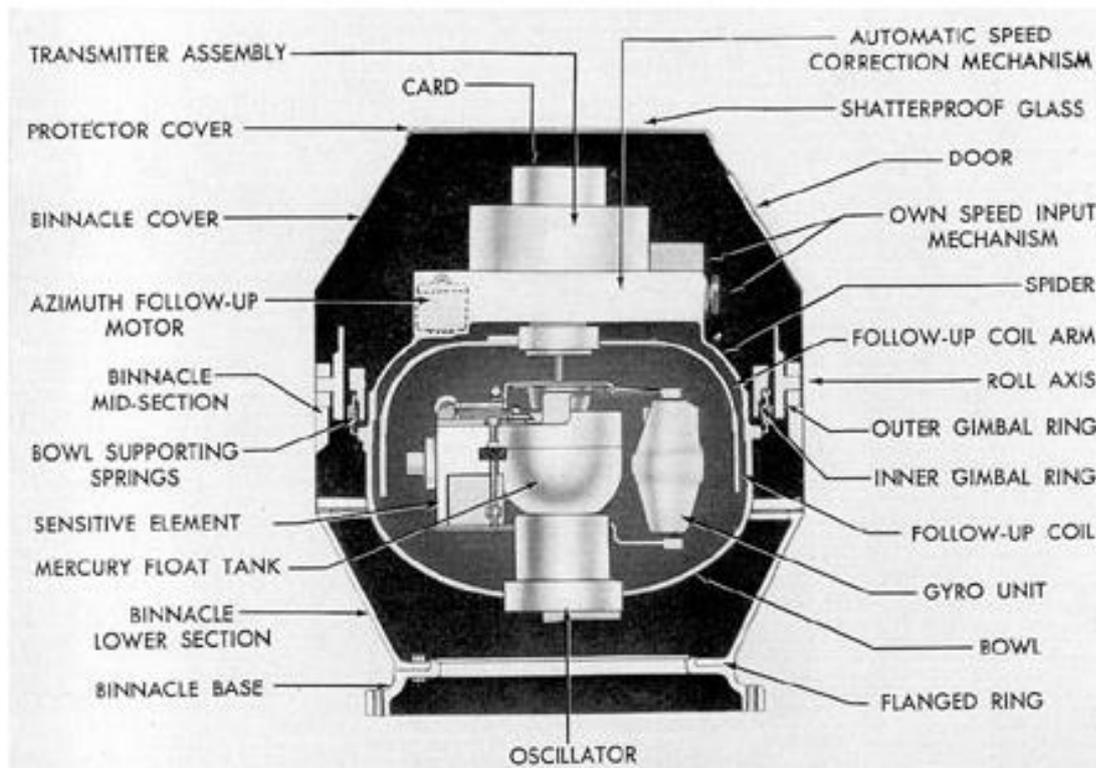


Fig. 3 Master compass.

Sensitive element. The north-seeking portion of the master compass is the sensitive element. This unit through gyroscopic action and by virtue of the earth's rotation tends to keep its axis in the meridian. By means of the follow-up system and transmitter, the position of the element controls the reading of repeater compasses throughout the ship. The sensitive element consists of a frame on which are mounted 2 gyro units and an oil damping device. Each gyro unit is free to rotate about a vertical axis but the 2 units are coupled together by a linkage. To limit the linear displacement of the sensitive element, it was placed inside a hollow ball called a outer sphere. It is a kind of cage for the sensitive element (inner sphere). The space between the surfaces of both spheres is small and only a few millimeters. To protect the fluid from spilling, the liquid reservoir is covered by support plate. The end of the gyrosphere placed the pin called compass card drive, is mounted on the table so that the azimuthal motor through the gear can rotate the fallow up system sphere in the horizontal position. The fluid container reservoir is attached to the housing via two gimbal rings (inner and outer), thanks to which, during the roll of the ship remains vertically, providing a sensitive element the best working conditions. The gyrocompass housing is completed with a binnacle base that is strongly attached to the ship's deck. In today's manufactured gyrocompasses, the fluid is eliminated, which makes them lighter. This solution also allows for better drainage of heat from the electrolyte that is escaped during the operation.

5.3. Hydrostatic, Dynamic Suspension and Centring of the Gyrosphere in the Outer Sphere

The weight of the gyrosphere and the specific gravity of the supporting liquid are adjusted exactly so that, with the gyrocompass at operating temperature, the gyrosphere has a slight residual weight.

This residual weight is cancelled by the liquid steam produced by the pump which thereby simultaneously centres the sphere. In this way, the gyrosphere floats freely in the outer sphere. When the compass equipment is switched on, the pump for the supporting liquid functions as well. The supporting liquid covers the gyrosphere and thereby forms the supporting bearing for the sphere. The weight of the gyrosphere and the specific gravity of the supporting liquid are adjusted exactly so that, with the gyro compass at operating temperature, the gyrosphere has a slight residual weight. This residual weight is cancelled by the liquid steam produced by the pump which thereby simultaneously centres the sphere. In this way, the gyrosphere floats freely in the outer sphere. A conductive tube is built into the fluid return line for the measurement of the conductivity of the supporting liquid. An alternating voltage at this location is constantly fed to a controller and evaluated there.

To determine the height of the gyrosphere, on the one hand the mean distance of the gyro-sphere from the reversing contacts is used and on the other the mean distance of the gyrosphere from the calottes via resistance measurements. The resulting values are processed and evaluated in a controller. On fig. 4 shown the Hydrostatic Suspension Principle of the Gyrocompass STANDARD 20 by Anschütz.

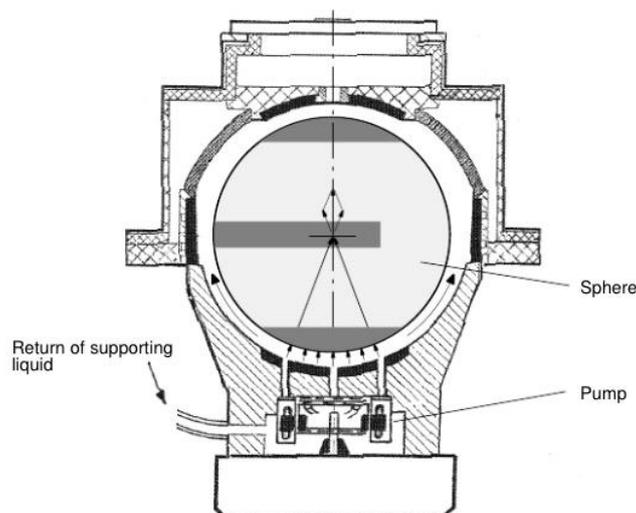


Fig. 4 Hydrostatic Suspension Principle

5.4. The Gyrosphere

The north-seeking element used in the system is the gyrosphere, a hermetically sealed unit with a funnel-shaped recess, reaching from the outer skin down to its center. Inside the gyrosphere, two mechanically linked gyroscopes are mounted with their spin axes horizontal in a carrying frame. The gyroscopes are allowed to turn around the

vertical, but torsion bands effect a defined rest position, while a mechanical linkage ensures that the resultant spin vector of the gyros remains stationary relative to the gyrosphere. This twin gyro arrangement eliminates intercardinal roll error. Once the gyros have run up to speed, their resultant spin vector, and with it the sphere, settles in the direction of true North. Fig. 5.



Fig.5. The gyrosphere

5.5. Power Supply in the Gyrosphere

The Gyrosphere required AC supply. The Gyrosphere equipped with two gyroscopes are attaining a speed of nearly 20000 rpm at a voltage of 100 VAC at 337 Hz. The electric current for supplying the gyro motors passes via the calottes of the outer sphere though slightly basic, and therefore conductive, supporting liquid to the calottes of the gyrosphere. There, it is picked up and fed to the two gyro motors.

The fluid contain:

- Distilled water,
- Glycerine - is a liquid that is well dissolved in water, has a rather high specific gravity of 1.26g / cm³, its greater electrolyte content increases the specific gravity of the electrolyte and is used to "balance" gyrosphere of greater specific gravity. Should fall, add glycerol to the fluid, when the gyrosphere flows upward, and add water to lower the specific gravity,
- Acid or base,
- Liquid reducing the freezing point of the electrolyte,
- Additional special ingredients.

The permitted ambient temperature for the operation of the gyrocompass system is -10 – +55 °C.

5.6. Electric Pick-off and Follow-up Course Transmission

At the equator of the sphere there is a conductive band; its ends are designed for pick-off of the sphere position with regard to the outer sphere. The pick-off has been designed as bridge circuit and is part of the follow-up system. The bridge circuit comprises the primary windings from the connected symmetrical transformer as well as both transfer resistances R1 and R2 of the supporting liquid between reversing contacts W1 and W2 of the outer sphere and the ends of the conductive band on the gyrosphere.

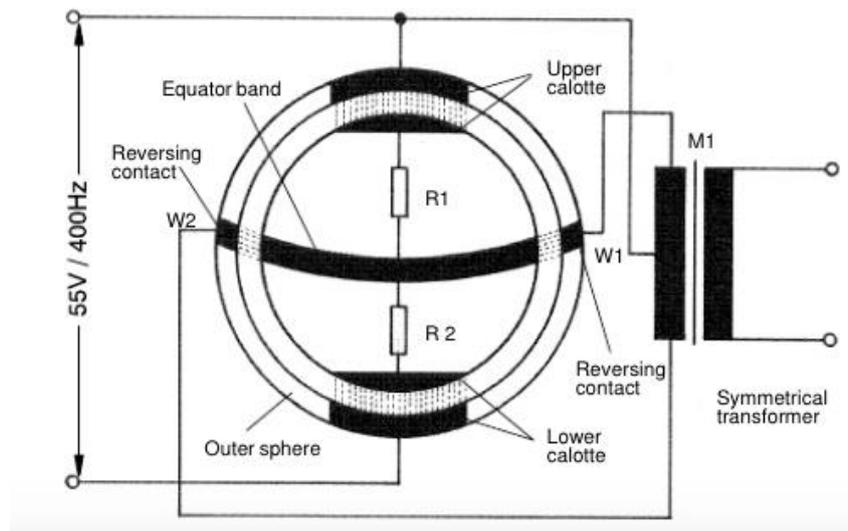


Fig. 5. Principle of Current Transmission and Pick-off between Gyrosphere and Outer Sphere

5.7. The alarm system of the Gyrocompass

An example of a frequent defect of the gyrocompass may be exceeding the permissible temperature of the electrolyte, resulting in the contact of both spheres. The Gyrocompass has built-in fluid temperature control. If it is exceeded, an alarm is triggered. The control circuits usually have the following systems:

- Cooling system,
- Follow up system system,
- Power Supply System

Following a follow up system failure there is an error in the transmission of course information from the Master compass to the repeaters, the navigator most often sees only the repeaters so is unable to state this error.

Following a power supply system failure. There are no current in one phase power supplying the Gyrosphere leads to the stops of gyroscopes, this leads to the departure of the axis gyro sphere meridian and the emergence of a large error rate. In the case of the alarm failure gyrocompass to be treated, during this time, you should use other course designators devices. Navigator should always compare the Gyrocompass instructions with other devices, such as a magnetic compass or a GPS

system. In order to increase the certainty of the ship's course, it is recommended to install two Gyrocompass working on ships simultaneously.