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NAVAL SHIPS TECHNICAL MANUAL

CHAPTER 9813

MINE PROTECTION
(Degaussing and Minesweeping)

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NAVAL SHIP SYSTEMS COMMAND, WASHINGTON, D. C. 20360

NAVAL SHIPS TECHNICAL MANUAL

CHAPTER 9813 – MINE PROTECTION (Degaussing and Minesweeping)

September 1968 Edition

SECTION I. SHIPBOARD DEGAUSSING INSTALLATIONS

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Part 1. Summary of Shipboard Degaussing Duties

9813.201 OPERATION

1. **Degaussing coils.**

a. The degaussing coils must be energized:

(1) When required by military conditions.

(2) When testing degaussing effectiveness or when required for maintenance purposes.

b. Energizing the degaussing coils consists of setting the coil currents to the values specified in the Degaussing Folder for the ship's position and heading.

2. **Automatic degaussing control equipment.** Instructions for the operation of the automatic degaussing control equipment, if installed, are given in the Technical Manual for the equipment.

3. **Compass compensating coils.** The operation of compass compensating coils is automatic after the initial compensation, therefore, no routine operation is necessary.

4. Electrical safety precautions in accordance with Chapter 9600 are to be observed by persons engaged in repair or operation of degaussing systems.

9813.202 MAINTENANCE, INSPECTION, AND TEST

1. **Degaussing coils.**

a. Run a degaussing range at every opportunity and at least once a year for a magnetic check.

b. Energize the coils once a week for a period of at least four hours for a maintenance check. (See Degaussing Folder.)

c. Remove connection box drain plugs once a month to drain moisture.

d. Check the insulation resistance of each coil once a week.

e. Enter the accomplishment and data for items a. to d. in the Ship's Force Degaussing Maintenance Record in the Degaussing Folder.

f. Take remedial action as necessary in accordance with Chapter 9600, if the insulation resistance falls below the minimum allowed by Chapter 9600.

g. Regularly inspect and maintain as required, the various components of the system such as cable, rheostats, motor-generators, etc., in accordance with Chapter 9600 and the applicable technical manual.

h. Arrange for inspection of the degaussing system by a naval shipyard at overhaul periods.

2. **Automatic degaussing control equipment.**

a. Regularly check the automatic degaussing control equipment, using the methods described in the applicable technical manual for the equipment to make sure that the proper degaussing coil current is being obtained. Take remedial action in accordance with the applicable technical manual, if the actual degaussing coil current differs from the required current.

b. Arrange for inspection of the equipment by a naval shipyard at overhaul periods.

3. **Compass compensating coils.**

a. Check periodically for change in deviations due to degaussing. (Refer to ship's compass coil manual in the Degaussing Folder for details.)

b. Arrange for inspection of the system by a naval shipyard at overhaul periods.

9813.203 REPAIRS

1. **Degaussing coils.**

a. Minor repairs are made by the ship's force using shipboard repair parts as required.

b. Repairs beyond the capacity of the ship's force are made by naval repair activities.

c. If the system becomes defective so that specified current values cannot be obtained while in or approaching magnetic danger areas and complete repairs cannot be made by the ship's force, the currents should be set as nearly as possible to the specified values.

2. **Automatic degaussing control equipment.**

a. Take corrective maintenance action which is within the capacity of the ship's force, as required. Follow implicitly the instructions in the applicable equipment technical manual.

b. Repairs beyond the capacity of the ship's force are made by naval repair activities.

c. If the automatic degaussing control equipment becomes inoperative when in or approaching magnetic danger areas and complete repairs cannot be made by the ship's force, set the degaussing coil currents to the required values and operate in manual control.

3. **Compass compensating coils.**

a. Minor repairs are made by the ship's force. (No compass coil repair parts are carried aboard.)

b. Major repairs, compass coil, and control box replacements are made by naval repair activities.

c. In cases where compass coil repair cannot be made by the ship's force and the vessel is traversing magnetic mine areas, the decision as to whether the degaussing coils are to be operated with the compass coils disconnected or the degaussing coils are to be secured, must be made by the commanding officer, considering the relative danger from mines and navigational conditions, condition of gyrocompass, etc.

d. Compass coils are sealed units. Never chip paint or coils as soldered seams may open.

9813.204 REPLACEMENTS

A quantity of all special components of the degaussing installation, such as rheostats and compass compensating coils, is normally stocked at all naval shipyards. Replacements of this nature would normally be considered as a major repair and beyond the scope of the ship's force.

Automatic control and power supply equipment is furnished with sets of onboard repair parts with which minor replacements may be made. Repair parts for the equipment should be obtained through the Ships Parts Segment of the Navy Supply System. Always order by Federal stock number, manufacturer's part number and NAVSHIPS drawing and item number when known.

Part 2. The Degaussing Installation

A. Description

9813.221 REASONS FOR DEGAUSSING

1. A ship is a magnet because of the presence of magnetic material (steel) in its hull, machinery, and cargo. Like any other magnet, it is surrounded by a magnetic field which is large near the ship and small at a considerable distance from it. When a ship is close to a magnetic mine or torpedo, the magnetic field of the ship actuates the firing mechanism and causes the mine or torpedo to explode.

2. The purpose of degaussing is to counteract the ship's magnetic field and establish a condition such that the magnetic field near the ship is, as nearly as possible, just the same as if the ship were not there. If this condition could be realized perfectly, the magnetic mine could not detect the presence of the ship and would not explode. Even though this condition cannot be realized perfectly, an approximation to such a condition decreases the danger from magnetic mines.

9813.222 DEGAUSSING METHODS

1. A ship can be degaussed either by magnetic treatment or by providing a shipboard degaussing installation.

2. **Magnetic treatment.** Some degaussing stations use coils installed temporarily to provide a magnetic treatment which furnishes some measure of protection against magnetic mines. No degaussing equipment is permanently installed aboard ship and, therefore, nothing concerned with degaussing has to be operated and maintained by ship's forces. Degaussing by magnetic treatment does not, however, protect against magnetic mines as effectively as a shipboard degaussing installation does and is used only to a limited extent.

3. **Shipboard degaussing installation.** A shipboard degaussing installation consists of permanently installed equipment. The major items are:

a. Degaussing coils.

b. A power source to supply direct current for the coils.

c. Means to control coil current, hence strength of magnetic field due to the coil.

d. Compass compensating equipment to prevent disturbance of the magnetic compasses by the magnetic field due to the degaussing coils. It is with shipboard degaussing installations that we are concerned here.

9813.223 PERMANENT AND INDUCED MAGNETIZATION

1. A ship's magnetic field is caused in part by the ship's permanent magnetization, and in part by the ship's induced magnetization.

2. **Permanent magnetization.** Ships are built in the presence of the earth's magnetic field and become permanently magnetized, just as a knife blade, for example, becomes magnetized if it is hammered in a magnetic field. The ship's permanent magnetization depends upon the earth's magnetic field at the place where the ship was built, the orientation of the ship with respect to the earth's field, the material of which the ship is constructed, and a number of other factors. All ships which are to be fitted with a shipboard degaussing installation and some that do not require degaussing installations are depermed. Deperming is essentially a large scale version of demagnetizing a watch. Its purpose is to reduce permanent magnetization and to bring all ships of the same class into a standard condition in which the permanent magnetization which remains after deperming is approximately the same for all ships of the class.

3. **Induced magnetization.** Magnetization is induced in a body of magnetic material when it is brought into a magnetic field. The induced magnetization depends upon the strength of the magnetic field and the orientation of the body of magnetic material with respect to the inducing field. For this reason it is necessary to consider the earth's magnetic field which induces magnetization in ships.

9813.224 THE EARTH'S MAGNETIC FIELD

1. **Lines of force.** The earth's magnetic field can be represented by lines of force as indicated in figure 9813-1. The direction of the field at any point is tangent to the line of force through the point. The field is strong where the lines of force are close together, weak where they are far apart.

2. **Unit of field strength.** The unit of magnetic field strength is now called the oersted. A magnetic field with a strength of one oersted corresponds to one line of force per square centimeter of area perpendicular to the line. A millioersted is one thousandth of an oersted. The unit

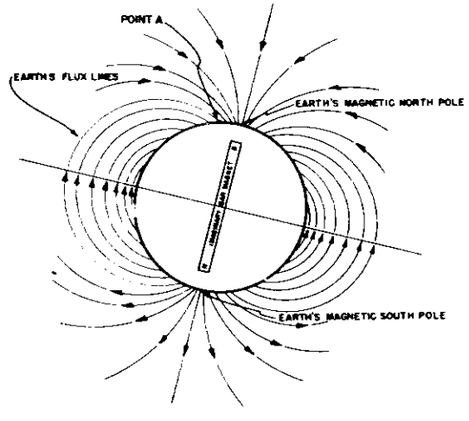


Figure 9813-1. The magnetic field about the earth.

of magnetic field intensity was formerly called the gauss, and "gauss" is now so firmly imbedded in degaussing terminology that it is not uncommon to speak of magnetic field strengths as being measured in gauss. This practice, while incorrect, does not lead to serious misunderstanding.

3. **Resolution into components.** At any point on the earth's surface, the earth's magnetic field can be resolved into a horizontal component and a vertical component. (See figure 9813-2.)

4. **Horizontal component.** The horizontal component of the earth's magnetic field:

a. Is always directed from magnetic south to magnetic north.

b. Is zero at the magnetic poles.

c. Is a maximum at the magnetic equator.

5. **Vertical component.** The vertical component of the earth's magnetic field:

a. Is directed radially outward (upward), south of the magnetic equator.

b. Is directed radially inward (downward), north of the magnetic equator.

c. Is zero at the magnetic equator.

d. Is a maximum at the magnetic poles.

9813.225 SHIP'S INDUCED MAGNETIZATION

1. **Longitudinal component.**

a. Consider a ship headed magnetic north. The horizontal component of the earth's magnetic field induces a north pole in the bow and a south pole in the stern (see figure 9813-3.), or induces a longitudinal or fore-and-aft component of magnetization. The stronger the horizontal component of the earth's magnetic field, the greater the longitudinal component of magnetization. If the ship starts at the south magnetic pole and steams north, the longitudinal component of induced magnetization starts at zero at the south magnetic pole, increases to a maximum at the magnetic equator, and decreases to zero at the north magnetic pole. Thus, for constant heading, the longitudinal component of induced magnetization changes when the ship moves to a position where the horizontal component of the earth's magnetic field is different, or, as it is commonly expressed, when the ship changes its magnetic latitude.

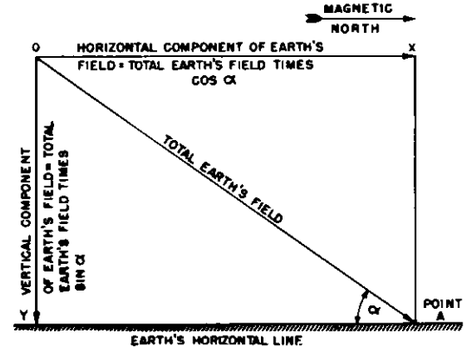


Figure 9813-2. Resolution of earth's magnetic field into horizontal and vertical components.

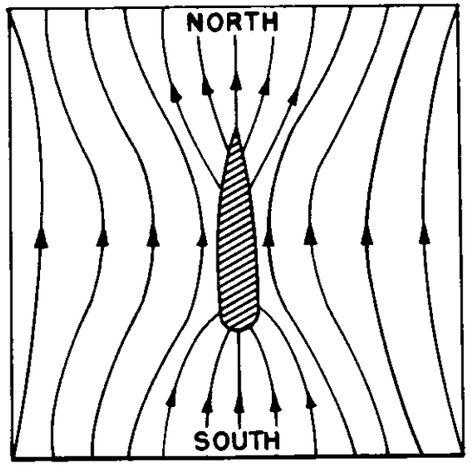


Figure 9813-3. Component of earth's magnetic field parallel to ship's fore-and-aft axis induces logitudinal megnetization.

b. If, at a given magnetic latitude, the ship changes heading from north to east, the longitudinal component of induced magnetization changes from a maximum on the north heading to zero on the east heading. When the ship changes heading from east to south, the longitudinal component increases from zero on the east heading to a maximum on the south heading. On southerly headings, a north pole is induced at the stern and a south pole at the bow, just the reverse of conditions on northerly headings when the induced north pole is at the bow and the south pole is at the stern.

c. The horizontal component of induced magnetization also changes, to some extent, as the ship pitches.

2. **Athwartships component.**

a. When a ship is on an east heading, a north pole is induced on the port side and a south pole on the starboard side (figure 9813-4.). This is the athwartship component of induced magnetization. Its magnitude depends upon the strength of the horizontal component of the earth's magnetic field or upon the magnetic latitude, being a maximum at the magnetic equator and zero at the magnetic poles.

b. The athwartship component of induced magnetization also changes when the heading changes, having its maximum magnitude when the ship is headed magnetic east or west, and zero magnitude when the ship is headed magnetic north or south.

c. The athwartships component of induced magnetization also changes, to some extent, as the ship rolls.

3. **Vertical component.**

a. When a ship is north of the magnetic equator, the vertical component of the earth's magnetic field is directed down. It induces in the ship a vertical component of induced magnetization which is also directed down, north pole below, south pole above. The magnitude of the vertical induced magnetization depends upon the magnetic latitude, being maximum at the magnetic poles and zero

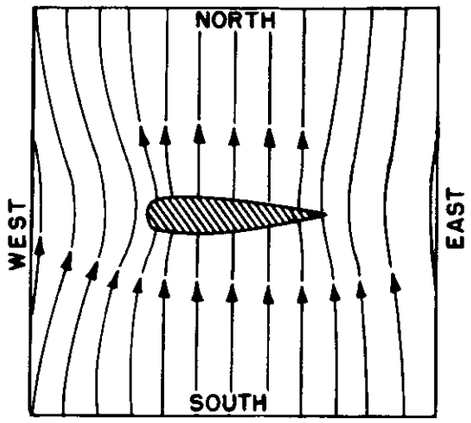


Figure 9813-4. Component of earth's magnetic field athwartships to ship's longitudinal axis induces athwartships magnetization.

at the magnetic equator. The vertical induced magnetization is directed down when the ship is north of the magnetic equator, up when the ship is south of the magnetic equator. The vertical induced magnetization thus changes with magnetic latitude.

b. Unlike the longitudinal and arthwartships induced magnetization, the vertical induced magnetization does not change with heading, since a change of heading does not change the orientation of the ship with respect to the vertical component of the earth's magnetic field.

c. The vertical induced magnetization changes, to some extent, when the ship rolls or pitches.

9813.226 THE SIX COMPONENTS OF MAGNETIZATION

1. **Permanent.** The ship's permanent magnetization can be resolved into the following components:

a. Vertical permanent magnetization.

b. Longitudinal permanent magnetization.

c. Athwartship permanent magnetization. These three components are constant (except for slow change with time) and are not affected by change in heading or magnetic latitude.

2. **Induced.** The induced components discussed in article 9813.226.1 change as follows:

a. Vertical induced magnetization changes when the magnetic latitude changes, when the ship rolls or pitches, but not when the heading changes.

b. Longitudinal induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship pitches.

c. Athwartship induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship rolls.

9813.227 DEGAUSSING COILS

1. **Function.** Each of the six components of ship's magnetization produces a magnetic field in the vicinity of the ship. The function of the degaussing coils is to produce magnetic fields which are, as nearly as possible, equal and opposite the magnetic fields produced by the six components of the ship's magnetization. The resultant of the ship's field and the field produced by the degaussing coils is made as nearly zero as possible so that the possibility of exploding a magnetic mine or torpedo is reduced.

2. **Field produced by a coil.** A straight wire carrying an electric current is surrounded by a magnetic field with lines of force as indicated in figure 9813-5. When the wire is wound into the form of the coil, the lines of force will be as indicated in figure 9813-6. The convention used throughout this section of the NAVSHIPS Technical Manual is that current flow in a wire connected to the terminals of a battery is in the direction from the positive terminal to the negative terminal. With this convention, the relation between the direction of current flow and the direction of the lines of magnetic force is as shown in figures 9813-5. and 9813-6.

9813.228 M COIL

1. **Location.** The M or main coil encircles the ship in a horizontal plane which is usually at about the water level. (See figure 9813-7.)

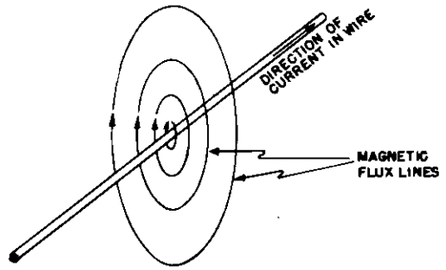


Figure 9813-5. Magnetic field around wire carrying current.

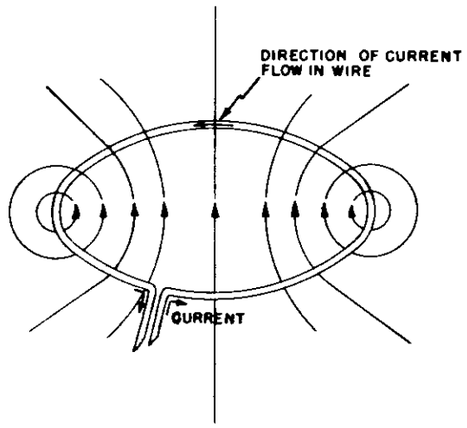


Figure 9813-6. Magnetic field of coil carrying current.

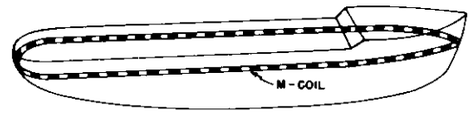


Figure 9813-7. M or main coil.

2. **Function.**

a. The function of the M coil is to produce a magnetic field which counteracts the magnetic field produced by the vertical permanent and the vertical induced magnetization of the ship.

b. Figure 9813-8 illustrates the magnetic field produced by the vertical magnetization of the ship. Figure 9813-9. illustrates the magnetic field produced by the M coil. Note that this is opposed to the magnetic field produced by the vertical magnetization of the ship. If the M coil field were everywhere exactly equal and opposite the field produced by vertical magnetization, the resultant of the two magnetic fields would everywhere be equal to zero. While it is not possible to attain such a perfect match, the resultant is very much less than the field produced by the vertical magnetization of the ship.

3. **Coil strength.** As pointed out in article 9813.226, the permanent vertical magnetization of a ship is constant while the vertical induced magnetization varies with magnetic latitude and with roll and pitch of the ship, but not with heading. The resultant of the permanent and induced vertical magnetization will also vary with magnetic latitude and with roll and pitch of the ship, consequently, the M coil strength must be changed when the ship changes magnetic latitude in order to keep the M coil field as nearly as possible equal and opposite the field produced by the ship's vertical magnetization. The change in vertical magnetization caused by roll and pitch of the ship is relatively small, and only in special cases is it necessary to change the M coil strength to compensate for this. The methods used to control degaussing coil strength are discussed in article 9813.234.

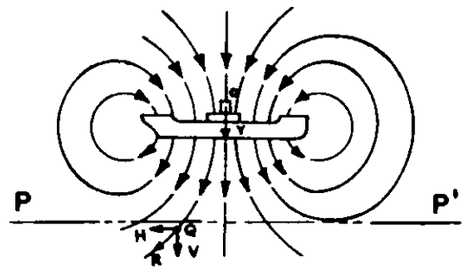


Figure 9813-8. Magnetic field due to vertical magnetization of ship.

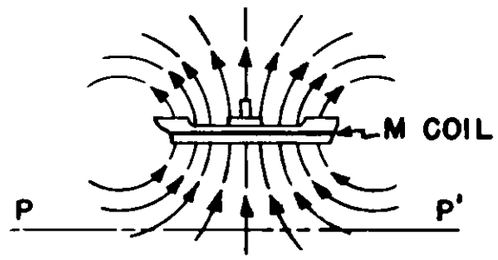


Figure 9813-9. Magnetic field due to M coil energized with positive polarity.

9813.229 F AND Q COILS

1. **Location.** The F or forecastle coil encircles the forward one-fourth to one-third of the ship and is usually just below the forecastle or other uppermost deck. The Q coil encircles the after one-fourth to one-third of the ship and is usually just beneath the quarterdeck or other uppermost deck. These locations are shown in figure 9813-10.

2. **Function.** The function of the F and Q coils is to counteract the magnetic field produced by the ship's longitudinal permanent and induced magnetization. It will be seen from figure 9813-11 that the shape of the magnetic field produced by the F and Q coils is somewhat different from that produced by the ship's longitudinal magnetization but that the two fields are, in general oppositely directed below the bow and stern of the ship.

3. **Coil strength.** The ship's longitudinal permanent magnetization is constant but the longitudinal induced magnetization changes with heading and magnetic latitude. The F and Q coil strengths must, therefore, both be changed

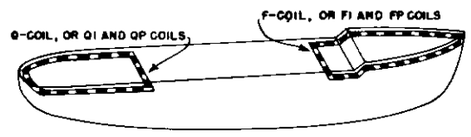


Figure 9813-10. F (forecastle) and Q (quarterdeck) coils.

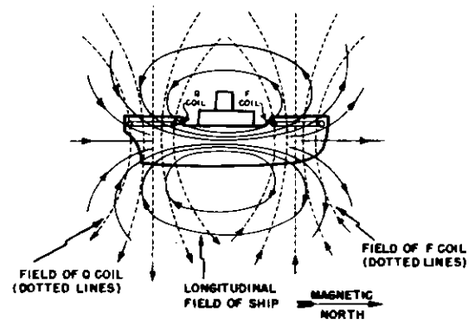


Figure 9813-11. Longitudinal field of ship and neutralizing fields of F-Q coils.

whenever the ship changes either its course or its magnetic latitude, otherwise the coil strengths would not have the right values to counteract the changed longitudinal induced magnetization. Note that two adjustments must be made, one to change the F coil strength, and one to change the Q coil strength.

9813.230 FI-QI AND FP-QP COILS

1. **Location.** In numerous installations the conductors of the F and Q coils are connected to form two separate circuits designated FI-QI coil and FP-QP coil. The FI-QI coil consists of an FI coil connected in series with a QI coil so that the same current flows in both. The FP-QP coil is similar. Installations with FI-QI and FP-QP coils are known as split-coil installations because the F and Q coils are each split into two coils.

2. **Coil strength.**

a. The FI-QI coil is used to counteract the magnetic field produced by the ship's longitudinal induced magnetization. Since the longitudinal induced magnetization changes when the ship changes heading or magnetic latitude, the strength of the FI-QI coil must be changed accordingly.

b. The FP-QP coil is used to counteract the magnetic field produced by the ship's longitudinal permanent magnetization. Since the longitudinal permanent magnetization does not change when the ship changes heading or magnetic latitude, no change in FP-QP coil strength is needed. As compared to F and Q coils, FI-QI and FP-QP coils require only one adjustment of coil strength, instead of two, when the ship changes heading or magnetic latitude.

9813.231 L COIL

1. **Location.** The L or longitudinal coil resembles a solenoid. It has loops in vertical planes parallel to the frames of the ship. (See figure 9813-12.)

2. **When used.** An L coil is always used when compensation for pitch of the ship is required.

3. **Function.** The function of the L coil is to counteract the magnetic field produced by the ship's longitudinal permanent and induced magnetization. It does this better than F and Q coils, or FI-QI and FP-QP coils. For this reason, an L coil is often used in mine warfare vessels.

4. **Coil strength.** Since the longitudinal induced magnetization changes when the ship changes heading or magnetic latitude, the L coil strength must be changed accordingly. When compensation for pitch is required, the L coil strength must also be changed as the ship pitches.

9813.232 A COIL

1. **Location.** The A coil has loops in vertical fore-and-aft planes. (See figure 9813-13.)

2. **Function.** The function of the A coil is to produce a magnetic field which will counteract the magnetic field caused by athwartship permanent and induced magnetization.

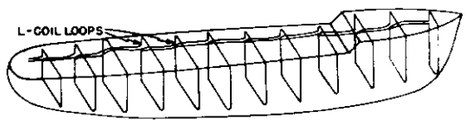


Figure 9813-12. L or longitudinal coil.

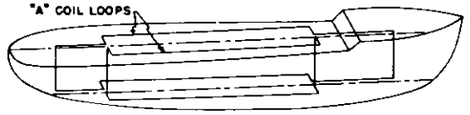


Figure 9813-13. A or athwartship coil.

3. **Coil strength.** Since the athwartship induced magnetization changes when the ship changes heading or magnetic latitude, the A coil strength must be changed accordingly. When compensation for roll is required, the A coil strength must also be changed as the ship rolls.

9813.233 NUMBER OF COILS USED

Different combinations of the degaussing coils described above are installed aboard ship. The combination selected for a particular ship will depend upon its size and intended service. The most common combinations used are:

M coil only.
M, F, Q.
M, FI-QI, FP-QP.
M, F, Q, A.
M, FI-QI, FP-QP, A.
M, L, A.
Malmaux (M, A, L, M auxiliary).

9813.234 COIL STRENGTH

1. **Ampere turns.** The magnetic field produced by a degaussing coil (coil strength) is proportional to ampere turns, NI, the product of the number of turns in the coil by the coil current in amperes. A specified number of ampere turns can be obtained by using one turn and a current numerically equal to the required ampere turns, or by using more turns and a correspondingly smaller current.

2. **Changing coil strength.** As pointed out above, the coil strengths of all degaussing coils, except the FP-QP coil, must be changed when the ship changes its magnetic latitude. In addition, the coil strengths of the F, Q, FI-QI, L, and A coils must be changed when the ship changes heading. When compensation for pitch and roll is required, the M coil strength must be changed when the ship pitches or rolls, the L, F, Q, or FI-QI coil strength must be changed when the ship pitches, and the A coil strength must be changed when the ship rolls. Coil strength is changed by changing the ampere turns. This can be done either by:

a. Changing current-turns constant.
b. Changing turns-current constant.
c. Changing both current and turns.

The first of these is the only method now used for new construction. In some installations made in the past, the second and third methods were used.

9813.235 SINGLE CONDUCTOR AND MULTICONDUCTOR COILS

Degaussing coils may be made with either single conductor or multiconductor cables.

1. **Single conductor coils.** Coils with single conductor cables have only one turn or a small number of turns. They carry a current of the order of hundreds of amperes at low voltages of the order of 10 to 65 volts. Single conductor coils or a combination of some single conductor and some multiconductor coils are usually specified for the M, F, Q and A coils used on large ships.

2. **Multiconductor coils.** When multiconductor cables are used for degaussing coils, the conductors in one or more cables are connected in series to give a considerable number of turns. The current in each conductor is of the order of tens of amperes at voltages of the order of 120 to 240 volts. Multiconductor cables for degaussing coils are usually specified for the high voltage, low current systems employed on smaller ships or for the FI-QI and FP-QP coils used on large ships.

9813.236 POWER SUPPLY

The degaussing coils must be energized with direct current. Current is supplied either by 120-volt or 240-volt, dc, ship's service generators or by degaussing power supply equipment, such as motor generators or metallic rectifiers, installed for the specific purpose of energizing the degaussing coils. .

9813.237 OPERATOR CURRENT CONTROL

Many of the older degaussing installations have operator current control only, that is, an operator adjusts the degaussing coil currents when they have to be changed because of a change in ship's heading, magnetic latitude, or both.

1. **Constant voltage power supply.** When power for a degaussing coil is taken from a constant voltage dc generator, the operator adjusts a rheostat connected in series with the coil and power supply. Manually operated rheostats are used in some installations; motor-operated rheostats with remote control in others. Motor-operated rheostats are also used with automatic systems and are equipped for emergency manual operation in case of need.

2. **Motor-generator power supply.** When power for a manually controlled degaussing coil is taken from a degaussing motor-generator, the operator adjusts a manually-operated or a motor-operated rheostat in the generator field circuit. This changes the generator voltage and brings the degaussing coil current to the desired value.

3. **Wiring diagrams.** Figure 9813-14 is an elementary wiring diagram of an installation in which rheostats are used to control the M, FI-QI, and FP-QP coil currents. Figure 9813-15 is an elementary wiring diagram of an installation in which the M, F, and Q coil currents are supplied by variable voltage degaussing motor-generators with generator voltage controlled by the generator field currents. Figure 9813-16 is an elementary diagram of an installation with a variable-voltage motor-generator for the M coil and with rheostat control of FI-QI and FP-QP coil currents. The Degaussing Folder on each ship has an Installation Certificate which shows the number and location of coils and a schematic diagram of the degaussing circuits. Further details of the degaussing installation are shown on the degaussing plans carried by the ship.

9813.238 AUTOMATIC CURRENT CONTROL

1. **Use.** Automatic degaussing control equipment is now installed on all new construction naval ships for which the degaussing specifications require that the coil currents be changed when the ship's heading changes.

2. **Compensation provided.** Most of the automatic degaussing control equipment now installed automatically sets the coil currents to compensate only for the change in induced magnetization caused by a change in ship's heading. In some installations, chiefly for minesweepers, the coil currents are also automatically adjusted to compensate for the changes in induced magnetization caused by pitch and roll.

a. **Heading only.** When compensation is for heading only, a heading signal is obtained from the ships's gyro compass system. For an L, F, Q, or an FI-QI coil, a signal is derived which is proportional to the cosine of the ship's heading. This signal is amplified and fed to the appropriate power supply so that its output is proportional to the cosine of the ship's heading. This is the variation needed to compensate for changes in longitudinal induced magnetization caused by changes in heading. For an A coil, the coil current is regulated to be proportional to the sine of the ship's heading.

b. **Heading and pitch and roll.** In cases where pitch and roll compensation is needed, additional signals are obtained from the gyro stabilizer system and fed into the automatic degaussing control equipment. A computer element in the control equipment makes use of the heading signal and pitch and roll signals, and causes the degaussing coil currents to vary in a manner which will compensate for heading and pitch and roll.

3. **Magnetic latitude and variation settings.** All types of gyro controlled automatic degaussing control equipment require manual settings for magnetic latitude and magnetic variation.

4. **Emergency manual control.** All types of automatic degaussing control equipment are equipped with emergency manual controls for use if the automatic controls become inoperative.

5. **Types of equipment.** A detailed description of each degaussing control equipment is given in its technical manual. A brief description of the different types is as follows:

Type	Description
SM	Magnetic amplifier type control. Controls selenium rectifier type power supply. (See figures 9813-17A. and 9813-17B.)
GM	Magnetic amplifier type control. Controls field of generator of degaussing motor-generator. (See figures 9813-18A. and 9813-18B.)
FM	Magnetic amplifier type control. Controls field of exciter of degaussing motor-generator.
RM	Magnetic amplifier type control. Controls motor of motor-operated rheostat. Rheostat is in series with degaussing coil which is connected across the ship's constant voltage dc power supply.

B. Polarity, Designation, and Marking

9813.251 DIRECTION OF ELECTRIC CURRENT

The convention used here is that the direction of electric current in a wire connected to a battery is from the positive terminal to the negative terminal. With this convention, the relation between the direction of current and the direction of the magnetic lines of force around the wire is as shown in figure 9813-5.

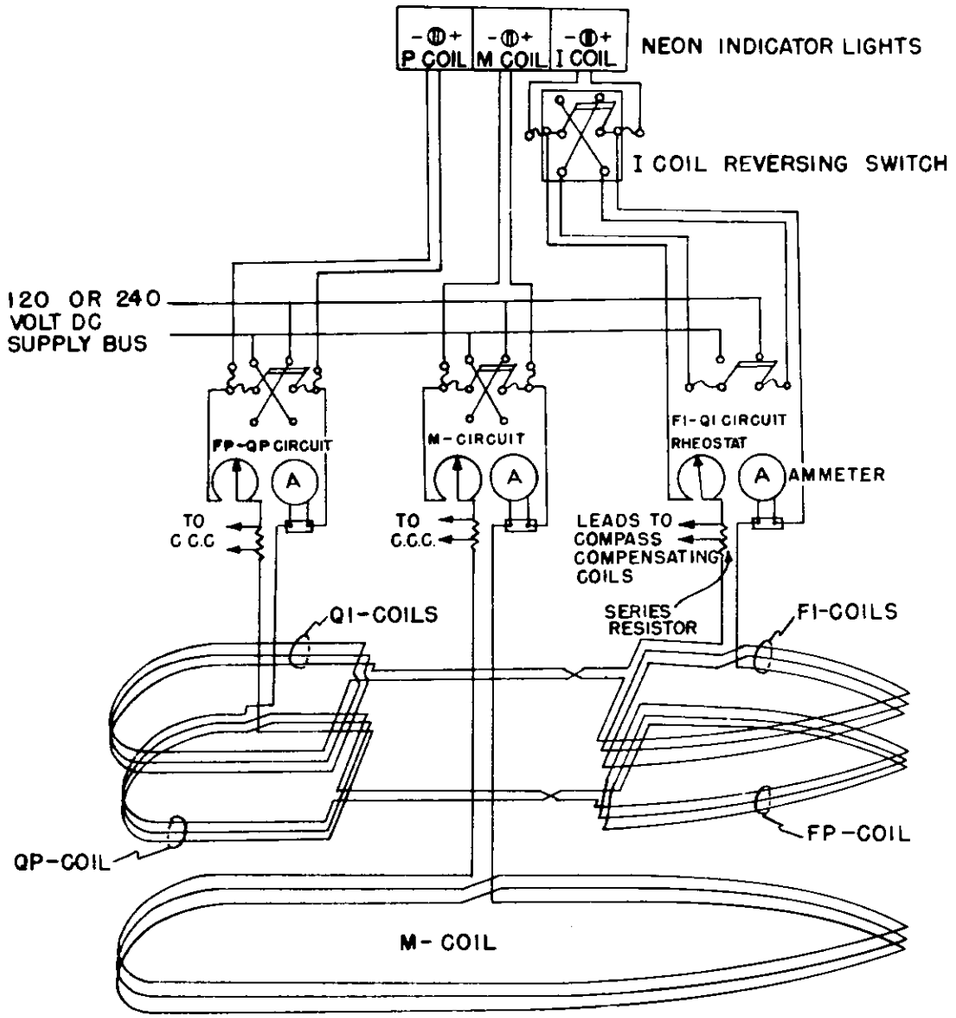


Figure 9813-14. M, FI-QI, and FP-QP coil deguassing installation with rheostat controls.

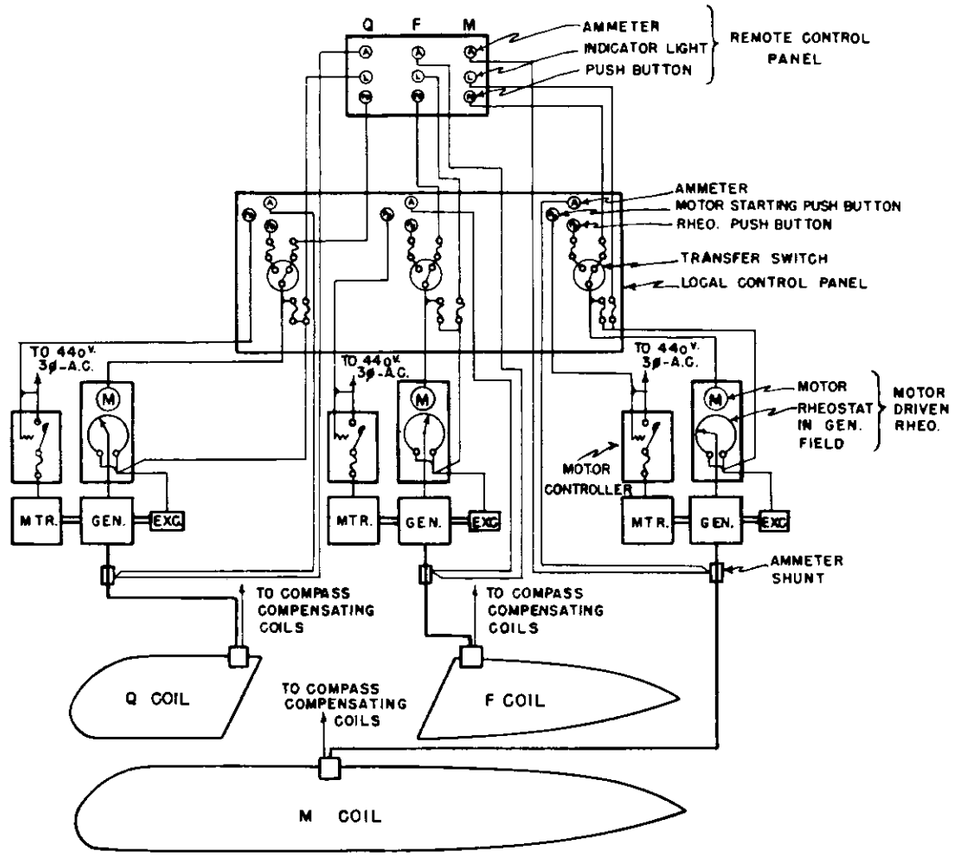


Figure 9813-15. Typical M, F, and Q coil motor-generator degaussing installation.

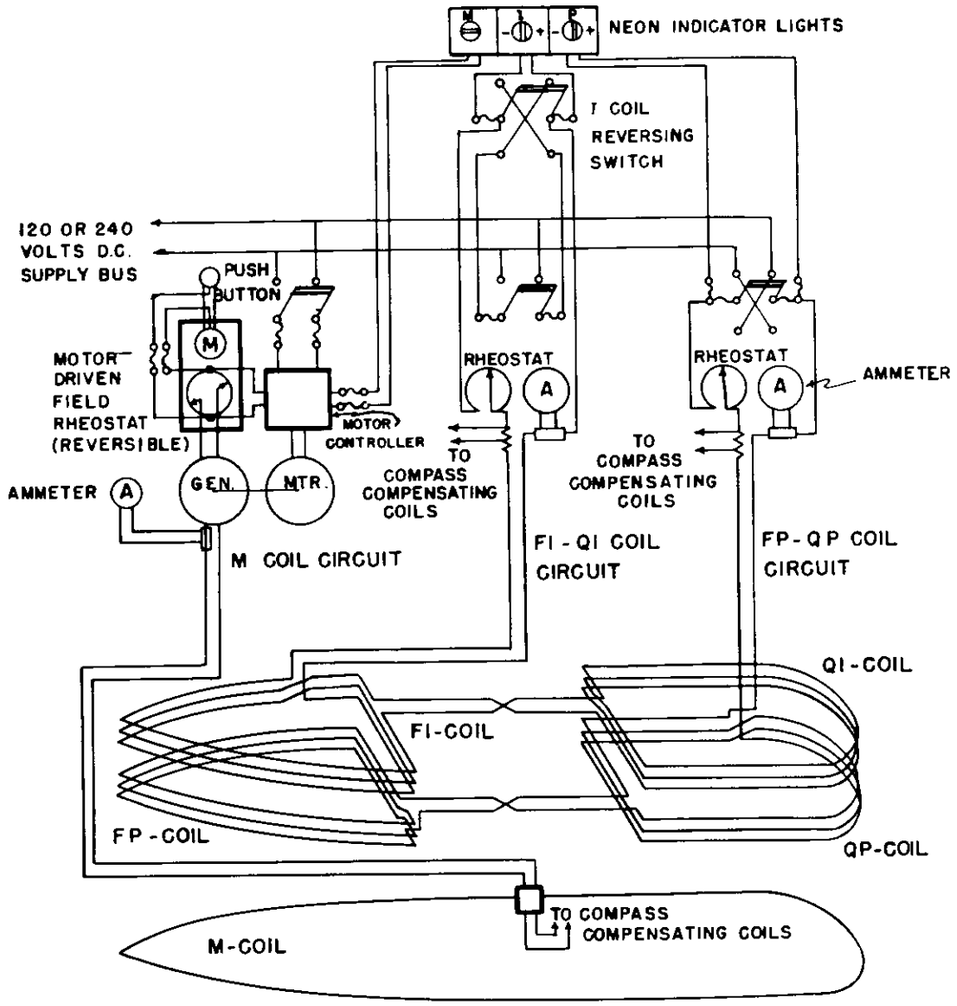


Figure 9813-16. M, FI-QI, and FP-QP coil degaussing installation using combination rheostat and motor generator control.

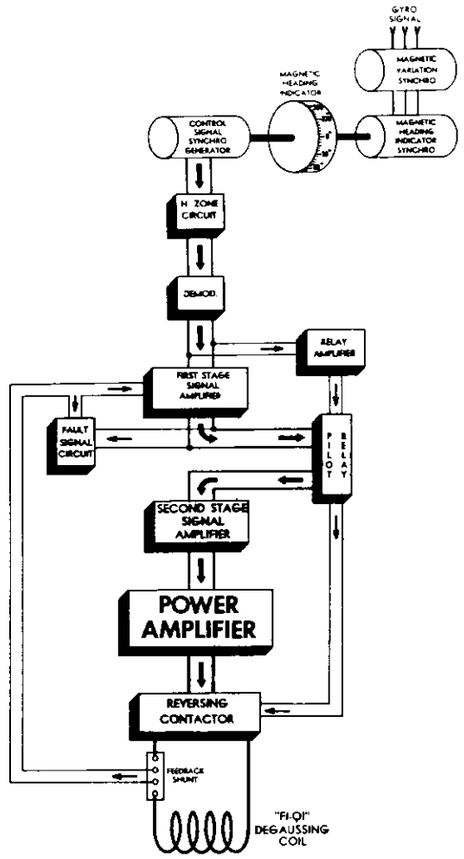


Figure 9813-17A. Block diagram for a typical type SM automatic degaussing control equipment giving heading compensation only.

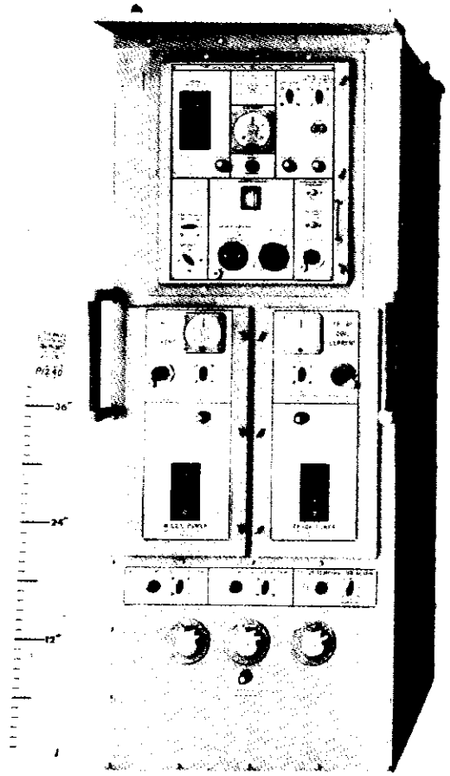


Figure 9813-17B. Typical type SM automatic degaussing control equipment (heading compensation only).

9813.252 CHECK ON DIRECTION OF CURRENT

1. The direction of current in a degaussing coil can be checked by using either a degaussing polarity indicator (such as Federal Stock Number H6625-314-4162) or a small hand compass. The polarity indicator dial is marked to show direction of current. Compass deflections which correspond to positive degaussing coil currents are given in article 9813.253.

2. To avoid reversing the needle in the polarity indicator or compass, neither should be brought too close to degaussing cables. In use, whichever one is used should be moved towards the cables until a good deflection is obtained, and no closer. In addition, the indicator or compass should be checked after each test to make sure the needle has not reversed.

9813.253 POLARITY OF DEGAUSSING COILS

1. In M, F, Q, FI, FP, QI, and QP coils, the direction of positive current is forward on the starboard side (counterclockwise as viewed from above the coil). A small compass held above the degaussing cable will point outboard for positive current in the coil.

2. In the A coil, the direction of positive current is aft in the upper limb (counterclockwise as viewed from the starboard side.) A small compass held below the upper run of the A coil will point to starboard for positive current in the coil.

3. In the L coil, the direction of positive current is upward on the starboard side (counterclockwise as viewed from the after side of the coil). A small compass held below the upper run where it crosses athwartships will point aft for positive current in the coil.

4. The FI and QI loops of an FI-QI coil are connected in series so that when current is positive in the FI loops it is negative in the QI loops. The polarity of the FI-QI coil is the same as the polarity of the FI loops, that is, the ammeter for the FI-QI coil indicates positive current when the FI loops are positive.

5. The FP and QP loops of an FP-QP coil on a new installation are connected in series, so that when current is positive in the FP loops, it is negative in the QP loops. If ranging the ship (article 9813.287) shows that it is

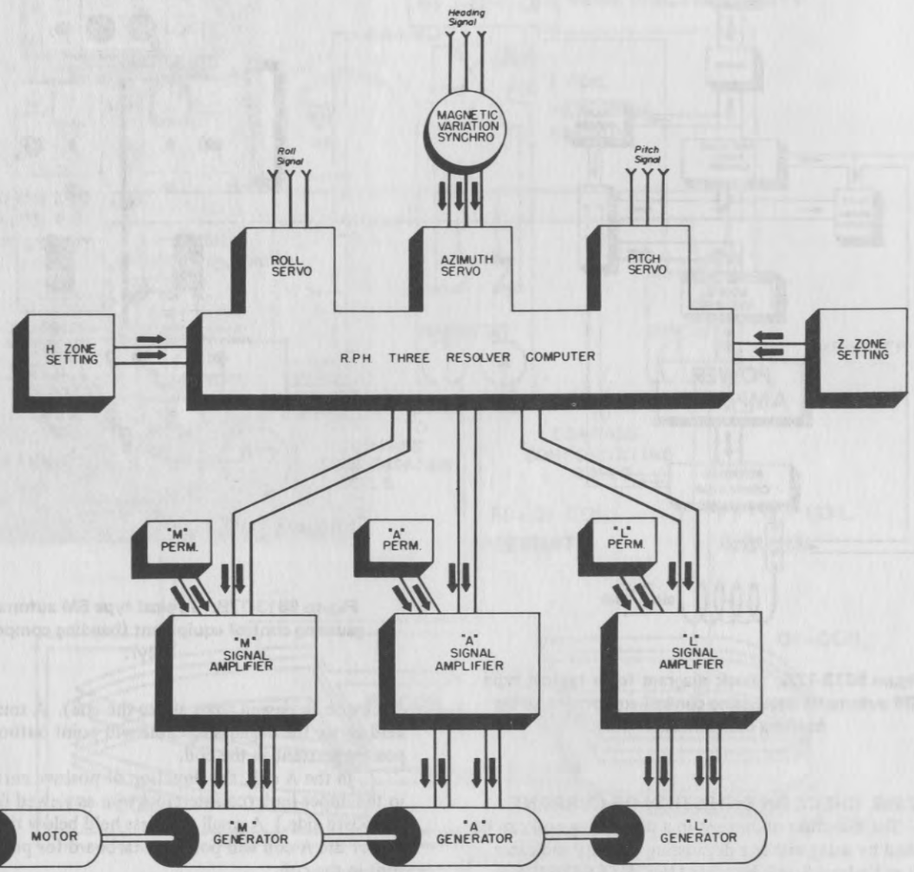


Figure 9813-18A. Block diagram for a typical type GM automatic degaussing control equipment giving heading, roll, and pitch compensation.

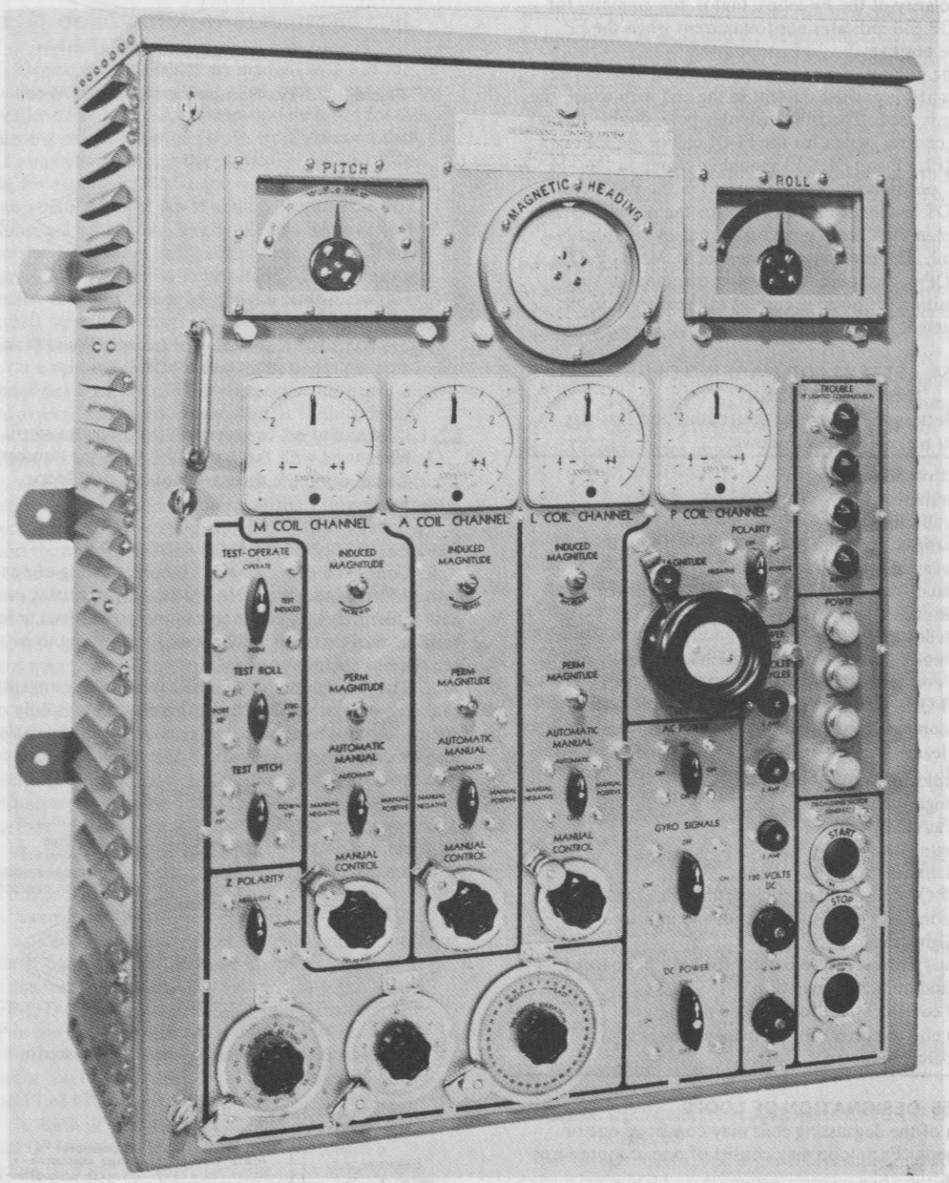


Figure 9813-18B. Typical type GM automatic degaussing control equipment (heading, roll, and pitch compensation).

desirable to have the FP and QP loops connected to produce fields in the same direction, they should then be reconnected. The polarity of the FP-QP coil is the same as the polarity of the FP loops, that is, the ammeter for the FP-QP coil indicates positive current when the FP loops are positive.

6. The pointer of a zero center ammeter shall deflect to the right for positive current in the coil with which the ammeter is used. The DPDT (double-pole, double-throw) heading control switch for the FI-QI coil of the split-coil system (FI, FP and QI, QP) should be closed in the "North" position for positive current in the FI-QI coil. The DPDT heading control switch for the A coil should be closed in the "East" position for positive current in the A coil. The reversing switches for M, Maux, F, Q, and FP-QP coils should be closed in the upper or right-hand position for positive current in these coils, in all cases where knife switches are used.

9813.254 LETTERS FOR MARKING DEGAUSSING INSTALLATIONS

The letters to be used for designating and marking and their meanings are as follows:

A	Athwartships coil
AMM	ammeter
AX	A auxiliary coil
CC	compass compensating coil
D	degaussing system
F	forecastle coil to correct for both permanent and induced magnetism
FDR	feeder
FI	F coil to correct for induced magnetism
FP	F coil to correct for permanent magnetism
I	FI-QI coil—used in conjunction with feeders, compass compensating coil, and indicator light leads
IL	indicator light
L	longitudinal coil
LX	L auxiliary coil
M	main coil
MX	Maux (main auxiliary) coil
P	FP-QP coil—used in conjunction with feeders, compass compensating coil, and indicator light leads
Q	quarterdeck coil to correct for both permanent and induced magnetism
QI	Q coil to correct for induced magnetism
QP	Q coil to correct for permanent magnetism
SPR	spare conductor

9813.255 DESIGNATION OF LOOPS

Each of the degaussing coils may consist of one or more loops. Each loop may consist of one or more turns of cable.

1. The number 1, when used with the M, F, of Q coil (MI, FI, QI), or the FI, FP, QI, or QP loops of the FI-QI or FP-QP coils, shall designate the longest loop. Other loops in each coil shall be numbered in sequence 2, 3, 4, and so on from bow to stern. (See figures 9813-19 and 9813-20.)

2. The number 1, when used with the L coil (L1), shall designate the forward loop. Other loops are designated

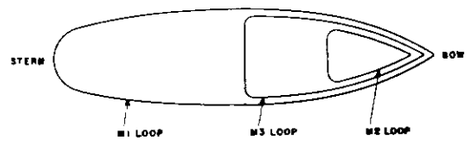


Figure 9813-19. Numbering of loops in M coil.

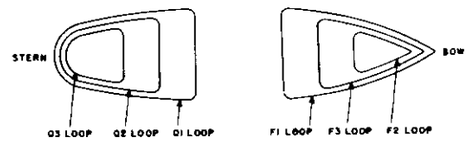


Figure 9813-20. Numbering of loops in F and Q coils, and FI-QI and FP-QP coils.

L2, L3, L4 and so on, in sequence, from bow to stern.

3. When used with the A coil (A1, A2), the numbers 1 and 2 shall designate the starboard and port loops, respectively.

9813.256 DESIGNATION OF CIRCUITS

1. Consider a degaussing coil loop consisting of one turn of four-conductor cable. Although degaussing cables have either only one conductor or more than four, a four-conductor cable serves to illustrate the meaning to be attached to circuits.

2. The four conductors in the cable can be connected as shown in figure 9813-21. In this case there is only one circuit. Alternatively, the four conductors in the cable may be connected as shown in figure 9813-22. In this case there are two circuits.

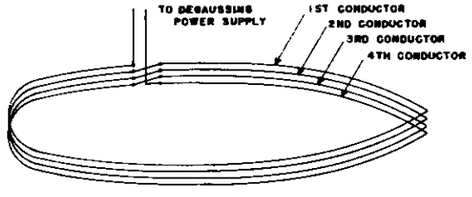


Figure 9813-21. M coil with a single circuit.

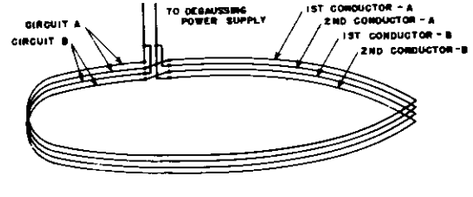


Figure 9813-22. M coil with two parallel circuits.

3. The letters A, B, C, and so on are used as indicated in article 9813.261.1. to designate the circuit in which a particular conductor is connected.

9813.257 DESIGNATION OF DEGAUSSING COIL CABLES

1. Degaussing coil cables are marked with a D for degaussing, a dash, a number 1, 2, 3, etc., to indicate the particular cable in a coil, the appropriate letter for the degaussing coil designation (M, F, etc.), a second dash, and a number to indicate the particular section of the cable, for example, D-2M-1 for the number 1 section of the number 2 cable of the M coil. A section of a degaussing coil cable is the length of cable between two successive connection or through boxes. The number designation for a cable is to be retained throughout one complete turn in a coil or loop if the cable makes a complete turn, or for as far as the cable goes if it does not make a complete turn, hence, the number designation for a cable (the number which precedes the coil designation) does **not** change when the cable goes through an intermediate connection or through box, the number designation for a section does. Section numbers are assigned as follows:

a. For a cable in a horizontal coil, section number 1 is assigned to the section which is farthest forward, and the remaining sections are numbered in sequence going around the coil in a counterclockwise direction as viewed from above.

b. For a cable in the A coil, section number 1 is assigned to the section which is highest and farthest forward, and the remaining sections are numbered in sequence going around the coil in a counterclockwise direction as viewed from the starboard side.

c. For a cable in the L coil, section number 1 is assigned to the section which is highest and farthest forward, and the remaining cable sections are numbered in sequence going around each loop in a counterclockwise direction as viewed from the after side of the loop and going from loop to loop in the direction from fore to aft.

d. The section number should always be included in a degaussing coil cable designation even if the cable has only one section.

2. **Examples.**

a. Each of the four cables in the FI and FP loops shown in figure 9813-23 makes a complete turn and has only one section, hence, carries section number 1, D-1FIFP-1, D-2FIFP-1, D-3FIFP-1, and D-4FIFP-1. The FIFP in the cable designation shows that the cables are used for both the FI and FP loops. A cable used exclusively for the FI or FP loop would carry the letter designation FI or FP, as the case may be.

b. Each of the number 1, 2, and 3 cables of the QI and QP loops shown in figure 9813-23 makes a complete turn and has three sections. The number 4 cable makes only part of a turn and has only one section.

9813.258 DESIGNATION DF FEEDER CABLES

1. **Power supply cables.** Degaussing power supply feeder cables are marked with a D for degaussing, a dash, FDR for feeder, a letter to indicate the coil to which the feeder carries current, a second dash, and a section number. A section in a feeder cable is the length of cable between two successive items of equipment. Sections should be numbered in sequence starting from the degaussing panel, as D-FDRI-1, D-FDRI-2, and so on, if there are several sections, or D-FDRI-1 if there is only a single section. When two or more feeder cables run to a coil, they should be numbered as indicated for degaussing coils, for example, D-1FDRM-1 and D-2FDRM-1 for two feeder cables to the M coil (see figure 9813-23.). When single conductor cables are used as feeder cables, the cable with the positive conductor should be numbered 1; the cable with the negative conductor should be numbered 2. If more than two single-conductor cables are used for the feeders to one coil, odd numbers should be used for the feeders with positive conductors.

2. **Interconnecting cables.** Interconnecting cables between FI and QI loops or FP and QP loops are considered as feeder cables and bear the designation of the loop to which they carry power. For example, the feeder cable which carries power from the degaussing panel to the FI-QI coil is designated D-FDRI-1, D-FDRI-2, and so on, irrespective of whether it connects to the FI loop or the QI loop. If the feeder cable for the FI-QI coil connects to the FI loop, the interconnecting cable between the FI and QI loops carries power from the FI to the QI loop and is designated D-FDRQI-1. If, on the other hand, the feeder from the degaussing panel connects to the QI loop, the interconnecting cable between the FI and QI loops carries power from the QI to the FI loop and is designated D-FDRFI-1 as illustrated in figure 9813-23.

3. **Compass compensating coil and indicator light cables.** Feeder cables for compass compensating coils, ammeters, or indicator lights should be designated D-FDR followed by a dash and letters to indicate the equipment to which they are connected, for example, D-FDRM-CC for an M coil compass coil feeder. Section numbers are omitted.

4. **Examples.** (See figure 9813-23.)

a. D-FDRP-1 designates the feeder cable to the FP-QP coil. In the arrangement shown in figure 9813-23., this cable runs directly from the degaussing panel to the coil and has only one section.

b. D-1FDRM-1 and D-2FDRM-1 designate two feeder cables to the M coil.

c. D-FDR-CC designates the compass coil feeder. The coil designation need be added only if the compass coil leads for different coils are run in separate cables. Thus, D-FDRM-CC would be the compass coil lead to the M coil.

d. D-FDR-CC-IL designates a cable used jointly for compass coils and indicator lights.

e. D-FDRI-1, D-FDRI-2, and D-FDRI-3 designate the three sections of the FI-QI feeder.

9813.259 DESIGNATION AND MARKING OF OTHER CABLES

All feeders, mains, and other cables supplying power to degaussing switchboards, power supplies and control panels shall be designated and marked as specified for power and lighting circuits in accordance with Navy Department General Specifications for Ships of the United States Navy, Section S28-2.

9813.260 DESIGNATION OF CONDUCTORS–GENERAL

Both the cable designation given in articles 9813.257 and 9813.258 and the conductor designation given in articles

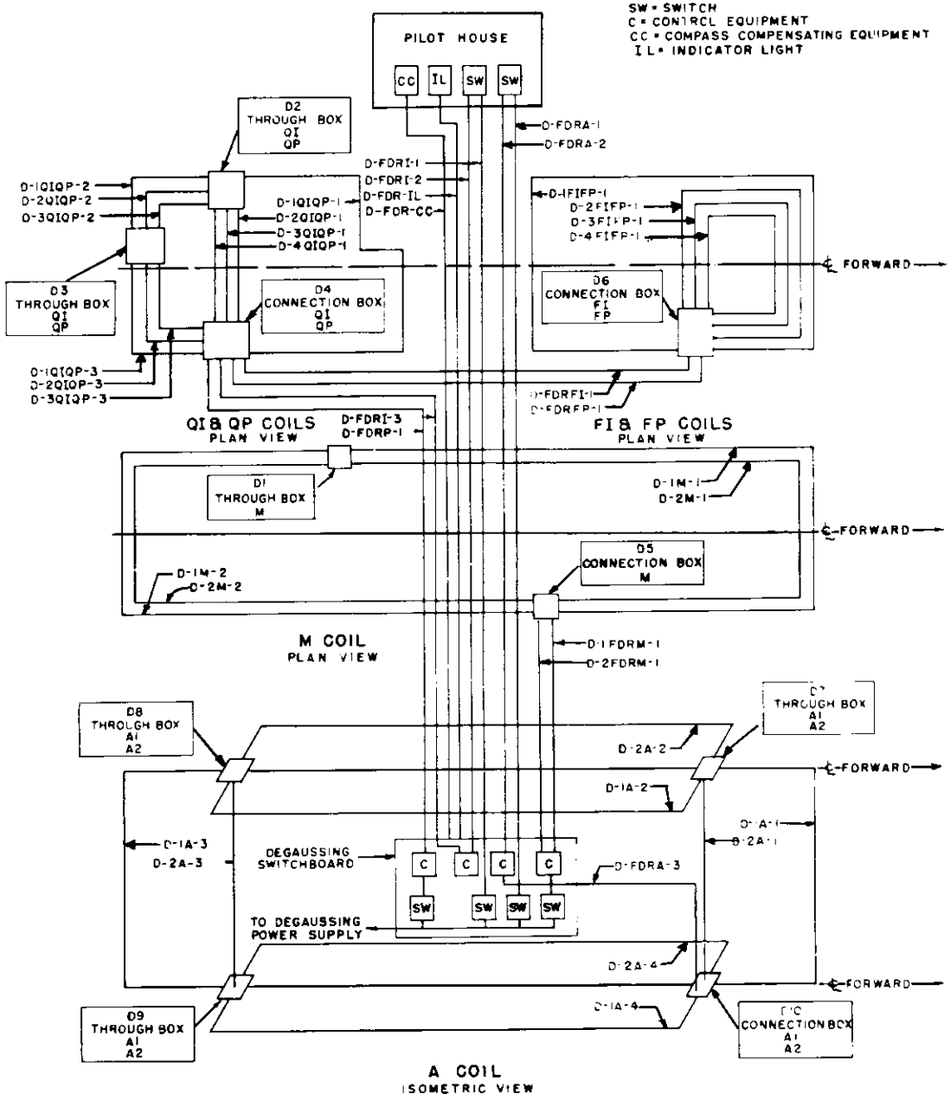


Figure 9813-23. Making scheme for degaussing coil cables, feeder cables, and connection and through boxes.

9813.261 and 9813.262 should be used even when the cable has only one conductor. This is because the conductor designation gives some information which the cable designation does not.

9813.261 DESIGNATION OF DEGAUSSING COIL CONDUCTORS

1. **Single conductors.** Degaussing coil conductors (except spare conductors, for which see articles 9813.261, 2., are to be marked by hot stamping (branding) insulating sleeving Mil. Spec. MIL-I-631, type F, grade A, form U (white) of appropriate size. The conductor marking shall conform with that of the terminal to which it connects. The following symbols, as applicable, should be used, arranged in the order given:

M, F, Q, FI, etc . . . . degaussing coil

1, 2, 3, etc . . . . . degaussing coil loop number. (See article 9813.255.) Omit the number if the coil has only one loop.

A, B, C, etc . . . . . First, second, third circuit in the coil. (See article 9813.256.) Use A if there is only one circuit.

1, 2, 3, etc . . . . . first, second, third series conductor in a circuit. A conductor which is connected in a degaussing coil or loop makes a complete turn and retains the same number designation throughout the entire turn.

+ and – . . . . . positive and negative geometrical polarity as follows:

a. The ends of M, F, Q, FI, FP, QI, and QP coil conductors approaching a box (article 9813.264) in the counterclockwise direction as observed from above the coil (for example, from aft for a box on the starboard side) will be positive.

b. The ends of A coil conductors approaching a box in the counterclockwise direction as observed from the starboard side of the coil (for example, from aft for a box in the lower limb of the coil) will be positive.

c. The ends of L coil conductors approaching a box in the counterclockwise direction as observed from the after side of the coil (for example, from below a box on the starboard side) will be positive.

d. The conventions used for geometrical polarity, positive direction of current flow (article 9813.251), and positive direction of currents in degaussing coils (article 9813.253), are so related that **when the current in a degaussing coil is negative, the electrical and the geometrical polarties of conductor ends are the same.**

2. **Spare conductors.** Spare conductors are marked with hot stamped plastic insulating sleeving with the same designations as for other conductors, except as follows:

a. For a spare conductor which is available for a complete turn, omit the circuit designation, A, B, C, etc., and substitute SPR in its place.

b. For a spare conductor which is not available for a complete turn use the designation of the cable in which the spare conductor is contained, including the cable section number, and follow the cable designation with SPR, a number to identify the spare conductor, and + or – to indicate geometrical polarity, for example, D-3M-1SPR2+.

3. **Paralleled conductors.** Conductors paralleled together **within a portion of** a particular series or parallel circuit and **not** constituting regular full length circuits, receive the same conductor designation that equivalent single conductors would receive.

4. **Examples.**

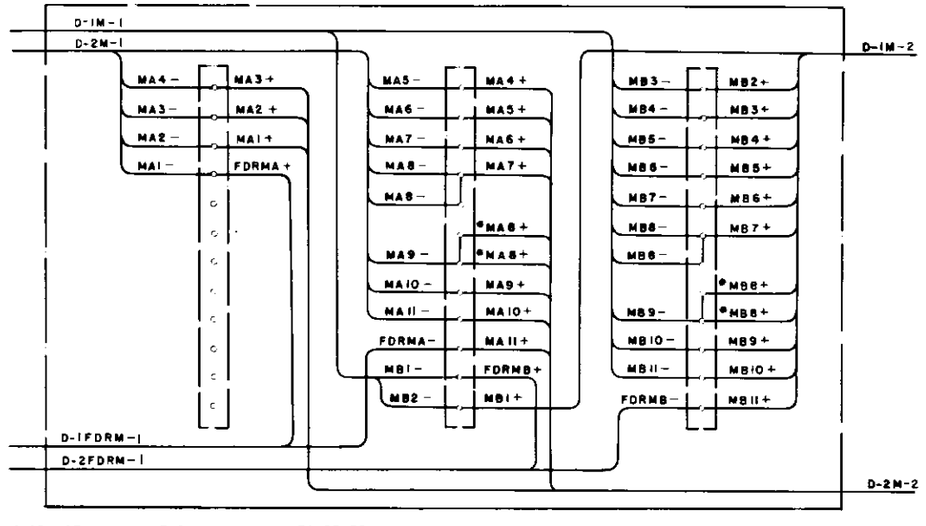
a. MA5 - designates the M coil (single loop since the loop number is omitted), the A parallel circuit, the fifth series conductor in the circuit, and the end approaching a box in the clockwise direction as observed from above the coil. (See figure 9813-24.)

b. M1B10 - designates the M1 loop of the M coil, the B parallel circuit, the tenth series conductor in the circuit, and the end approaching a box in the clockwise direction as observed from above the coil.

c. QP2A6+ designates the QP2 loop of the FP-QP coil, the A parallel circuit, the sixth series conductor in the circuit, and the end approaching a box in the counterclockwise direction as observed from above.

d. QP2SPR2+ designates the QP2 loop of the FP-QP coil, the number 2 spare conductor, and the end approaching a box in the counterclockwise direction as viewed from above.

e. D4QIQP-1SPR9 - designates a spare conductor which is in the number 1 section of the number 4 cable of the QI-QP coil and which is not available for a complete loop, hence, is given the cable designation. The 9 is for the ninth spare conductor, and the - is for the end approaching a box in the clockwise direction as observed from above.



* TWO OR MORE CONDUCTORS PARALLELED TOGETHER WITHIN A PARTICULAR SERIES OR PARALLEL CIRCUIT RECEIVE THE SAME CONDUCTOR DESIGNATION AS AN EQUIVALENT SINGLE CONDUCTOR WOULD RECEIVE.
12 CONDUCTOR CABLE USED FOR M COIL.

Figure 9813-24. Typical single loop M coil connection box (box D5 of Fig. 9813-23) as seen looking to starboard.

9813.262 DESIGNATION OF FEEDER CABLE CONDUCTOR

1. **Power supply cables.** Conductors in cables for power supply to degaussing coils are designated by the following symbols, as applicable, in the order given:

FDR . . . . . feeder

M, F, Q, FI, etc . . . . . degaussing coil

1, 2, 3, etc . . . . . coil loop number. The loop number is omitted if power for the entire coil is fed into one loop.

A, B, C . . . . . circuit designation. Is used only when individual parallel circuits are fed separately, for example, where multicircuit rheostats are used.

+ and – . . . . . positive and negative electrical polarity when the controls are in the position for positive current. (See article 9813.253.)

2. **Compass compensation and indicator light cables.** Conductors in compass compensating and indicator light feeder cables are designated with the following symbols, in the order given:

M, F, Q, I, P, A, L, etc degaussing coil

CC . . . . . for compass compensating coil conductors, or,

II . . . . . indicator light conductors

+ or –. . . . . electrical polarity when current in coil is positive.

3. **Examples.**

a. FDRP+ designates the FP-QP coil feeder conductor which has positive electrical polarity when the controls are set for positive current in the FP-QP coil. (See figure 9813-25.)

b. M-CC+ and M-CC– designate the two compass coil conductors from the M coil. (See figure 9813-25.)

c. I-IL+ and I-IL– designate the two indicator light conductors for the FI-QI coil. Polarities are marked for positive polarity in the FI coil. (See figure 9813-25.)

9813.263 CABLE AND CONDUCTOR TAGS

1. Cable and conductor tags on naval ships should conform to section S28-2 of the General Specifications for ships of the United States Navy and 9813.261. Tags and markings are to be rigidly attached to the cable or conductor so that the tag marking is parallel to the axis of the cable or conductor.

2. Cable and conductor markings for merchant vessels are the same as for naval vessels.

3. In both naval and merchant vessels, a degaussing coil conductor marking is to be fastened to each end of a conductor inside the connection or through box.

9813.264 CONNECTION AND THROUGH BOXES–DEFINITIONS

Connection and through boxes are identical in construction but differ in use.

1. A connection box is a watertight box used to connect loops together, to connect conductors in series, to reverse turns, etc. The power supply connection for a coil and all adjustments of ampere turn ratios between loops are made within connection boxes. The power supply cable and interconnecting cable for the FI-QI and FP-QP coils terminate at connection boxes.

2. A through box is a watertight box used to connect conductors together without changing the order of conductor connections. It is used whenever it is necessary to connect sections of cable together. In some cases splicing in lieu of through boxes is used.

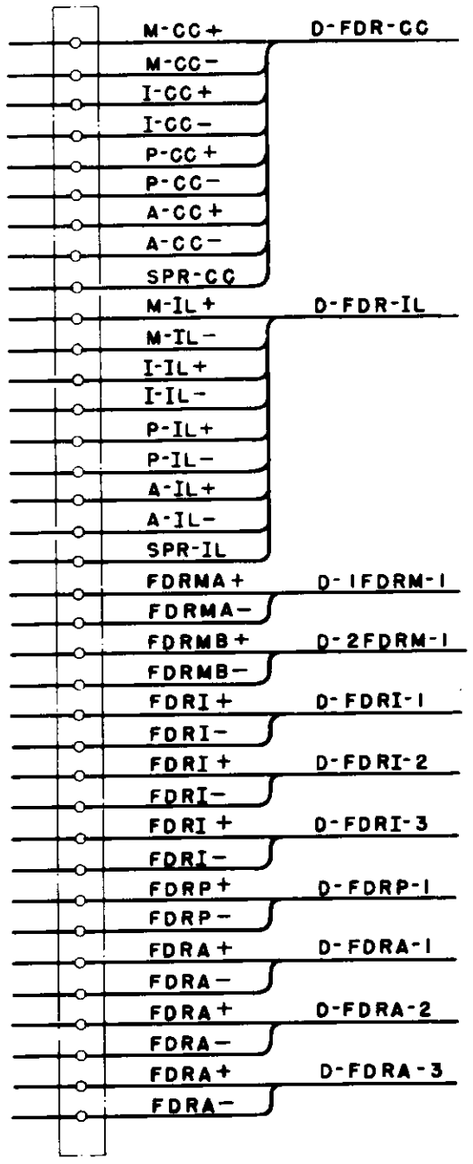


Figure 9813-25. Typical degaussing switchboard connection strip.

9813.265 CONNECTION AND THROUGH BOXES–NUMBERS

1. Connection and through boxes in the M, Maux, F, Q, FI-QI, and FP-QP coils are considered to be in one group. They are numbered D1, D2, D3, etc., in sequence starting at the bow and going around the vessel in a counterclockwise direction as observed from above. (See figure 9813-23.)

2. Boxes for the A coil receive the next higher numbers after numbers for the M, F, FI, FP, QI, and QP boxes have been assigned. Numbers for the A coil boxes are in sequence starting with the highest forward box and continuing aft on the upper limbs of both the A1 and A2 loops, then down to and forward on the lower limbs, and then up. (See figure 9813-23.)

3. Boxes for the L coil receive the next higher numbers after numbers for the A coil boxes have been assigned. Numbers for the L coil boxes are assigned in sequence starting with the highest forward box on the port side and continuing around the vessel in a counterclockwise direction as viewed from above. Boxes on the center line are considered to be on the port side for number assignment.

9813.266 CONNECTION AND THROUGH BOXES–IDENTIFICATION PLATES

Connection and through boxes should have identification plates marked as follows:

Degaussing box number. . . . D1, D2, D3, etc.

Connection box and/or through box, as applicable.

Coil and loop designation . . M1, M2, FI2, QI1, etc.

Example

D1

Connection box	Through box
M1	F1
M2	

This example identifies the number one degaussing box serving as a connection box for the M1 and M2 loops and as a through box for the F1 loop.

9813.267 CONNECTION AND THROUGH BOXES–WIRING DIAGRAM

A wiring diagram of the connection within a box should be pasted on the inside of the cover of the box and coated with varnish or shellac. The wiring diagram for connection boxes should designate the conductors which may be reversed without reversing other loops: should indicate the arrangement of parallel circuits so that equal changes can be made in all parallel circuits when such changes are required; and should also show spare conductors. Spare conductors should be secured to connectors and should be connected to form a closed or continuous circuit when possible. All conductors within a connection box shall be cut to allow 1-1/2 times the length required to reach the farthest terminal within the box.

C. Operation

9813.281 ESSENTIAL POINTS IN OPERATION

1. The two essential points in the operation of the degaussing installation are:

a. Energize the degaussing coils in accordance with the instructions in the Naval Ship Systems Command Degaussing Folder which is aboard each ship. The Degaussing Folder is an official ship log. It contains instructions for operation of the degaussing system, degaussing charts and values for coil settings, Installation Certificates and a log section showing all details of action taken on the ship's degaussing system for the information of degaussing authorities.

b. With manual systems and when manually operating the automatic control equipment, set the coil currents to and maintain them at the values specified in the Degaussing Folder. The Degaussing Folder contains current setting charts which are prepared by the Degaussing Range when the ship is ranged (article 9813.287) and which give the degaussing coil currents to be used for any position on the earth's surface and any heading of the ship. The automatic control equipment, when in operation, should maintain the coil currents at the proper values at all times without manual adjustment.

2. If a ship's Degaussing Folder is lost, a replacement can be obtained by application to the nearest Degaussing Activity.

9813.282 CHECK ON COIL CURRENTS

1. **Installations with operator control.** In most degaussing installations now in use, degaussing coil currents are set to the required values by an operator. (See article 9813.283 for rheostat installations and article 9813.284 for motor-generator installations.) Currents should be checked periodically, at least once an hour, and readjusted to the correct value when necessary. Changes in degaussing coil resistance caused by change in cable temperature and changes in the voltage of the power supply for the degaussing coils will both change degaussing coil currents and necessitate readjustment. It is particularly important that the degaussing coil currents have the correct polarity. If the polarity of any of the degaussing coils is wrong, the ship is very likely to be in much greater danger from magnetic mines than if no degaussing system were installed. The polarity of a coil should be checked by observing whether the pointer of the ammeter for the coil is on the "positive" (right) or "negative" (left) side of the zero center of the ammeter and/or whether the "positive" or "negative" plate glows in the neon indicator light for the coil. For positive polarity, the right-hand plate will glow; for negative polarity, the left-hand plate will glow.

2. **Installations with automatic degaussing control equipment.** New construction ships are being equipped with automatic degaussing control equipment to change coil currents automatically when the ship changes its position with respect to the earth's field. (See article 9813.285.) All of the automatic degaussing control equipments (except a few of the early models) have indicator lights to show when the equipment is not functioning properly. These lights should be checked periodically, at least once a watch, and at the same time the coil currents should also be checked.

9813.283 CHANGING COIL CURRENTS–OPERATOR CONTROL

1. For each ship the Degaussing Folder gives the current needed for each coil for all positions on the earth's surface and for all headings. One or more of the coil currents must be changed whenever one of the following occurs:

a. When the ship passes from one Z zone into another. See Degaussing Chart No. 1 in the Degaussing Folder.

b. When the ship passes from one H zone into another. See Degaussing Chart No. 2 in the Degaussing Folder.

c. When the ship's heading changes from one sector to another. The entire range of headings from 0° to 360° is divided into a number of sectors, each covering a part of the whole range of courses. See Course Correction Setting Diagram No. 1 or 2, or Course Correction Setting Table No. 1, 2, or 3 in the Degaussing Folder. None of the degaussing coil currents is changed as long as the course remains in one sector; some of the coil currents must be changed when the course changes from one sector to another.

2. The changes required (except as noted in article 9813.283, 3. are as follows:

a. FP-QP coil current—Is not changed no matter how the heading or the ship's position changes.

b. M coil current—Must be changed when the ship moves from one Z zone to another. Is not changed when the ship moves from one H zone to another, or when the heading chages from one sector to another.

c. F, Q, FI-QI, L, and A coil currents—Are not changed when the ship moves from one Z zone to another but must be changed if either:

(1) The ship moves to a different H zone.

(2) The heading changes to a different sector.

(3) In a few ships, exceptional conditions may require a departure from the schedule of changes listed above. In all cases, the Degaussing Folder will show the currents to be used.

9813.284 OPERATOR CONTROL—RHEOSTAT INSTALLATIONS

1. The degaussing coils in rheostat installations should be energized by closing the main degaussing feeder switch and the individual coil switches (in proper polarity position) after all rheostats are set for maximum resistance. Set the current in each coil by cutting out resistance. Operate the rheostats for the M and FP-QP coils (assuming that both are installed) until the M and FP-QP coil currents have the values specified in the Degaussing Folder for the ship's position. Operate the rheostats for the F, Q, FI-QI, L, and A coils (except those which are not installed) until the coil currents have the values specified in the Degaussing Folder for the ship's position and heading. Check on coil currents periodically (article 9813.282,1.), and change coil currents as required by changes in ship's position and heading. (See article 9813.283.)

2. In installations employing motor-driven rheostats, polarity is changed only when the current is zero, either by means of a motor-driven polarity changer and pushbutton or by operating the rheostat through and beyond the maximum resistance position. At this point reversal of current will take place automatically by virtue of the internal cross-wiring of the rheostat buttons on either side of this point or by means of a motor-driven polarity changer actuated by the rheostat arm. In the event of failure of the motor-driven system of any of these rheostats, manual operation can be resorted to by turning the emergency handwheel provided on the rheostat. In the type of rheostat having the pushbutton operated polarity changer, a small handwheel is also provided for turning the polarity changer. It is important that the caution plate instructions to reduce the current to zero before operating the polarity changer be adhered to, since the contacts will burn out from operation under load.

3. In the rheostat type of installation it is usual to have the degaussing switchboard located in the engine room. This switchboard is used for mounting disconnect switches for F, Q, FI-QI, L, and A coils, reversing switches for M and FP-QP coils, rheostats, series resistors, fuses, and ammeters. A remote degaussing panel is located in the pilot or chart house to permit changing of F, Q, FI-QI, L, and A coil currents with heading. This remote panel includes ammeters or polarity indicator lights for all coils and rheostats (rheostat pushbuttons for remote operation), reversing switches for F, Q, and L coils or reversing switches for FI-QI and A coils. The M and FP-QP rheostats ammeters, and switches on some installations also are mounted on this remote panel.

4. Telephone communication is provided between the remote and main panels. When the degaussing system is to be energized, the remote position may call the main panel and have all switches closed and have those currents normally controlled from the main panel set by means of rheostats. The remote position will then set those currents normally controlled by rheostat from that position and has the responsibility of keeping the correct current values at all times. It is the responsibility of the main panel position to correct for any subsequent voltage change and current decrease caused by temperature rise of the cable.

9813.285 OPERATOR CONTROL—MOTOR-GENERATOR INSTALLATIONS

1. In motor-generator installations the degaussing coils should be energized by closing the disconnect switch to the motors after the generator field rheostats have been set for maximum resistance, and operating the pushbutton to start the motor. In this type of installation, the degaussing switchboard is located in (or in the vicinity of) the engine room near the degaussing motor-generators. This switchboard mounts ammeters, the pushbuttons for starting the motors, and the motor-driven field rheostat for the generator. In many installations where the motor-generators are not located together, a separate switchboard is provided for each group of motor-generators.

2. After the motor has been started, the currents in the coils are set by means of pushbuttons controlling the motor-driven field rheostats for the generators. The pushbuttons are located on the remote control panel in the pilot or chart house or on the degaussing switchboard. Zero center ammeters mounted above the pushbuttons are used to determine whether the "positive" or "negative" pushbutton should be pushed to obtain the specified currents. The "positive" pushbutton will operate the motor-driven generator field rheostat to give an increase of current in the positive direction (or a decrease in the negative direction). The "negative" pushbutton will give an increase of current in the negative direction (or a decrease in current in the positive direction).

9813.286 AUTOMATIC CONTROL

The automatic degaussing control equipment installed on new construction ships automatically makes all changes in coil currents that are required because of changes in ship's heading and in some installation, for heading, roll and pitch. They do **not** automatically make the changes in degaussing coil current that are necessary when the ship moves from one Z or H zone to another. Whenever this happens, an operator must adjust the automatic degaussing control equipment to take care of the changed conditions. A technical manual is furnished with each automatic degaussing control equipment and should be consulted for detailed information on how to operate the equipment.

9813.287 MAGNETIC RANGES AND RANGING

1. A magnetic range is a station equipped to measure and record the magnetic field of ships which pass over measuring equipment located at or near the bottom of the channel in which the ships travel. A ship is said to be "ranged" when its magnetic field is measured at a magnetic range.

2. Purpose of ranging:

a. Check ranging determines that the ships degaussing installation is operating satisfactorily. The following operating conditions are checked:

(1) Adequacy of current settings in degaussing coils.

(2) Performance of degaussing equipment and personnel.

b. Calibration ranging serves the following functions:

(1) Determines initial degaussing coil current settings.

(2) Provides information for degaussing charts.

(3) Indicates changes or modifications are required to the degaussing installation.

3. Ship's responsibilities for accurate ranging:

a. The ship must pass directly over the range at a constant speed and heading.

b. The degaussing coils must be set correctly.

c. The range officer must be notified of coil settings.

d. The range officer must be notified of the ships draft, fwd and aft, to the nearest six inches, for depth correction.

D. Maintenance

9813.301 GENERAL INSTRUCTIONS

1. Due to the long lengths of cable in the degaussing system, running around the entire skin of the ship and, of necessity, through all kinds of compartments and in moist locations, and due to the fact that the system may be idle or be operated at very light currents for long periods of time, it is essential that special efforts be made to preserve it by careful maintenance. If this is not done, deterioration will result from moisture gradually entering the cables.

2. Since the degaussing system consists of electrical cable, rheostats, ammeters, connection boxes, motor-generator sets, and in many cases, costly automatic control equipment, it should be maintained in conformity with the instructions for maintenance of electrical equipment given in other chapters of the NAVSHIPS Technical Manual and applicable technical manuals for equipment installed. Specific items of maintenance procedure for the degaussing installation are given in the next article.

3. Report all equipment defects, failures, and replacements by form NAVSHIPS 3621 (Material Analysis Data). This report assists the Naval Ship Systems Command supplying the fleet with improved equipment.

9813.302 SPECIFIC ITEMS OF MAINTENANCE PROCEDURE

1. When the system is not in normal use, energize all coils at least once a week to the limiting maximum ampere values specified in the Degaussing Folder. After operating the coils for at least four hours with current in one direction, bring the current to zero and energize the coil momentarily with maximum current in the opposite direction.

2. Check each degaussing coil for grounds by insulation resistance measurement at least once a week, using a 500-volt megger. When rectifiers are used for the degaussing power supply, the degaussing coils must be disconnected from the rectifiers before a 500-volt megger is used. Otherwise, the rectifier may be damaged. These check measurements should be made as closely as possible under similar temperature and humidity conditions and with the same degaussing equipment connected in the circuit. It is recommended that these measurements be taken between the coil disconnect switch and ground. In the cases of F, Q, and A or I, P, and A coils where a reversing switch is located on the coil side of the disconnect switch the reversing switch should be closed for the measurement. It is suggested that this measurement be made just before the weekly energizing of the coils specified above in order that similar conditions obtain to give comparative readings. By means of these data it will be possible to detect abnormal decreases in resistance and take corrective action before the system is beyond repair. In cases where abnormal decreases are indicated, the various components of the circuit can be isolated and insulation resistances individually checked to determine the cause of the low reading. See chapter 9600 for detailed information on the measurement of cable insulation resistance and the minimum permissible insulation resistance for degaussing cables.

3. Due to condensation and leakage of water past improperly seated gaskets, connection boxes may often accumulate considerable amounts of water. In such cases the moist atmosphere in the box gradually will force moisture into the cable ends and reduce the insulation resistance. If not checked in time, the cable may be ruined and require replacement. Therefore, drain each connection and through box at least once a month to allow any water it has accumulated to run out. If a box does not have a drain plug or a drain cock at the lowest point of the box, one should be installed. Boxes showing abnormal accumulations of water should be opened, dried out, and the gaskets checked and replaced if necessary.

4. Remove corrosion on rheostat contact buttons with fine sand paper or wire brush, and coat the buttons lightly with a graphite lubricant.

5. Clean automatic degaussing control equipment both inside and out by removing accumulations of dirt and dust which are impairing the natural flow of air around the components and possibly causing overheating; use a vacuum cleaner or bellows for this job—never use compressed air.

6. Observe the preventive maintenance requirements for automatic control equipment and motor driven rheostats as outlined in applicable technical manual.

7. Observe the maintenance of electrical equipment and electrical safety precautions as required by chapter 9600.

8. Conduct weekly linearity checks as required on ships equipped with automatic degaussing units in accordance with applicable technical manual.

9813.304 LOCATING AND ELIMINATING GROUNDS IN DEGAUSSING CIRCUITS

Grounds in a degaussing conductor can be located by breaking the conductor into its component sections by opening connections at connection and through boxes, and testing each section of the conductor individually to find which is grounded. Grounds in feeders and control equipment circuits can be located by isolating the different components which are shown for typical installations in figures 9813-14. to 9813-16., and taking the necessary precautions stated in article 9813.302 for rectifiers. When making such tests, reconnect all ungrounded connectors to their terminals immediately after they have tested clear in order to prevent misconnection later. A suggested procedure for grounds is as follows:

1. Open the supply switch for the degaussing coil and close the reversing switch in either position.

2. Disconnect the feeder conductors from the degaussing coil at the feeder connection box.

3. Measure the insulation resistance to ground from each of the feeder conductors.

a. If the insulation resistances are satisfactory, the feeder conductors and the equipment connected to them are free from objectionable grounds.

b. If the insulation resistance to ground is unsatisfactory for either one or more of the feeder conductors, proceed as in article 9813.305.

9813.303 MOST COMMON MAINTENANCE TROUBLES IN DEGAUSSING INSTALLATIONS

Equipment	Trouble	Causes
Cable	Conductors grounded, short circuited, or low insulation resistance	Moisture entrance through damaged or deteriorated sheath or wet connection box.
	Conductors open circuited or high resistance	Conductor or connection burned open by overload. Mechanical damage has severed conductor, loose or corroded terminal.
Connection box	Grounded or short circuited terminals	Wet or corroded due to condensation, leaky gaskets, misalinement of cover, flooding of compartment, loose cover.
Rheostat	Grounded or short circuited	Mechanical damage. Electrical breakdown due to moisture. Collection of oil, dirt, and metal dust around buttons. Arcing due to worn shoes or improper spring pressure. Bent resistor ribbons. Moisture.
	Open circuited	Mechanical damage. Vibration of resistor ribbons. Overload. Poor shoe contact due to weak springs, arc burns, or corrosion.
Series resistor	Grounded	Mechanical damage. Bent resistor ribbons. Moisture.
	Open circuit	Mechanical damage. Vibration of resistor ribbons. Overload. Loosened tap connections.
Ammeter	Sticking needle	Worn or dirty bearings. Dirt or filings in air gap. Bent needle.
	Error in reading	Improper resistance of shunt leads. Damaged movement.
Switches	Burned blades	Nonquick break type opened under heavy load. Opening with overload (quick break type).
Pushbuttons Polarity changers Motor generators	Open circuit or high resistance Pitted contacts Ground or low insulation Normal wear	Dirty contacts. Open under load. Collection of oil, dirt, and carbon dust. Moisture. Worn brushes, worn bearings. Condition commutator in accordance with chapter 9600.
Indicator lights Automatic control equipment	Burned out lamps See trouble shooting section of applicable instruction book.	Normal wear. Shock.

4. Measure the insulation resistance from the degaussing coil to ground.

a. If the insulation resistance of the degaussing coil is satisfactory (see chapter 9600 for information on what constitutes satisfactory insulation resistance), no further insulation tests on the coil are necessary.

b. If the insulation resistance of the degaussing coil is not satisfactory, proceed as in article 9813.306.

9813.305 GROUNDS IN FEEDER CONDUCTORS

Unsatisfactory insulation resistance of a feeder conductor indicates a ground in the feeder conductor or in some of the equipment (ammeter shunt and ammeter, rheostat, series resistor, compass compensating equipment, etc.) which is electrically connected to the conductor. The procedure to follow is:

1. Start at one end of the grounded conductor.

2. Disconnect one piece of equipment or one section of conductor, whichever comes first, and measure the insulation resistance to ground from the remainder of the circuit. Proceed in this way until the grounded piece of equipment or section of conductor is found.

3. Check the grounded items to determine the nature of the drying out, repairs, etc., that are necessary to restore satisfactory insulation resistance.

9813.306 GROUND IN DEGAUSSING COIL

If the insulation resistance of a degaussing coil is unsatisfactory, the grounds which are responsible for the low insulation resistance must be located and removed. For the sake of simplicity, the instructions for step 2. below have been given in terms of a specific example, namely, an M coil circuit in which the geometrically negative end of the first conductor, MA1-, is normally connected to the positive feeder conductor. It is to be noted, however, that the procedure is applicable to any degaussing coil circuit.

1. Check the connection box to make sure that the feeder conductors are disconnected from the degaussing coil; open all connections between parallel circuits (see article 9813.256) if there are two or more parallel circuits; and use an insulation resistance measuring meter (megger, ohmmeter) to make measurements on each circuit according to steps 2. and 3.

2. Connect one terminal of the meter to ground and one to MA1-. Disconnect MA1+ and read the meter.

a. If the insulation resistance is unsatisfactory, conductor 1 is grounded. Shift the meter terminal from MA1- to MA2- and proceed as if the circuit started with second conductor.

b. If the insulation resistance is satisfactory, conductor 1 is not grounded. Reconnect MA1+ to MA2-, disconnect MA2+, and read the meter. This will show whether conductor 2 is or is not grounded.

(1) If conductor 2 is grounded, shift the meter terminal to MA3- and proceed as if the circuit started with the third conductor.

(2) If conductor 2 is not grounded, reconnect MA2+ to MA3-, disconnect MA3+, and read the meter to determine whether conductor 3 is or is not grounded.

3. Continue as outlined in step 2. until all the grounded conductors in the circuit have been located, one by one.

4. For each grounded conductor (turn) which is located, find which section or sections are grounded by breaking the turn up into its sections at the through boxes and checking each section for grounds.

5. If a spare conductor runs in the same cable as a grounded conductor, it should be substituted for the grounded conductor in the circuit, making sure that the connection is made so that the current flow will be in the original direction.

6. If no spare conductor is available in the cable section containing the grounded conductor, it will be necessary to disconnect the entire turn from the circuit. In this case, the current setting of the coil must be increased proportionally, provided the current rating is not exceeded, in order to retain the original number of ampere-turns. For example, if a coil with all conductors connected in series has 20 turns with 10 amperes flowing, the number of ampere turns will equal $20 \times 10 = 200$. If two turns must be removed from the circuit leaving a new total of 18, the new current will be found by dividing the required ampere turns by the new number of turns or

$$I = \frac{200}{18} = 11.1 \text{ amperes}$$

7. Label all grounded sections of conductors "grounded —date" with a small nonmetallic tag in the connection box. Label all ungrounded sections of the disconnected turn "spare" and remove the existing conductor tag.

8. Where a spare turn or section of a turn is substituted for a grounded one, the tags from the grounded sections should be transferred to the newly connected sections.

9. Enter all changes made in the Degaussing Folder and check the ship's degaussed condition at a magnetic range as soon as possible. Notify the range of the changes made prior to range runs.

Part 3. The Compass Compensating Installation

A. Description

9813.321 PURPOSE

Degaussing coils must produce large magnetic fields in order to provide satisfactory degaussing. Unless neutralized in the vicinity of the magnetic compass, these fields may be of sufficient magnitude to make the compass useless for navigation. The purpose of compass compensating coils is to set up a "compensating" magnetic field which is equal and opposite to the degaussing coil field in the immediate vicinity of the compass.

9813.322 VERTICAL COMPONENT

Almost all degaussing coils create a vertical component of magnetic field at the compass. A vertical component at the compass causes the compass to deviate when the ship heels even though it will usually cause no deviation when the ship is on an even keel. To compensate for the vertical component of magnetic field caused by the degaussing coils, a compass compensating coil, called the heeling coil, is used. The heeling coil is placed in a horizontal plane around the binnacle usually at the level of the compass needles, with its vertical axis passing through the center of the compass. A heeling coil is used in all types of compass compensating coil assemblies.

9813.323 HORIZONTAL COMPONENT

1. In addition to the vertical component of magnetic field, degaussing coils also create a horizontal component of magnetic field at the compass. The horizontal component of magnetic field at the compass causes compass deviations whether or not the ship is on an even keel. The "deviation due to degaussing" on any heading can be obtained by subtracting the magnetic compass reading with degaussing "off" from the magnetic compass reading with degaussing "on." The horizontal component of magnetic field is compensated by two mutually perpendicular vertical coils or pairs of coils.

2. In figure 9813-26., E represents the horizontal component of the earth's magnetic field, D the horizontal component of magnet field produced by a degaussing coil, and R their resultant. The magnetic compass will point in the direction of R and will, therefore, be in error by the angle ϕ. When the ship changes heading, D will move with it and ϕ, the compass error or deviation caused by degaussing, will change with heading. This error can be eliminated by installing compass compensating coils to produce a magnetic field equal to -D at the compass. The result is to cancel the component D produced by the degaussing coil so that the compass will point in the direction of the earth's field.

3. A horizontal component of magnetic field equal to -D can be produced either by:

a. Two cardinally mounted coils, one which produces a B (fore-and-aft) component of magnetic field while the other produces a C (athwartship) component of magnetic field. (See figure 9813-27.)

b. Two intercardinally mounted coils which produce NE and NW components of magnetic field. (See figure 9813-28.)

4. The B and C coils are known as cardinal coils because they produce magnetic fields which are in the cardinal directions when the ship is headed north. The NE and NW coils are known as intercardinal coils because they produce magnetic fields which are in the intercardinal directions when the ship is headed north.

5. A single B coil can be used as illustrated in figure 9813-27., or alternatively, a pair of B coils, one at each end of a diameter passing through the axis of the compass. The same is true of C, NE, and NW coils.

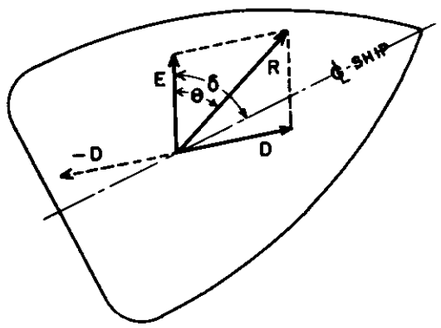


Figure 9813-26. Effect of degaussing coil magnetic field on magnetic compass.

6. The magnitude of the magnetic field produced at the compass by a degaussing coil varies with the degaussing coil current.

To compensate this field, the magnetic field produced by the compass compensating coils must also vary in the same way. This is arranged by connecting the equipment so that the compass compensating coil current is always the same fraction of the degaussing coil current. When this fraction is so adjusted that the magnetic fields produced by the degaussing coil and the compass compensating coil are equal and opposite, the balance between them is maintained no matter how the degaussing coil current varies. Doubling the degaussing coil current, for example, would double the magnetic field produced at the compass by the degaussing coil, and would also double the field produced by the compass compensating coils used to compensate the degaussing coil.

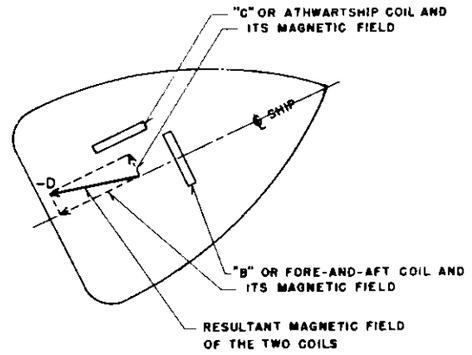


Figure 9813-27. Compensation of cardinal components of degaussing coil magnetic field.

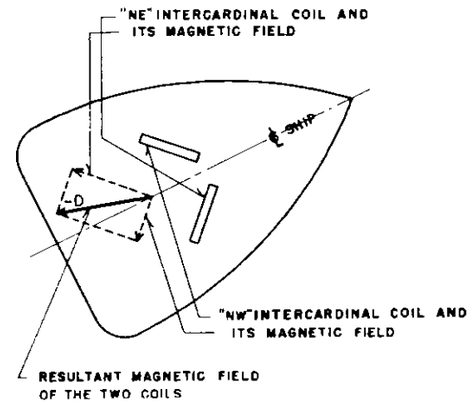


Figure 9813-28. Compensation of intercardinal components of degaussing coil magnetic field.

9813.324 CONSTRUCTION OF COMPASS COMPENSATING COILS

Most of the standard types of compass compensating coils are furnished as a coil assembly which consists of enclosures to protect the coils from damage, a single heeling coil to compensate the vertical component, and two coils, or two pairs of coils, to compensate the cardinal or intercardinal components. Each coil consists of a number of windings, one winding for each degaussing coil which produces at the compass a magnetic field that must be compensated.

9813.325 TYPES OF COIL

A considerable number of different types of compass compensating coils have been developed. Some of the types are now obsolete and should be removed and replaced by standard types; others are to be left in place where now installed, if in good condition, but are not to be used for new installations or for replacements; and still others are the modern standard types which are used for new installations and replacement of older types.

1. **Types to be removed.** The following types of compass compensating coils are to be removed from **all** installations in which they are found, regardless of the condition of the coils, and replaced with modern standard types at the first opportunity:

Mark I
Mark II
Mark III
Type "A" Flinders bar coils.
Type "A" sphere coils.
Type "B" Flinders bar coils.
All **locally** manufactured coils.

2. **Types to be left installed but not used for new installations or replacements.** The following types are to be left in place in installation where they now occur provided the coils are in good condition and there is no indication of approaching failure, but are not to be used for new installations or replacements except that type "K-1," "Filled K," and "R-1" may be used if the standard types listed below are not available.

Type "B" (except Flinders bar coil, for which see article 9813.325.1.)
Type "B-Mod."
Type "C".
Type "C-Special."
Type "G".
Type "K".
Type "K1."
Type "Filled K."
Type "R1."

3. **Standard types.** The present standard types of compass compensating coils and their uses are shown in the following table. These are the coils to be used for new installations and replacements.

Standard types of compass compensating coils.

Type	Use
"K-2"	This is the latest type of general purpose compass compensating assembly coil. This type should be used in new installations and for replacement of earlier type "K" coils which are removed because they are defective or show signs of impending failure (see article 9813.325.2). Type "K-2" fits USN standard Mark VII binnacle, USN standard No. 1 shelf type binnacle, and all types of binnacles on merchant ships built for the U.S. Maritime Commission in World War II. The type "K-2" assembly is interchangeable with the "K-1" and "Filled K" types except where quadrantal cylinders instead of quadrantal spheres are used. In this special case, type "K-2" coils will not fit. See figure 9813-48 for type "K-1" assembly and associated Type A control boxes installed on a Navy Standard Mark VII binnacle.
"R-2"	The Type R-2 compass compensating coil (figure 9813-49) is used for compensation of the USN No. 5 boat compass, the USN No. 3 compass, the gyro fluxgate compass, and the modified magnesyn compass. The assembly for use in small minesweeping boats is furnished as a complete unit and consists of the earlier "R-1" coil assembly, a No. 5 boat compass, and a mounting stand. When used to compensate the No. 3 compass the coil is supported by brackets or collars to accomodate special compass mounting, as on DDE's for example.
"T"	For magnesyn, fluxgate, slave-gyro, and USN No. 6 vehicle type compasses, also USN No. 5 boat compass and USN No. 3 shelf type boat compass if type "T" coil has adequate strength of field and number of circuits. (See figure 9813-50.)

9813.326 POWER SUPPLY FOR COMPASS COILS

The power supply used for the compass compensating coils is usually the voltage drop across a fixed resistor connected in series with the degaussing coil (figure 9813-34) or the voltage drop across a number of turns of the degaussing coil. This voltage is proportional to the degaussing coil current, hence, the current which the power supply sends through the compass compensating coils is also proportional to the degaussing coil current. This is the condition which must be satisfied to ensure that compass compensation will not be disturbed by a change in degaussing coil current. (See article 9813.323.6.)

9813.327 CONTROL BOXES

1. One type "A" or type "A-1" control box is used for each degaussing coil which requires compass compensation. The control box consists of a watertight enclosure with a removable cover and contains three sets of resistors, one used for compensating the H component and two for the horizontal components, B and C components or the NE and NW, as the case may be.

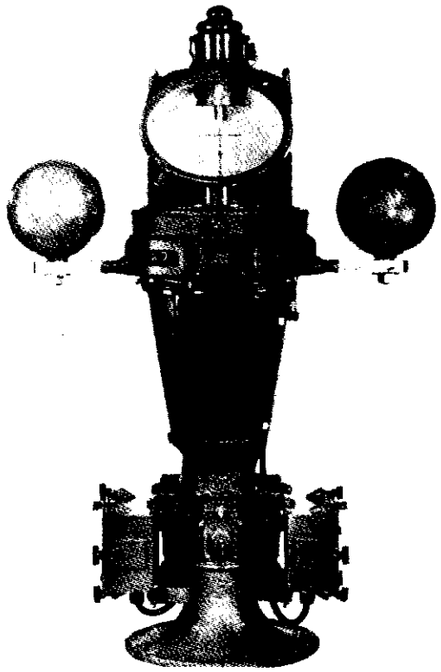


Figure 9813-29. Type "K-1" compensating coil assembly and Type A control boxes installed on a standard USN standard Mark VII binnacle.

2. Figures 9813-33. and 9813-34. show type "A" and type "A-1" control box wiring diagrams, respectively. The current in a compass compensating coil winding is adjusted, when the compass is compensated for degaussing, by shorting out one or more of the fixed resistors (in the case of the type "A" box) and adjusting the variable resistors.

9813.328 WIRING DIAGRAMS

Wiring diagrams for type "K-2," or "Filled K," and type "T" compass compensating coils are shown in figures 9813-35 and 9813-36. Similar diagrams, filled in to conform with the actual installation, are filed in the compass compensating coil manual which is to be filed in the Degaussing Folder on each vessel.

B. Installation and Compass Compensation

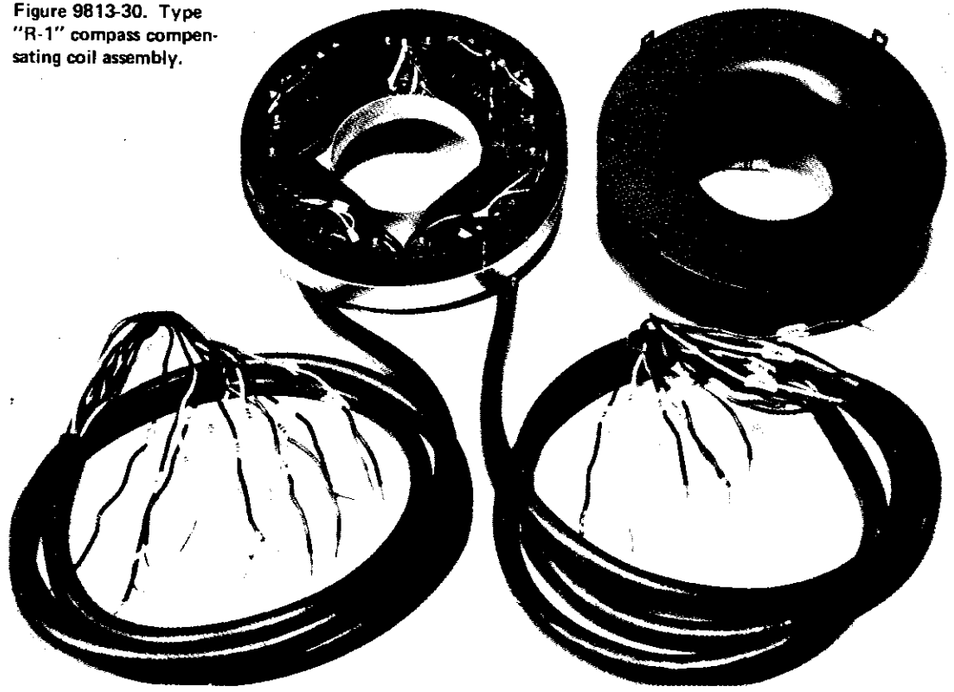
9813.341 INSTALLATION

Compass compensating coils are usually installed by the personnel at a naval shipyard or degaussing activity, not by ship's forces. If it is ever necessary for ship's forces to install compass compensating coils, the installation should be made in accordance with the instruction manual furnished with the coils.

9813.342 COMPASS COMPENSATION–GENERAL

1. Compasses are usually compensated for degaussing by personnel at a naval shipyard or a degaussing activity. At times, however, ship's forces may have to compensate compasses after repairs to the compass compensating coil

Figure 9813-30. Type "R-1" compass compensating coil assembly.



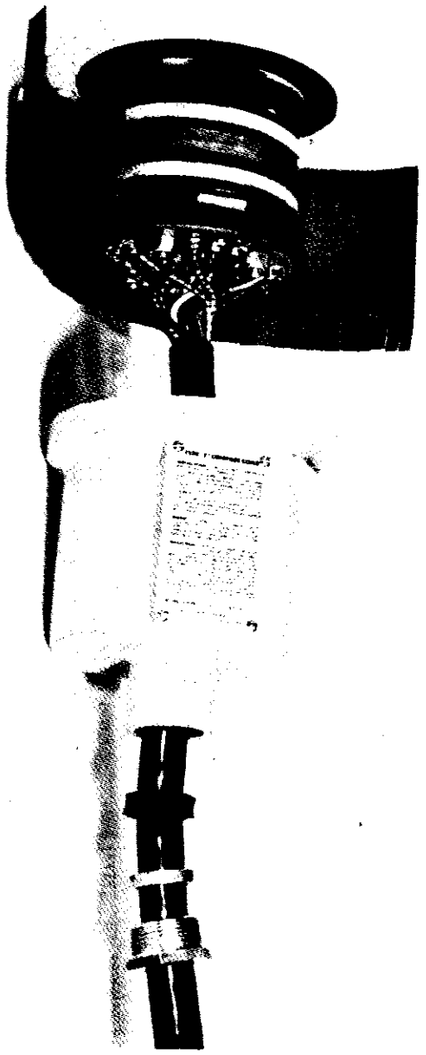


Figure 9813-31. Type "T" compass compensating coil assembly with internal parts removed from case.

installation. For this reason, instructions on compass compensation are included below.

2. Compass compensation for degaussing consists of adjusting the resistors in the control boxes so that the compass points in the same direction irrespective of whether the degaussing coils are turned on or off.

9813.343 STEPS INVOLVED

1. **Compensation–general term.** The general term "compensation" includes the three following distinct steps or procedures:

   a. A preliminary or "dockside" compensation.
   b. A "final" compensation.
   c. A swing for deviations.

2. **Dockside compensation.** The dockside compensation is a preliminary compensation which is usually made soon after the degaussing system is installed and tested. The dockside compensation is made while the ship is moored. The compass is deflected with one degaussing coil at a time turned on, and the appropriate control resistor is adjusted so that the compass error caused by the degaussing coil is a minimum.

3. **Final compensation.** The final compensation is made in the harbor or "swinging area" upon completion of normal compass compensation (magnets, spheres, etc.) with the ship away from dockside disturbances and is a refinement of the dockside compensation. The final compensation is made by placing the ship on the desired heading and then with one degaussing coil at a time turned on, adjusting the appropriate control resistor so that the compass error caused by degaussing is a minimum. Both the dockside and the final compensations should be made only by qualified adjusters.

4. **Swing for deviations.** Immediately following the final compensation, the ship is swung to determine compass deviations.

9813.344 HEADINGS USED FOR COMPENSATION

1. **Cardinal mountings.** Cardinally mounted compass coils are compensated on cardinal headings, that is, with the compass reading N or S for compensating the C component, and E or W for compensating the B component. For these headings, the compass **needles** are perpendicular to the component of degaussing coil magnetic field which is being compensated.

2. **Intercardinal mounting.** Intercardinally mounted compass coils are compensated on intercardinal headings, that is, with the compass reading NE or SW for compensating the NE component, and NW or SE for compensating the NW component. Note that the headings used are such that the compass **needles** are perpendicular to the component of degaussing coil magnetic field which is being compensated.

3. **Heeling coil.** The heeling coil for either cardinally or intercardinally mounted coils can be compensated on any heading.

9813.345 PRECAUTIONS

In both the dockside and the final compensation, care must be taken to see that the safe currents of resistors and coils are not exceeded.

1. **Resistors.** The resistors in the type "A" control box may be connected in various parallel and series combinations provided that the maximum currents do not exceed:

25 ohm variable resistor	1.41 amperes.
50 ohm fixed resistor	1.00 ampere.
150 ohm fixed resistor	.58 ampere.
400 ohm fixed resistor	.35 ampere.

The maximum currents in the type "A-1" box resistors should not exceed:

15 ohm variable resistor	2.00 amperes.
300 ohm variable resistor	
260 ohm portion	0.32 ampere.
40 ohm portion	1.25 amperes.

2. **Coils.** The maximum current in any one winding of a coil should not exceed the value given below:

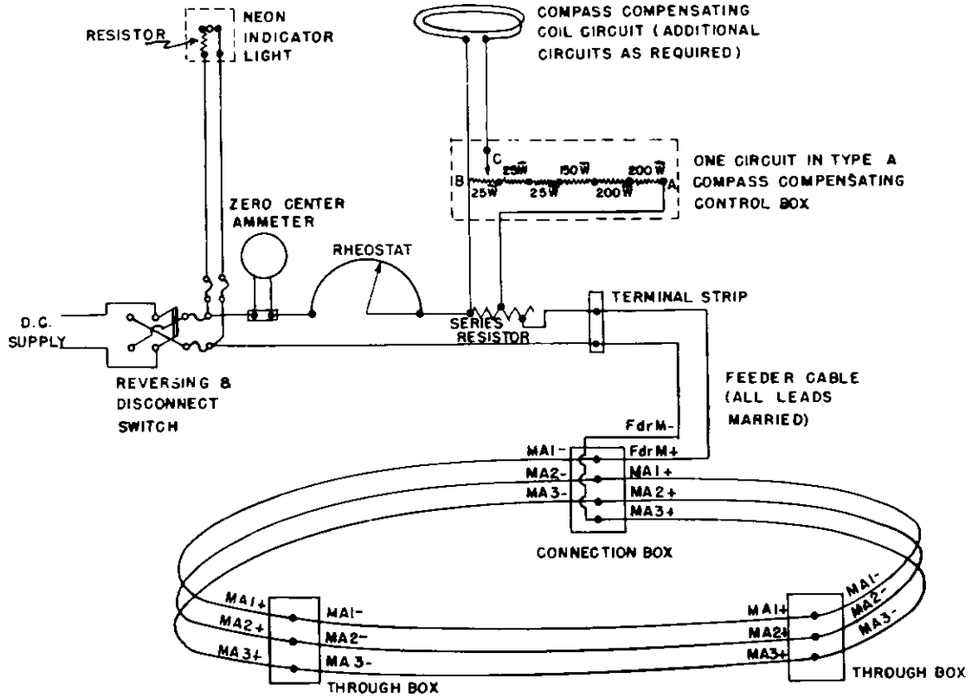
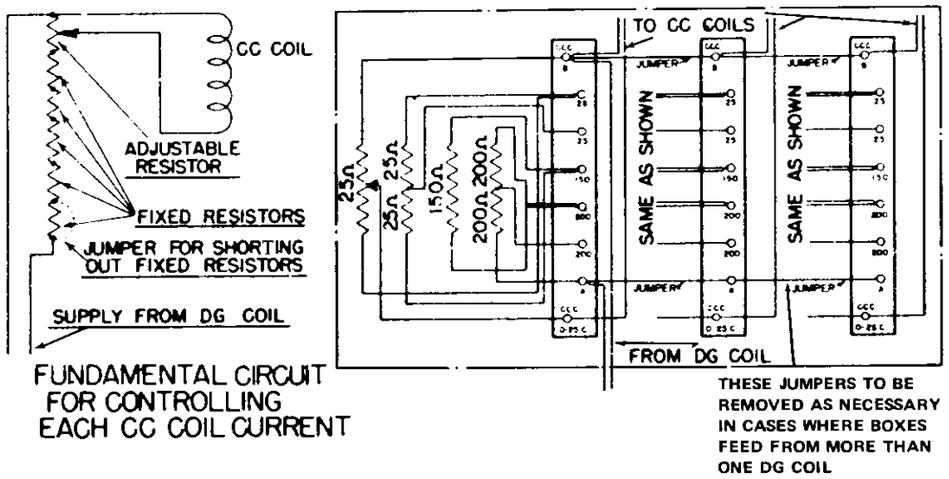


Figure 9813-32. Schematic wiring diagram of typical M coil degaussing system.



T OTAL RESISTANCE OF BANK MAY BE VARIED BY FOLLOWING MEANS:
(1) SLIDER ON ADJUSTABLE RESISTOR
(2) SHORT OUT FIXED RESISTORS AT TERMINAL STRIP
(3) CONNECT RESISTORS IN PARALLEL

Figure 9813-33. Type "A" control box wiring diagram.

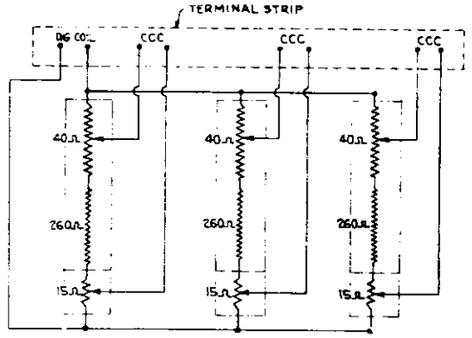


Figure 9813-34. Type "A-1" control box wiring diagram.

Type of coil	Maximum current (amperes)
"A"	1.4
"B" and "B Mod."	1.4
"C" and "C Special."	1.4
"G" and "G Mod."	1.4
"K", "K-1" and "Filled K:"	
NE and NW coils	1.4
Heeling coil	2.0
"R-1"	1.0
"R-2"	1.0
"T"	1.0
"TE"	1.0

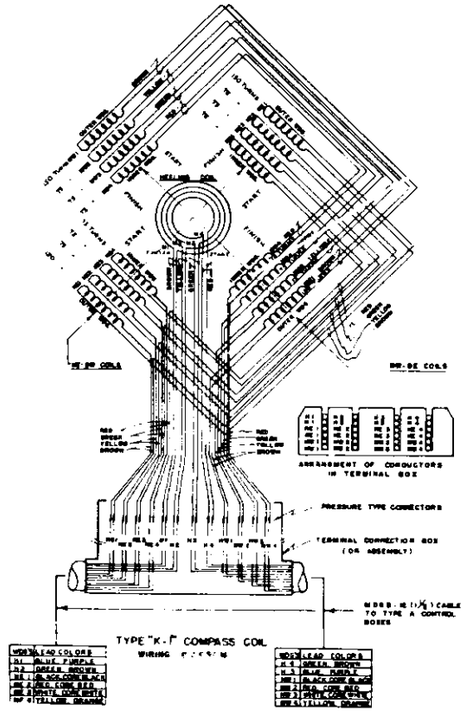


Figure 9813-35. Type "K-1" compass compensating coil wiring diagram.

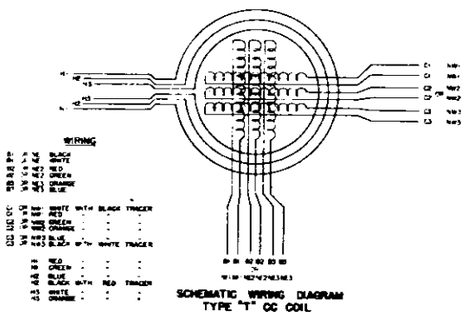


Figure 9813-36. Type "T" compass compensating coil wiring diagram.

9813.346 CONDITIONS FOR DOCKSIDE COMPENSATION

1. **Safety.** The maximum degaussing coil currents specified in the ship's degaussing folder should be used during dockside compensation. These are not the coil currents which are correct for proper degaussing of the ship at the place where the compensation is made and the heading of the ship during compensation. It is, therefore essential that the dockside compensation be made only in waters which are known to be free from magnetic mines.

2. **Magnetic disturbances.** Local magnetic disturbances such as those caused by moving cranes, moving vessels alongside, arc welding, etc., may impair the accuracy of dockside compensation, hence, dockside compensations should be made, if possible when the disturbances are a minimum, such as during the noon hour or at changes of shifts.

3. **Normal compass adjustment.** Better dockside compensation will result if the compass is in good normal adjustment. If the compass is not in good normal adjustment, normal adjustment should be at least approximated. If normal adjustment or a partial adjustment cannot be made, the dockside compensation should be made nevertheless, since, even under poor conditions the dockside compensation gives a check on correct voltage supply, electrical connections and polarities of windings. When the dockside compensation is made under good conditions, good normal adjustment of the compass and freedom from local magnetic disturbances, only slight resetting of the control resistors is required in the final compensation.

9813.347 COMPENSATION OF H COMPONENT

The H component should be compensated first; then the horizontal components. The following procedure

should be used for compensating the H component, both for cardinally and intercardinally mounted compass coils:

1. Start with all degaussing coil currents set at their maximum value and then reduce all coil currents to zero by the method of reversals described in article 9813.353.

2. Remove the compass and put a calibrated dip needle in place of the compass. For model A magnesyn transmitters the dip needle pivot should be centered 3/4″ ± 1/8″ above the top of the compass coil. For model B magnesyn transmitters the distance should be 3″ ± 1/8″. For other type compasses, center the dip needle at the level of the compass card. Adjust the weight on the dip needle to make the needle horizontal. If the weight on the dip needle was previously set for normal compass adjustment and it is desired not to disturb this setting, level the needle by raising or lowering the heeling magnet, **but make sure that the heeling magnet is restored to its correct position after compensating the H component of degaussing coil field.** In certain cases (as with the T coil) it may not be convenient to replace the compass with a dip needle. Under these conditions other provisions such as placing the dip needle to one side of the compass compensating coil at a predetermined location may be necessary.

3. Energize one degaussing coil with its maximum current and note any dip of the needle. If the needle does not dip, operations 4. and 5. are not necessary.

4. Increase or decrease the current in the heeling coil circuit for the degaussing coil which is energized in order to make the dip needle return to its original position. This may necessitate shorting out or adding fixed resistance as well as adjusting the variable resistor, or it may require reversing the compensating coil leads. To see whether the heeling coil leads need reversing, note the dip with and without the heeling coil in the circuit. The heeling coil leads should be reversed if the needle dips more in the same direction when the heeling coil is in the circuit.

5. Check the current through the compass compensating coils and the variable and fixed resistors of the control box to make sure that the current in each circuit element does not exceed the current rating of the element.

6. Reduce the degaussing coil current to zero and then increase to the maximum value in the opposite direction. Note any dip in the needle, other than a momentary dip, and make any further adjustments necessary.

7. Reduce the degaussing coil current to zero by the method of reversals. (See article 9813.353.)

8. Repeat operations 3. to 7. for each degaussing coil.

9. Record the compensation data, as it is taken, on NAVSHIPS 8950/41. (See figure 9813-37.)

9813.348 DEFLECTING THE COMPASS FOR HORIZONTAL COMPONENTS

1. **Reason for deflecting.** The heading of the ship is not changed during a dockside compensation. Instead of this, a suitable arrangement of deflector magnets is employed to deflect the compass to the reading specified in article 9813.348, 2., and to approximate at the compass the strength and direction of the magnetic field that would be present if the ship were placed on the heading which corresponds to the compass reading.

2. **Procedure for deflecting.** To deflect the compass by means of a permanent magnet (or a bundle of magnets), the deflecting magnet is placed with the longitudinal axis perpendicular to the imaginary vertical plane which bisects the angle between the original direction of the compass needle and the desired direction. The magnet may be placed either above (preferred), to the side, or below the compass provided the axis of the magnet is perpendicular to the bisecting plane. The desired compass heading is obtained by moving the magnet closer to or farther from the compass. Figure 9813-38. illustrates this method of deflecting the compass. It is essential that this procedure for deflecting the compass be used so that the directive force at the compass will be maintained for the new heading.

9813.349 COMPENSATION OF B AND C COMPONENTS

1. **Cardinal mounting.** For cardinally mounted compass compensating coils, the horizontal components which are compensated are the B and C components.

2. **Order of compensation.** The larger component should be compensated first.

3. **Compensation of B component.** The procedure given below should be followed for setting the B coil control resistors to compensate the B component:

a. Replace the dip needle with the regular compass.

b. Deflect the compass to a 90° or 270° reading by the procedure given in article 9813.348, 2.

c. Energize one degaussing coil with its maximum current and note the compass deflection. If the compass does not deflect, steps d. and e. are not necessary for this degaussing coil.

d. Increase or decrease the current in one of the B windings to make the compass return to the reading obtained in step b. This may require shorting out or adding fixed resistors as well as adjusting the variable resistor in the control box, and it may also require reversing the compensating coil leads. To see if the coil leads need reversing, note the compass deflection with and without the compensating coil in the circuit. Reverse the compass coil leads if the deflection with the coil in the circuit is greater than but in the same direction as the deflection without the coil in the circuit.

e. Check the current through the coils and the fixed and variable resistors in the control box to make sure that the current in each circuit element is no greater than the rating of the element.

f. Reduce the degaussing coil current to zero and then increase to a maximum in the other direction. Note any deviations and make any refinements necessary.

g. Reduce the degaussing coil current to zero by reversals. (See article 9813.353.)

h. Repeat steps c. to g., inclusive, for each degaussing coil.

i. Record the compass compensating data, as it is taken, on NAVSHIPS 8950/41. (See figure 9813-39.)

4. **Compensation of C component.** The procedure given above for compensation of the B component is repeated for compensation of the C component except that the compass is deflected in step b. to a reading of 0° or 180°.

NAVY DEPARTMENT BUREAU OF SHIPS

COMPASS COMPENSATING COIL DATA

1. SS Chesapeake NO. AM2 LOCATION Safe Harbor, Md. DATE 9-9-46 (OF COMPENSATION)

COMPASS: MAKE C.G.CONN. TYPE: #1 [X], #2 [ ], #3 [ ], OTHER ___ (OTH); ST'D [X], ST'R'G [ ], OTHER ___

BINNACLE: MAKE Solarlite MARK VII [ ], SHELF [X], OTHER ___; PILOT HOUSE [ ], FLYING BRIDGE [X], OTHER ___ (INDICATE)

FLINDERS BAR: F'W'D [X], AFT [ ], SLEWED ___, LENGTH 18 (FOR PEDESTAL) (COMMERCIAL PLYWOOD STAND ETC) (INCHES) (LOCATION)

2. DEGAUSSING: COILS M,I,P,A (M,I,P,A ETC), CONTROL Motor Oper.M, Manual I,P and A in pilothouse. (DEGREES)

3. C.G. COILS: TYPE K-1 (T,K-1 ETC), INSTALLED BY: FAST S.B.CO. (NAVAL, YARD, A&E, SUP, A&E ETC) DATE 8-9-46

VOLTAGE SUPPLY: FIXED RESISTOR [X] CONTROL BOXES: TYPE R-lug (4-LUG, 6-LUG ETC) NO. 4 (QUANTITY)

ACROSS D.G. COILS [ ] MOUNTED: IN WEATHER [ ], PROTECTED [X]

OTHER ___ (TAP ON D.G. COIL ETC) ON BINNACLE [ ], BULKHEAD [ ], OTHER ___ (MAST, STACK)

4. OBSERVED DEGAUSSING EFFECTS (C.G. COILS DISCONNECTED) ROUGH [ ], ACCURATE [X]

D.G. SETTING			NW/SE [X] OR B [ ] EFFECT (COMPASS I.F. MAGNETOMETER READING)			NE/SW [X] OR C [ ] EFFECT (COMPASS MAGNETOMETER READING)			HEELING EFFECT (CHECK ONE (✓))				(OR BY MAGNETOMETER)		
COIL	+OR-	*AMP	D.G. OFF	D.G. ON	DIFF	D.G. OFF	D.G. ON	DIFF	✓	✓	✓	✓	D.G. OFF	D.G. ON	DIFF
M	+	24	134.5	139	4.5	225	214	-11				X			
I	+	28	134.5	137	2.5	225	221	-4			X				
P	+	758	134.5	136	1.5	225	223	-2	X						
A	+	25	134.5	126	-7.5	225	207.5	-17.5	X						

*D.G. CURRENT IN 4 AND 5 SHOULD BE MAXIMUM SETTING FOR ANY ZONE AS SPECIFIED IN DEGAUSSING FOLDER.

5. RECORD OF COMPENSATION DOCKSIDE [X], OR FINAL [ ]

COMPONENT	VOLTAGE ACROSS SUPPLY LEADS	VOLTAGE ACROSS C.G. COIL	*CURRENT IN C.G. COIL	RESISTORS IN OR IN CIRCUIT MIN.—MAX.	REMARKS ON COMPENSATION (INCLUDE INFORMATION USEFUL TO COMMANDING OFFICER OR ADJUSTER e.g. UNCOMPENSATED DEVIATIONS OR HYSTERESIS.)
H-M	9.5	0.13	0.081	36-51	
NW or (B)-M	9.5	.12	.075	666-816	
NE or (C)-M	9.5	.15	.094	50-75	
H-	6.5	.02	.012	600-625	
NW or (B)-	6.5	.07	.044	50-75	
NE or (C)-	6.5	.07	.044	886-1136	
H-	6.3	.00			Disconnected and taped open
NW or (B)-	6.3	.03	.019	250-275	
NE or (C)-	6.3	.03	.019	250-275	
H-A	8.5	.00			Disconnected and taped open
NW or (B)-A	8.5	.17	.033	886-1136	
NE or (C)-A	8.5	.20	.038	666-816	

6. REMARKS ON INSTALLATION** After compens. {Random Hdg., All DG OFF -173°; " " " ON - 171-1/2°

* A-Boxes located out of weather, mounted on overhead beneath binnacle.

7. SIGNED: R.A.Robinson, (ADJUSTER) 5 N.D. (NAVY YARD OR DISTRICT)

**INCLUDE UNDER REMARKS, DETAILS OF ANY SPECIAL EQUIPMENT SUCH AS TYPE "X" HEELING.

Figure 9813-37. NAVSHIPS 8950/14.

9813.350 COMPENSATION OF NE and NW COMPONENTS

1. **Intercardinal mounting.** For intercardinally mounted coils, the horizontal components which are compensated are the NE and the NW components.

2. **Order of compensation.** The larger component should be compensated first.

3. **Compensation of NE component.** The following procedure should be used for compensating the NE component.

a. Replace the dip needle with the regular compass.

b. Deflect the compass to a 45° or 225° reading by the procedure described in article 9813.348, 2.

c. Energize one degaussing coil with its maximum current and note the compass deflection. If the compass does not deflect, steps d. and e. are not necessary for this degaussing coil.

d. Increase or decrease current in the NE compensating coil winding for the degaussing coil being compensated to make the compass return to the heading obtained in step b. This may require shorting out or adding fixed resistors as well as adjusting the variable resistor in the control box, and it may also require reversing the compass compensating coil leads. To see if the coil leads need reversing, note the compass deflection with and without the compensating coil in the circuit. Reverse the leads if the deviation with

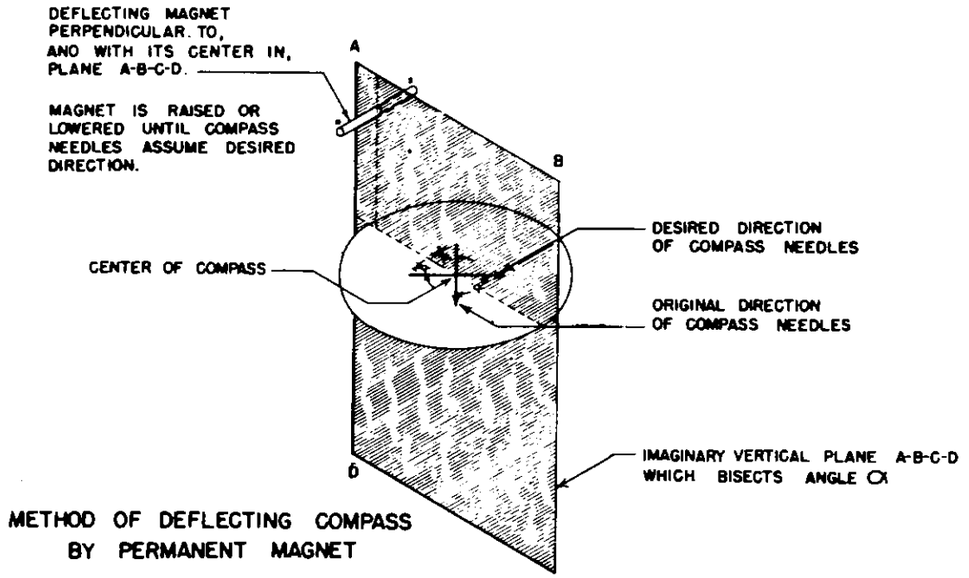


Figure 9813-38. Method of deflecting compass with permanent magnet.

the coil in the circuit is in the same direction and larger than when the coil is not in the circuit.

e. Check the current through the coil and the variable and fixed resistors in the control box to make sure that the current in each circuit element is no greater than the current rating of the element.

f. Reduce the degaussing coil current to zero and then increase to a maximum in the other direction. Note any deviations and make any refinements necessary.

g. Reduce the degaussing coil current to zero by reversals. (See article 9813.353.)

h. Repeat operations c. to g., inclusive, for each degaussing coil.

i. Record the compass compensation data, as it is taken, on NAVSHIPS 8950/41. (See figure 9813-37.)

4. **Compensation of NW component.** The procedure given above for compensation of the NE component is repeated for compensation of the NW component except that the compass is deflected in step b. to a reading of 45° or 225°.

9813.351 CHECK ON RESISTOR SETTINGS

A major change of the current in one compass coil winding will change the voltage drop in the compass coil power supply leads and, therefore, will change the voltage applied to the other compass coil windings. Hence, when one or more compasses are being compensated, all coils of all the compasses should be approximately compensated before making the final resistor settings. If only one compass coil is installed aboard ship, the resistor settings may be made immediately after compensation because there are no other coils to be adjusted and no possibility of disturbing the adjustment of the single coil.

9813.352 CHECK FOR RESIDUALS

With the compass deflected to a reading of about 90° or 270°, energize a degaussing coil with its maximum positive value, and then deenergize without reversals. If the compass fails to return to within one degree of its original reading, that particular degaussing coil should be secured by a series of reversals as explained in article 9813.353. Each degaussing coil should be checked for residuals for both positive and negative coil current. If a coil should require securing by reversals, this fact should be noted on form NAVSHIPS 8950/14 (figure 9813-37) by an entry under "Remarks" and on form NAVSHIPS 1104 (figure 9813-39) by inserting the designations of the coils which should be cycled, that is secured by the method of reversals.

9813.353 SECURING BY REVERSALS

The adjuster should secure coils by reversal when specified in the procedure for compass compensation given above. The procedure for securing a degaussing coil by reversal is as follows:

1. Starting with the maximum current specified in the Degaussing Folder, reduce the current to zero and then increase to the starting value in the reverse direction.
2. Reduce the current to zero and then increase to 3/4 value in the original direction.
3. Reduce the current to zero and then increase to 1/2 value in the reverse direction.
4. Reduce the current to zero and then increase to 1/4 value in the original direction.
5. Reduce the current to zero and then increase to 1/8 value in the reverse direction.
6. Reduce the current to zero.

MAGNETIC COMPASS TABLE
NAVSHIPS 1104 (REV. 10-47) — REPORT-SHIPS-9530-2

J.S.S. TRACTOR — NO. ARS 15
[x] PILOT HOUSE [ ] SECONDARY CONNING STATION [ ] OTHER
BINNACLE TYPE: [x] AFT STB'D [ ] OTHER
COMPASS 7-1/2 MAKE Lionel SERIAL NO. 4688
TYPE CC COILS "K-1" DATE 30 June 1950
READ INSTRUCTIONS ON BACK BEFORE STARTING ADJUSTMENT

SHIPS HEAD MAGNETIC	DEVIATIONS DG OFF	DEVIATIONS DG ON	SHIPS HEAD MAGNETIC	DEVIATIONS DG OFF	DEVIATIONS DG ON
0	0	1E	180	1E	1E
15			195		
30			210		
45	0	1/2E	225	1E	1E
60			240		
75			255		
90	1/2W	1/2W	270	1/2W	0
105			285		
120			300		
135	1E	0	315	1W	1/2W
150			330		
165			345		

DEVIATIONS DETERMINED BY: [ ] SWINGS AZIMUTHS [x] BUOYS [ ] SINGLE BEARINGS

B 2 MAGNETS RED [x] FORE [ ] AFT AT 17 1/2 ° FROM COMPASS CARD
C 1 MAGNETS RED [x] PORT [ ] STBD AT 16 3/4 ° FROM COMPASS CARD
D 2-7½ [x] SPHERES [ ] CYLS AT 12 " [x] ATHWARTSHIP [ ] ALONGSHIP 0 ° [ ] CLOCKWISE [ ] CTR. CLOCKWISE
HEELING MAGNET: [x] RED UP [ ] BLUE UP 10 " FROM COMPASS CARD
FLINDERS BAR: [ ] FORE [ ] AFT None "
[ ] LAT [ ] LONG
[x] B 0.20 [x] Z 0.50
SIGNED (Adjuster or Bootjacker): S.J. JONES, LTJG, USN
APPROVED (Commanding): P.J. SMITH, CAPT. USN

VERTICAL INDUCTION DATA
(Fill out completely before adjusting)
RECORD DEVIATION ON AT LEAST TWO ADJACENT CARDINAL HEADINGS
BEFORE STARTING re/ADJUSTMENT: N 1E, E 1/2W, S 1E, W 0.
RECORD BELOW INFORMATION FROM LAST NAVSHIPS 1104 DEVIATION TABLE:
DATE 6/30/49 [ ] LAT [ ] LONG
[x] B 0.2C [x] Z 0.45
None FLINDERS BAR [ ] FORWARD [ ] AFT
DEVIATIONS N 1E, E 2W, S 2E, W 0.
RECORD HERE DATA ON RECENT OVERHAULS, GUNFIRE, STRUCTURAL CHANGES, FLASHING, DEPERMING, WITH DATES AND EFFECT ON MAGNETIC COMPASSES
Ship overhaul Mare Island Naval Shipyard from 3-7-50 to 6-1-50

PERFORMANCE DATA

COMPASS AT SEA:	[ ] UNSTEADY	[x] STEADY
COMPASS ACTION:	[ ] SLOW	[x] SATISFACTORY
NORMAL DEVIATIONS:	[ ] CHANGE	[x] REMAIN RELIABLE
DEGAUSSED DEVIATIONS:	[ ] VARY	[x] DO NOT VARY

REMARKS

INSTRUCTIONS
1. This form shall be filled out by the Navigator for each magnetic compass as set forth in Chapter 24, Part 2, and Chapter 81, Section III, of Bureau of Ships Manual.
2. When a swing for deviations is made, the deviations should be recorded both with degaussing coils off and with degaussing coils energized at the proper currents for heading and magnetic zone.
3. Each time this form is filled out after a swing for deviations, a copy shall be submitted to the Bureau of Ships. A letter of transmittal is not required.
4. When choice of box is given, check applicable box.
5. Before adjusting, fill out section on "Vertical Induction Data" above.

NAVSHIPS-1104 (REV. 10-47) BACK

Figure 9813-39. NAVSHIPS 1104.

9813.354 FINAL COMPENSATION

The final compensation is a refinement of the dockside compensation and is made under actual operating conditions away from dockside magnetic disturbances and after a fairly accurate normal compass adjustment. The final compensation is made in the same way as the dockside compensation except that a deflecting magnet is not used to deflect the compass needle to the desired reading. Instead of this, the vessel itself is placed on the heading which gives the compass reading desired for compensation.

9813.355 ACCURACY OF COMPENSATION

1. The compensation should reduce the degaussing deviations to as small a value as practicable. It is expected that normally the deviation can be reduced to 2° or less, and the heeling effect so small as to cause no oscillation in a heavy sea with the degaussing coils on. In some cases however, where the initial horizontal deviations are large (30° to 60°) it may not be practical to reduce these deviations to the 2° value. In such cases it is expected that deviations can always be reduced to less than 10 percent of the original deviation and normally can be reduced to less than seven percent of the original deviation.

2. Unsymmetrical magnetic fields due either to the compass magnets or to the compass coils may, under unusual conditions, result in unsymmetrical deviations which cannot be reduced to the limits specified above. Unsymmetrical deviations occur on headings different from those used for setting compass coil currents and, therefore, cannot be compensated by resetting these currents. Thus in the case of cardinally mounted compass coils, unsymmetrical

deviations are maximum on headings other than N/S or E/W and for intercardinally mounted coils are maximum on headings other than NE/SW or NW/SE.

3. Unsymmetrical deviations may be reduced to the limits specified above by:

a. Replacing the compass coils with a modern assembly of known symmetry.

b. Replacing the magnetic compass with one of known symmetry.

c. Relocating the binnacle to a position farther from degaussing coil crossovers.

d. Relocating the degaussing coil crossover to a position farther from the binnacle, if such relocation will maintain an equally satisfactory magnetic signature.

4. A check to determine whether the binnacle is too close to a degaussing coil crossover can be made by application of the formula for this distance,

$$D = \frac{NI}{200}$$

where D = distance in feet
NI = total ampere turns in degaussing coil at crossover

If the separation between compass and crossover is less than that obtained by the above formula, the condition should be reported to the naval shipyard at the next availability.

9813.356 DEVIATION CARDS

See chapter 9240, articles 9240.28.4. and 9240.28.7.

9813.357 FORWARDING OF FORMS

For specific instructions regarding forwarding of form NAVSHIPS 1104 refer to chapter 9240, article 9240.28.4. A copy of form NAVSHIPS 8950/41 should be filed with the compass manuals at the rear of the degaussing folder. One copy of the form should be forward to the Naval Ship Systems Command at time of initial compensation and upon any subsequent compensations made as a result of adding additional compensating equipment or of changing the type of this equipment. In the case of changing or adding equipment this form will normally be made out by the installing activity. However, if this activity does not perform the compensation, the form should be submitted by the ship's force.

C. Operation and Maintenance

9813.371 OPERATION

The compass compensating coils operate automatically when the degaussing coils are turned on. Operation should be checked at least once a week, preferably at the time the degaussing coils are energized to dry out the cables, see article 9813.302, by noting whether any compass deviation in excess of the allowable limits (article 9813.355) are caused when the degaussing coils are turned on or off.

9813.372 MAINTENANCE

The compass compensating equipment should be given the same care as the other electrical and navigational equipment aboard ship. The most common sources of trouble experienced for the various components of the system are as discussed below:

1. **Compass compensating coils.** Care should be taken that the position of the coils on the binnacle is not changed. Grounds and resultant "burn-outs" of windings may be caused by breaking of the coil case seams due to mechanical damage or improper installation. An insufficient number of shims used between the coil and binnacle and subsequent tightening of coil mounting bolts may permit distortion of the case and breakage of the soldered seams. Leaky packing glands and gaskets may also permit the entrance of moisture into the case with resulting grounds. Increase in degaussing deviation may be caused by lack of recompensation of the compass coils after alterations to the degaussing coils or after changes in the ship's steel.

2. **Control boxes.**

a. Grounds, poor electrical connections, corrosion of resistors, and burning out of windings and resistors may be caused by entrance of moisture into type "A" control boxes. This moisture is usually the result of loose covers or leaky gaskets or stuffing tubes. When grounds are isolated in the compass compensating system, the box for the circuit involved should be opened and if wet should be drained and dried out.

b. All corrosion should be cleaned from the resistor contacts, and if beyond repair the entire resistor assembly should be replaced. Open circuits may result from overloading of the resistors. Entrance of cable into control boxes located in the weather should be on the bottom or on the sides, not on the top. Where repeated grounds occur in a four-lug control box mounted in the weather, the entire unit should be replaced with a six-lug control box and in addition, mounted out of the weather, where practical.

3. **Connecting cables.** Cable from the compass coils to the control boxes should be checked for possible cracks in the sheath or mechanical damage. If this cable is run through a deck, suitable protection should be afforded by kick-pipes. Entrances of nipples into control boxes should be watertight.

4. **Reports.** Report all equipment failures and replacements on "Material Analysis Data" (form NAVSHIPS 3621).

9813.373 ELECTRICAL CHECK-OFF LIST—COMPASS COIL TROUBLE SHOOTING

1. Check each winding for short circuits and community. (Use ohmmeter at control box.)

2. Test each winding for magnetic effect and identify. (Use 1-1/2 volt flashlight battery across winding leads in control box. Explore with pocket compass for effect of winding.) Make sure windings in series do not buck. Make sure each winding is connected to proper control circuit and tagged.

3. Test insulation resistance between compensating coil windings and from each winding to ground. (Use megger.) (See article 9813.304 for procedure.)

4. Make sure control resistor contacts and terminals are not corroded. Inspect cover and terminal tubes for leakage if corrosion exists.

5. Check supply voltage to control box. It should be proportional to degaussing current and should reverse in polarity with degaussing circuits. But results are obtained when the supply voltage to control box is between six and ten volts. (Degaussing current set at maximum value specified in Degaussing Folder.)

6. Make sure each compass compensating effect is strong enough to compensate the degaussing effect.

7. Make sure winding current does not exceed 1.4 amperes on all coils except T coils. (Do not exceed 1.0 ampere on T-Coils.)

9813.374 LOCATING GROUNDS IN COMPASS COIL CIRCUITS

If a ground appears in the compass coil circuits:

1. Open the type A compass compensating coil control box for the degaussing coil circuit grounded.

2. Disconnect the compass feeder from the degaussing circuit. Check both conductors of the feeder for grounds.

3. If grounded reading is obtained here, disconnect feeder at the other end to isolate ground in either feeder conductor.

4. If the feeder is not grounded, then:

a. Isolate the circuits compensating the degaussing coil being checked by disconnecting the jumpers (if installed) paralleling the A terminals in the control box and also the jumper paralleling the B terminals.

b. Check insulation resistance for each compass coil circuit to ground by connecting meter between terminal A or B and ground.

c. Upon finding grounded circuit ascertain whether ground is in compass resistors or in compass coil winding by disconnecting compass coil winding at terminals CCC-B and CCC-O-25C in control box.

d. In the event winding is grounded and coil is otherwise satisfactory physically (no cracked seams, etc.) and electrically, substitute spare winding of same coil if available. This substitution will require checking of compensation and recompensation as necessary.

e. If the ground is located in the resistor bank of the type A control box and is due to moisture, wipe box clean and dry by means of exposure to sunlight or heat by electric light bulb. Check for entrance of moisture due to distorted box cover, improperly seated gasket, or leaky terminal tubes.

9813.375 REFERENCE LIST—COMPASS COMPENSATION DATA—MANUALS

1. **Type "R-2" coils.** Installation Data, NAVSHIPS 250-660-37 dated March 1953.

2. **Type "K-1" coils.** "Maintenance and Compensation Data" NAVSHIPS 250-660-29 dated 15 February 1945.

3. **Type "T" coils.** "Installation and Compensation Data" NAVSHIPS (660g) S81-6 dated 1 July 1944.

4. **General Information.** Handbook of Magnetic Compass Adjustment and Compensation—Hydrographic Office Publication Number 226.

5. Copies of any of the above manuals with the exception of H. O. 226 may be obtained upon request from NAVSHIPS. Copies of H. O. 226 may be obtained from the Hydrographer, Navy Department, Washington, D. C., or the local office of this activity.

SECTION II. MINESWEEPING

9813.81 PERMANENT MILITARY FEATURE

Minesweeping gear is considered a permanent military feature in minesweeping vessels.

9813.82 MINESWEEPING INSTRUCTIONS

Instructions pertaining to the tactical use of minesweeping equipment are contained in NWP 27, Mine Countermeasures Operations and NWIP 27-1, Supplement to Mine Countermeasures Operations issued by the Commander of Naval Operations, and in Ships 9, Operation and Maintenance of Minesweeping Gear issued by the Naval Ship Systems Command. Ships 9 will be superseded by NAVSHIPS 250-530 when completed. Navships 250-620-30, Index of Mine Countermeasures Material, also issued by the Commander of the Naval Ship Systems Command, contains information for the use of all Naval activities concerned with the identification and ordering of mine countermeasures equipment.

CHAPTER 9813—MINE PROTECTION (Degaussing and Minesweeping)

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