DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

Calibration, GS Maintenance, and Troubleshooting Instructions For Remote Magnetic Heading System (RMHS) Magnetic Compass MK 27, Mod 0 Gyrocompass System MK 27, Mod 1 Gyrocompass System

Headquarters, Department of the Army, Washington, D. C.
26 October 1979

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Section I. INTRODUCTION

1. Purpose. This technical bulletin provides information and instructions for the calibration, GS maintenance, and troubleshooting of the magnetic compass, RMHS, and MK 27, Mod 1, Mod 0 gyrocompass.

2. Scope. This technical bulletin applies to all GS level maintenance activities servicing the magnetic RMHS, and gyrocompass systems on all Army watercraft.

Section II. CALIBRATION OF COMPASS SYSTEMS

3. Calibration Instructions for Magnetic Compass.

a. Dockside Tests and Adjustments Required Prior to Calibration of Magnetic Compass.

(1) Physical checks on the compass and binnacle (Fig. 1).

(a) Remove any bubbles in compass bowl; refer to manufacturers manual for type and quantity of fluid required and procedure.

(b) Test for movement and sensibility of compass needles.

(c) Remove any slack in gimbal arrangement.

(d) Check for magnetization of spheres and flinders bars.

(e) Alignment of compasses with fore and aft line or ship.

(f) Alignment of magnets in the binnacle.

(g) Alignment of heeling magnet tube under pivot point of compass.

(h) Ensure that corrector magnets are on hand.

(2) Physical checks of gyro, azimuth circle, and peloruses.

(a) Align all gyro repeater peloruses or dial peloruses with fore and aft line of vessel.

(b) Synchronize gyro repeaters with master gyro compass.

(c) Insure that azimuth circle and peloruses are in good operating condition.

(3) Data required.

(a) Past history of log data that will establish length of flinders bar, if equipped. (Some magnetic compasses were installed without a flinders bar.)

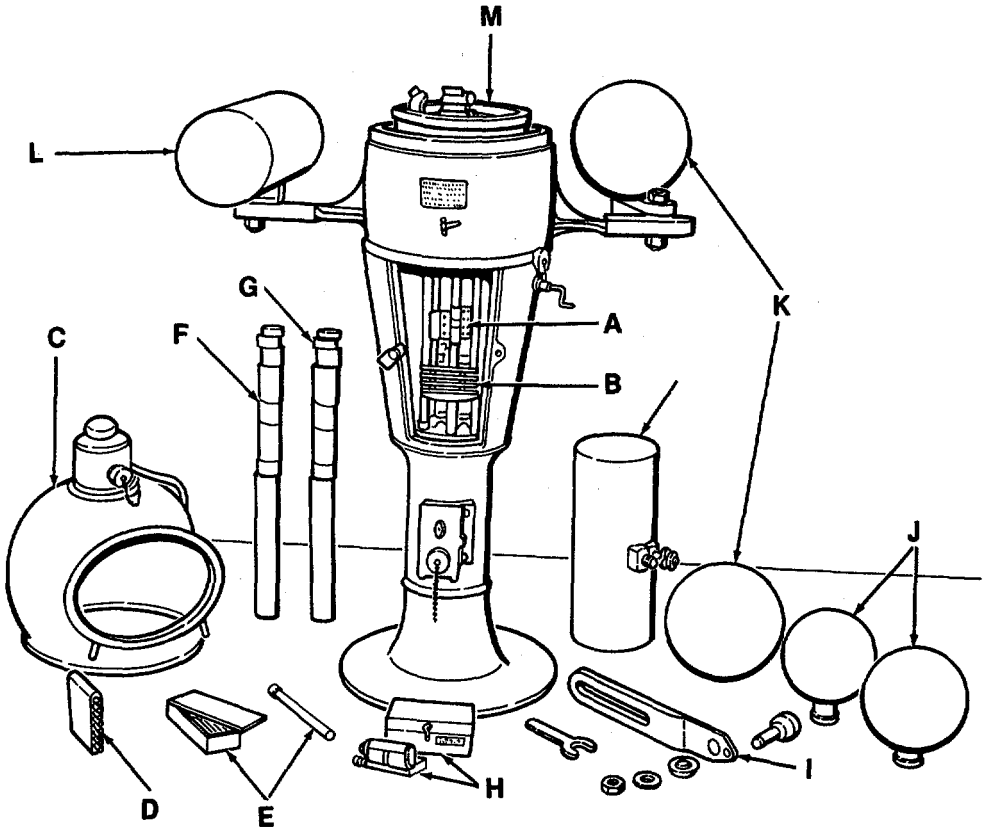
(b) Azimuths for given date and latitude.

(c) Ranges of distant objects in vicinity (local charts).

(d) Correct variation (local charts).

(4) Precautions.

(a) Determine transient deviations of compass from gyro repeaters, doors, guns, etc..



A—TRAYS FOR FORE-AND-AFT MAGNETS;
B—TRAYS FOR ATHWARTSHIP MAGNETS;
C—BINNACLE HOOD;
D—MAGNETS FOR FORE-AND-AFT AND ATHWARTSHIP TRAYS;
E—HEELING MAGNETS;
F—FLINDERS BAR SPACERS;
G—FLINDERS BAR;
H—DIP NEEDLE;
I—E-LINK;
J—7-INCH SPHERICAL QUADRANTAL CORRECTORS;
K—9-INCH SPHERICAL QUADRANTAL CORRECTORS;
L—CYLINDRICAL QUADRANTAL CORRECTORS;
M—COMPASS WITH AZIMUTH CIRCLE.

Figure 1. Binnacle With Compass and Correctors.

Fore-and-aft and athwartship magnets			Quadrantal spheres			Flinders bar		
Deviation Magnets	Easterly on west and westerly on east. (+B error)	Westerly on east and easterly on west. (-B error)	Deviation Spheres	E. on NE. W. on SE, E. on SW, and W. on NW. (+D error)	W. on NE. E. on SE, W. on SW, and E. on NW. (-D error)	Deviation change with latitude change Bar	E. on E. and W. on W. when sailing toward equator from north latitude or away from equator to south latitude.	W. on E. and E. on W. when sailing toward equator from north latitude or away from equator to south latitude.
No fore and aft magnets in binnacle.	Place magnets red forward.	Place magnets red aft.	No spheres on binnacle.	Place spheres athwartship.	Place spheres fore and aft.	No bar in holder.	Place required amount of bar forward.	Place required amount of bar aft.
Fore and aft magnets red forward.	Raise magnets.	Lower magnets.	Spheres at athwartship position.	Move spheres toward compass or use larger spheres.	Move spheres outwards or remove.	Bar forward of binnacle.	Increase amount of bar forward.	Decrease amount of bar forward.
Fore and aft magnets red aft.	Lower magnets.	Raise magnets.	Spheres at fore and aft position.	Move spheres outward or remove.	Move spheres toward compass or remove.	Bar aft of binnacle.	Decrease amount of bar aft.	Increase amount of bar aft.
Deviation Magnets	Easterly on north and westerly on south. (+C error)	Westerly on north and easterly on south. -C error)	Deviation Spheres	E. on N. W. on E. E. on S. and W. on W. (+E error)	W. on N. E. on E. W. on S. and E. on W. (-E error)	Bar Deviation change with latitude change	W. on E. and E. on W. sailing toward equator from south latitude or away from equator to north latitude.	E. on E. and W. on W. sailing toward equator from south latitude or away from equator to north latitude.
No athwartship magnets in binnacle.	Place athwartship magnets red starboard.	Place athwartship magnets red port.	No spheres on binnacle.	Place spheres at port forward and starboard aft intercardinal positions.	Place spheres at starboard forward and port aft intercardinal positions.	Healing magnet (Adjust with changes in magnetic latitude)		
Athwartship magnets red starboard.	Raise magnets.	Lower magnets.	Spheres at athwartship position.	Slew spheres clockwise through required angle.	Slew spheres counter-clockwise through required angle.	If compass north is attracted to high side of ship when rolling, raise the heeling magnet if red end is up and lower the heeling magnet if blue end is up.		
Athwartship magnets red port.	Lower magnets.	Raise magnets.	Spheres at fore and aft position.	Slew spheres counter-clockwise through required angle.	Slew spheres clockwise through required angle.	If compass north is attracted to low side of ship when rolling, lower the heeling magnet if red end is up and raise the heeling magnet if blue end is up. NOTE: Any change in placement of the heeling magnet will affect the deviations on all headings.		

Figure 2. Mechanics of Magnetic Compass Adjustment

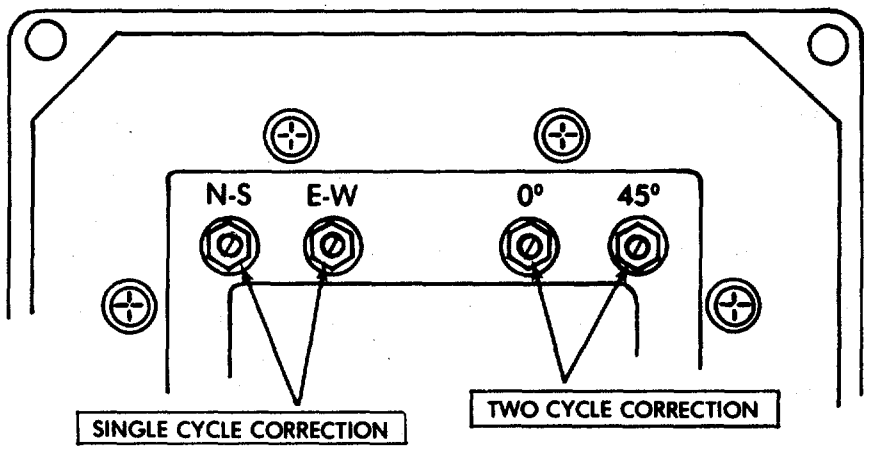


Figure 3. Partial rear View of RMHS Indicator.

(b) Secure all effective magnetic gear in normal sea going position prior to making adjustments.

(*c)* When using a gyro compass, swing from heading to heading slowly and check gyro error by sun's azimuth by range on each heading before using it as a reference. Be sure gyro is set for the average speed and latitude of the vessel.

b. Calibration Procedure For Magnetic Compass.

NOTE

These adjustments are made with the vessel underway, on an even keel, and after steadying on each heading. Refer to Mechanics of Magnetic Compass Adjustment (Fig. 2).

*(*1) Adjust the heeling magnet so as to remove oscillations of compass card, with vessel under rolling conditions on a north and south heading.

*(*2) Come to a cardinal magnetic heading, e.g. east (090°). Insert fore-and-aft B magnets, or raise or lower the existing B magnets, in such a manner as to remove all deviation.

(3) Come to a south (180° magnet heading. Insert athwartship C magnets if required, or raise or lower the existing C magnets, in such a manner as to remove all deviation.

(4) Come to a west (270°) magnetic heading. Correct half of any observed deviation by raising or lowering the B magnets.

(5) Come to a north (000°) magnetic heading. Correct half of any observed deviation by raising or lowering the C magnets.

NOTE

The cardinal heading adjustments should now be complete.

(6) Come to any intercardinal magnetic heading, northeast (045°). Correct any observed deviation by moving the spheres in or out.

(7) Come to the next intercardinal magnetic heading, e.g. southeast (135°). Correct any observed error by moving the spheres in or out.

NOTE

The intercardinal heading adjustments should now be complete.

(8) Secure all correctors before swinging for residual deviations.

(9) Swing vessel through the eight cardinal and intercardinal headings. to determine deviations at the eight headings.

(10) Recalibrate if the final error is more than +5° at any of the eight cardinal and intercardinal headings.

(11) Record deviations of eight headings and details of corrector positions on compass deviation card and in the ship's log in accordance with AR 56-9.

NOTE

Frequent, careful observations should be made to determine the constancy of deviations and results should be recorded in ship's log. Significant changes in deviation will indicate the need for readjustment.

NOTE

The calibration procedures listed above are extracted from the Hand- book of Magnetic Compass Adjust-ment Publication No. 226 Defense Mapping Agency Hydraphia Center.

4. Calibration Instructions for RMHS. Refer to procedures contained in Sperry Publication No. 19-3151-05-00, June 20, 1975.

NOTE

Readings shown on the RMHS are relative to the magnetic north pole.

a. Part A - Eight (8) Point Heading Swing of Vessels to Determine Index Error.

*(*1) Center the two single-cycle correction and the two two-cycle correction adjustment screws at the rear of the RMHS indicator (refer to fig. 3) by turning each screw 25 turns one way and then turn back 12 1/2 turns.

*(*2) Align vessel to 000-degree magnetic reference heading, Compare reading of indicator with the reading of the reference heading. Record reading of the indicator and its error (+) from the reading of the reference heading.

(3) Repeat step (1) for 045, 090, 135, 180, 225, 270, and 315-degree headings.

(4) Algebraically add sums from the 8 heading readings and divide by 8. Record the quotient (index error).

(5) Index error is to be no more than ± 1 degree. If more than ± 1 degree proceed with steps (5) thru (8) below.

(6) Align vessel to 000-degree heading and record reading of indicator.

(7) Draw a straight line with a ball point pen on side and mounting plate of transmitter case, refer to figure 1. (This is a reference line only.)

(8) Remove all magnetic material (rings, pens, watches) from person who is to be adjusting the transmitter case. Loosen the three nuts that secure the transmitter case to the mast support. Rotate transmitter case so that the new heading on the indicator is equal to heading recorded in step (4) plus or minus the index error (± number) calculated in step (3).

(9) Secure transmitter case with the three mounting nuts, insuring that the position of transmitter case does not change.

b. Part B - Single Cycle Compensation.

(1) With the vessel aligned to 000-degree reference heading, compare reading of indicator and adjust N-S adjustment screw to obtain 000-degree reading indicator.

(2) Align vessel to 090-degree reference heading, compare reading of indicator and adjust screw to obtain 090-degree reading on indicator.

(3) Align vessel to 180-degree reference heading, compare reading of indicator and adjust N-S adjustment screw to remove one-half (1/2) of error of indicator reading.

(4) Align vessel to 270-degree reference heading, compare reading of indicator and adjust E-W adjustment screw to remove one-half (1/2) of error of indicator reading.

c. Part C - Two Cycle Compensation.

(1) With vessel aligned to 000-degree reference heading, compare reading of indicator and adjust 0-degree adjustment screw to obtain 000-degree reading on indicator.

(2) Align vessel to 180-degree reference heading, compare reading on indicator and adjust O-degree adjustment screw to remove one-half (1/2) of error of indicator reading.

(3) Align vessel to 045-degree reference heading, compare reading of indicator and adjust 045-degree adjustment screw to obtain 045-degree reading on indicator.

(4) Align vessel to 225-degree reference heading, compare reading of indicator and adjust 045-degree adjustment screw to remove one-half (1/2) of error of indicator reading.

d. Part D - Eight (8) Point Heading Swing to Determine Final Error.

(1) Align vessel to 000-degree reference heading. Compare reading of indicator with reference heading. Record heading of the indicator and its error (±1) from the reference heading.

(2) Repeat step (1) for 045-degree, 090-degree, 135-degree, 180-degree, 225-degree, 270-degree and 315-degree headings.

(3) Final error is to be no more than ± 3-degrees at any of the 8 headings.

(4) If final error is more than ± 3-degrees at any of the 8 headings, center the 4 adjustment screws at rear of indicator by turning each in 25 turns and then back 12 1/2 turns. Repeat entire calibration procedures.

(5) Record errors at 8 headings on compass deviation card and enter into ship's log, in accordance with AR 56-9.

5. Calibration Instructions for Gyrocompass MK 27, Mod 1, Mod 0.

a. Calibration instruction for the Gyrocompass, Mark 27, Mod 1 are contained in Navy Publication NAVSEA 0924-LP-038-1010.

b. Calibration instruction for the Gyrocompass, Mark 27, Mod 0 are contained in TM 55-6605-261-15.

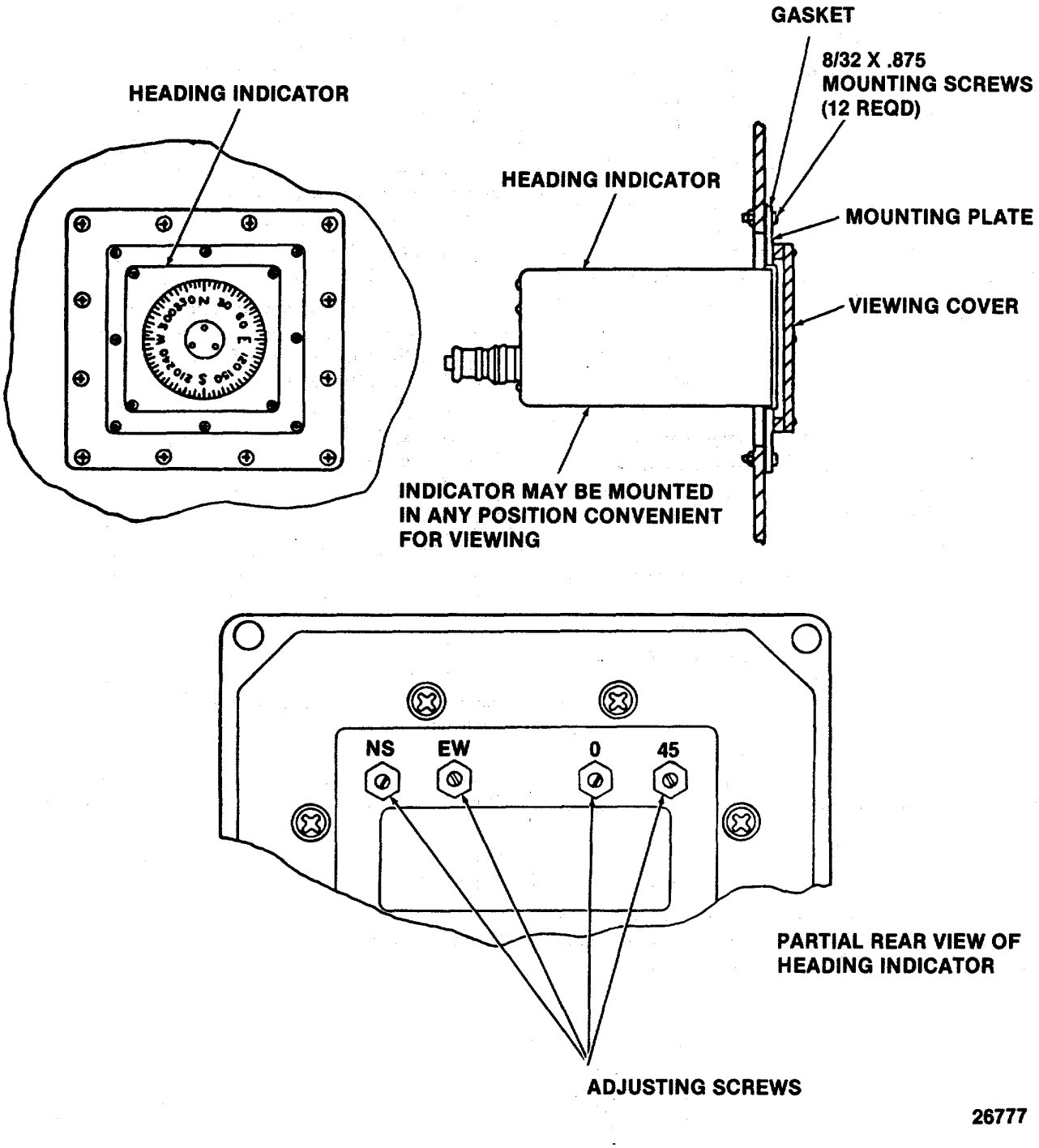


Figure 4. Typical Heading Indicator Installation.

RMHS

CALIBRATION WORKSHEET DATE:_____

Hull No:_____ Location:_____

Magnetic Ref Heading:_____ Latitude:_____

Flux Valve Serial No:_____ Indicator Serial No._____

1. Transmitter Index Error:

Mag Ref Heading	Indicator Reading	Error	Index Error
a. 000			If within ± 1°, secure flux valve; if over ± 1°, move flux valve and repeat procedure.
b. 045			
c. 090			NOTES:
d. 135			
e. 180			
f. 225			
g. 270			
h. 315			

Algebraic Sum = _____ - 8 = _____ Index Error

2. Indicator Calibration:

Mag Ref Heading	Indicator Reading	Error	Remove Error	Adjust Pot	
a. 000				NS all	NOTES:
b. 090				EW all	
c. 180				NS 1/2	
d. 270				EW 1/2	
e. 000				0 all	
f. 180				0 1/2	
g. 045				45 all	
h. 225				45 1/2	

(Readings may very drastically and may require several swings to bring Indicator within ± 3° Error required.)

3. Final Check:

Mag Ref Heading	Indicator Reading	Error	
a. 000			NOTES: Final Indicator Error must be no more than ± 3° at each heading.
b. 045			
c. 090			
d. 135			

Figure 5. RMHS Calibration Work Sheet.

COMPASS DEVIATION CARD

Hull No:_____ Geographical Location:_____

Magnetic Reference Heading:_____ Latitude:_____

Compass Serial Number:_____ Date:_____

1. Transmitter Index Error:

Mag Reference Heading	Indicator Reading	Deviation
a. 000		
b. 045		
c. 090		
d. 135		
e. 180		
f. 225		
g. 270		
h. 315		

NOTES:
1. Deviations should be no more than ± 3° for RMHS.
2. Deviations are to be entered into Ships Log in accordance with AR 56-9.
3. Mount this card in waterproof plastic close to Compass/Indicator.

Signature: _____

Figure 6. RMHS Compass Deviation Card.

Section III. GS MAINTENANCE INSTRUCTIONS

6. Maintenance Instructions for Magnetic Compass. Maintenance of magnetic compass is limited to changing burned out lamps, cleaning of glass, replacement of defective lighting cables, and removal of air bubbles.

NOTE

Do not interchange fluids, use only the type fluid specified for specific compass.

7. Maintenance Instructions for RMHS.

a. Check for water or moisture in Flux Valve housing; replace gasket/screws as required.

b. Check for 5 Amp fuses for RMHS.

c. Check for water in terminal boxes, repack stuffing tubes if required.

d. Be sure no continuity exists between terminal on terminal blocks- (could be caused by saturation of terminal block by water standing in box).

e. Check cables for defects, cuts, frayed braiding, shorts, etc.

f. Check vessel's power with all systems energized and engine running, 26 + 3 VDC required for RMHS operation.

g. Check packing in stuffing to prevent water leakage into terminal boxes.

h. Energize RMHS when operating vessel to prevent moisture from entering system.

i. Replace 3 aluminum 1/2 inch nuts at bottom of transmitter case with brass/310 stainless nuts.

8. Maintenance Instructions For MK 27, Mod 1 and Mod 0 Gyrocompasses by General Support Maintenance. Perform the following maintenance on an annual basis. Clean and inspect electronic control cabinet and/ or power converter.

9. Maintenance Instructions for MK 27, Mod 1 and Mod 0 Gyrocompasses By General Support Maintenance. Perform the following maintenance on an annual basis.

Clean and inspect electronic control cabinet and/or power converter.

(1) Safety Precautions.

(a) Observe standard safety precautions.

(b) De-energize power supply and tag "Out of Service".

(2) Tools Required.

(a) Flashlight.
(b) Safety Tag.
(c) Shorting probe.
(d) Voltage tester.
(e) Dusting brush.
(f) Vacuum cleaner (with non-metallic nozzle).
(g) Lint-free rags.
(h) Camel's hair brush.
(i) No. 2 Phillips screwdriver.
(j) 6 inch normal duty screwdriver.

(3) Maintenance Procedures.

(a) Release fasteners, remove chassis from housing.

(b) Check with voltage tester to ensure electrical circuits are de-energized.

(c) Vacuum interior of housing with nonmetallic nozzle, insuring that dirt and dust is removed from elements. Use dusting brush to reach hard to get areas.

(d) Clean components and surface areas with lint-free rags.

(e) Inspect electrical and mechanical connections for tightness.

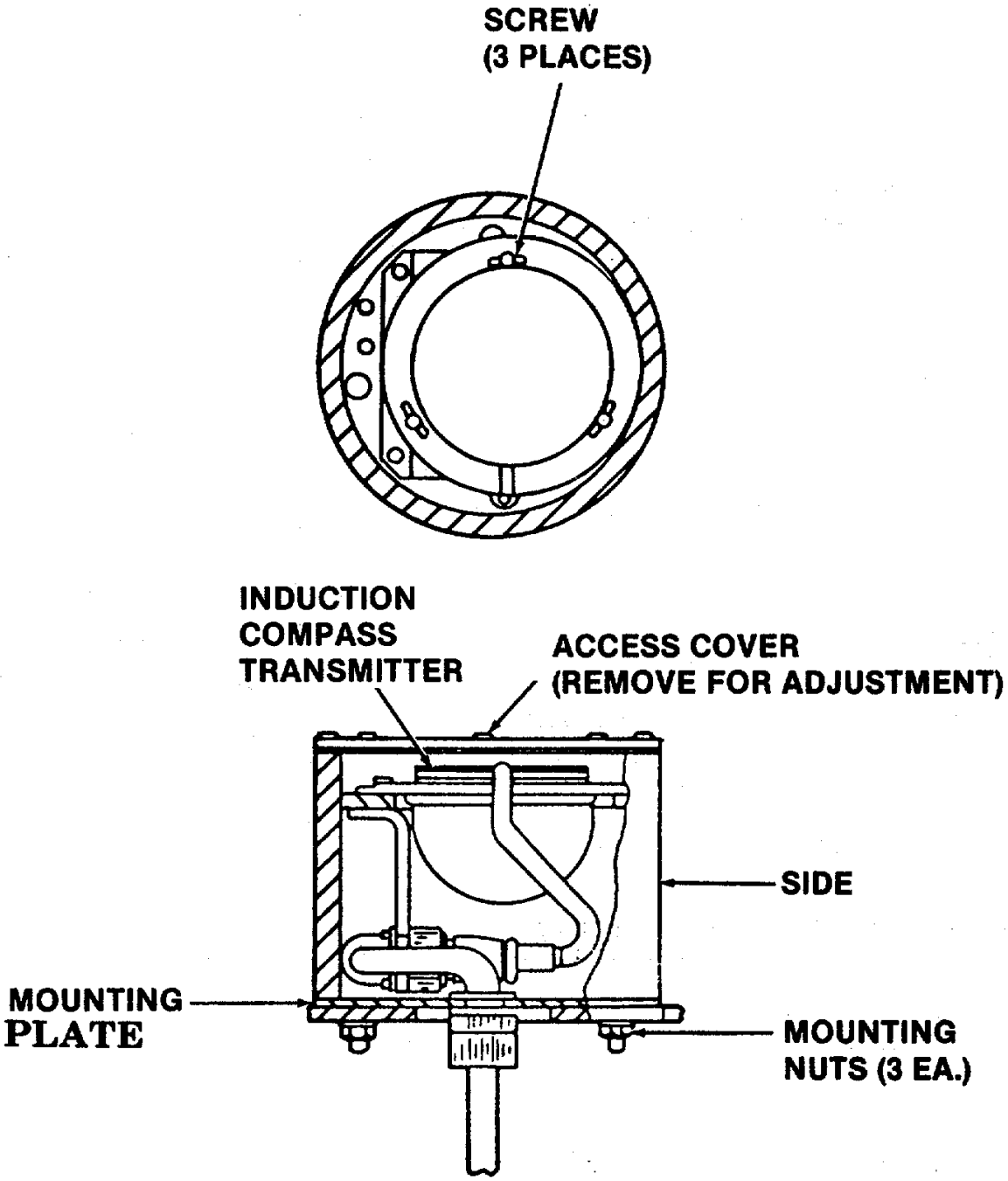


Figure 7. Typical Induction Compass Transmitter Installation.

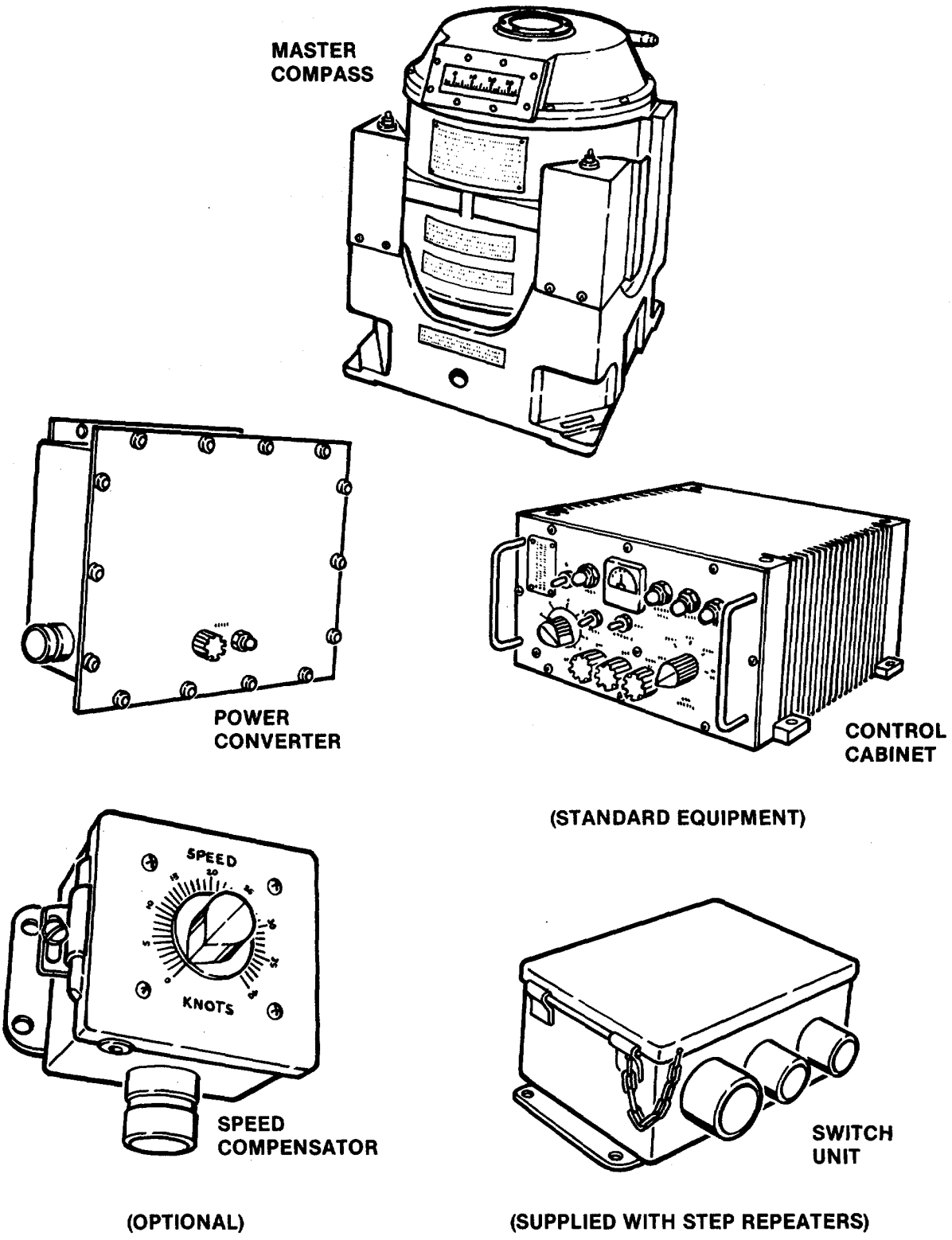


Figure 8. Mark 27 Mod 1 Gyrocompass Equipment.

(f) Tighten loose connections, using jam-nuts or lockwashers to achieve connection tightness.

(g) Inspect wiring for overheating, chafing, fraying, and chipped insulation. (Repair as necessary.)

(h) Clean electronic circuit boards and components with camel's hair brush.

(i) Inspect electronic components for discoloration, blistering, bulging of containers and leakage of insulating compounds.

(j) Inspect gasket for tears and cuts.

(k) Re-install chassis into housing and tighten fasteners.

(l) Operate switches and controls through full range of travel to detect faulty operation.

(m) Remove safety tag from power supply.

Section IV. TROUBLESHOOTING INSTRUCTIONS

10. Troubleshooting Instructions For Magnetic Compass.

Coefficient	Type deviation curve	Compass headings of maximum deviation	Causes of such errors	Correctors for such errors	Magnetic or compass headings on which to apply correctors
A	Constant.	Same on all.	Human-error in calculations. Physical-compass, gyro, pelorus alignment magnetic-unsymmetrical arrangements of horiz. soft iron.	Check methods and calculations. Check alignments. Rate arrangement of soft iron rods.	Auy.
B	Semicircular sin 0.	000° 270°	Fore-and-aft component of permanent magnetic field. Induced magnetism in unsymmetrical vertical iron forward or aft of compass.	Fore-and-aft ***B*** magnets. Flinders bar (forward or aft).	000° or 270°.
C	Semicircular cos 0.	000° 180°	Athwartship component of permament magnetic field. Induced magnetism in unsymmetrical vertical iron port or starboard of compass.	Athwartship ***C*** magnets. Flinders bar (port or starboard).	000° or 180°.
D	Quadrantal sin 20.	045° 135° 225° 315°	Induced magnetism in all symmetrical arrange- ments of horizontal soft iron.	Spheres on appropriate axis. (athwartship for +***D***) (fore and aft for -***D***) ***See sketch a***	045°,135°,225°, or 315°.
E	Quadrantal cos 20.	000° 090° 180° 270°	Induced magnetism in all unsymmetrical arrange- ments of horizontal soft iron.	Spheres on appropriate axis. (port fwd - stb'd aft for +***E***) (stb'd fwd - port aft for -***E***) ***See sketch b***	000°,090°,180°, or 270°.
Heeling	Oscillations with roll or pitch. Deviations with constant list.	000° roll 180° 000°pitch 270°	Change in the horizontal component of the induced or permanent magnetic fields at the compass due to rolling or pitching of the ship.	Heeling magnet (must be readjusted for latitude changes).	000° or 270° with dip needle. 000° or 180°while rolling.

Figure 9. Summary of Magnetic Compass Errors and Adjustment.

11. Troubleshooting Instructions for RHMS.

Problem	Probable Cause	Remedy
Compass card jumps or drags when swinging vessel 360°.	Warpage of indicator bazel plate.	Replace indicator assembly.
	Battery output low.	Charge batteries
Compass card follows erratically when swinging vessel.	Loose or wrong connections in terminal box.	Tighten or change (especially terminal No. 6 & 9).
	Open or short in cables.	Repair or replace as necessary.
	Battery output low.	Charge or replace to achieve 26 + 3 VDC.
	Water in terminal boxes.	Remove water, check terminal block for continuity across terminals, replace terminal block if necessary, replace gaskets and screws.
Compass reading 180° out from known reference and seeking only 45° in each direction.	Vessel's steel mast magnetized.	Modify mast to remove magnetism from area of Transmitter Assy.
	Water of moisture in transmitter case of terminal boxes.	Refer it III, remove water, replace gasket and screws.
Compass card hunting back and forth at any heading.	Potentiometers (NS, EW, O, 45) located at bottom of indicator assembly are turned in or out too far. Also check all causes listed above.	Bottom pots by turning in (CW) 25 turns then back out (CCW) 12 1/2 turns then proceed with calibration.

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