DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORGANIZATIONAL DS, AND GS, MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LISTS INDICATOR ID-48A/ARN

Headquarters, Department of the Army Washington D.C.
12 March 1971

LIST OF ILLUSTRATIONS

CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *31 August 1977*

Organizational, DS, and GS Maintenance Manual Including Repair Parts and Special Tools Lists INDICATOR ID-48A/ARN (NSN 5826-00-036-6504)

TM 11-5840-270-241, 12 March 1971, is changed as follows:
1. Title of manual is changed as shown above.
2. Insert pages as indicated in the list below.

Remove	*Insert*
None	Add Radiation Warning front of manual.

3. File this change sheet in front of the publication for reference purposes.

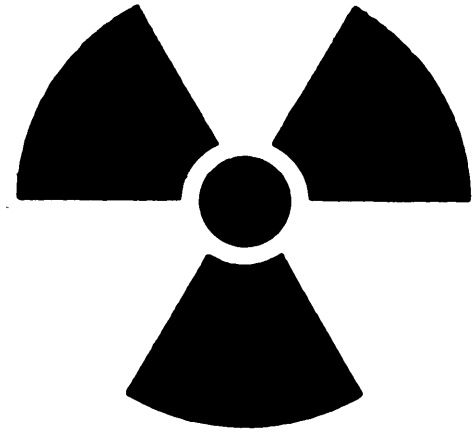
By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

PAUL T. SMITH
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-36, Organizational avionics literature requirements for ID-48/ARN.



STD-RW-2

Indication ID-48/ARN Ra 226 1.45 µ Ci 6610-00-839-8638
Radiation Hazard Information: The following radiation hazard information must be read and understood by all personnel before operating or repairing Indicator ID-48A/ARN. Hazardous radioactive materials are present in the ID-48A/ARN.

The components are potentially hazardous when broken. See qualified medical personnel and the local Radiological Protection Officer (RPO) immediately if you are exposed to or cut by broken components. First aid instructions are contained in TB 43-0122, and AR 755-15.
NEVER place radioactive components in your pocket. Use extreme care NOT to break radioactive components while handling them.
NEVER remove radioactive components from cartons until you are ready to use them.
If any of these components are broken, notify the local RPO immediately. The RPO will survey the immediate area for radiological contamination and will supervise the removal of broken components. The above listed radioactive components will not be repaired or disassembled.
Disposal of broken, unserviceable, or unwanted radioactive components will be accomplished in accordance with the instructions in AR 755-15.

*U.S. GOVERNMENT PRINTING OFFICE: 1977-765010/133

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual contains information for the maintenance of the Indicator ID-48A/ARN. Included are instructions for the overhaul and repair, calibration and test procedures to be used in the performance of organization, direct and general support maintenance.

1-2. Index of Publications

a. DA Pam 310-4. Refer to DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO'S) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army)/NAVSUP Publication 378 (Navy/AFR 71-4 (Air Force)/ and MCO P4630.29 (Marine corps).

c. Discrepancy in Shipment Report (DISREP) (SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF361) as prescribed in AR 55-38 (Army)/NAVSUP Pub 459 (NAVY)/AFM 75-34 (Air Force)/ and MCO P4610.19 (Marine Corps).

d. Reporting of Equipment Publication Improvements. The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-ME-NMP-AN, Fort Monmouth, N.J. 07703.

Section II. DESCRIPTION AND DATA

1-4. Purpose and Use

a. Purpose. The Instrument Approach System provides the pilot with a straight line glide path beam and a runway localizer beam. To enable the pilot to follow the two beams, the aircraft is equipped with an ID-48/ARN Indicator. The Indicator operates from the output of the aircraft localizer and glide path receivers. The marker beacon lamp on the Indicator is operated from a separate marker beacon receiver.

b. Use. The Indicator is used in conjunction with instrument approach receivers to provide a visual indication of the position of the aircraft with respect to radio-frequency space patterns generated by the ground transmitter equipment of the instrument approach systems. The Indicator two main indicating pointers, localizer and glide path pointers, establish the position of the runway localizer and the glide path beams with respect to the image of the airplane printed at the center of the dial of the instrument.

1-5. Technical Characteristics

Characteristic	*Description*
Type of input signals	Dc levels derived from instrument approach receivers.
Vertical pointer input	150 - 0 -150 µA full sca1e
Horizontal pointer input	150 - 0 -150 µA full scale
Horizontal and Vertical flag inputs	250 µ A to deflect out of view
Beacon lamp input.	27.5 volts dc ± 10%, 0.2 amperes max.
Terminal resistance of each pointer and flag input.	1000 ohms ±3% at 25 deg C.
Operating temperature.	+ 71 deg C. to -55 deg C.
Vibration	10 to 50 Hz at 5 G's.
Storage	2 years at 25 deg C.

1-6. Physical Description

(fig. l-l)

a. The Indicator has four moving-element displays, consisting of two main tubular indicating pointers and two warning flag mechanisms. A glass covered dial with an aircraft image printed in the center, and a beacon lamp assembly are installed in the instrument case, which encloses the entire unit. Luminescent finish is used on the pointer, flag, airplane image, indicated lettering, and indicated port and starboard sector areas.

b. External connections to the Indicator are made through a 10-pin receptacle for the pointer and warning flag circuits, and through a 3-pin receptacle for the beacon lamp circuit.

c. The overall dimensions of the Indicator are 3¼ inches wide by 3¼ inches high by 4-15/32 inches deep. The depth includes the projecting beacon lamp cap. The weight of the Indicator is approximately 1 pound, 1 ounce.

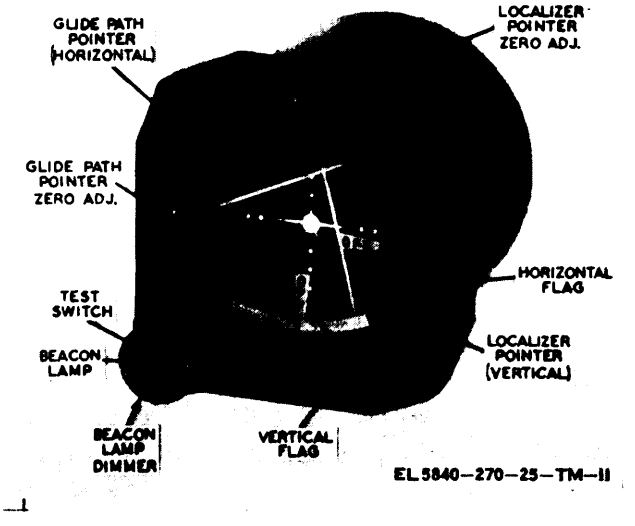


Figure 1-1. Indicator ID-48A/ARN, front view.

1-7. Detailed Description

(fig. l-l)

a. Case Assembly. The case assembly consists of an aluminum case and a bezel assembly in which a mask and glass are held by spring clips. Captions GLIDE PATH, LOCALIZER OR RANGE and MARKER are printed on the mask in non-luminescent green to identify the associated pointer function. Two sectors printed adjacent to the lower mask opening identify the port (blue) and starboard (yellow) sections. The yellow and blue fluorescent materials are in accordance with specification MIL-D-25177. Zero correctors mounted in holes in the glass permit external adjustment of the zero current position of the localizer and glide path pointers. The beacon lamp and switch assembly extends through a threaded opening in the lower left corner of the bezel.

b. Mechanism Assembly (fig. 4-3). Four mechanisms (localizer mechanism, glide path mechanism, localizer flag mechanism, and glide path flag mechanism) are mounted on a plate attached to the cast aluminum alloy housing. The plate also supports the dial. The dial markings are coated with luminescent material in accordance with MIL-L-25142.

c. Pointer and Flag Mechanisms.

(1) *Arrangement of mechanisms.* The four mechanisms are identical in construction except that the pointers are designed for the particular function of the mechanism. The localizer (vertical) and glide path (horizontal) pointers are formed from aluminum tubing and coated with luminescent material in accordance with MIL-L-25142. The vertical and horizontal flags are coated with red fluorescent material in accordance with AF Specification No. 14157, type 2, color No. 66. The word OFF is printed in black on the flags.

d. Housing. The housing MP14 supports the four mechanisms, the case, the 10-pin connector and the 3-pin connector.

1-8. Controls and Indicators

(fig. l-l.)

Control, indicator, or connector	*Function*
Beacon lamp.	Lights when aircraft passes over a marker beacon. Dc power is applied to light the lamp.
Beacon lamp dimmer	Mechanical iris varies brightness of beacon lamp when rotated.
PRESS-TO-TEST switch	Lights beacon lamp when pressed, to test lamp.
Localizer (vertica) pointer	Moves left and right of center to indicate that aircraft is off course.
Localizer warning flag	Appears in window to indicate unreliable signal or loss of adequate signal.
Glide path (horizontal) pointer	Moves above or below center to indicate deviation from desired glide path. (Aircraft is too high or too low).
Glide path warning flag	Appears in window to indicate unreliable signal or loss of adequate signal.
Localizer pointer zero adjust	Aligns localizer pointer over dots
Glide path pointer zero adjust	Aligns glide path pointer over dots

CHAPTER 2

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

2-1. Scope

The maintenance duties assigned to the organizational repairman of the ID-48A/ARN are limited preventive maintenance and replacement of the beacon lamp and lens.

2-2. Organizational Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent occurrence of trouble, to reduce repair time, and to insure equipment serviceable under normal operating conditions.

2-3. Organizational Preventive Maintenance Checks and Services

Before and after each operating period and prior to storage, visually inspect the ID-48A/ARN as follows:

a. Insure that all parts and components are secure.

b. Insure that the bezel is clean and unbroken.

c. Insure that the marker beacon lamp is operating.

d. Check zero adjust of pointers.

2-4. Cleaning

Clean exterior of dust, using damp cloth. Dry with lint-free cloth. Clean window with lint-free cloth. Brush pins of connectors to remove dust or foreign matter.

2-5. Organizational Troubleshooting

Press the PRESS-TO-TEST switch (fig. 1-1). If the beacon lamp does not light, replace it (para 2-6).

2-6. Replacing Beacon Lamp

a. Unscrew the dimmer ring and lens assembly.

b. Remove the bayonet base lamp and replace it.

c. Replace the dimmer ring and lens assembly.

2-7. Zero adjust of pointers

(fig. 1-1)

To adjust the Localizer or Glide path pointers turn the zero adjust screws on the window to align with the dots on the ID-48A/ARN.

CHAPTER 3

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

3-1. Disassembly of Equipment

Equipment disassembly is not required. The procedures for removing the ID-48A/ARN from the aircraft are specified in the aircraft system manual.

3-2. Repackaging of Equipment

Repackaging of equipment for shipment or limited storage normally will be performed at a packaging facility or by repackaging team. If practicable, the original packaging materials should be stored and used for repackaging. Should emergency packaging be required, select the materials from those listed in SB 38-100. Package the equipment in accordance with the original packaging, so far as possible with the available materials.

3-3. Packaging Data

The Indicator ID-48A/ARN is in a carton 8½ x 5 $^{5}/_{8}$ x 5 $^{5}/_{8}$ inches in size. Figure 3-1 shows a typical packing arrangement. It is only necessary to open the outer carton by slitting the waterproof tape, open the carton and remove the cover on the inside container, lift the bag out, and remove the indicator from the bag.

3-4. Checking Unpacked Equipment

a. Inspect the equipment for damage that may have occurred during shipment. If the equipment has been damaged, fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies).

b. Check to see that the equipment is complete as listed on the packing slip. Report all discrepancies in accordance with instructions given in TM 38-750.

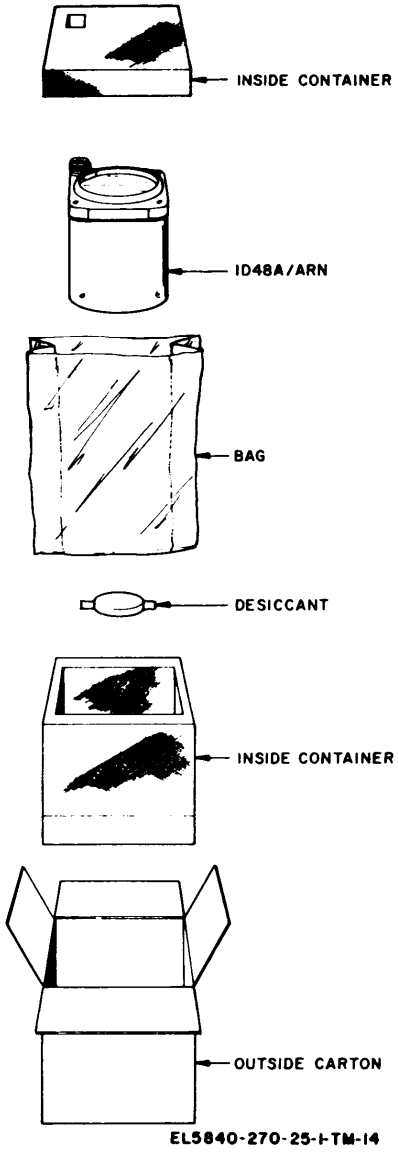


Figure 3-1. Typical packaging.

Section II. DEMOLITION TO PREVENT ENEMY USE

3-5. Authority for Demolition

Demolition of the equipment will be accomplished only upon order of the commander. Use the destruction procedures outlined in paragraph 3-6 to prevent further use of the equipment.

3-6. Methods of Destruction

Any or all of the methods of destruction given below may be used. The time available will determine the order and methods of destruction. Also, the tactical situation will determine how the destruction will be carried out. In most cases, it is preferable to demolish completely the computer rather than partially destroy all the components of the navigation set.

a. Smash. Smash the navigation set components; use sledges, axes, hammers, crowbars, and any other heavy tools available.

b. Cut. Cut the interconnecting cables and equipment internal cable harnesses; use axes, handaxes, machetes, and similar tools.

c. Burn. Burn as much of the equipment as is flammable; use gasoline, oil, flamethrowers, and similar flammables. Burn the technical manuals first. Pour gasoline on the cut cables and internal wiring and ignite it. Use a flamethrower to burn spare parts or pour gasoline on the spares and ignite them.

WARNING

Be extremely careful with explosives and incendiary devices. Use these items only when the need is urgent.

d. Explode. Use explosives to complete demolition or to cause maximum damage, before burning, when time does not permit complete demolition by other means. Power charges, fragmentation grenades, or incendiary grenades may be used. Incendiary grenades usually are most effective.

e. Dispose. Bury or scatter destroyed parts or throw them into nearby waterways. This is particularly important if a number of parts have not been completely destroyed.

3-7. Reporting Destruction

Report of equipment destruction will be made through command channels.

CHAPTER 4

DIRECT AND GENERAL SUPPORT MAINTENANCE

Section I. PRINCIPLES OF OPERATION

4-1. General

The marker beacon lamp flashes a coded signal as the aircraft passes over each of the three marker beacon transmitters. These transmitters are located at approximately 4.5 miles, 1.0 mile, and 200 feet from the end of the runway. The outer marker beacon is identified by a 2 dashes-per-second signal, the middle marker beacon by a 6 dots-per-second signal and the boundary marker beacon by an unkeyed signal. As these signals are received, the pilot checks the distance to the runway and the altitude at the time of crossing.

4-2. Block Diagram Analysis

a. Figure 4-1 shows a simplified block diagram of the Instrument Approach System. The signal is split at the ground transmitter; one section is modulated at 90 cycles per second, and the other is modulated at 150 cycles per second. For convenience in flight, these sectors are designated as blue and yellow sectors and the indicator face is marked with corresponding blue and yellow sectors. The blue sector is transmitted to the right of the beam in respect to the landing aircraft and the yellow sector is transmitted to the left of the landing aircraft. The signals are received by the localizer receiver and separated by frequency discriminators or hand-pass filters, individually rectified and recommended by differential connection of the rectifier output to actuate the pointer. The glide path transmitter and receiver operate in a similar manner to establish the glide path intelligence.

b. The vertical pointer supplies a visual indication of the lateral position of the aircraft with rcspect to the on-course signal of the localizer beam. The horizontal pointer shows the relationship of the aircraft to the glide-path beam. When the aircraft is properly aligned on the approach path, the pointers are crossed at the center of the dial.

c. The dotted circuit of figure 4-1 shows the connections of the flag mechanism in the output circuit of the receivers. The warning flags operate from the summation of the rectifier outputs while the pointers operate from the difference of these outputs. This arrangement provides positive "nonoperating" signals by virtue of the fact that the "sum" and "difference" are obtained from the same output.

d. The mechanisms Ml, M2, M3, and M4 are similar in construction and operating principle. Each mechanism is a permanent magnet moving-coil type microammeter, which consists essentially of a moving coil mounted and pivoted in the field of a permanent magnet (fig. 4-2). Current flowing through the coil causes the coil to rotate, which moves the attached pointer across the scale. The deflection of the moving coil is proportional to the current flowing through the coil, and hence, to the strength of the signal received from the aircraft receiver.

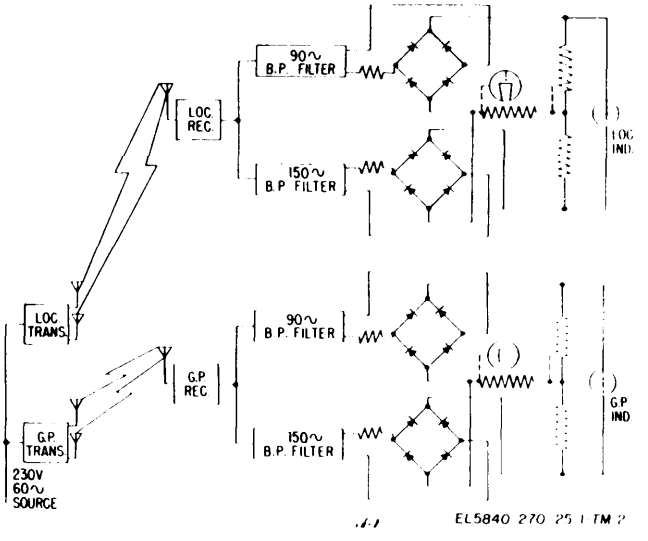


Figure 4-1. Simplified block diagram of indicator in instrument approach system.

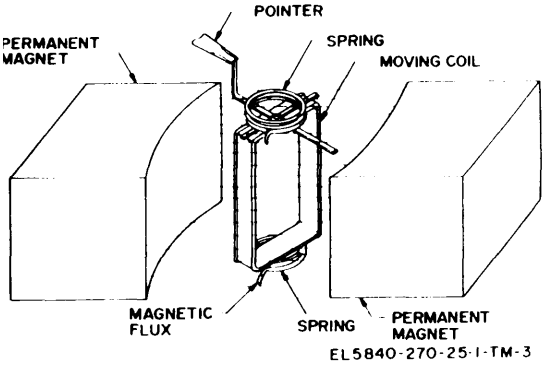


Figure 4-2. Permanent magnet, moving-coil type mechanism.

Section II. TROUBLESHOOTING

4-3. Scope

The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at organizational level, is carried to a higher maintenance category in this section. Sectionalizing and isolating techniques used in the troubleshooting procedures are more advanced.

4-4. Troubleshooting Procedures

a. General. The first step in servicing a defective indicator is to sectionalize the fault. Sectionalization means tracing the fault to a major component. The second step is to localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal conditions. Some faults, such as burned out resistors, cracked insulation, or damaged mechanical parts can often be located by sight, smell, or hearing. The majority of faults, however, will be located by injecting simulated operating signals and observing the results on the indicator displays.

b. Sectionalization. Listed below are tests arranged to reduce unnecessary work and to aid in tracing trouble in a defective indicator.

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All visual signs should be observed and an attempt made to sectionalize the fault to a particular section of the indicator.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. Operational tests are given in section VI of this chapter.

c. Localization. After the trouble has been sectionalized *(b* above), the methods in (1) and (2) below will aid in localizing the trouble to a defective circuit element.

(1) *Resistance measurements. Make* resistance measurements on the indicator only as directed in paragraphs 4-20 and 4-26.

(2) *Intermittent troubles.* In all the tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the indicator. Make a visual inspection of the wiring and connections of the indicator.

4-5. Tools and Test Equipment Required

The following is a listing of tools, test equipment, and the associated technical manuals required for troubleshooting the indicator.

a. Test Equipment.

Test equipment	*Technical manual*	*Common name*
Test Panel, Indicator ID-48A/ARN	None.	Test Panel
Multimeter TS-352B /U	TM 11-6625-366-15	Multimeter

b. Tools. Refer to the Maintenance Allocation Chart in the appendix.

4-6. Special Materials Required

Item	*Mfr. and type*	*Use*
Epoxy Cement	Eccobond Emerson & Coming Inc. Canton, Mass.	To cement window in bezel.
Solvent, Epoxy	Mona strip EP stripper, Mona Industries, Inc. Patterson 17, N. J.	To remove or clean epoxy cement residue.

4-7. Troubleshooting Chart

a. General. The troubleshooting chart in this section supplements the operational tests contained in sections V and VI. The chart indicates operational symptoms, probable troubles, and corrective measures that should be taken to remedy the trouble. Troubleshooting instructions are based on performance of the equipment. Depending upon the nature of the operation trouble symptom, one or more localizing procedures will be necessary. The troubleshooting chart lists abnormal indications and probable causes for the tests performed in section VI. Perform the tests and refer to the troubleshooting chart if correct readings cannot be obtained.

b. Chart.

Item No.	Symptom	Probable cause	Corrective action
1	Pointer moves off center when indicator is rotated about the horizontal axis (para 4-17).	Pointer mechanism out of balance.	Replace the mechanism
2	Warning flag changes position or goes out of view when indicator is rotated about the horizontal axis.	Flag mechanism out of balance.	Replace the mechanism
3	Terminal resistance is not 1000 ohms (para 4-20).	Incorrect resistor R1 in compensating network.	Change series resistor R1 as required. (fig. 4-5)
4	Current required for deflection of pointer is incorrect (para 4-21).	Defective mechanism	Replace mechanism
5	Current required for deflection of flag is incorrect (para 4-22).	*a.* Defective mechanism.	*a.* Replace mechanism
		b. Spring tension on armature in mechanism is incorrect.	*b.* Readjust the spring tension (para 4-22).
6	Pointer does not leave stop at correct current (para 4-23).	*a.* Dirty mechanism or meter stop.	*a.* Clean stop, clean mechanism.
		b. Defective mechanism.	*b.* Replace mechanism
7	Pointer response time is incorrect (para 4-24).	Defective mechanism.	Replace mechanism
8	Beacon light is inoperative (para 4-25).	*a.* Lamp is defective	*a.* Replace lamp
		b. Lamp switch or lampholder is defective.	*b.* Replace if required
9	Electrical short between case and a pin on a connector (para 4-26)	Internal wiring shorted.	Open case and inspect for solder or wire touching case. Remove any excess solder and move component leads or wiring to prevent shorting to case.

Section III. DISASSEMBLY AND REASSEMBLY

4-8. Case Removal

a. Remove four screws H9 (fig. 4-4) and four washers H10 securing smaller connector J2.

b. Disconnect three leads from connector J2 Remove connector J2 and gasket MP13.

c. Remove four screws H1 (fig. 4-3) and carefully slide the mechanism assembly out the rear of the case.

4-9. Disassembly of Indicator Case and Bezel Assembly

(fig. 4-3)

a. Remove six screws H2 and two screws H3 from rear of case flange and lift case MP9 from bezel assembly. Remove gasket MP10.

b. Remove four screws H4 and four clips MP2.

c. Remove mask MP4 and gasket MP3.

d. Unscrew dimmer cap A3MP1 and remove A3DS1.

e. Loosen two setscrews H 6.

f. Unscrew socket A3XDS1 and remove mom bezel MP1.

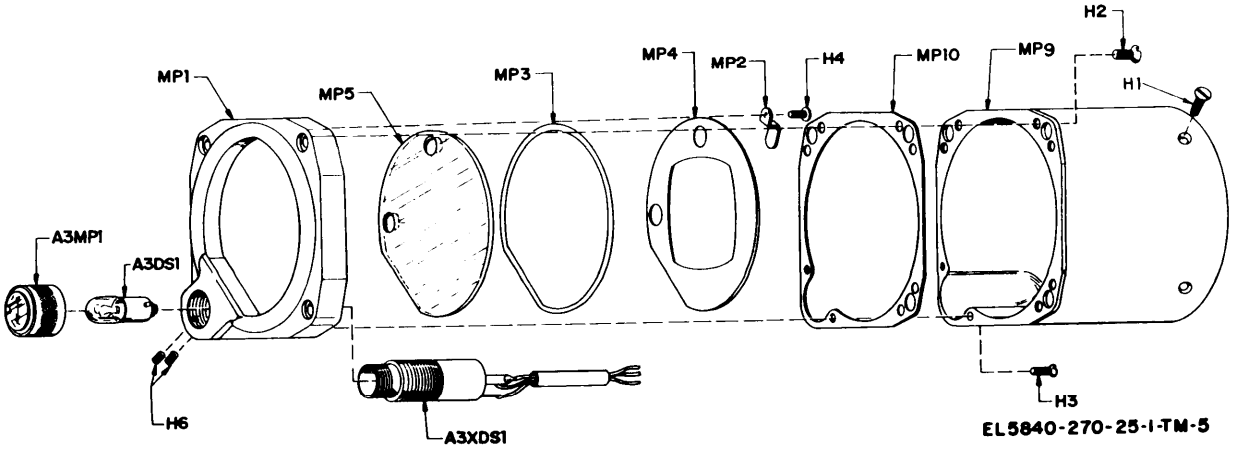


Figure 4-3. Indicator case, exploded view.

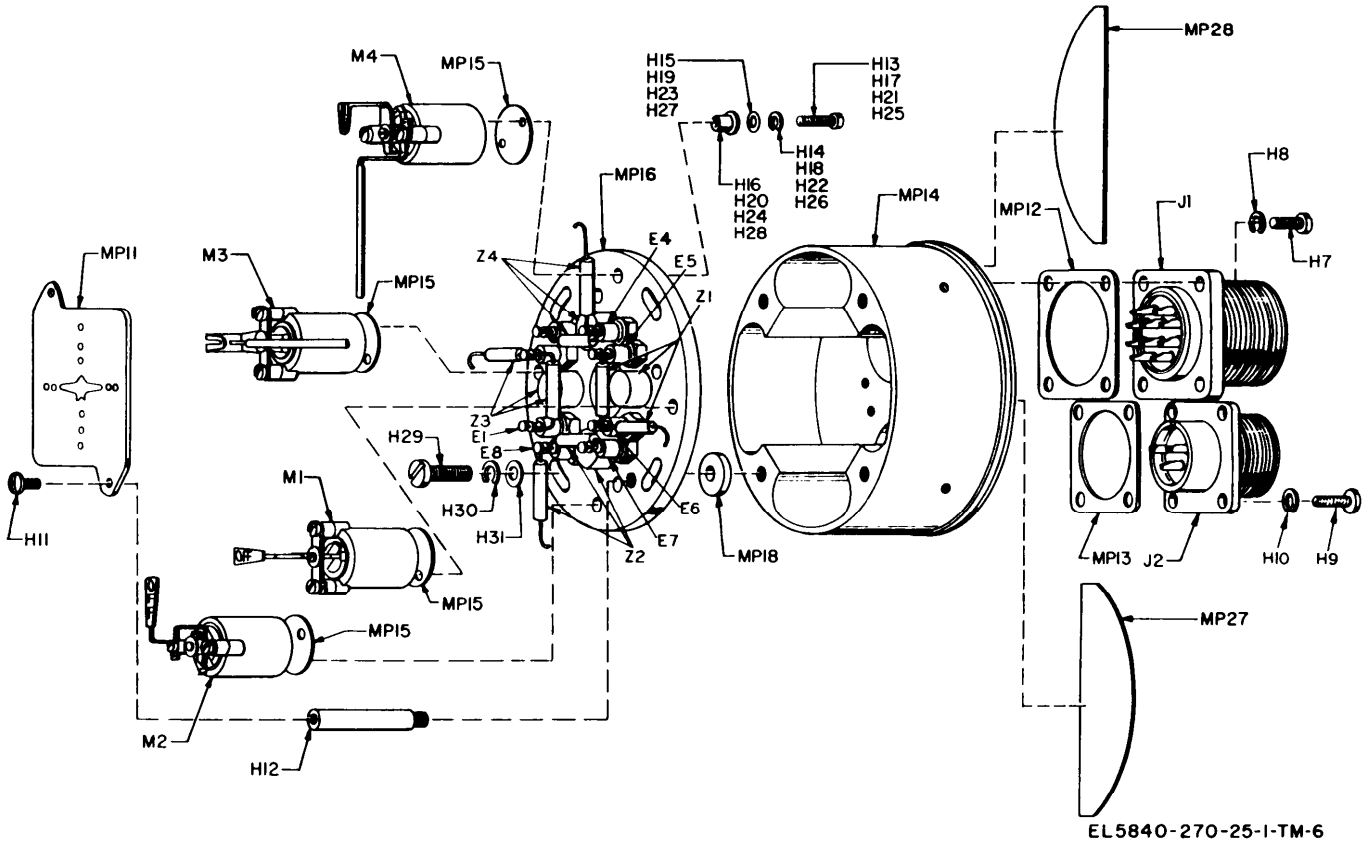


Figure 4-4. Mechanism assembly, exploded view.

g. Remove window MP5 from cemented position in bezel MP1 only if scratched, cracked, broken, or discolored. Window is cemented at four spots. Push it out of the bezel and scrape epoxy from bezel.

4-10. Disassembly of Mechanism Assembly (fig. 4-4.)

a. Remove four screws H7 (fig. 4-4) and four washers H8.

b. Extract large connector J1 from housing MP14.

c. Disconnect eight leads, remove large connector J1 and gasket MP12.

d. Remove four screws H29, four washers H30, and four washers H31. Maintain a firm grip on plate MP16 to prevent damaging four mechanisms Ml, M2, M3, M4 as screws are removed.

e. Carefully lift plate MP16 from housing MP14 and remove four insulators MP18.

f. Remove mechanism MP4 as follows:

(1) Disconnect the wire and resistor lead attached to the mechanism.

(2) Remove screw H13, lockwasher H14, flat washer H15 and bushing H16.

(3) Carefully remove mechanism MP4 and its insulator MP15.

g. Remove mechanisms MP1, MP2, and MP3 the same as MP4, using screws H17, H21, and H25, Iockwashers H18, H22, and H26, flat washers H19, H23, and H27, and bushings H20, H24, and H28.

h. Remove two screws H11. Maintaining a firm grip on dail MP11 lift carefully away from posts H12.

i. Unscrew posts H12 from plate MP 16.

j. Disconnect compensator network Z1,Z2, Z3, or Z4 from the eight standoff terminals E1 through E8.

4-11. Reassembly of Mechanism Assembly (fig. 4-4.)

a. General. Before reassembly, perform cleaning, inspection and repair procedures as required. See sections V and VI. Compensating networks Z1, Z2, Z3 and Z4 are identical and interchangeable but may require changing the value of R1 to obtain desired terminal resistance of 1000 ohms.

NOTE

Terminals E1 through E8 are numbered clockwise beginning with terminal adjacent to notch in edge of plate MP16. Refer to figure 4-5 and figure 4-4 when making connections.

b. Procedure.

(1) Connect components of compensating networks to standoff insulators E1 through E8. Refer to figure 4-5 and figure 4-4.

(2) Mount dial mounting posts H12 on plate M16 and mount dial MP11 to posts with screws H11. Use care to avoid bending flags or pointers.

(3) Secure each mechanism M1, M2, M3 and M4 to plate MP16 using insulator MP15, bushings H16, H20, H24 and H28, washers H15, H19, H23 and H27, washers H14, H18, H22, and H26, and screws H13, H17, H21, and H25 as shown in figure 4-4.

(4) Connect resistor R1 lead from each compensating network to left external terminal of adjacent mechanism.

(5) Refer to schematic, figure 4-5, and connect wire leads from connector J1 to center terminal of each mechanism. Observe correct wire color (eg: orange wire to Ml, etc.).

(6) Position insulators MP18 and secure plate MP16 to housing MP14 with washers H31, washers H30, and screws H29. Before tightening screws H29 align plate so that screws are approximately centered in slotted holes in plate. Tighten screws H29.

(7) Thread wire leads through gasket MP12, and solder leads to J1, Refer to schematic diagram, figure 4-5.

(8) Secure connector J1 to housing MP14 with four washers H8 and four screws H7.

(9) If required, adjust vertical and horizontal pointer mechanisms, M4 and M3 respectively, until pointers are centered over appropriate dots on dial MP11, by turning the U-shaped bracket on top of the two mechanisms.

4-12. Reassembly of Case and Bezel Assembly

(fig. 4-3)

a. If window is being replaced in an old bezel, clean the bezel assembly (with epoxy solvent) where the window will contact the bezel.

b. Place epoxy cement at four spots, equally spaced, around the inside edge of the bezel opening and press the new window in place.

c. Place gasket MP3 against window MP5 and position mask MP4. Secure with four clips MP2 and four screws H4.

d. Screw lampholder A3XDS1 into bezel MP1 until approximately one thread protrudes through front of bezel.

e. Secure lampholder A3XDS1 with two setscrews H6.

f. Insert lamp A3DS1 and install dimmer cap A3MP1.

g. Position gasket MP10 and secure case MP9 to bezel MP1 with six screws H2 and two screws H3.

4-13. Final Reassembly

(fig. 4-3 and 4-4)

NOTE

If a meter mechanism or part of a compensating network has been replaced, check the terminal resistance for 1000 ohms before reassembling. If incorrect, change R1 on the network as required (fig. 4-5).

a. Adjust the bracket on top of M4 so the slot in the bracket is vertical.

b. Adjust the bracket *on* top of M3 so the slot in the bracket is horizontal.

c. Turn the top adjusting screw on window MP5 so the pin on the rear of the screw is on a vertical line with the center of the screw.

d. Turn the side adjusting screw on window MP5 so the pin on the rear of the screw is on a horizontal line with the center of the screw.

e. Feed three leads from lampholder A3XDS1 through notch in edge of plate MP16 and out through opening in rear of housing MP14.

f. Align holes in case with proper holes in MP14, and without turning case, slide case straight over mechanism assembly, using extreme care not to damage the four mechanisms. Secure with four screws H1.

g. Turn the two screws on the window through 360 degrees and observe that the two pointers are adjusted, assuring proper engagement. Adjust screws to align pointers with dots.

h. Position gasket MP13 and connect leads of lampholder to pins of connector J2 in accordance with schematic, figure 4-5.

i. Secure gasket MP13 and connector J2 with four washers H10 and four screws H9.

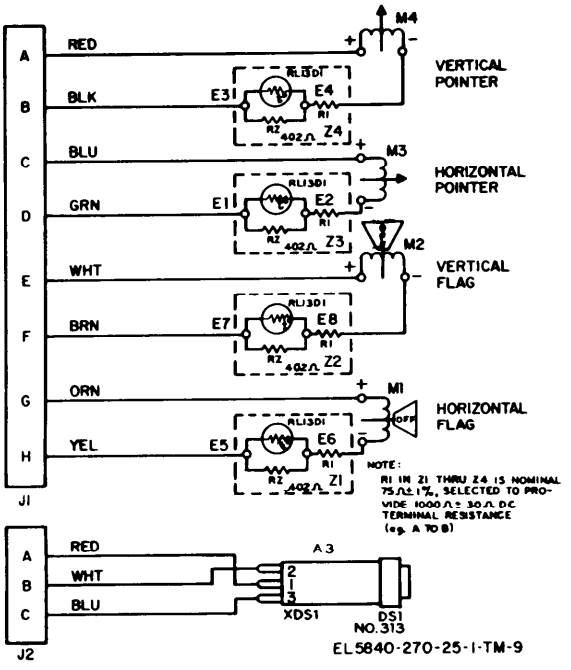


Figure 4-5. Schematic diagram.

Section IV. CLEANING, INSPECTION, AND REPAIR

4-14. Cleaning

After disassembly, clean the parts of the indicator as specified in table 4-1.

4-15. Inspection

Inspect all parts of the disassembled indicator as indicated in table 4-1.

4-16. Repair

Except for minor dents and scratches, no repair is possible. Replace all parts that are defective or damaged. If a meter mechanism or compensating network is replaced, R1 on the network may require changing to obtain 1000-ohm terminal resistance (para 4-20).

Table 4-1. Cleaning and Inspection of Indicator ID-48A/ARN

Part	Cleaning	Inspection
Mechanism Ml, M2, M3, M4.		
Movements	Remove any fuzz of lint using a soft bristle brush or low pressure air source. Do not use cleaning fluid.	Inspect for loose or broken wires and loosely mounted pivot bases.
Pointers	Luminescent painted surface may be cleaned with benzine.	Inspect for bent or dirty pointer, loose balance weights or chipped surface. Pointer should be perpendicular to the moving coil and parallel to the dial when mounted.
Pointer Stops	Clean with acetone.	None.
Wiring and Soldered Connections.	Clean connections and terminals before resoldering.	Inspect for poor solder joints, loose connections and mounting, broken or shorted wires.
Dial MP11 and Mask MP4.	Clean dirty markings with a cloth moistened with benzine.	Inspect for chipped or dirty luminous marking.
Window MP5	Wipe clean with soft cloth.	Inspect for scratched or broken glass, loose mounting.

Section V. BALANCE TEST PROCEDURE

4-17. Scope

This section describes the balance test procedure for the meter movement mechanisms. Mechanism moving elements must be well balanced about their axis of rotation in order to provide accurate indication while in normal operating position as well as when tilted, as may occur in service. Adjustable balance weights are provided on pointer tail and arms for balancing purposes during fabrication.

4-18. Procedure

a. Place indicator in horizontal position, as normally occupied in panel of aircraft.

b. Observe the two pointers, they must be aligned with the two rows of dots. If not, adjust the movement mechanisms so each pointer is aligned over its corresponding row of dots.

c. Rotate the indicator clockwise 90° from vertical and observe the pointers. They must still be aligned over the rows of dots.

d. Rotate the indicator to 90° counterclockwise from vertical and observe the pointers. They must still be aligned over the rows of dots.

Section VI. TEST PROCEDURES

4-19. Preliminary Procedures

a. General. Connect the indicator to the Indicator ID-48A/ARN Test Panel, using the branched cable supplied with the test panel. Place all controls on the test panel as indicated in the following paragraph. Then connect the test panel to 115 vac 60 Hz power, place the POWER switch in the ON position and observe that the lamp beside the switch is lighted.

b. Test Panel Controls (fig. 4-6).

Control identification	*Setting*
POWER/ON switch	Down in off position
R1 control	Maximum counterclockwise
R2 control	Maximum counterclockwise
S1 rotary switch	H position
S7 2-position switch	A position
S8 flag override switch	OFF position

NOTE

Other switches on panel are spring return to off position.

c. Indicator. Place the indicator on a solid support or table, positioned in the normal operating position.

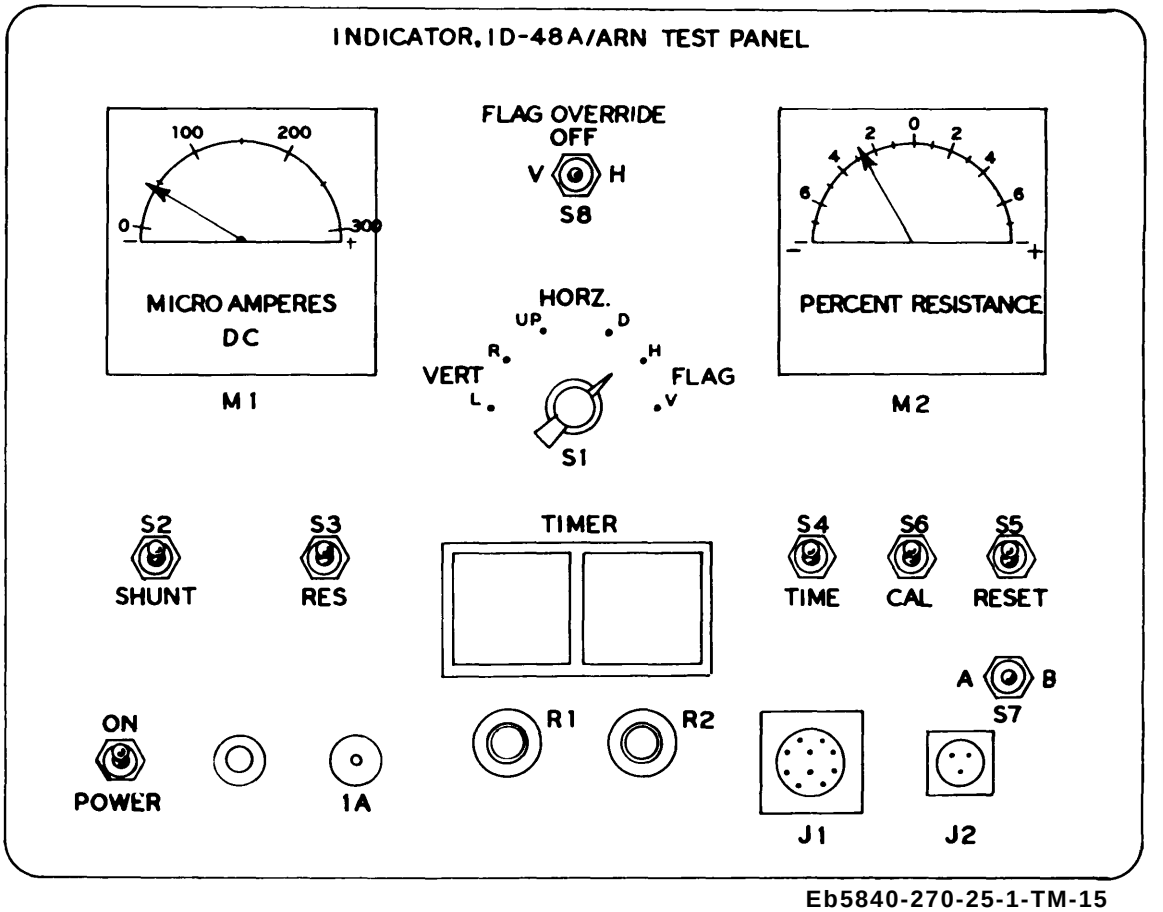


Figure 4-6. Test panel, Indicator ID-48A/ARN.

4-20. Terminal Resistance Test

a. Depress S3. Observe that M2 indicates center zero ± 3 percent. Release S3.

b. Repeat *a.* above for all positions of S1.

4-21. Pointer Deflection Test

a. Set S8 to H position.

b. Set S1 to R.

c. Adjust R1 until vertical pointer is aligned over right end of airplane on indicator dial. Observe that Ml indicates 90±11 microampere.

d. Adjust R1 until vertical pointer is aligned with first dot right of airplane. Observe that M1 indicates 120±11 microampere.

e. Adjust R1 until vertical pointer is aligned over second dot right of airplane. Observe that M1 indicates 150±7.5 microampere.

f. Rotate R1 full counterclockwise.

g. Set S1 to L.

h. Adjust R1 until vertical pointer is aligned over left end of airplane on indicator dial. Observe that Ml indicates 90±11 microampere.

i. Adjust R1 until vertical pointer is aligned with first dot left of airplane. Observe that M1 indicates 120±11 microampere.

j. Adjust R1 until vertical pointer is aligned over second dot left of airplane. Observe that M1 indicates 150±7.5 microampere.

k. Rotate R1 full counterclockwise.

l. Set S8 to V position.

m. Set S1 to UP.

n. Adjust R1 until horizontal pointer is aligned over first dot above airplane on indicator dial. Observe that M1 indicates 65±11 microampere.

o. Adjust R1 until horizontal pointer is aligned over second dot above airplane. Observe that M1 indicates 107±11 microampere.

p. Adjust R1 until horizontal pointer is aligned over third dot above airplane, observing 150±7.5 microampere on M1.

q. Rotate R1 full counterclockwise.

r. Set S1 to D position.

s. Adjust R1 until indicator horizontal pointer is aligned over first dot below airplane on indicator dial. Observe that Ml indicates 65±11 microampere.

t. Adjust R1 until horizontal pointer is aligned over second dot below airplane. Observe that M1 indicates 107±11 microampere.

u. Adjust R1 until horizontal pointer is aligned over third dot below airplane. Observe that M1 indicates 150±7.5 microampere.

v. Rotate R1 full counterclockwise.

w. Set S8 to OFF position.

4-22. Warning Flag Deflection Test

a. Check that S8 is in OFF position.

b. Set S1 to V position

c. Adjust R1 until vertical warning flag (fig. 1-1) just moves. Observe that M1 indicates 125 microamperes ±6.25 µA.

NOTE

In *c* above, if current is above 131.25 µA, mechanism spring tension must be adjusted to reduce tension. Move the terminal on the flag mechanism with the white wire clockwise slightly and recheck. If c above is under 118.75 µA, move terminal on mechanism counterclockwise slightly and recheck. The case must be removed to obtain access to mechanism (para 4-8).

d. Adjust R1 until vertical flag disappears behind mask. observe that M1 indicates 250 microamperes ±12.5 µA.

e. Rotate R1 to maximum counterclockwise position.

f. Set S1 to H position.

g. Adjust R1 until horizontal warning flag (fig. 1-1) just moves. Observe that M1 indicates 125 microamperes ±6.25 µA.

NOTE

In *g* above, if current is above 131.25µA, mechanism spring tension must be adjusted to reduce tension. Move the terminal on the flag mechanism with the orange wire clockwise slightly and recheck. If g above is under 118.75µA, move terminal on mechanism counterclockwise slightly and recheck. The case must be removed to obtain access to mechanism (para 4-8).

h. Adjust R1 until horizontal flag disappears behind mask. Observe that M1 indicates 250 microampere ±12.5µA.

i. Rotate R1 to maximum counterclockwise position.

4-23. Pointer Stops Test

a. Set S1 to R position.

b. Depress and hold S2.

c. While holding S2, adjust R1 until Ml indicates 750 microampere. Observe that vertical pointer is off-scale (beyond dots and against right internal stop).

d. Continue to hold S2 depressed and adjust R1 counterclockwise until vertical pointer just moves away from the stop. Observe that M1 indicates not less than 130 microampere.

e. Release S2 and rotate R1 to maximum counterclockwise.

j. Set S1 to L.

g. Depress and hold S2.

h. While holding S2, adjust R1 until M1 indicates 750 microampere. Observe that vertical pointer is off-scale (beyond dots and against left internal stop).

i. Continue to hold S2 depressed and adjust R1 counterclockwise until vertical pointer just moves away from the stop. Observe that M1 indicates not less than 130 microampere.

j. Release S2 and rotate R1 to maximum counterclockwise.

k. Set S1 to UP.

l. Depress and hold S2.

m. While holding S2, adjust R1 until M1 indicates 750 microampere. Observe that vertical pointer is off-scale (Beyond dots and against top internal stop).

n. Continue to hold S2 depressed and adjust R1 counterclockwise until vertical pointer just moves away from the stop. Observe that M1 indicates not less than 130 microampere.

o. Release S2 and rotate R1 to maximum counterclockwise.

p. Set S1 to DWN.

q. Depress and hold S2.

r. While holding S2, adjust R1 until M1 indicates 750 microampere. Observe that vertical pointer is off-scale (beyond dots and against bottom internal stop).

s. Continue to hold S2 depressed and adjust R1 counterclockwise until vertical pointer just moves away from the stop. Observe that M1 indicates not less than 130 microampere.

t. Release S2 and rotate R1 to maximum counterclockwise.

4-24. Pointer Response Time Test

a. Set S1 to R.

b. Depress and hold S6.

c. While holding S6, adjust R2 until vertical pointer is just tangent to inside edge of outermost dot on indicator dial. Release S6.

d. Observe and record M1 indication. Multiply recorded indication by 1.1.

e. Adjust R2 to current value computed in *d*. above.

f. Depress S5 to reset timer to 00, and then release S5.

g. Depress S4 and hold until vertical pointer is

just tangent to inside edge of outermost dot, then immediately release S4.

h. Observe time indicated on the tow-digit TIMER and record.

i. Repeat *g* and *h* above at least five times. The TIMER indication should average 1.2 seconds maximum.

j. Set S1 to L.

k. Depress and hold S6.

l. While holding S6, adjust R2 until vertical pointer is just tangent to inside edge of outermost dot on indicator dial. Release S6.

m. Observe and record M1 indication. Multiply recorded indication by 1.1

n. Adjust R2 to current value computed in step m.

o. Depress S5 to reset timer to 00, and then release S5.

p. Depress S4 and hold until vertical pointer is just tangent to inside edge of outermost dot, then immediately release S4. TIMER shall indicate 1.2 seconds maximum.

q. Observe time indicated on the two-digit TIMER and record.

r. Repeat *p* and *q* above at least five times. The TIMER indication should average 1.2 seconds maximum.

s. Set S1 to UP.

t. Depress and hold S6.

u. While holding S6, adjust R2 until horizontal pointer is just tangent to inside edge of uppermost dot on indicator dial. Release S6.

v. Observe and record M1 indication. Multiply recorded indication by 1.1.

w. Adjust R2 to current value computed in v above.

x. Depress S5 to reset timer to 00, and then release S5.

y. Depress S4 and hold until horizontal pointer is just tangent to inside edge of uppermost dot, then immediately release S4. TIMER shall indicate 1.2 seconds maximum.

z. Observe time indicated on the two-digit TIMER and record.

aa. Repeat *y* and *z* above at least five times. The TIMER indication should average 1.2 seconds maximum.

ab. Set S1 to D.

ac. Depress and hold S6.

ad. While holding S6, adjust R2 until horizontal pointer is just tangent to inside edge of lowest dot on indicator dial. Release S6.

ae. Observe and record M1 indication. Multiply recorded indication by 1.1.

af. Adjust R2 to current value computed in *ae* above.

ag. Depress S5 to reset timer to 00, and then release S5.

ah. Depress S4 and hold until horizontal pointer is just tangent to inside edge of lowest dot, then immediately release S4. TIMER shall indicate 1.2 seconds maximum.

ai. Observe time indicated on the two-digit TIMER and record.

aj. Repeat *ah* and *ai* above at least five times. The TIMER indication should average 1.2 seconds maximum.

4-25. Beacon Light Test

a. Set S7 to A.

b. Depress cap of indicator beacon light. Lamp shall light. Release cap, lamp shall go out.

c. Set S7 to B. Lamp shall light. Depress cap, lamp shall go out.

4-26. Internal Short Test

a. Set multimeter to measure ohms.

b. Set range to highest resistance range.

c. Connect one ohmmeter lead to shell of either connector on rear of indicator.

d. Measure the resistance between the case (connector shell) and each pin of each connector. Resistance should be infinite, indicating no internal shorts.

CHAPTER 5

OVERHAUL STANDARDS

5-1. Scope

The tests outlined in this standard are designed to measure the performance capability of repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests. Refer to chapter 4 for test procedures.

5-2. Applicable References

a. Repair Standards. Applicable procedures of the depot performing this test and the general standards for repaired electronic equipment given in TBSIG 355-l, TB SIG 355-2 and TB SIG 355-3 form a part of the requirements for testing this equipment.

b. Modification Work Orders. Perform all modification work orders applicable to the ID-48A before making the tests specified. DA PAM 310-7 lists all available modification work orders.

5-3. General Test Requirements

The tests indicated in this chapter should be conducted at a temperature of approximately 25°C. (77°F.). The Indicator should be lightly tapped or vibrated when taking readings except where otherwise stated.

5-4. Terminal Resistance Test

Resistance of each mechanism circuit shall be 1000 ±30 ohms, measured at connector J1 terminals (para 4-20).

5-5. Balance Test

Glide path and localizer pointers shall be aligned with appropriate row of dots when in normal vertical mounting position. Rotating Indicator 90° left and right and to dial-upward positions shall not cause pointers to indicate off dot furthest from pointer (para 4-17).

5-6. Pointer Stops Test

a. Pointer stops shall permit deflection of horizontal and vertical pointers to end dot without interference. Pointer shall deflect slightly past end dot, or approximately 10% beyond full scale deflection (para 4-23).

b. With an overload current of 750 microampere applied to either pointer, in either direction, pointer will deflect to stop. Gradually and evenly reducing current to 130 microampere will cause pointer to leave stop without tapping or vibrating the instrument. Break away current shall not be less than 130 microampere (para 4-23).

5-7. Pointer Clearance Test

With current applied to any combination of mechanisms no pointer will interfere with operation of any other pointer at any position or deflection.

5-8. Sensitivity Tests

a. Horizontal and vertical pointers shall deflect to end dots, either side of center, with 150 ± 7.5 microampere applied to appropriate pins of connector J1 (para 4-21).

b. Horizontal and vertical flags shall leave stops with 125 ± 6.0 microampere applied and shall be concealed by mask when 250 ± 12.5 microampere are applied (para 4-22).

5-9. Response Time Test

The time required for the horizontal or vertical pointer to reach 90 percent of its deflection distance, counted from the instant current is applied shall be 1.2 seconds maximum (para 4-24).

APPENDIX A

REFERENCES

The following publications contain information applicable to the operation and maintenance of the system test set.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U. S. Army Equipment Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies, and Equipment Used by the Army.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 11-6625-366-15	Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352B/U.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.

APPENDIX B

MAINTENANCE ALLOCATION

SECTION I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations covered in the equipment literature for the AN/APM-322. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

B-2. Maintenance Functions

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

b. Test. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc. This is accomplished with external test equipment and does not include operation of the equipment and operator type tests using internal meters or indicating devices.

c. Service. To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.

d. Adjust. To rectify to the extent necessary to bring into proper operating range.

e. Align. To adjust two or more components or assemblies of an electrical or mechanical system so that their functions are properly synchronized. This does not include setting the frequency control knob of radio receivers or transmitters to the desired frequency.

f. Calibrate. To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

g. Install. To set up for use in an operational environment such as an encampment, site, or vehicle.

h. Replace. To replace unserviceable items with serviceable like items.

i. Repair. To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes, but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

j. Overhaul. Normally, the highest degree of maintenance performed by the Army in order to minimize time work in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.

k. Rebuild. The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.

l. Symbols. The uppercase letter placed in the appropriate column indicates the lowest level at which that particular maintenance function is to be performed.

B-3. Explanation of Format

a. Column 1, Group Number. (Not applicable.)

b. Column 2, Functional Group. Column 2 lists the names of components, assemblies, subassemblies, and modules on which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the maintenance category at which performance of the specific maintenance function is authorized. Authorization to perform a function at any category also includes authorization to perform that function at higher categories. The codes treed represent the various maintenance categores as follows:

Code	*Maintenance category*
C	Operator / Crew
O	Organizational Maintenance
F	Direct Support Maintenance
H	General Support Maintenance
D	Depot Maintenance

d. Column 4, Tools and Test Equipment. Column 4 specifies, by code, those tools and test equipment required to perform the designated function. The numbers appearing in this column refer to specific tools and test equipment which are identified in table I.

e. Column 5, Remarks. Self-explanatory.

B-4. Explanation of Format of Table 1, Tool and Test Equipment Requirements

The columns in table 1 are as follows:

a. Tools and Equipment. The numbers in this column coincide with the numbers used in the tools and equipment column of the Maintenance Allocation Chart. The numbers indicate the applicable tool for the maintenance function.

b. Maintenance Category. The codes in this column indicate the maintenance category normally allocated the facility.

c. Nomenclature. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

d. Federal Stock Number. This column lists the Federal stock number of the specific tool or test equipment.

e. Tool Number. Not used.

SECTION II. MAINTENANCE ALLOCATION CHART

MAINTENANCE ALLOCATION CHART

GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											TOOLS AND EQUIPMENT	REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	ID-48A/ARN	O	O											
				O	O			O	O				1	Pointer Adj
			D										2,3,4	
										D			2	
											D		2,3,4	
	Beacon-Lamp	O												
			O											
								O	O					
	Indicator Assembly							D					2,4	
									D				2,4	
										D			2,4	
	Case Indicator Assembly							D					2	
									D				2	
			D										2,4	Internal Short Test
	Mechanism Assembly									D			2,3	
									D				2,3	
	Mechanism Horizontal Flag									D			2,3	
									D				2,3	
	Mechanism Horizonal Pointer									D			2,3	
									D					
	Mechanism Vertical Flag									D			2,3	
									D					
	Mechanism Vertical Pointer									D			2,3	
									D				2,3	

TABLE I. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL AND TEST EQUIPMENT REQUIREMENTS				
TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
	O	Tool Kit, Electronic Repairman TK-105/G	5180-610-8177	1
	D	Tool Kit, Electronic, Repairman TK-100/G	5180-605-0079	2
	D	Test Panel AAR Corp Number 6010022000	NONE	3
	D	Multimeter TS-352B/U	6625-553-0142	4

APPENDIX C

ORGANIZATIONAL REPAIR PARTS LIST

The only repair parts authorized at Organizational level are:

Description	*Federal stock No.*
Lamp: A3DSl (fig. 4-3)	.6240-155-8714
Lens: A3MPl (fig. 4-3).	.6210-513-9594

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-36 (qty rqr block No. 379) Organizational requirements for Avionics literature for All Fixed and All Rotor Wing Aircrafts.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1971-431-104/678

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

TEAR ALONG PERFORATED LINE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

This fine document...

Was brought to you by me:

Liberated Manuals -- free army and government manuals

Why do I do it? I am tired of sleazy CD-ROM sellers, who take publicly available information, slap “watermarks” and other junk on it, and sell it. Those masters of search engine manipulation make sure that their sites that sell free information, come up first in search engines. They did not create it... They did not even scan it... Why should they get your money? Why are not letting you give those free manuals to your friends?

I am setting this document FREE. This document was made by the US Government and is NOT protected by Copyright. Feel free to share, republish, sell and so on.

I am not asking you for donations, fees or handouts. If you can, please provide a link to liberatedmanuals.com, so that free manuals come up first in search engines:

<A HREF=http://www.liberatedmanuals.com/>Free Military and Government Manuals</A>

- Sincerely
  Igor Chudov
  http://igor.chudov.com/
- Chicago Machinery Movers