

INCH-POUND

MIL-I-49466
2 April 1990MILITARY SPECIFICATION
INSULATOR; DISKS, PLATES, AND WASHERS

GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for insulator; disks, plates, and washers used in conjunction with small electrical and electronic devices.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

QQ-S-781	-	Strapping, Steel, and Seals.
PPP-B-566	-	Boxes, Folding, Paperboard.
PPP-B-601	-	Boxes, Wood, Cleated-Plywood.
PPP-B-621	-	Boxes, Wood, Nailed and Lock-Corner.
PPP-B-636	-	Boxes, Shipping, Fiberboard.
PPP-B-676	-	Boxes, Setup.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Laboratory Command, Reliability, Logistics and Standardization Div., ATTN: SLCET-R-S, Fort Monmouth, NJ 07703-5000, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5970

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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MILITARY

MIL-P-116 - Preservation, Methods of.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
 MIL-STD-794 - Parts and Equipment, Procedures for Packaging of.
 MIL-STD-1285 - Marking of Electrical and Electronic Parts.

(Copies of specifications, standards, handbooks, drawings, and publications and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 1225 - Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

2.3 Order of precedence. In event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern. (If a specific requirement specified herein is not required for an item it shall be indicated on the specification sheet; for example, "Thermal impedance - N/A").

3.2 Quality conformance inspection. Insulators shall be products which have been inspected and passed the quality conformance inspection.

3.3 Material. Insulators shall be fabricated from material as specified on the applicable specification sheet (See 3.1).

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3.4 Design, construction, and dimensions. Design, construction, and dimensions of the insulators shall be as specified herein and on the applicable specification sheet (see 3.1).

3.4.1 Color. Unless otherwise specified, the color of the insulators is optional. Color of insulators shall not affect the part number.

3.5 Thermal impedance. When tested as specified in 4.6 the thermal impedance of the material used to fabricate the insulators shall be no more than the maximum value specified on the applicable specification sheet (see 3.1).

3.6 Marking. The insulators need not be marked. Marking shall be in accordance with 5.3.

3.7 Workmanship. Insulators shall be processed in such a manner as to be uniform in quality and shall be free from surface flaws and other defects that will affect life or serviceability.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of section 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Materials inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).
- c. Packaging inspection (see 4.7).

4.3 Materials inspection. Materials inspection shall consist of certification

supported by verifying data that the materials used in fabrication the insulators, are in accordance with the applicable referenced specifications (see 3.1), and when specified the requirements of 3.5, prior to such fabrication.

4.4 Quality conformance inspection. Quality conformance inspection shall include the examination of 4.5. Additionally when 3.5 is a requirement the test of 4.6 shall apply.

4.5 Product examination. Insulators shall be visually and dimensionally examined to verify that design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.6, and 3.7).

4.6 Thermal impedance. Thermal impedance shall be determined by method A (4.6.1) or method B (4.6.2).

4.6.1 Method A.

4.6.1.1 Apparatus. The general features of the apparatus are shown in figure 1. All contacting surfaces shall be smoothly finished to within 16 microinches (0.4 micrometers) so as to approximate a true plane for the meter bars in contact with the specimen surface. A List of the basic components required for determination of thermal impedance is as follows:

- a. Heater - A block of copper or other highly conductive material, into which wire wound cartridge heaters are inserted. This block is thermally insulated by a 5 mm layer of epoxy FR-4 or similar material. Outside this layer is a guard heater of similar construction to thermally insulate the heater from the press and ensure that all heat is transferred to the upper meter bar.
- b. Meter bars - Two meter bars constructed from high thermal conductivity material having parallel working surfaces and good surface finish. A suitable material of construction is a high purity grade aluminum.
- c. Reference calorimeter - A reference calorimeter constructed from a material which has a well characterized thermal conductivity over the range of test temperatures to be used. A recommended material is SRM-1462 austenitic stainless steel. A list of other useful materials of construction is in ASTM E 1225.
- d. Cooling unit - The cooling unit is a metal block cooled by fluid supplied from a constant temperature bath such that the temperature is maintained uniform at ± 0.2 °C.
- e. Press - A press capable of transmitting the specified force to the test fixture through a free-floating spherical seat attachment, preventing offset loads and uneven pressures on the test specimen.
- f. Insulation - A fibrous thermal insulating blanket.

4.6.1.2 Procedure.

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4.6.1.2.1 Specimens. Two pieces of material of the thickness specified in 3.1 and of the same area (length and width) as the meter bars shall be prepared from the insulator material specified in 3.3. The pair shall be designated as the test specimen. The specimen shall be tested in the as-received state. Any obvious contamination shall be removed by a suitable, non-reactive solvent prior to testing. Any cleaning shall be followed by drying procedures to assure the removal of all solvents.

4.6.1.2.2 Apparatus setup. The general arrangement of the components are illustrated in figure 1. Center the test specimen between the two meter bars and insert the reference calorimeter between the lower meter bar and the cooling unit. Place the assembled test stack into the press. Apply thermal insulation around the stack if measurements are to be made at temperatures above 27 °C. With the press, apply a force of 300 psi (2.07 MPa) of pressure to the stack. Circulate cooling fluid and apply power to the heating element. Maintain the temperature of the guard heater to within ± 0.2 °C of the heater. Continuously adjust the applied force in the press during heat-up to counter act the increased pressure on the specimen due to thermal expansion.

4.6.1.2.3 Measurement. Record the temperatures of the meter bars and the reference calorimeter at equilibrium. Equilibrium is attained when 2 successive sets of temperature readings are taken at 15 minute intervals and the differences between the two are observed to be within ± 0.2 °C.

4.6.1.3 Calculations.

4.6.1.3.1 Calculate heat flow from the reference calorimeter as follows:

$$Q = \frac{\lambda_s A}{X} [T_E - T_F]$$

where:

- Q = heat flow in watts
- λ_s = thermal conductivity of reference calorimeter, W/in °C
- A = area of the reference calorimeter, square in.
- T_E = upper temperature of calorimeter, °C
- T_F = lower temperature of calorimeter, °C
- X = distance between the reference calorimeter thermocouples, inches

4.6.1.3.2 Calculate the temperature of the upper meter bar as follows:

$$T_1 = T_B - \left[\frac{d_B}{d_A} (T_A - T_B) \right]$$

where:

- T_1 = temperature of the upper meter bar, °C
- T_A = upper temperature of the upper meter bar, °C
- T_B = lower temperature of the upper meter bar, °C
- d_A = distance between thermocouples of upper meter bar, inches

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d_u = distance from the lower thermocouple to the lower surface of the upper meter bar, inches

4.6.1.3.3 Calculate the temperature of the lower meter bar as follows:

$$T_4 = T_c + \left[\frac{d_c}{d_D} (T_c - T_D) \right]$$

where:

T_4 = temperature of the lower meter bar, °C

T_c = upper temperature of the lower meter bar, °C

T_D = lower temperature of the lower meter bar, °C

d_c = distance from the upper thermocouple to the upper surface of the lower meter bar, inches

d_D = distance between thermocouples of lower meter bar

4.6.1.3.4 Calculate thermal impedance as follows:

$$\theta = (T_1 - T_4) / q$$

where:

θ = thermal impedance, °C in²/W

q = rate of heat flow through the sample per unit area, Q/A

4.6.2 Method B.

4.6.2.1 Apparatus. List of basic components required for determination of thermal impedance is as follows:

a. Heater/sensor - an electrically insulated wire-wound coil for applying a measured quantity of heat energy into the assembly and a second winding used to sense the temperature in the assembly. It shall have parallel strands of #40 AWG copper wire having identical thermal resistance at 20 °C. The surface areas are closely matched. Details are illustrated in Fig 4.

b. Wheatstone bridge - is used for minimizing zero shifts caused by small increments in the temperature of the heat sinks. The bridge, illustrated in Fig. 3, uses an amplifier with a gain of 2000X. The bridge shall have a standardization resistor specific to the temperature coefficient of resistance of the heater/sensor strand wire.

c. Press - a spring loaded, screwthread, or hydraulic arbor press is used to maintain essentially constant force with changes in operating temperatures.

d. Sheet, thermally conductive - A thin, very resilient and flexible sheet material to cover the two sensors and minimize the strain sensitivity of the heater/sensors. A .1 inch (25 micrometer) polyester film is satisfactory for this material.

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4.6.2.2 Procedure.

4.6.2.2.1 Specimens. Six pieces of material of the thickness specified in 3.1 having an area greater than the heater/sensor shall be prepared from the insulator material specified in 3.3. The six pieces shall be designated as the test specimen. The specimen shall be tested in the as-received state. Any obvious contamination shall be removed by a suitable, non-reactive solvent prior to testing. Any cleaning shall be followed by drying procedures to assure the removal of all solvents.

4.6.2.2.2 Apparatus setup. The general assembly of the apparatus is shown in figure 2. A schematic electrical layout is shown in figure 4. Place specimens in the assembly in accordance with configuration 1 of figure 2. With the press apply a force of 300 psi (2.07 MPa) to the system. Leave the specimen under this condition for a minimum of one hour.

4.6.2.2.3 Measurement. Turn on and zero the amplifier with the bridge power off. Turn the bridge power on and zero the bridge. Turn the bridge calibration switch on and record the change in the signal (V_C). Turn the bridge calibration switch off. Turn the power switches of the two heaters on. Introduce pieces of thin polymeric film into either cavity to achieve a small positive reading and record this reading as V_1 . Rearrange the assembly in accordance with configuration 2 of figure 2, repeat the above operations, and record the small positive reading as V_2 .

4.6.2.3 Calculations.

4.6.2.3.1 Calculate the 'cell constant' of the wheatstone bridge assembly as follows:

$$\text{cell constant} = \left[\frac{2 A R_{SB} (R_{A3})^2}{\alpha R_{HA} R_{SA} R_B (R_{A3} + R_{A4})} \right]$$

where:

- A = the area of one side of the heater/sensor.
- α = the temperature coefficient of resistivity of the alloy of the sensor strand wire.
- R_{SA} & R_{SB} = the sensor electrical resistance (ohms).
- R_B = the bridge electrical resistance (ohms).
- $R_{A3} + R_{A4}$ = the electrical resistance of the calibration network (ohms).
- R_{HA} = the electrical resistance of the heater at $\theta^\circ\text{C}$ (ohms).
- I = the current in the heater winding (amperes).

4.6.2.3.2 Calculate the thermal impedance as follows:

$$\theta = \frac{(V_2 - V_1) \text{ cell constant}}{V_C I^2}$$

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where:

$V_c, V_1, & V_2$ = as recorded in 4.5.2.2.3.2
 I = current in the heater winding, (amperes).
 θ = thermal impedance, °C in²/W

4.7 Inspection of packaging. The sampling and inspection of the preservation and interior pack marking shall be in accordance with the group A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129.

5. PACKAGING

5.1 Preservation. Preservation shall be levels A, B, or C, as specified (see 6.2).

5.1.1 Levels A and B.

5.1.1.1 Cleaning. Insulators shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Insulators shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

5.1.1.4 Unit packs. Unless otherwise specified in the contract (see 6.2), insulators shall be unit packed five each in accordance with MIL-P-116, method III, insuring compliance with the applicable requirements of that specification.

5.1.1.5 Intermediate packs. Insulators unit packed as specified in 5.1.1.4 shall be placed in intermediate containers conforming to PPP-B-566 or PPP-B-676. Intermediate containers shall be uniform in size, shape, and quantities, shall be of minimum tare and cube and shall contain multiples of five unit packs, not to exceed 100 unit packs. No intermediate packs are required when the total quantity shipped to single destination is less than 100 packs.

5.1.2 Level C. The level C preservation of insulators shall conform to the MIL-STD-794 requirements of this level.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A. Insulators preserved as specified in 5.1 shall be packed in wood containers conforming to PPP-B-601, overseas type or PPP-B-621, class 2. Closure and strapping shall be in accordance with the applicable container specification except that metal strapping shall conform to QQ-S-781, type I, finish A.

5.2.2 Level B. Insulators preserved as specified in 5.1 shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. The requirements for box closure, waterproofing,

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and reinforcing shall be in accordance with method V of the PPP-B-636 appendix.

5.2.3 Level C. The level C packing for insulators shall conform to the MIL-STD-794 requirements for this level.

5.3 Marking. In addition to any special or other identification marking required by the contract (see 6.2), each unit, intermediate and exterior container shall be marked in accordance with MIL-STD-129. The complete military or contractor's type or part number (including the CAGE), as applicable, shall be marked on all unit and intermediate packs in accordance with the identification marking provisions of MIL-STD-129.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2, and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Packaging inspection. The inspection of these packaging requirements shall be in accordance with 4.7.

5.4.3 Army acquisitions.

5.4.3.1 Level A and B unit and intermediate packs. In addition to that specified in 5.1.1.4 and 5.1.1.5, unit and intermediate containers shall either be weather or water resistant (e.g., variety 2 of PPP-B-566 or PPP-B-676) or overwrapped with waterproof barrier materials. Intermediate containers shall not exceed 50 unit packs. Intermediate containers shall not be required when the total quantity to be shipped will result in only one intermediate pack per shipping container.

6. NOTES

6.1 Intended use. Insulators covered by this specification are intended for use as electrical insulating, mounting and assembly components, and may be used to enhance the flow of heat from an electronic device to a heat sink while at the same time electrically isolating the two devices.

6.2 Ordering data. Acquisition documents should specify the following:

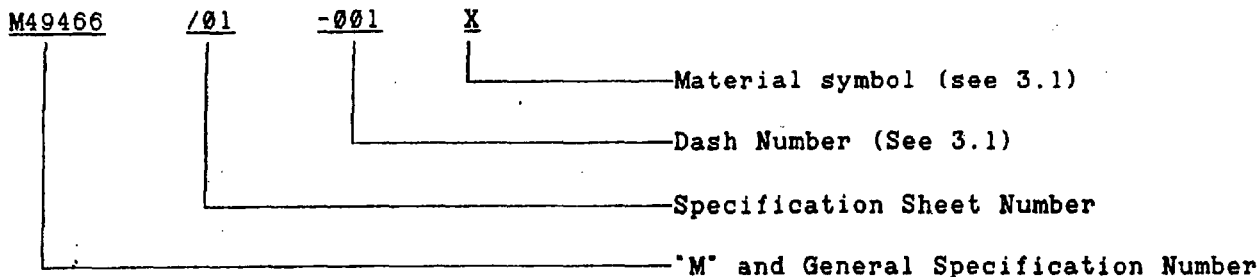
- a. Title, number, and date of this specification and the complete part number (see 6.4).
- b. Marking of insulators if other than specified (see 3.5).
- c. Levels of preservation and packing required (see 5.1 and 5.2).
- d. Quantity per unit pack, if other than five each (see 5.1.1.4).
- e. If special or additional identification marking is required (see 5.3).

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f. Certification of compliance to material specification.

6.3 Conditions for use of level B preservation. When level B preservation is specified (see 5.1.1), this degree of protection should be used for insulators under known favorable conditions during transportation, storage and handling.

6.4 Part or Identifying Number (PIN). The PIN to be used for insulators acquired to this specification are created as follows:

6.5 Subject term (keyword) listing.

Thermal impedance

Custodians:

Army - ER
Navy - SH
Air Force - 85

Review activities:

DLA - GS
Air Force - 11, 19, 99

User activities:

Navy - CG, MC

Agent:

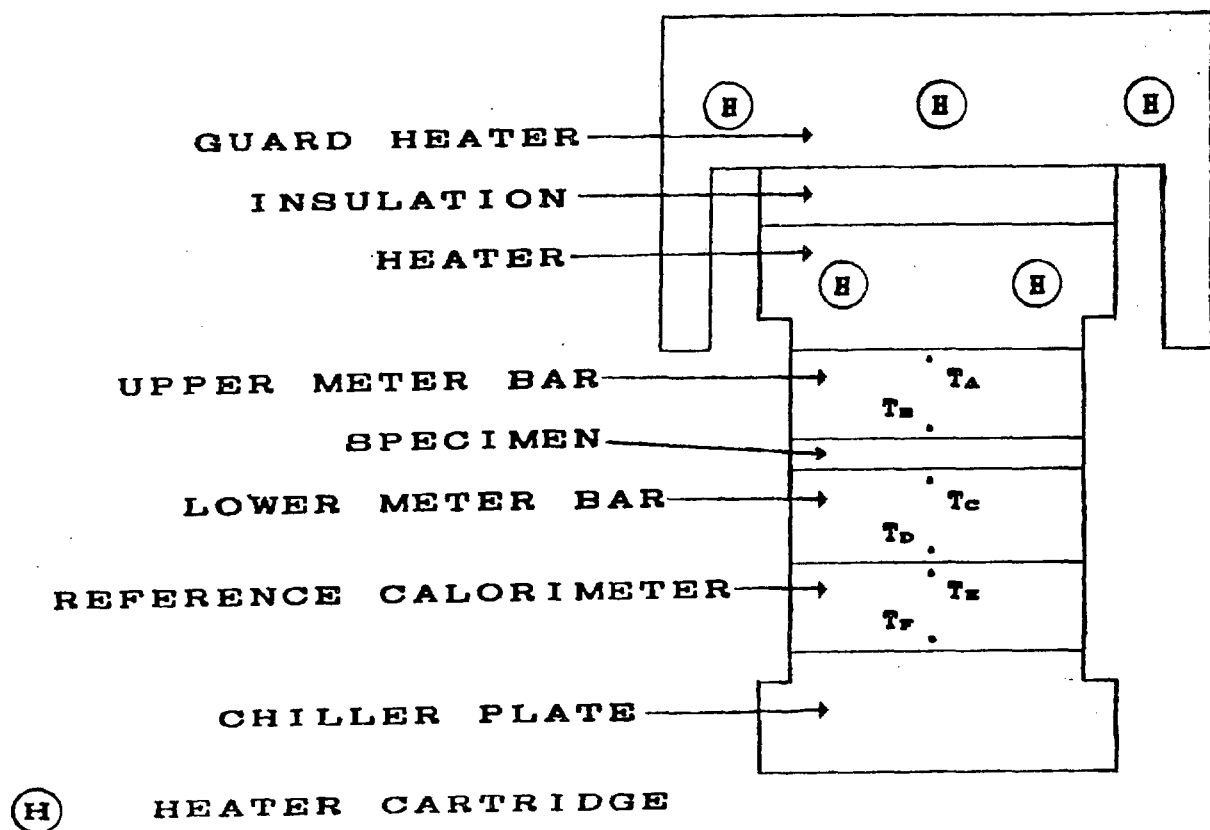
DLA - GS

Preparing activity:

Army - ER

(Project 5970-0633)

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T_A through T_F represent temperature measuring points.

FIGURE 1. Test fixture - Method A.

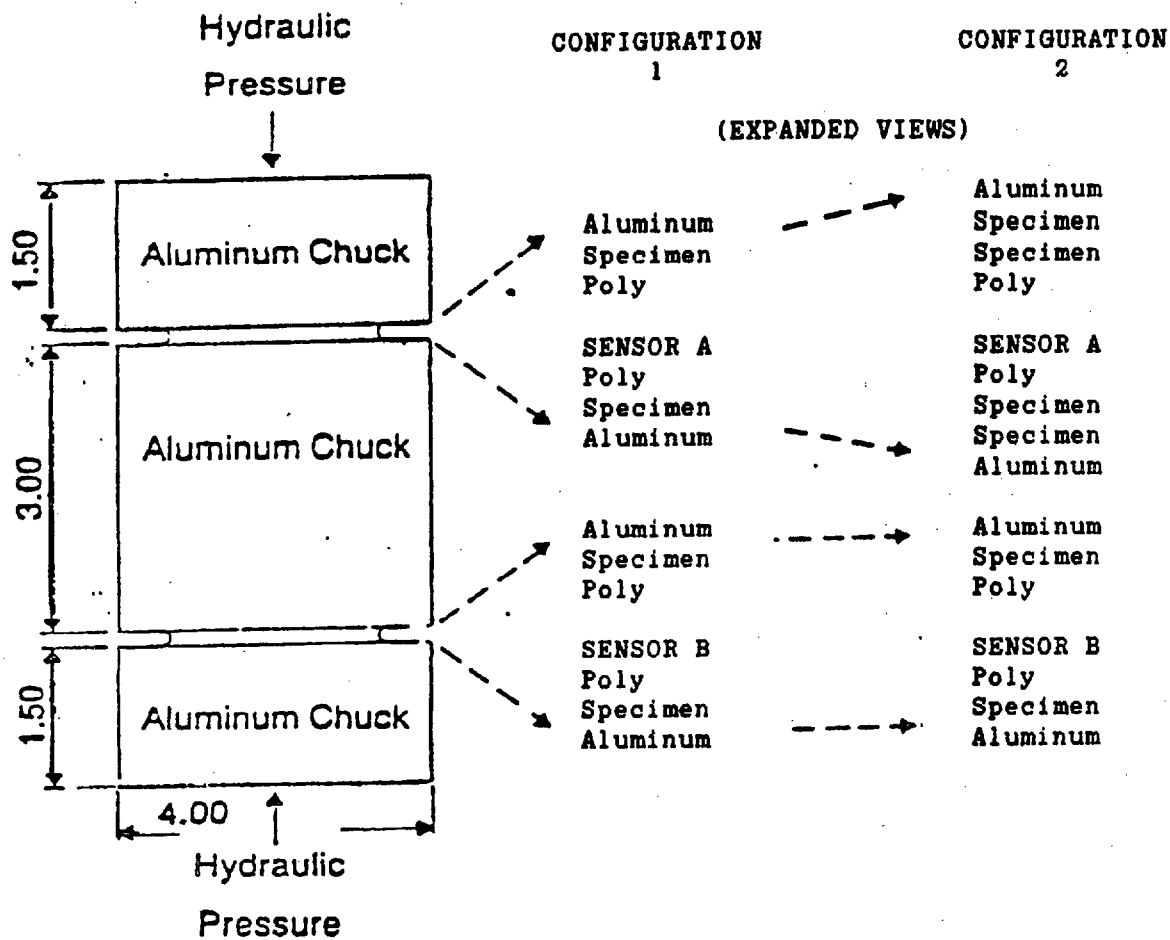
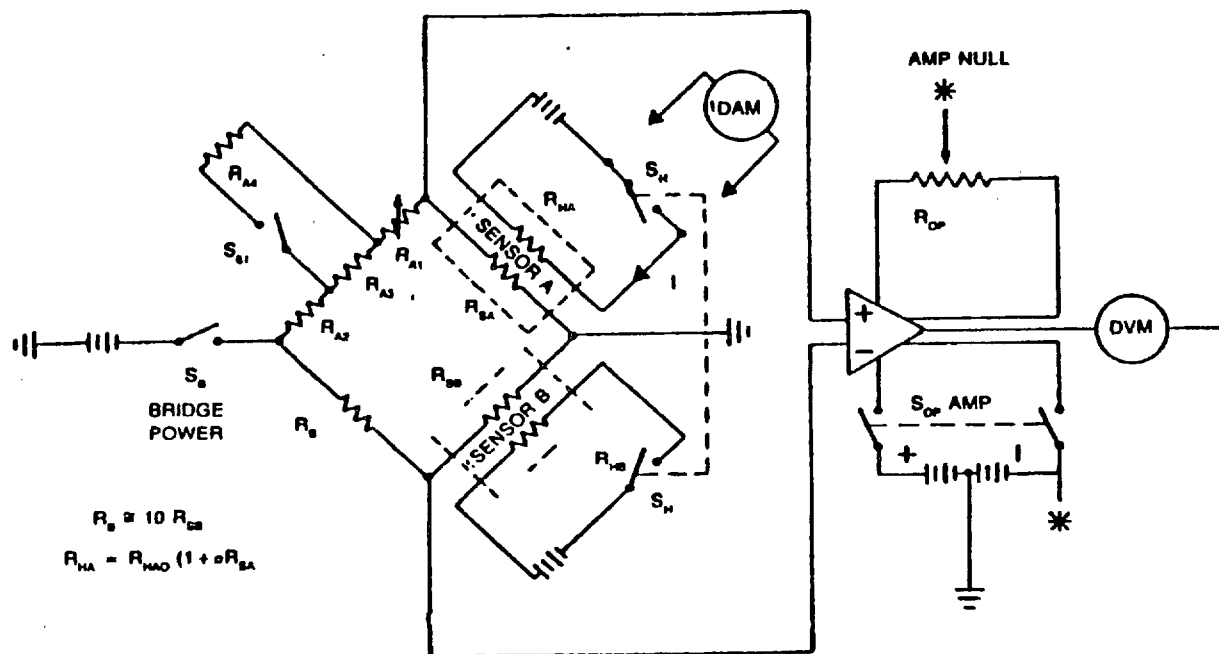
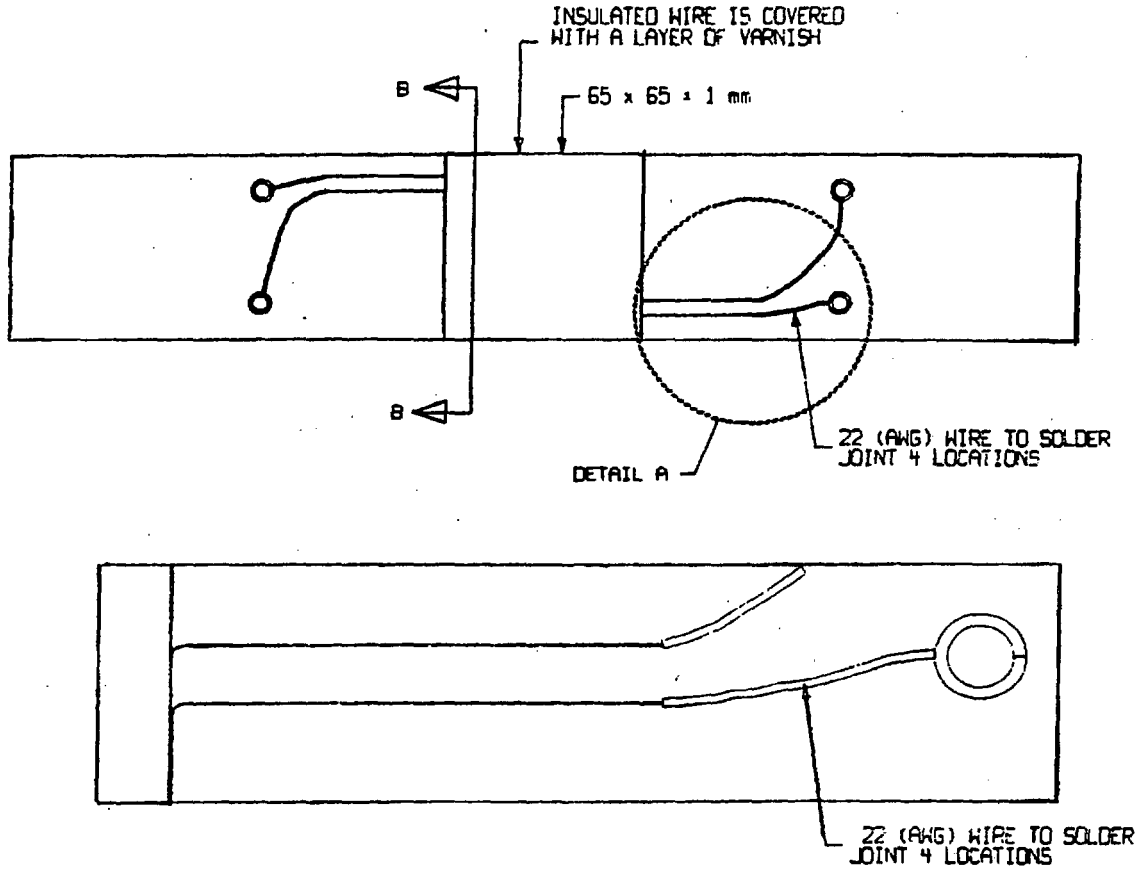


FIGURE 2. Test fixture - Method B.

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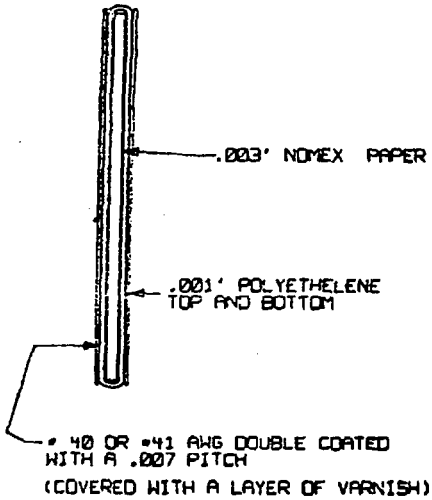
FIGURE 3. Electrical schematic - Method B.

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SECTION B-B

DETAIL A-A



NOTES:

1. DOUBLE COATED WITH A SOLVENT SENSITIVE (ALCOHOL) TOP COATING FOR BONDING TO THE SUPPORT AND THE ADJACENT WIRE
- 40 OR • 41 PN BOND #1, MWS WIRE INDUSTRIES

FIGURE 4. Heater/Sensor - Method B.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-I-49466

2. DOCUMENT DATE (YYYYMMDD)
19900402

3. DOCUMENT TITLE INSULATOR; DISKS, PLATES, AND WASHERS GENERAL SPECIFICATION FOR

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYYYMMDD)

8. PREPARING ACTIVITY

a. NAME U.S. ARMY AVIATION AND MISSILE COMMAND

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(1) Commercial
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