INCH-POUND
MIL-E-45782C
27 August 1993
SUPERSEDING
MIL-E-45782B
28 December 1967

MILITARY SPECIFICATION

ELECTRICAL WIRING, PROCEDURES 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 fabrication and termination of shielded electrical harness and cable assemblies, and the wiring of electrical and electronic circuits of subassemblies used in missile systems.

1.2 Classification. Shield termination and securing of harnesses, cables, and wire bundles are classified using the following types, classes, and methods, as specified. In the event that a class or method is not applicable to a particular assembly, that portion of the classification should be omitted from the ordering data (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 1430

1.2.1 Types. Types of shield terminations are as follows:

Type I	-	without ferrules
Type II	-	with one-piece ferrules (not for use in new design, see 3.8).
Type III	-	with two-piece ferrules

1.2.2 Class. Classes of shield terminations are as follows:

Class 1	-	ungrounded
Class 2	-	grounded

1.2.3 Terminating method. Methods used for shields terminated with ferrules are as follows (see 3.3.3.2 and 3.3.3.3):

Method A	-	one-piece ferrule (see 3.8).
Method B	-	two-piece ferrule (braided shield)
Method C	-	two-piece ferrule (combed shield)
Method D	-	two-piece ferrule (folded, combed shield)
Method E	-	two-piece ferrule (insulated, folded, combed shield)
Method F	-	two-piece ferrule, multiple-shielded conductor, double-folded shield
Method G	-	two-piece ferrule, multiple-shielded conductors, single-folded shield.

1.2.4 Securing method. Methods to be used when cables, harnesses, or wire bundles are to be secured are as follows (see 3.3.8):

Method a	-	double-lock stitch
Method b	-	single-lock stitch
Method c	-	lacing ties
Method d	-	harness straps

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 document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

O-F-506	-	Flux, Soldering; Paste and Liquid
P-D-680	-	Dry Cleaning and Degreasing Solvent
QQ-B-575	-	Braid, Wire (Copper, Tin-Coated, or Silver Coated, Tubular, or Flat)
QQ-S-571	-	Solder, Tin Alloy, Tin-Lead Alloy, and Lead Alloy

MILITARY

MIL-C-17	-	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-I-631	-	Insulation, Electrical, Synthetic-Resin Composition, Nonrigid
MIL-T-713	-	Twine, Fibrous: Impregnated, Lacing and Tying
MIL-Y-1140	-	Yarn, Cord, Sleeving, Cloth, and Tape-Glass
MIL-I-3190	-	Insulation Sleeving, Electrical, Flexible, Coated, General Specification for
MIL-I-3190/6	-	Insulation Sleeving, Electrical, Flexible, Coated, Class 200, Type D, Category C
MIL-C-5015	-	Connectors, Electrical, Circular Threaded, AN Type, General Specification for
MIL-W-5086	-	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy
MIL-W-5088	-	Wiring, Aerospace Vehicle
MIL-C-7078	-	Cable, Electric, Aerospace Vehicle, General Specification for
MIL-I-7444	-	Insulation Sleeving, Electrical, Flexible

MIL-T-7928	-	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification for
MIL-T-7928/5	-	Terminals, Lug and Splices, Conductor, Crimp Style, Splice, Electric, (Permanent, Type II, Class 1) for 105°C Total Conductor Temperature
MIL-C-8603	-	Clamps, Tube Support, Loop Type
MIL-F-14256	-	Flux, Soldering, Liquid (Rosin Base)
MIL-W-16878	-	Wire, Electrical, Insulated, Specification for
MIL-F-21608	-	Ferrule, Shield Terminating, Crimp Style
MIL-I-22076	-	Insulation Tubing, Electrical, Nonrigid, Vinyl, Very Low Temperature Grade
MIL-I-22129	-	Insulation Tubing, Electrical, Polytetrafluoroethylene Resin, Nonrigid
MIL-C-22520/5	-	Crimping Tools, Terminal, Hand, Wire Termination, Large for Coaxial, Shielded Contacts and Ferrules, Terminal Lugs, Splice and End Caps
MIL-W-22759/1	-	Wire, Electric, Fluoropolymer-Insulated, TFE and TFE-Coated-Glass, Silver-Coated Copper Conductor, 600-Volt
MIL-W-22759/2	-	Wire, Electric, Fluoropolymer-Insulated, TFE and TFE-Coated-Glass, Nickel-Coated Copper Conductor, 600-Volt
MIL-I-23053	-	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for
MIL-S-23190	-	Strap, Clamps, and Mounting Hardware, Plastic and Metal for Cable Harness Tying and Support
MIL-C-26482	-	Connectors, Electrical, (Circular, Miniature, Quick Disconnect, Environment Resisting), Receptacles and Plugs, General Specification for

MIL-C-26500	-	Connectors, General Purpose, Electrical, Miniature, Circular, Environmental Resisting, General Specification for
MIL-C-27500	-	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded, General Specification for
MIL-C-45224	-	Cable and Harness Assemblies, Electrical, Missile System: General Specification for
MIL-W-81044	-	Wire, Electric, Cross Linked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy
MIL-C-83723	-	Connectors, Electrical, (Circular, Environment Resisting), Receptables and Plugs, General Specification for
MIL-C-85049/1	-	Connector Accessories, Electrical, Backshell, Environmental, Cable Sealing, Straight, Grounding (Without Strain Relief), Category 1C (for MIL-C-5015 Solder Type, V Thread of MS310X Classes A, B, C or K Connectors)
MIL-C-85049/2	-	Connector Accessories, Electrical, Backshell, Environmental, Cable Sealing Straight, Category 1C (for MIL-C-5015 Solder Type, V Thread of MS310X Classes A, B, C or K Connectors)
MIL-C-85049/41	-	Connector Accessories, Electrical, Nonenvironmental, Strain Relief, Straight, Category 4C (For MIL-C-5015 Solder Type, V Thread of MS310X Classes A, B, C or K Connectors)
MIL-C-85049/42	-	Connector Accessories, Electrical, Nonenvironmental, Strain Relief, Straight, Category 4A (for MIL-C-5015

Solder Type, V Thread of MS310X Classes A, B, C or K Connectors)

STANDARDS

MILITARY

MIL-STD-130	-	Identification Marking of US Military Property
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts
MIL-STD-454	-	Standard General Requirements for Electronic Equipment
MIL-STD-461	-	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	-	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-2000	-	Standard Requirements for Soldered Electrical and Electronic Assemblies
MS3367	-	Strap, Tiedown, Electrical Components, Adjustable Self-Clinching, Plastic, Type I Class 1
MS17776	-	Crimping Tool, Terminal, Hand, Lug Terminal and External Power Plug Socket Contacts, 22-10 Capacity
MS20659	-	Terminal, Lug, Crimp Style, Copper, Uninsulated, Ring Tongue, Type I, Class 1 for 175°C Total Conductor Temperature
MS25036	-	Terminal, Lug, Crimp Style, Copper, Insulated, Ring Tongue, Bell-Mouthed, Type II, Class 1, (For 105°C Total Conductor Temperature)

MS27470	-	Connector, Receptacle, Electrical, Jam Nut Mounting, Solder Type, Hermetic Seal, Series I
MS27471	-	Connector, Receptacle, Electrical, Solder Mounting, Solder Type, Hermetic Seal, Series I
MS90387	-	Tool, Hand Adjustable for Plastic and Metal Tiedown Straps
MS90485	-	Dies, Crimping Tool, for Use with MS20659 Uninsulated Wire Terminals and External Power Plug Socket Contacts (for Wire Sizes 8 Through 4/0)

(Unless otherwise indicated, copies of the federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

SOCIETY OF AUTOMOTIVE ENGINEERS

AMS-3815	-	Braid, Flat, Nylon, Electrical Tying, Synthetic Rubber Coated

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, PA 15096.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document,

however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3) in accordance with 4.4.

3.2 Materials and parts. Materials and parts shall conform to the applicable drawings and specifications referenced thereon, or shall be as specified herein or as specified in the contract or order (see 6.2). Unless otherwise specified, MS parts shall be used in accordance with MIL-W-5088.

3.2.1 Solder. Soldering shall be in accordance with MIL-STD-2000, unless otherwise specified on engineering drawings or in the contract or order (see 6.2). Solder shall be in accordance with QQ-S-571 (SN-50 or SN-60), either plain or fluxcore. The flux shall be rosin or alcohol rosin conforming to MIL-F-14256 or O-F-506.

3.2.2 Shielding. Shielding shall be in accordance with MIL-C-7078, MIL-W-16878, MIL-C-27500, or QQ-B-575.

3.2.3 Clamps. Loop-type support clamps shall be in accordance with MIL-C-8603.

3.2.4 Lacing twine, cord, or braid. Lacing twine, cord, or braid shall be in accordance with MIL-T-713, MIL-Y-1140, AMS-3815, or shall be manufactured from other non-fungus nutrient synthetic fibers and suitable treated to prevent fraying and slippage, and prior to use, shall be specifically approved by the procuring activity, as specified in the contract or order (see 6.2).

3.2.5 Insulated conductors. Insulated conductors shall be in accordance with MIL-W-5086, MIL-W-16878, MIL-W-22759/1 (Class I), MIL-W-22759/2 (Class II), or MIL-W-81044.

3.2.6 Connectors. Connectors shall be in accordance with MIL-C-5015 Series R, MIL-C-26482, MIL-C-26500, MIL-C-83723, MS27470, or MS27471.

3.2.6.1 Connector clamps. Connector clamps shall be in accordance with MIL-C-85049/1, MIL-C-85049/2, MIL-C-85049/41 or MIL-C-85049/42.

3.2.7 Potting material. Potting material shall provide protection from destruction or deterioration due to moisture, vibration, shock, temperature, salt air, fungus, or any other environmental factor.

3.2.8 Solvents. Solvents used for cleaning or removal of grease and oil shall consist of a suitable noncorrosive material, such as trichloroethane, tricholorethylene, alcohol, or solvent in accordance with P-D-680.

3.2.9 Sleeving. Insulation sleeving shall be in accordance with MIL-I-631, MIL-I-7444, MIL-I-3190 and MIL-I-3190/6, MIL-I-22076, MIL-I-22129, or MIL-I-23053.

3.2.10 Cable, coaxial. Coaxial cable shall be in accordance with MIL-C-17.

3.2.11 Terminal lugs. The fabrication materials for terminal lugs shall be in accordance with MIL-T-7928 and as specified herein. Types and classes of terminal lugs shall be determined by the specific application.

3.2.12 Splice connectors. The fabrication materials for splice connectors shall be in accordance with MIL-T-7928 and as specified herein. Unless otherwise specified, splice connectors shall be used only in applications specifically approved by the procuring activity (see 6.2). Types or classes of splice connectors shall be determined by the specific application.

3.2.13 Ferrules.

3.2.13.1 One-piece. The fabrication materials for one-piece ferrules shall be in accordance with MIL-F-21608 and applicable drawings, or left to the discretion of the manufacturer, subject to approval of the procuring activity and acceptable performance in accordance with the requirements specified herein. The types and classes on one-piece ferrules shall be determined by the specific application.

3.2.13.2 Two-piece. The materials and design of the outer and inner ferrule shall be in accordance with MIL-F-21608 and associated standards or left to the discretion of the manufacturer, subject to approval of the procuring activity and acceptable performance in accordance with the requirement specified herein.

3.2.14 Straps. Cable straps shall be in accordance with MIL-S-23190, MS 3367 or as specified on applicable drawings.

3.3 Procedures. Procedures (see 6.4.11) for terminating and splicing cable and harness assemblies and securing wire bundles shall be as specified herein.

3.3.1 Soldering. Soldering shall be in accordance with MIL-STD-2000.

3.3.2 Potting. If required by the procuring activity, connectors shall be potted as specified on the applicable assembly drawing (see 6.2).

3.3.3 Shield termination. When ferrule shielding terminations are being made, extreme care shall be exercised in selecting the proper size ferrule rings and crimping tools to assure a reliable joint. Because of the danger of damaging the conductor insulation, solder shall not be used in making shielding terminations with ferrules. All shields terminating with ferrules shall have the ferrule assembly covered with a snug, flexible insulating sleeve except where preinsulated ferrules are used. The sleeve shall fit snugly over the ferrule assembly so that it does not slip during handling. The sleeve shall extend approximately 0.250 inch beyond each ferrule end. A spot tie may be used between each ferrule end and the end of the insulating sleeve. Lacing cord, when required, shall be used for the spot tie. Clear heat-shrinkable sleeving may be used in lieu of the above, upon approval of procuring activity. When a cable or harness assembly contains individually shielded conductors, the shields may be terminated with the use of ferrules. If the assembly contains less than five individuals shielded conductors, each shield may be terminated with either a one- or two-piece ferrule assembly. The ferrule assemblies shall be staggered in the cable or harness as shown in figure 1 except where radio frequency interference attenuation requirements demand that all ground leads to be the shortest possible length. If the harness, cable, or wire bundles contains five or more individually shielded conductors, each conductor shall be prepared as described in 3.3.3.3.6 or 3.3.3.3.7.

3.3.3.1 Jumpers. Jumpers and ground wires shall be fabricated from insulated, flexible, stranded wire (insulation of type used in the assembly), or as specified on the detail drawing. In general, jumpers shall not cause strain on the termination points.

3.3.3.2 Ungrounded with ferrules. The procedure for terminating ungrounded shields with ferrules shall be the same as that for grounded shields with ferrules, except that the grounding lead shall be omitted.

3.3.3.3 Grounded with ferrules. Grounding of shielding with ferrules shall be accomplished by one of the following methods.

3.3.3.3.1 Method A - one-piece ferrules. The installation of standard one-piece ferrules (see 3.8 and 6.4.9) to terminate or ground a braided shield shall be as follows:

a. Strip the insulation jacket, the braided shield, and the conductor insulation to the approximate length as shown in figure 2.

b. Flare the braid slightly by rotating the insulated conductor as shown in figure 3.

c. Select the proper ferrule by measuring the diameter of the conductor insulation and selecting the ferrule in accordance with respective dimensions shown on applicable drawings.

d. Select the crimping dies recommended for the application in accordance with applicable drawings. Determine that the crimping tool has been checked for proper adjustment. Gages conforming to drawing requirements shall be used.

e. Place ferrule in position, ferrule inner support ring under the cable shielding and the outer ring (as shown in figure 3) over the cable shielding as shown in figure 4.

f. Place the ground wire between the braid and outer ring of the ferrule as shown in figure 5.

g. Insert preassembled ferrule flush against the stop plate of the crimping tool (inspection holes of ferrule in visible and vertical position) as shown in figure 6 and close the crimping tool until dies are completely closed (dies closed to minimum opening or the crimping tool ratchet releases).

h. Remove the crimped ferrule from the crimping tool and examine for proper crimp.

i. When required by the contract or order (see 6.2), destructive test samples shall be prepared under production

conditions in accordance with the sampling procedure specified (see 4.5.3.2.2.2.1).

3.3.3.3.1.1 Nonstandard ferrule (see 3.8 and 6.4.10). Installation procedures of procuring activity approved, preinsulated, one-piece ferrules shall be as specified herein. Crimp tools used shall be as recommended by the ferrule manufacturer and approved by the procuring activity (see 4.6.4).

3.3.3.3.1.1.1 Application of nonstandard ferrules. In ferrule application, for preclusion of excessive cable build-up on shielded multiconductor cables, no greater than 15 shields and a ground wire shall be group terminated into a one-piece ferrule (see 3.3.3.3.1.1).

3.3.3.3.1.1.2 Installation of nonstandard ferrules. Nonstandard, preinsulated, one-piece ferrules shall be installed as follows:

a. Strip the cable insulation and each shielded conductor as required to maintain the insulation, shield, and conductor integrity.

b. Grouping of ferrules may be staggered to preclude buildup and installation interference.

c. The type and size of ferrule for shield termination shall be in accordance with the drawing.

d. Destructive test samples, if required, shall be prepared in accordance with the tests specified herein (see 4.5.3.2.2). Crimped ferrules shall be examined visually and when deemed necessary shall withstand a 20-pound pull test (see 4.5.2.2).

e. Unless otherwise specified, ground wire shall be unshielded AWG No. 20 stranded insulated conductors of the same type used in the cable or harness assembly.

f. For external ground support equipment assembly applications, the ferrule terminations shall be embedded in the potting compound that is used in the cable or harness assembly. For internal assembly applications, the shielded termination shall be insulated and securely tied with the same materials used in the cable or harness assembly.

3.3.3.3.1.2 Multiconductor terminations. In applications where all conductors are not shielded or where a specific application does not permit practical use of two-piece ferrule terminations for commoning the ground of multiconductor cables, one piece ferrules similar to one of the examples shown in figure 1 may be used with procuring activity approval. If one-piece ferrules are used, the installation shall be as follows:

a. Strip the multiconductor cable covering as necessary to interconnect the individual shields.

b. Strip the individual conductors in accordance with the procedure specified for one-piece ferrules (see figure 2).

c. Install ferrules as specified in 3.3.3.3.1 and as shown in figure 1 as necessary for the specific application.

3.3.3.3.1.3 Shield termination ferrule installation procedures. Installation of standard one-piece shielding ferrules to terminate on ground braided shields shall be as follows:

a. The shield of a wire shall be separated from the insulated wire as shown in figure 7. The strands of the shielded wire shall be separated with a pointed tool to make a hole large enough to pull the insulated wire through. A maximum of 10 percent shield strand damage shall be permitted only on high temperature or hard coated wire. Shield strands on the other type wire shall not be damaged.

b. Braids shall be prepared as shown in figure 8. The loose braid shield shall be pulled taut and twisted approximately 180 degrees so as to make a snug fit around the installation. The length of the braid strap shall be not less than 1.5 inches or if not practicable, the length shall be dictated by the application considering radio frequency interference.

c. An example of shields and jumper leads inserted in ferrules is shown in figure 9. Ferrule sizes shall be as specified on the detail drawings. When the specified ferrule size does not provide a secure hold on shield terminations, shields shall be folded in order to fill the ferrule. Reference design requirements for ferrule size selection shall be as specified in table I.

TABLE I. Ferrule selection.

Braid mass factor	"A" Dimension of 3.5.3.1
500 - 646	.156
646 - 791	.180
791 - 917	.187
940 - 1026	.207
1126 - 1296	.235
1296 - 1688	.261

d. If more than one braid group is used, the braid terminations may be staggered, keeping a 0.125 inch distance between ferrules as shown in figure 10 or as specified in the detail drawing.

e. When staggering is not required, braids shall be stripped uniformly as shown in figure 11.

f. Ferrule terminations shall be embedded into the potting compound in external cable applications requiring potting boots whether staggered or uniformly stripped. When a protective sleeve is used, covering the main cable, the sleeve end shall cover the ferrules and be tied securely prior to potting. When a right angle potting boot is used, an additional boot, as required to fit shield terminations, shall be used to the rear of the right angle potting boot. Internal cable applications, when potted, shall ordinarily require short potting boots.

3.3.3.3.2 Method B - Two-piece ferrule - braided shield. Installation of two-piece uninsulated ferrules (outer and inner) as dead end or floating termination of the shield on a cable or to install a common ground connection shall be as follows:

a. Strip conductor shield to expose the conductor installation as shown in figure 12.

b. Measure conductor insulation diameter, select inner ferrule having inside diameter not less than 0.005-inch greater than the diameter of the conductor insulation. Select outer ferrule by adding 0.025-inch for braid thickness (single braid) and 0.040-inch for ground wire to the outside diameter of the inner ferrule.

c. Place the outer ferrule over the conductor braid and jacket (see figure 12).

d. Rotate the insulated conductor slightly to fan out the braid and slide the inner ferrule under the braid (see figure 3 and 13).

e. Inner ferrule shall extend not less than 0.062 inch and shall be not greater than 0.125 inch beyond the end of the conductor shield (see figure 14).

f. Insert the 0.300 inch stripped end of ground lead under the outer ferrule (between the inside surface of the ferrule and the shield) and position the outer ferrule over the inner ferrule. No frayed strands of the braid shall be visible beyond the connector end of the inner ferrule (see figure 15).

g. Select the crimping die recommended for the application. Determine that the crimping tool has been certified for proper adjustment in accordance with 4.6.4.

NOTE: If outer ferrule used has different diameters, crimp shall be made on the small diameter only (ferrule end adjacent to the stripped end of the conductor).

h. Position tool in place over the outer ferrule and close until dies are completely bottomed (dies closed to minimum opening or the crimping tool ratchet releases).

i. Remove crimped conductor from crimping tool and examine crimp and ground wire for proper assembly (see figure 16).

j. When required by the procuring activity (see 6.2), prepare destructive test samples under production conditions in accordance with the sampling procedures specified in 4.5.3.2.2.

3.3.3.3.3 Method C - two piece ferrule - combed shield.

a. Repeat steps a. through c. of Method B.

b. Unbraid the shield strands that will contact the ferrule sleeves, and comb out the strands.

c. Repeat steps d. through j. of Method B.

3.3.3.3.4 Method D - two-piece ferrule - folded, combed shield.

a. If an outer insulation is used over the shielding braid, strip the insulation back to allow installation of the ferrule on the shield.

b. Trim the shield braid so that a length of braid twice the length of the ferrule is left for installation under the ferrule.

c. Slip the inner ferrule sleeve over the shielding braid and into assembly position.

d. Separate and comb out the braided shield strands that extend beyond the inner ferrule sleeve. Fold the combed strands back over the inner ferrule sleeve.

e. Repeat steps f. through j. of Method B.

3.3.3.3.5 Method E - two-piece ferrule - insulated, folded, combed shield. (Method E applies only to single or multiconductor shielded wires with an insulating cover over the shield braid).

a. Strip the outer insulating cover to a point where the ferrule assembly will be located. The inner ferrule must be over the insulating cover with the ferrule edge even with the edge of the wire covered.

b. Trim the braided shield so that the bare portion is the same length as the ferrule. Place the inner ferrule sleeve over the outer insulating cover.

c. Unbraid and comb the bare shield strands extending beyond the shield cover. Fold the strands back over the inner ferrule sleeve.

d. Repeat steps f. through j. of Method B.

3.3.3.3.6 Method F-two-piece ferrule, multiple - shielded conductors, double-folded shield. Ferrules may be used to terminate shields of five or more individually shielded conductors. This method employs only one inner ferrule sleeve to cover the entire group of conductors including unshielded conductors, placing the previously separated braided shield of the individual conductors on the outside of the inner ferrule sleeve and

assembling an outer ferrule sleeve over the inner ferrule sleeve and shield braid as follows:

a. Prepare each individually shielded wire by separating the shield strands with a pointed tool to make a hole large enough to pull the insulated conductor through, as shown in figure 17. The hole in the shield shall be made so that when the inner ferrule sleeve is properly positioned, the sleeve edge will be at the approximate location of the hole in the braid. When this method is used on a harness or cable, the ferrule assembly shall be as close to the connector as possible.

b. Fold the loose ends of the shields back against the harness. These loose ends should be uniformly distributed around the diameter of the harness.

c. Measure the harness diameter and select inner ferrule having an inside diameter not less than 0.010 inch greater than the diameter of the harness.

d. Slip the inner ferrule sleeve over all the insulated conductors and shields and position the sleeve as shown in figure 18.

e. Fold the loose ends of the shield braid (evenly distributed around periphery of inner ferrule) over the inner ferrule sleeve and trim the ends of the shield with the edge of the ferrule sleeve.

f. Select an outer ferrule having an inside diameter not less than 0.120 inch and not greater than 0.275 inch greater than the outside diameter of the inner ferrule, depending on the number of shielded conductors.

g. Position the outer ferrule over the inner ferrule leaving approximately 0.0625 inch of the connector-end of the inner ferrule extending beyond the outer ferrule. Exercise care to prevent frayed ends of shielding from extending beyond the edge of the outer ferrule (see figure 19(A)).

h. When the shields are to be connected to a solder pot in a connector, fold the free end of the ground wire under the inner ferrule and pull the lead through the inner ferrule into position for connection to the solder pot of the connector.

i. When crimp connections are to be used, repeat g. through j. of Method B.

3.3.3.3.7 Method G-two-piece ferrule, multiple - shielded conductors, single-fold shield. This method is similar to method F in that the inner and outer ferrule sleeves are used over the entire group of shielded conductors but the method folding the loose shield ends over the inner ferrule is different. Either method is approved.

a. Repeat step a. of method F.

b. Measure the harness diameter and select inner ferrule having an inside diameter not less than 0.005 inch greater that the diameter of the harness.

c. Slip the inner ferrule sleeve over all the conductors and loose shield ends and position as shown in figure 19(B).

d. Fold the loose shield ends back over the inner ferrule sleeve with the shields evenly distributed around the sleeve circumference. The shields should be trimmed even with the edge of the ferrule sleeve.

e. Repeat steps f. through j. of Method B.

3.3.3.3.8 Ferrule termination of outer shield. When the harness, cable, or wire bundle contains an outer shield over all the conductors, the shield may be terminated by using a two-piece ferrule with an inner and an outer sleeve. The steps to be performed are the same as those of 3.3.3.3, method F or G, using the inner and outer sleeves, except the shield will consist of one piece instead of individual shields.

3.3.3.4 Ungrounded without ferrules. With the shield prepared as described in 3.3.3.3.6a, the loose end of the shielding shall be cut off so that approximately 0.500 inch remains. The loose ends of the shield shall be folded back over the lacing, and either a second wrapping of lacing or length of insulation sleeving applied over the folded portion as shown in figure 20. If sleeving is used, the sleeving shall cover the entire folded portion of the shield and shall be of the proper size so that it will not move. When the individual shielded conductors in an assembly are terminated as described, lacing cord shall be wrapped around the entire assembly at the location of the shield termination. The wrapping shall consist of a spot tie of at least four turns. If a

multiconductor assembly contains an outer shield over all conductors, the shield breakout shall be performed as described for the individually shielded conductors as shown in figures 21 and 22.

3.3.3.4.1 Heat-shrinkable sleeving application. As an alternate method to that specified in 3.3.3.4, heat-shrinkable sleeving may be used to insulate the cut-off shielding ends. Unbraid the shield and cut off the strands 0.250 inch from the end of the outer insulation. Lay the strands back on the outer insulation and slide a 0.625 inch length of snug fitting heat-shrinkable sleeving over the strands. Center the sleeving over the cut-off strands. Direct the hot air from a heater gun to all areas of the heat-shrinkable sleeving to assure proper shrinkage. The heat-shrunk sleeving shall be snug fitting around the joint and provide a nonslip permanently fixed assembly.

3.3.3.5 Grounded without ferrules. When the cable, harness, or wire bundle contains individually shielded conductors and the shields are to be terminated and grounded to a connector shell without the use of ferrules, the individual shields will be terminated as described in 3.3.3.3.6a. The hole in the shield shall be properly located so that enough loose shield will be available for making the connection to the connector clamp, as shown in figure 23. The loose shield on each conductor shall be pulled taut, to smooth out any wrinkles, and twisted to make a snug fit around the conductor. The individual loose shield ends shall be twisted or plaited together. A terminal lug shall be soldered or crimped to the ends of the shields, and shall be mounted to the cable clamp screw. The complete assembly shall be as shown in figure 23.

3.3.4 Shield termination at terminal boards. When ferrules are used to terminate shields at terminal boards and the shield is to be grounded, the following procedure shall be used:

a. Strip back the shielding, and outer insulation cover if used, not greater than 2.500 inches from the end of the shielded wire.

b. Assemble the ferrule and jumper as specified in 3.3.3.3, method A, B, C, D, or E.

c. Install sleeving.

d. If the shielding is to be connected to terminal, strip the insulation from the loose end of the jumper wire, tin the wire, and

solder it to the terminal, using the procedures in accordance with MIL-STD-2000.

e. If the shield is to be grounded to a chassis, or component by attaching it to a fastening screw, strip the insulation from the loose end of the jumper and attach a ground lug. The ground lug shall be assembled to the screw as specified in 3.3.5.

3.3.5 Terminal lug connector grounding. When terminal grounding lugs are used and assembled to the screw of the connector clamps or other approved grounding screws, the lug shall be assembled with a split washer and flat washer (flat washer next to terminal lug) between the screw head and the terminal lug. The terminal lug shall make direct contact with the grounding surface. The complete grounding connection shall be oversprayed with an acrylic spray or varnish.

3.3.5.1 Grounding surface. The terminal lug grounding surface shall be free of dirt, grease, or any other foreign matter that would create a high-resistance contact. The contacting surface shall be a metallic, low-resistance surface. There shall be no paint or insulating finish that would create a high-resistance surface. The resistance from the terminal lug to the grounding medium shall meet the requirements of 3.4.5.

3.3.5.2 Terminal lug assembly. Terminal lugs may be an open tab solder cup, solderless crimp-type, or other approved types for attaching shields or conductors to component screw terminals, connector cable clamp screws, and chassis or bus bar ground screws. The open tab type is generally used for grounding the braided shield of a shielded conductor, cable, or harness where applicable.

3.3.5.3 Terminal lugs used to secure conductor, cable, or harness shields. When a terminal lug is used to secure the shield of a conductor, cable, or harness to a screw fastener, and when the shield termination is prepared without ferrules, the following procedures shall be used:

a. The end of the shield where the lug will be fastened may be twisted, braided, or combed, but shall be neat and free of loose strands.

b. The shield end shall be placed in contact with the terminal lug fastening area, taking maximum advantage of the area. If the terminal lug contains crimping tabs, the shield must extend fully under all tabs. The terminal lug will be crimped or the tabs

bent over the shield with the specified tool. The assembly shall be capable of withstanding a 15-pound tensile test between the terminal lug and the shield without movement of the shield in the terminal lug.

3.3.6 Terminal lugs used to secure insulated, stranded conductors. When a terminal lug is used to secure an insulated, stranded conductor to a screw, one of the following procedures shall be used. Broken strands of the conductor shall be not greater than the limits in accordance with MIL-STD-454, Requirement 5.

3.3.6.1 Standard crimp terminal lugs. Installation procedures for crimping standard insulated or uninsulated terminal lugs to AN-22 through AN-4/0 copper conductors shall be as follows:

a. Remove the insulation from the conductor to a distance within the limits shown in figure 24.

b. Measure the diameter of the bare conductor (see figure 25) and select proper terminal lug by the conductor diameter and circular mil area in accordance with table II.

TABLE II. Conductor diameter and circular mil area.

Terminal or connector size	Range of circular mil area		Maximum outside diameter of conductor (inches)
	Minimum	Maximum	
22-18	511	2050	0.052
16-14	2050	5180	0.077
12-10	5180	13090	0.122
8	13090	20820	0.172
6	20820	33090	0.219
4	33090	52620	0.277
2	52620	74000	0.352
1	74000	94000	0.387
0	94000	119000	0.437
00	119000	155000	0.497
000	155000	190000	0.552
0000	190000	230000	0.619

c. Select applicable crimping tool in accordance with MS90485, MS17776, or MIL-C-22520/5.

d. Determine that crimping die opening has been certified for proper adjustment (see 4.6.4).

e. Insert terminal lug, tongue first, into selected crimping tool. Position the leading edge of terminal lug against the locator stop (see figure 26).

f. Squeeze grips of crimping tool slowly until jaws hold terminal firmly in place without denting the barrel of the terminal lug.

g. Insert stripped wire into barrel of terminal lug until the conductor butts firmly against the forward stop of the terminal lug barrel (see figure 27) with the strands of the conductor clearly visible through the inspection opening of the terminal lug.

h. Squeeze tool handles until ratchet releases. For approved crimping tools not equipped with a ratchet release, squeeze the tool handles until the dies are completely bottomed (dies closed to minimum opening).

i. Remove crimped terminal lug from the crimping tool and examine for proper crimp.

j. When required by the procuring activity (see 6.2), prepare destructive test samples under production conditions in accordance with the sampling procedures specified in 4.5.3.2.2.1.

3.3.6.2 Nonstandard crimp terminal lugs. Installation of nonstandard insulated or uninsulated terminal lugs to copper conductors shall be in accordance with the procedures specified for standard terminal lugs, except the crimping tool shall be as recommended by the terminal lug manufacturer and approved by the procuring activity.

3.3.6.3 Solder terminal lugs. When a solder termination is specified the installation shall be as follows:

a. The insulation of the wire shall be stripped back sufficiently to allow the conductor strands to penetrate the full depth of the solder cup and allow approximately 0.125 inch between the end of the lug solder cup and the conductor insulation.

b. The conductor end shall be tinned in accordance with MIL-STD-2000.

c. The solder cup and conductor shall be soldered in accordance with MIL-STD-2000.

3.3.7 Splice connectors. Splice connectors are not acceptable for use with coaxial cabling.

3.3.7.1 Pre-insulated connectors. Crimping procedures for preinsulated splice connectors for use with copper conductors, wire sizes AN-22 through AN-10, shall be as follows:

a. Remove insulation from the conductor in accordance with lengths specified in table III and figure 28. The remaining insulation shall not be damaged. Broken strands of the conductor shall be not greater than the limits specified in 3.3.6.

TABLE III. Wire stripping lengths for copper conductor slices.

AN wire sizes	Strip length (inches)
22	0.187
20-18	0.250
16-14	0.250
12-10	0.312
8	0.437
6	0.500
4	0.500
2	0.625
1	0.625
1/0	0.687
2/0	0.812
3/0	0.812
4/0	0.875

b. Measure the diameter of stripped conductor (see figure 25) and select the proper splice connector by the conductor diameter and circular mil area as specified in table II.

c. Select applicable crimping tool in accordance with MS90485, MS17776, or MIL-C-22520/5.

d. Determine that crimping tool has been checked for proper adjustment (see 4.6.4).

e. Insert one end of splice connector into properly selected crimping tool. If the connector stop plates have been removed from crimping tool, center splice barrel over tool indentor. When crimping tool stop plates are in position, insert splice connector barrel into crimping position as shown in step 1 of figure 29.

f. Squeeze crimping tool handles slowly until the crimping jaws hold the connector body firmly in place without denting the crimping barrel of the connector.

g. Insert stripped conductor into the crimping barrel of the connector, insulation shall butt firmly against crimping barrel of the splice connectors.

h. Check position of conductor to determine that the conductor is fully bottomed (ends of conductor wire clearly visible through the splice connector inspection hole).

i. Close crimping tool handles until ratchet releases. For approved crimping tools not equipped with ratchet release, squeeze tool handles until the dies are completely bottomed (dies closed to minimum opening) as shown in step 2, figure 29.

j. Remove crimped connector from the crimping tool and examine for proper crimp.

k. Rotate crimping tool 180° and repeat steps (a) through (j) for the second conductor as shone in step 3, figure 29.

3.3.7.2 Uninsulated splice connectors, large conductors. Crimping procedure for large copper conductors of wire sizes AN-8 through AN-4/0 shall be as follows:

a. Strip the conductors to be connected to the lengths specified in table III. When insulation of the splice connection is required, insert the wire through the insulation sleeve before crimping. The wire insulation remaining on the conductor shall not be damaged. Broken strands of the conductor shall be not greater than the limits specified in 3.3.6.

b. Examine the crimping tool to determine that it has been properly certified for proper adjustment (see 4.6.4).

c. Place one end of splice connector into crimping position in the crimping tool and squeeze the tool to firmly hold connector without denting the barrel of the connector.

d. Insert stripped conductor into the end of the splice connector gripped in the crimping tool. Observe connector inspection opening to determine that the conductor is fully bottomed (conductor firm against conductor stop) in the connector.

e. Close the crimping tool handles until the ratchet releases. For tools not equipped with ratchet release, squeeze tool handles until the dies are completely bottomed (dies closed to minimum opening).

f. Release splice connector and crimp the other end of the connector by repeating steps (c), (d), and (e).

g. Examine crimp to determine proper connection.

h. When insulation of connection is required after crimping, cover splice connector with approved insulation tubing (preferably transparent plastic, length as specified in table IV) and secure each end with fungus resistant cord or approved substitute. When approved shrinkable tubing is used as insulating material, fungus resistant cord is not required.

TABLE IV. Length of insulation sleeve (large conductors).

AN wire size	Insulation sleeve length (inches)
8	1.312
6	2.125
4	2.125
2	2.406
1	2.406
1/0	2.531
2/0	2.781
3/0	2.812
4/0	2.937

3.3.7.3 Nonstandard splice connectors. Installation of nonstandard insulated or uninsulated splice connectors for use with copper conductors shall be in accordance with the procedure specified for standard splice connectors, except the crimping tool

shall be as recommended by the splice connector manufacturer and approved by the procuring activity.

3.3.8 Securing wire bundles. All wire bundles and harnesses which are not enclosed in conduit or other protective covering shall be continuously laced when the length is sufficient to accommodate two or more complete stitches. As an alternate method, cable or harness straps may be used, if approved, in lieu of lacing. Spot ties may be substituted for a continuous lace within subassemblies when the lacing length is less than four complete stitches. All lacing or spot ties shall be performed with materials specified herein and shall be snug. All knots of all lacing shall be coated with an acrylic spray or other suitable lacquer. The starting and terminating sections and the stitching shall be as specified in the following procedures; however, when specified on the applicable drawings or by the procuring activity, other approved methods of lacing may be used. Assemblies being laced in accordance with these methods shall be long enough to accommodate the termination of lacing, distances between component and termination of the lacing, and distance required for two complete stitches. At sharp bends in the harness or wire bundle, the spacing between stitches shall be shortened to provide a better lacing dress. When coaxial cables are routed with other cable groups, they shall be routed on the inside of the wire bundle providing the cables are sufficiently buried in the bundle to prevent damage from cable clamps and string ties. Cables routed with small harness bundles which do not contain sufficient number of wires to completely surround the cables, shall be routed so that the cables lie on the outside of the wire bundle and shall be secured in place with electrical insulation tape. During lacing operations, care should be taken to keep the lacing cord tension to a minimum consistent with the intended usage.

3.3.8.1 Method a-double - lock stitch. This method consists of starting and terminating sections of wound lacing cord locked in place and double-lock stitch plus running-hitch stitching.

a. To prevent undue stress between the laced harness or wire bundle and the attached components (connector, relay pins), and to prevent the individual conductors from flaring out, the distance between the component and the termination section (see figure 30, reference A) shall be not greater than one stitching interval as specified in table V.

TABLE V. Assembly diameter and stitching interval.

Assembly diameter (inch)	Interval (maximum)
0.250	0.750
0.500	1.500
1.000	2.000
Over 1.000	3.000

NOTE: When the cable diameter is between the listed sizes, revert to the smaller diameter for applicable stitching interval. (Example: Harness size 0.375 inch, use 0.750 inch stitching interval).

b. Cut a piece of lacing approximately eight inches long, fold in half, and lay on assembly parallel to conductors with the loop end toward the assembly (the end to which component will be attached), as shown in figure 31.

c. Divide the conductors into two equal groups, unwind estimated length of lacing cord necessary to wrap the assembly as specified herein, and feed between conductor groups at location of cord (see figure 31).

d. Wind not less than six turns clockwise, looking from the short end of the assembly (see figure 32). The turns shall be wound away from the short end of the assembly, starting at a position to meet the requirements of table V and step a. above.

e. Repeat a second layer of winds clockwise, returning over the first layer. The last turn shall cover the first turn, as shown in figure 33.

f. Feed the loose end of the lacing cord through the middle of the assembly, between two even groups of conductors, and through the loop of the cord, as shown in figure 33.

g. Pull the loose end of the lacing cord tight, closing the loop and locking the lacing in place. Trim all the loose ends. The finished section should be as shown in figure 34.

h. Stitch the entire assembly with the double-lock stitch plus running hitch shown in figure 35, with the stitching intervals meeting the requirements of table V.

i. The terminating section at the opposite end of the assembly will be performed as specified in steps a. through g. above.

3.3.8.2 Method b - single-lock stitch. This method consists of starting and terminating sections of wound lacing cord (figure 34) and single-lock stitching.

a. Perform a starting section as specified in 3.3.8.1, steps a. through g.

b. Stitch the complete assembly using the single-lock stitch shown in figure 36.

c. The lacing shall be terminated at the opposite end of the assembly as specified in 3.3.8.1, steps a through g.

3.3.8.3 Spot ties.

3.3.8.3.1 Method c -lacing tie. When lacing ties are used, they shall consist of at least two complete turns of lacing cord around all the conductors being tied. The lacing cord shall be secured with a suitable non-slip knot to prevent movement of the tie during handling of the assembly. The tie shall be performed as follows:

a. Holding a short length of lacing cord parallel with the conductors (see figure 37), wrap two turns of lacing cord loosely around the complete assembly. The first turn should lap over the parallel section, and the second turn should run under the parallel section, as shown in figure 37, reference A.

b. Pull the ends of the lacing cord, as shown in figure 37, reference A, so that the turns are snug.

c. Tie a terminating knot with loose ends of the lacing cord, as shown in figure 37, reference B.

d. Trim the loose ends of the lacing cord so they are approximately 0.250 inch in length as shown in figure 37, reference C.

3.3.8.3.2 Method d - harness straps. Plastic or nylon harness straps of an approved source may be used on harness or wire bundles. The straps shall be mounted snugly on the assembly conductors and be capable of being locked to prevent loosening or

opening. These straps shall be positioned to correspond with the stitching interval specified in table V. Straps may be used to secure the wire bundle or harness that mounts directly to the electrical assembly chassis. Procedures for installation of harness or cable straps shall be in accordance with instructions of the strap manufacturer subject to approval of the procuring activity.

3.3.8.4 Lacing branches and breakouts. When a harness assembly or wire bundle contains branches or conductor breakouts, the following procedures shall apply:

a. Where practicable, the main trunk of the wire bundle or harness shall be continuously laced between connectors or components. The main trunk is the portion containing the largest number of wires as shown in figure 38 reference A.

b. A terminating section as described in 3.3.8.1 shall be performed on the main trunk of the harness or wire bundle at the beginning of a wye branch, as shown in figure 38, reference B.

c. The branch shall be continuously laced, beginning at the junction as shown in figure 38, reference C.

d. Terminating sections shall be placed on both sides of a tee junction as shown in figure 38, reference D.

e. If the branch or breakout consists of three or fewer conductors, spot ties may be used in place of the terminating sections described in steps b. and d. above.

3.3.9 Grommet holes. If the connector is equipped to contain more wires than those specified on the detail drawing, unused insulating grommet holes shall be filled with vinyl or nylon rod.

3.3.10 Insulation sleeving. Unless protected by an insulation grommet, sleeving shall be used at the soldered terminations of relay pins, connector plugs, and receptacle solder pots. The sleeve shall be slipped over the conductor and soldered terminal after the solder joint has cooled. Connections to be potted shall not be sleeved.

3.3.11 MS-R connector torque. When the backshells, adapters, and connector cable clamps are assembled to the connector, and when plugs are mated with receptacles or MS-R connectors, all threaded

joints shall be torqued to assure that sealing is obtained. The minimum torque values specified in table VI shall be used.

TABLE VI. MS-R connector torque.

Connector size	Torque ft-lbs
14	4
20	7
24	9
28	11
32	13
40	17

3.4 Performance.

3.4.1 General.

3.4.1.1 Terminal lugs and splice connectors. Terminal lugs and splice connectors shall conform to the performance requirements of MIL-T-7928, except for the tensile strength and dielectric strength requirements which shall be as specified herein.

3.4.1.2 One-piece ferrules. One-piece ferrules shall conform to the performance requirements of MIL-F-21608, except for the tensile strength, dielectric strength and grounding resistance requirements which shall be as specified herein.

3.4.1.3 Two-piece ferrules. Two-piece ferrules attached to the shielding over one or more cables shall conform to the voltage drop, temperature cycling, vibrations, and corrosion resistance requirements specified for one-piece ferrules (see 3.4.1.2).

3.4.1.4 Straps. Cable straps shall conform to the performance requirements of MIL-S-23190 and applicable drawings.

3.4.2 Tensile strength.

3.4.2.1 Terminal lugs and splice connectors. The crimped connection between the terminal lug or splice connector shall not break or become distorted to the extent that it is unfit for the purpose intended under the tensile load specified in table VII.

3.4.2.2 One-piece ferrule. The mechanical connection between the ferrule and the ground wire of the crimped ferrule shall not break or become distorted to the extent it is unfit for the purpose intended under the tensile load specified in table VII.

TABLE VII. Tensile strength requirements.

Wire size (AWG)	Tensile strength (pounds) Terminal lugs, splices and one-piece ferrules	Tensile strength (pounds) Two-piece ferrules
	Pounds	Pounds
26	7	
24	10	
22	15	18
20	19	20
18	38	40
16	50	
14	70	
12	110	
10	180	
8	225	
6	300	
4	400	
2	550	
1	650	
0	700	
00	750	
000	825	
0000	875	

3.4.2.3 Two-piece ferrule. The crimped connection shall be capable of withstanding a tensile pull in accordance with table VII.

3.4.2.4 Straps. Cable straps shall conform to the tensile strength requirements of MIL-S-23190.

3.4.3 Dielectric strength.

3.4.3.1 Terminal lugs and splice connectors. The insulation over the barrel of insulated terminal lugs or splice connectors shall have a dielectric strength sufficient to withstand not less

than 1,500 volts root mean square (rms) at commercial frequencies for not less than one minute.

3.4.3.2 Ferrule. The insulation over the surface of the outer shell shall have a dielectric strength sufficient to withstand not less than 1,500 volts rms at commercial frequencies for not less than one minute.

3.4.4 Continuity. All electrical circuitry and grounds involving no electrical components shall be continuous according to the individual wiring diagrams or running lists.

3.4.5 Grounding resistance. The resistance to ground of grounded shields shall be not greater than 0.1 ohm or as specified on applicable drawings.

3.4.6 Insulation resistance.

3.4.6.1 Cable and harness assemblies. The insulation resistance of cable and harness assemblies shall be in accordance with MIL-C-45224.

3.4.6.2 Electrical subassemblies. The insulation resistance shall be not less than 100 megohms at a specified voltage (see 4.6.3.3.2).

3.4.7 Radio frequency interference. The mechanical connection of a crimped terminal, splice connector, or ferrule shall meet the radio frequency interference requirement in accordance with MIL-STD-461 and MIL-STD-462.

3.5 Dimensions.

3.5.1 Terminal lugs. Dimensions for standard terminal lugs shall conform to MS20659 or MS25036 as applicable. Dimensions of non-standard terminal lugs shall be furnished to the procuring activity by the manufacturer. Dimensions furnished shall be those indicated in figure 39. Maximum dimension shall be shown for the A dimension; minimum dimensions shall be shown for B, C, J and X dimensions; maximum and minimum dimensions shall be shown for D, E, F, G and W dimensions.

3.5.2 Splice connectors. Dimensions for standard splice connectors shall conform to MIL-T-7928/5 and this specification. The contour in areas other than critical dimensions areas may vary from that shown in figure 40. Dimensions of nonstandard splice

connectors shall be furnished to the procuring activity by the manufacturer. Dimensions furnished shall be those delineated in figure 37.

3.5.3 One-piece ferrules. Dimensions for one-piece ferrules shall conform to applicable drawings and shall be furnished the procuring activity by the manufacturer. Dimensions furnished shall be those dimensions shown in figure 41. Only dimensions A, B, C, G, and K shall apply to uninsulated ferrules. Dimension tolerances for one-piece ferrules shall be approved by the procuring activity.

3.5.3.1 Shield termination ferrule. Dimensions for shielding ferrules shall be furnished to the procuring activity by the manufacturer. Dimensions furnished shall be in accordance with figure 42. Dimension tolerances shall be approved by the procuring activity.

3.5.4 Two-piece ferrules. The dimensions shown in figure 43 for inner and outer ferrules shall be furnished to the procuring activity by the ferrule manufacturer. Unless otherwise specified by the procuring activity, the dimensions of inner and outer ferrules used to terminate or ground shields for single or multiple conductors terminating into electrical connectors shall be as specified herein.

3.5.5 Wire, cable, harness, and wire bundles. Wire, cable, harness lengths, or wire bundles shall be as specified on the applicable detail drawing; otherwise, lengths shall be as short as possible in order to perform the necessary function with no undue stress on the wire, cable, harness, or termination. Acceptable wiring lengths and routing are shown in figure 44.

3.5.6 Straps. Cable strap dimensions shall conform to MIL-S-23190 and associated military standards.

3.6 Product marking. Unless otherwise specified herein or on detail drawings, marking for identification shall be in accordance with MIL-STD-130.

3.6.1 Cable and harness assemblies. Marking methods as specified on the detail drawing or in accordance with MIL-C-45224 shall be applied to the cable or harness. In case of conflicting marking requirements between this specification and the applicable drawing, the latter shall govern.

3.6.2 Subassembly connectors, jacks, and terminals. Designations for connectors, jacks and terminals that are permanently installed in a subassembly may be made on a surface close to the device with a permanent ink or etching.

3.7 Crimping tools. Crimping tools not conforming to the following standards shall be submitted to the procuring activity for approval prior to production use. The assembly manufacturer shall obtain crimping die dimensions (indentor and nest) and "close position" die clearance (opening between crimping dies) for nonstandard tools. The assembly manufacturer shall be responsible for the development of suitable gages or test methods, approved by the procuring activity, to ensure proper tool adjustments.

3.7.1 Terminal lugs and splice connectors. Standard crimping tools for crimping terminal lugs or splice connectors shall conform to MS90485 (conductor sizes AN-10 through AN-4/0), MS17776, or MIL-C-22520/5 (conductor sizes AN22 through AN-10) and this specification.

3.7.2 One-piece ferrules. Crimping tools used for crimping one-piece ferrules shall be as specified in the contract or order (see 6.2).

3.7.3 Two-piece ferrules. Crimping tools for crimping two-piece ferrules shall be tools recommended by the ferrule manufacturer and approved by the procuring activity.

3.7.4 Straps. Tools to install cable straps shall be in accordance with MIL-S-23190, MS90387 or shall be in accordance with the strap manufacturer's specifications subject to approval by the procuring activity.

3.8 Type II with one-piece ferrules. Type II shield terminations shall not be used for new design unless specifically required by the procuring activity. In all cases where type II terminations are not considered mandatory by the procuring activity, type III (two-piece) ferrules shall be used with the applicable terminating method (see 1.2.3).

3.9 Workmanship. The electrical subassemblies, cables, and harnesses shall contain no protrusions, sharp edges, dents, cracks, bends, breaks, chips, loose solder, loose solder connections, broken wire strands (other than specified herein), discontinuity of shielding or jacket, chipped paint, or any other defect that would indicate poor quality of workmanship or render the assembly

unsuitable for the purpose intended. Crimped insulated terminations shall not exhibit splits, chips, or punctured insulation. Workmanship during initial crimping operations shall be of the highest quality, crimped connections shall be adequate, and over and under crimping shall be avoided.

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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 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. First article inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in applicable test methods documents and paragraph 4.6 in this specification.

4.3.1 Lot size. An inspection lot shall consist of materials and parts fabricated to a particular type of conductor or multiconductor, as applicable, under essentially the same conditions and presented for acceptance at any one time.

4.4 First article inspection. When specified in the contract or order (see 6.2), a first article sample be subjected to first article inspection. Subsequent units shall not be considered for acceptance until Government approval of the first article sample has been obtained (see 3.1 and 4.2).

4.5 Quality conformance inspection. Quality conformance inspection shall be as specified herein.

4.5.1 Visual examination. A visual examination of materials, workmanship, construction, crimping, marking and dimensions shall be made to determine conformance to this specification and applicable standards and drawings.

4.5.2 Materials and components examination.

4.5.2.1 Materials and procedures. The inspector shall ascertain that all terminal lugs, splice connectors or ferrules used in fabrication of terminations and the crimping tools used in crimping and all straps and strap tools have been inspected and accepted prior to assembly in accordance with their respective specifications, standards or drawings. The inspector shall ascertain that the procedures used are in accordance with this specification or as approved by the procuring activity.

4.5.2.2 Ferrules. Installation of nonstandard ferrules (see 6.4.10) shall be examined to determine compliance with 3.3.3.3.1.1.2. It shall be ascertained that the installation of nonstandard ferrules are in accordance with this specification and are capable of meeting 20-pound pull test requirements.

4.5.3 Sampling.

4.5.3.1 First article sample. The sample submitted for first article approval, if required (see 6.2), shall consist of the number of samples specified in the contract or order (see 6.2). The first article sample shall be subjected to the examinations and tests specified herein (see 4.6.1)

4.5.3.2 Production test samples.

4.5.3.2.1 Nondestructive inspections. The sample for nondestructive inspections shall consist of all crimped terminations submitted for acceptance at any one time (see 4.6.3).

4.5.3.2.2 Destructive tests. The sample for destructive tests (see 4.6.2) shall consist of the samples by type, crimp and wire size as specified herein. Upon satisfactory exhibition of acceptable performance, a reduced sampling plan may be offered for Government approval.

4.5.3.2.2.1 Terminal lug or splice connector. The sample for destructive tests shall consist of prepared samples equal to but not less than four percent of production but not less than two samples from each lot or order of 20 or less. The samples shall be prepared during regular production crimping utilizing completed items from normal production.

4.5.3.2.2.2 Ferrules.

4.5.3.2.2.2.1 One-piece. The sample for destructive tests shall consist of prepared samples equal to not less than four percent of production but not less than two samples from each lot or order of 20 or less. The samples shall be prepared during regular production utilizing completed item for normal production.

4.5.3.2.2.2.2 Two-piece. The sample for destructive tests for two-piece ferrule crimps shall consist of prepared samples equal to not less than four percent of production but not less than two samples from each lot or order of 20 or less for single conductor crimps. Samples shall consist of prepared samples equal to not less than two percent but not less than one sample from each lot or order of 50 or less for multiconductor crimps. The samples shall be prepared under production conditions utilizing completed items from normal production.

4.5.3.2.2.3 Straps. The sample for destructive tests for cable straps shall consist of four percent of production, but not less than two samples from each lot or order of 20 or less. The samples shall be prepared under production conditions utilizing completed items from normal production.

4.6 Test procedures.

4.6.1 First article approval.

4.6.1.1 Terminal lug and splice connector. The terminal lug or splice connector first article sample of 4.5.3.1, prepared from identical materials (terminal lugs or splice connector and conductor) utilizing approved crimping tools and crimping procedures to be used in regular production, shall be subjected to the examinations of 4.2, 4.3, the acceptance test specified herein, and the following test.

4.6.1.1.1 Radio frequency interference. The crimped terminal lug or splice connector first article sample shall be subjected to the radio frequency interference tests in accordance with MIL-STD-461 and MIL-STD-462 to determine conformance of the terminal lug or splice connector, as applicable, to the requirement of 3.4.7.

4.6.1.2 Ferrules.

4.6.1.2.1 One-piece. The one-piece ferrule first article approval sample of 4.5.3.1, prepared from identical materials (ferrules and conductors) utilizing approved crimping tools and crimping procedures to be used in regular production, shall be subjected to the examinations of 4.5.1, 4.5.2, the acceptance tests specified herein, and the following test.

4.6.1.2.1.1 Radio frequency interference. The crimped one-piece ferrule first article sample shall be subjected to the radio frequency interference tests in accordance with MIL-STD-461 and MIL-STD-462 to determine conformance of the one-piece ferrule to the requirement of 3.4.7.

4.6.1.2.2 Two-piece. Two-piece ferrules first article approval samples of 4.5.3.1, prepared from identical materials (outer and inner ferrules and single or multiconductor cables) utilizing approved crimping tools and crimping procedures to be used in regular production, shall be subjected to the examinations of 4.5.1 and 4.5.2, the acceptance tests specified herein, and the following tests.

4.6.1.2.2.1 Voltage drop. Millivolt drop across the crimped ferrule shall be measured from the intersection of the tongue and barrel of the grounding wire terminal lug to a point on each shielded wire as shown in figure 45. Measurements shall be made after the temperature of the cable assembly has stabilized. These voltage drops shall be caused by a test current not greater than one ampere (see 3.4.1.3).

4.6.1.2.2.2 Temperature cycling. Not less than one sample crimped to a ground conductor in accordance with the procedure of 3.3.3.3.2 or 3.3.3.3.6, as applicable, shall be subjected to a temperature cycling test by alternately placing the test termination in hot and cold temperature chambers for 30 minute periods. The temperature of the hot chamber shall be not less than 125° Celsius (C) and the temperature of the cold chamber shall be not less than 29°C. During temperature cycling, the test sample shall be placed in room ambient temperature of 21 ± 3°C for not less than 15 minutes between each hot and cold phase of the test. After five cycles from hot to cold temperature the voltage drop across the connection shall be measured to determine that the crimped termination meets the temperature cycling requirements of 3.4.1.3.

4.6.1.2.2.3 Vibration. Not less than one sample, crimped to a ground conductor (AN-22 or AN-20) in accordance with the procedure of 3.3.3.3.2 or 3.3.3.3.6, as applicable, shall be subjected to a voltage drop test (see 4.6.1.2.2.1) prior to vibration. The sample shall be mounted on a vibration table with the cable secured to the table within two inches from the crimped ferrule. The free end of the ground wire shall be attached to a stable support with slack allowed in the ground wire (figure 46). The sample shall be vibrated for six hours in each of the three major axes in accordance with method 201 of MIL-STD-202. Electrical continuity through the sample shall be monitored throughout the test, and there shall be no interruption of continuity greater than 10 microseconds. After the vibration test, the sample shall be subjected to the voltage drop tests to determine conformance to the vibration requirement of 3.4.1.3.

4.6.1.2.2.4 Corrosion resistance. At least one crimped termination shall be tested for voltage drop prior to subjection to corrosion tests. The test sample shall be subjected to a five percent salt-solution concentration fog in accordance with method 101, condition A, of MIL-STD-202. The test specimen shall be placed in a position within the test chamber which will permit the most uniform coverage of the test specimen by the fog. Following the salt-spray (fog) test, the samples shall be washed thoroughly with distilled water and air dried for not less than one hour. The test specimen shall be subjected to the voltage drop test and the results compared to the original voltage drop tests to determine damage caused from salt-spray exposure. Voltage drop after the corrosion test shall not be greater than 150 percent of the initial value.

4.6.1.2.2.5 Radio frequency interference. The crimped first article sample shall be subjected to the radio frequency interference tests in accordance with MIL-STD-461 and MIL-STD-462 to determine conformance of the two-piece termination to 3.4.7.

4.6.1.3 Straps. The cable strap first article approval sample of 4.5.3.1, prepared from identical materials, shall be in accordance with MIL-S-23190 and tests specified on applicable drawings.

4.6.2 Acceptance tests.

4.6.2.1 Terminal lug and splice connectors. The destructive test samples of 4.5.3.2.2 shall be subjected to the acceptance tests as specified herein. Insulated samples shall be divided into two equal groups, one group shall be subjected to the dielectric strength test and one group shall be subjected to the tensile strength test. Applicable tests shall be conducted in the order listed.

4.6.2.1.1 Dielectric of insulation. Insulated terminal lug or splice connector dielectric strength shall be measured by dipping the terminal lug tongue or approximately one half of the splice connector in hot beeswax having a temperature not greater than 154°C. The component shall be dipped to a depth sufficient to close the open end of the terminal lug or splice connector without covering the edge of the depression resulting from the crimping operation. When the beeswax has hardened, the barrel of the terminal lug or splice connector shall be immersed in a five percent salt water solution to a depth sufficient to cover the crimped areas of the barrel and the insulation support. A voltage of 1,500 rms at commercial frequencies shall be applied between the wire, assembled (crimped) to the terminal lug or splice connector, and the salt water solution for not less than one minute to determine conformance to 3.4.3.1.

4.6.2.2 Ferrules.

4.6.2.2.1 One-piece. The destructive test samples of 4.5.3.2.2 shall be subjected to the acceptance tests as specified herein. Insulated ferrules shall be divided into two groups, one group shall be subjected to the dielectric strength test and one group shall be subjected to the tensile strength test.

4.6.2.2.1.1 Dielectric of insulation. Insulated ferrule dielectric strength shall be determined by removing the inner wire

(conductor and conductor insulation) from the metal shield and crimped ground wire. The ferrule shall be dipped in hot beeswax (temperature not greater than 154°C) to a depth sufficient to seal the end of the ferrule having the two "peep holes' (figure 47) but not covering the crimped area of the ferrule. When the beeswax has hardened, the sample shall be immersed in a five percent salt water solution to a depth sufficient to cover the crimped areas of the insulation sleeve. A voltage of 1,500 rms at commercial frequencies shall be applied between the metal shield braid and the salt water solution for not less than one minute to determine conformance to 3.4.3.2.

4.6.2.1.2 Tensile strength. The terminal lug or splice connector test sample shall be placed in a standard tensile testing machine and sufficient force applied to pull the conductor out of the terminal lug or splice, or break the wire, terminal lug or splice connector. The speed of the folding head shall be not greater than one-inch-per-minute. Determine conformance to 3.4.2.1.

4.6.2.2.1.2 Tensile strength. The sample shall be placed in a standard tensile-testing machine and sufficient force applied to the ground wire to pull the crimped wire from the crimped ferrule or to break the wire. The test shall be made with a head speed travel of not greater than one-inch-per-minute. Determine conformance to 3.4.2.2.

4.6.2.2.2 Two-piece tensile strength. Tensile strength tests of two-piece ferrule terminations shall be conducted by placing the test sample in a tensile testing machine (figure 48) and applying pull force, in the direction of the arrow (figure 48), to the crimped ground wire. The speed of the crimping jaw shall be not greater than one-inch-per-minute. Determine conformance to 3.4.2.3.

4.6.2.3 Straps. The destructive test samples of 4.5.3.2.2 shall be subjected to the tensile strength and melting point tests of MIL-S-23190.

4.6.3 Final assembly tests. The following tests shall be made on each cable, harness, wire bundle, and electrical assembly fabricated in accordance with this specification.

4.6.3.1 Continuity. Each cable, harness, or electrical assembly shall be tested for electrical continuity according to the applicable wiring diagram or running list. The test shall be in

accordance with MIL-C-45224. Other methods of performing this test require the approval of the procuring activity (see 3.4.4).

4.6.3.2 Grounding resistance. The resistance to ground of grounded shields shall be measured with a low resistance measuring instrument having a suitable resistance scale to determine compliance with 3.4.5.

4.6.3.3 Insulation resistance. After installation of the assembly, with connectors, splices, or terminals attached, and prior to connecting functional electrical components, the insulation resistance shall be measured between all isolated conductors and between all isolated conductors and ground. Exceptions shall be as specified on the detail drawings. The measurement shall be performed with an insulation-resistance instrument and shall meet the requirements of 3.4.6. The potential shall be applied for a period not greater than one minute.

4.6.3.3.1 Cable and harness assemblies. The insulation resistance test shall be in accordance with MIL-C-45224.

4.6.3.3.2 Electrical assemblies. The insulation resistance shall be measured with an instrument that has a test potential of 100 volts direct current. The instrument shall have a full-scale reading of 2,000 megohms or greater, with an accuracy of not less than five percent at 100 megohms.

4.6.4 Crimping tool inspection. The crimping tool die clearance "G" dimensions (figure 49) with the tool in the fully closed position, shall be gaged with "GO" and "NO GO" gages prior to initial production and after each 40 hours of use, or other inspection schedule (approved by the procuring activity) which shall assure performance of the termination as specified herein. Gages, for acceptable tools not conforming to military standards, shall be checked with gages recommended by the tool manufacturer and approved by the procuring activity (see 3.9).

4.7 Design criteria for ferrule and tool selection (see 3.3.3.3.1.3). The selection of proper ferrule size, as determined by the braid mass factor, shall be in accordance with table I. The braid mass factor shall be determined as specified in table VIII.

TABLE VIII. Mass factor determination.

Number of conductors in a common shield	Wire gauge	Weight of 30-inch length of shield in ounces	Braid mass factor
1	24	0.159	72
2	24	0.335	152
3	24	0.370	168
1	22	0.220	100
2	22	0.275	125
3	22	0.356	161
4	22	0.409	186
1	20	0.226	103
2	20	0.229	136
3	20	0.383	173
1	18	0.296	134
3	18	0.466	210
3	16	0.473	214
1	16	0.268	123
2	22*	0.536	240
4	22*	0.741	336
4	10*	0.741	336

* High temperature wire

NOTE: Braid mass factor includes the use of a 20-gauge jumper or ground wire

5. PACKAGING

This section is not applicable to this specification.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The materials, parts, tools, methods, and procedures covered by this specification are intended for use in the fabrication and testing of crimp-type (solderless) and solder-type terminations on electrical cables, harnesses, wire bundles, single or multiconductor electrical circuits, and the wiring of electronic and electrical subassemblies used in missile systems.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification

b. When a class or method is not applicable (see 1.2)

c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2)

d. When first article is required (see 3.1 and 4.4)

e. Type soldering required (see 3.2.1)

f. Type lacing twine, cord, or braid to be used (see 3.2.4)

g. When splice connectors can be used (see 3.2.12)

h. When potting of connectors is required (see 3.3.2)

i. When destructive test samples are required (see 3.3.3.3.1i, 3.3.3.3.2j, 3.3.6.1j)

j. Number of units required for first article sample (see 4.5.3.1).

6.3 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a first article sample, a first production item, or a number of items to be tested as specified in 4.4. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions.

6.4.1 Ferrule. For the purpose of this specification the term ferrule, either one-piece or two-piece, insulated or uninsulated, is defined as a ring(s) used to strengthen an electrical conductor at termination point, either to ground, or at termination of shielded or coaxial cable. The ferrule is so constructed to permit the crimping of ground wire (as applicable) and cable shield(s) between the inner and outer ferrules (for two-piece ferrules) or between the inner surface of the outer shell (ferrule skirt) and the barrel (shield receiving surface) of the ferrule (for one-piece ferrules).

6.4.2 Crimp connections. For the purpose of this specification, crimp connections are defined as those connections, insulated or uninsulated, made by crimping terminal lugs, splice connectors, or ferrules to copper conductors.

6.4.3 Cable assembly. A cable assembly consists of two or more insulated conductors with a concentric lay or unilay design, assembled with connectors or terminals, and having a protective outside cover or jacket as an integral part of the cable construction or other component.

6.4.4 Harness assembly. A harness assembly consists of two or more conductors, laced or jacketed together with or without breakouts, and assembled with connectors or terminals at one or both ends.

6.4.5 Lacing. Lacing refers to the complete, continuous method of securing wires together in a harness, wire bundle, or cable assembly with specified lacing cord, from the initial turn of the starting section to the last turn of the terminating section. Lacing includes the starting and terminating sections plus the running stitches. Spot ties are considered as an alternate type of lacing.

6.4.6 Stitching. Stitching is a portion of the completed lacing between the starting and terminating sections.

6.4.7 Wire bundles. A wire bundle is a group of two or more conductors connecting relays, terminal boards, or other electrical components within an electrical assembly that may be laced, spot tied, or supported by cable clamps to form a neat compact trunk.

6.4.8 Crimp tool. For the purpose of this specification, crimp tools are defined as tools utilized to form solderless

terminations or connections in electrical circuits utilizing copper conductors.

6.4.8.1 Indentor. The indentor of a crimp tool is the die making the indentation or crimp forming the connection of conductor to the terminal lug, splice connector, or ferrule.

6.4.8.2 Nest. The nest of the crimp tool is the die that holds or anchors the terminal lug, connector or ferrule during crimping operations.

6.4.9 Standard terminations and tools. For the purpose of this specification, standard terminal lugs, splice connectors, one-piece ferrules, two-piece ferrules, and crimp tools are defined as those terminations or crimp tools meeting the requirements of the respective specifications, standards, or drawings specified herein.

6.4.10 Nonstandard terminations and tools. For the purpose of this specification, nonstandard terminal lugs, splice connectors, one-piece ferrule, two-piece ferrules and crimp tools are those terminations or crimp tools that do not meet all the requirements of the respective specifications, standards, or drawings specified herein or any standard, specification, or drawing in existence and require procuring activity approval prior to production use.

6.4.11 Installation procedures. Installation procedures specified herein are not to be considered restrictive. Procedures other than those specified herein require procuring activity approval.

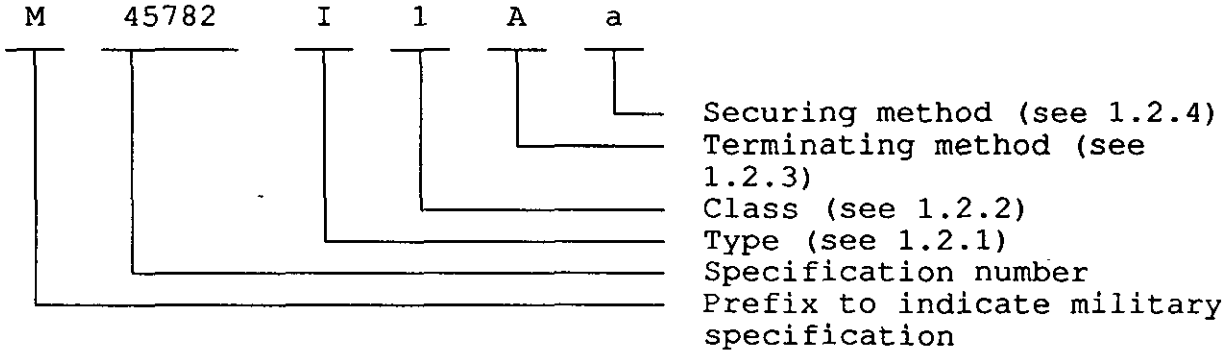
6.5 Cross reference chart of classification.

	*ABMA-PD-E-53	MIL-E-45782
Type	A B C	I II III
Class	I II	1 2
Method:	Terminating 1 2 3 4 5 6 7	Terminating A B C D E F G
Method:	Securing a b c d	Securing a b c d

*NOTE: Superseded Army Missile Command purchase description.

6.6 Metrication. Metric equivalents in accordance with FED-STD-376 are acceptable for use in this specification.

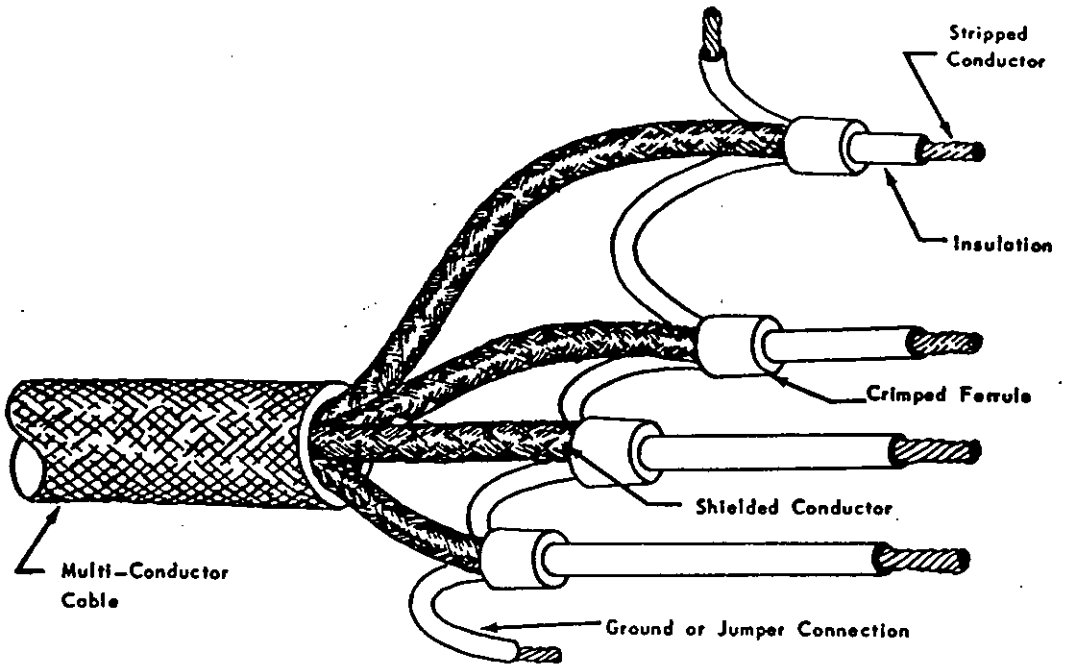
6.7 Part or identifying number (PIN). The PIN to be used for cable terminations acquired to this specification is created as follows:



6.8 Subject term (key word) listing.

Cables, electric
Cable terminations
Electronic components
Harnesses, electric
Shields

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.



NOTE: Stagger Ferrule Connections To Prevent Build-up of Ferrules.

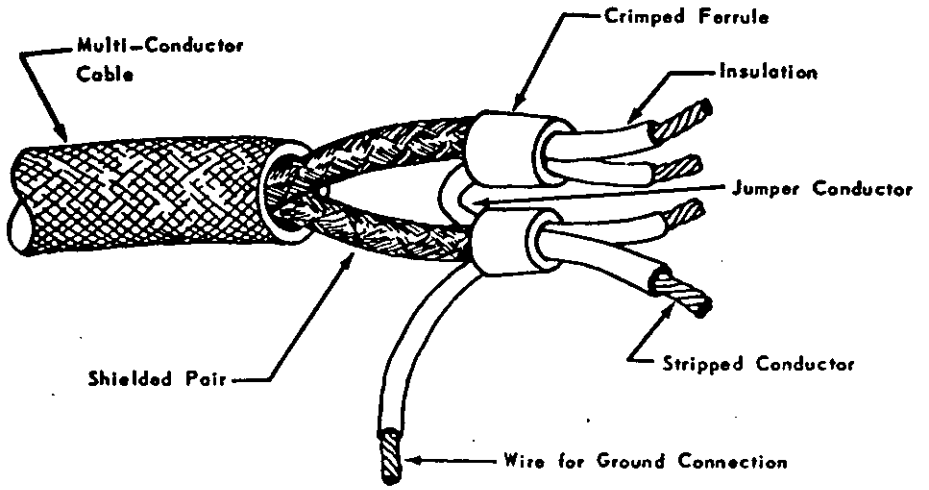
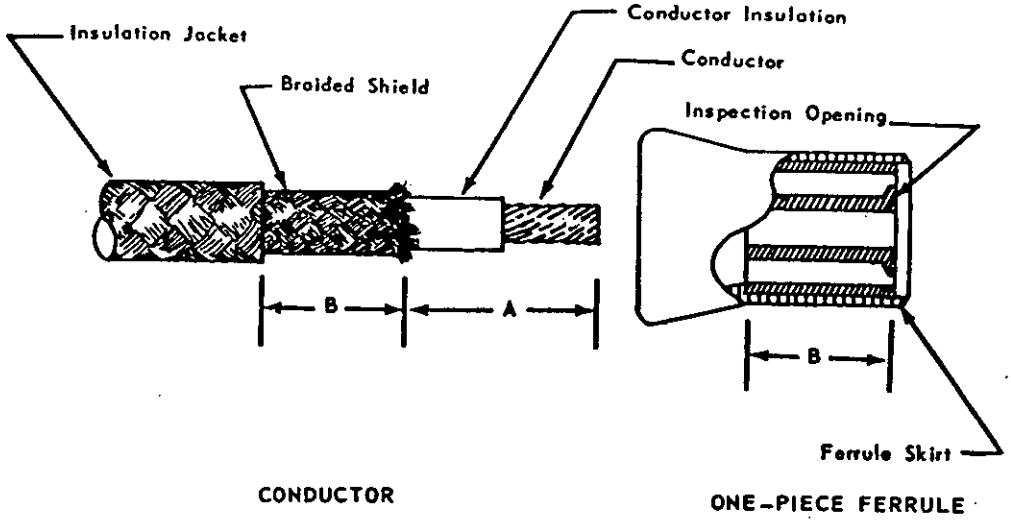


FIGURE 1. One-piece ferrule multi-conductor connections.



A - Desired length
B - Length of conductor receiving barrel of ferrule

FIGURE 2. Cable stripping for one-piece ferrule installation.

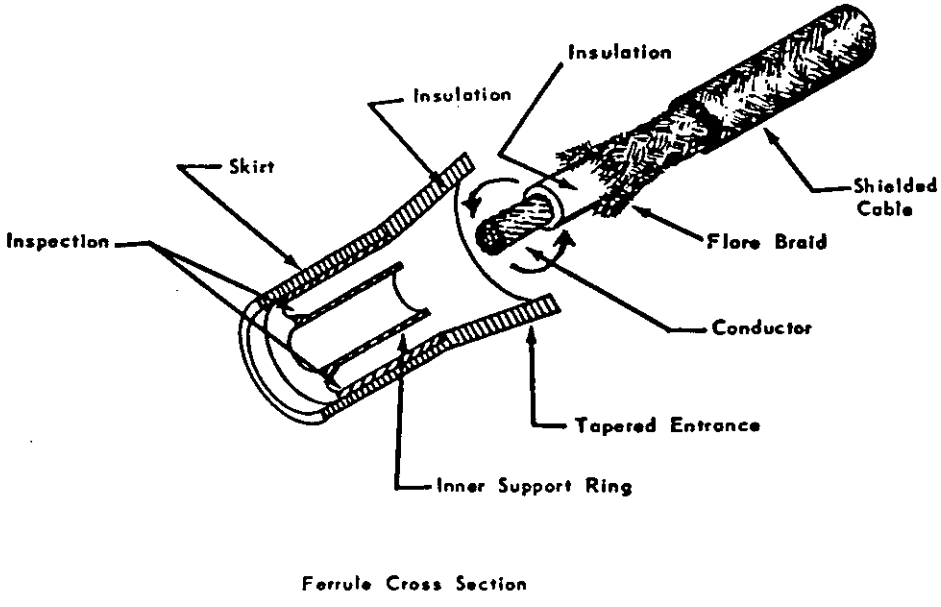


FIGURE 3. Flare conductor braid.

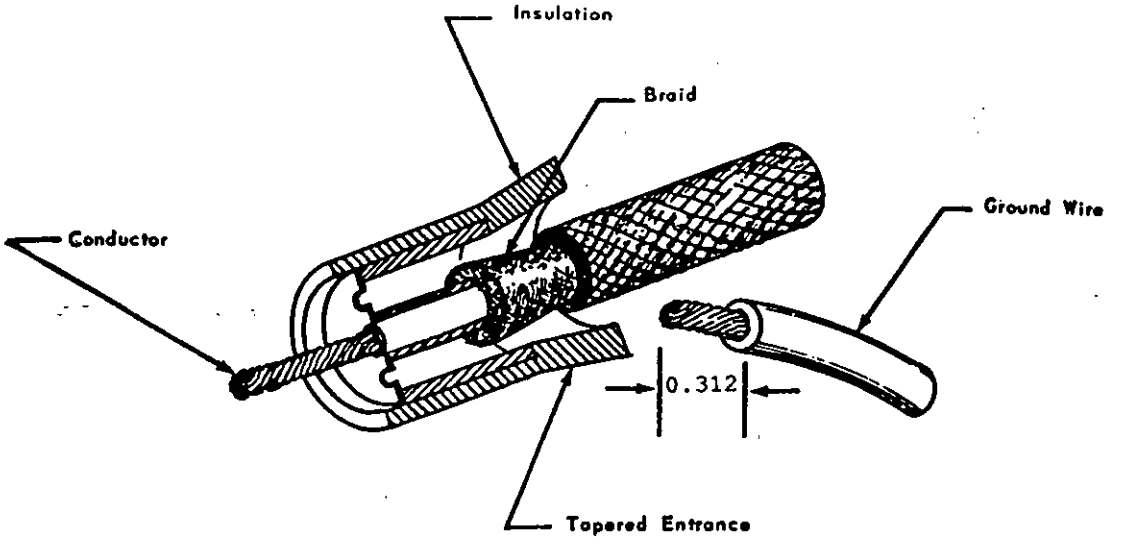


FIGURE 4. Preparation of one-piece ferrule termination.

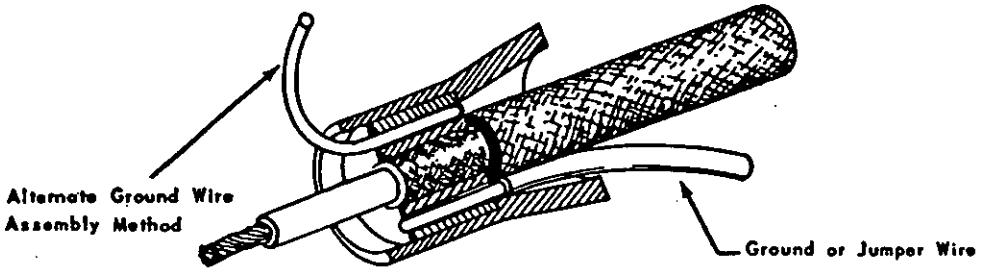


FIGURE 5. Preassembled one-piece ferrule termination.

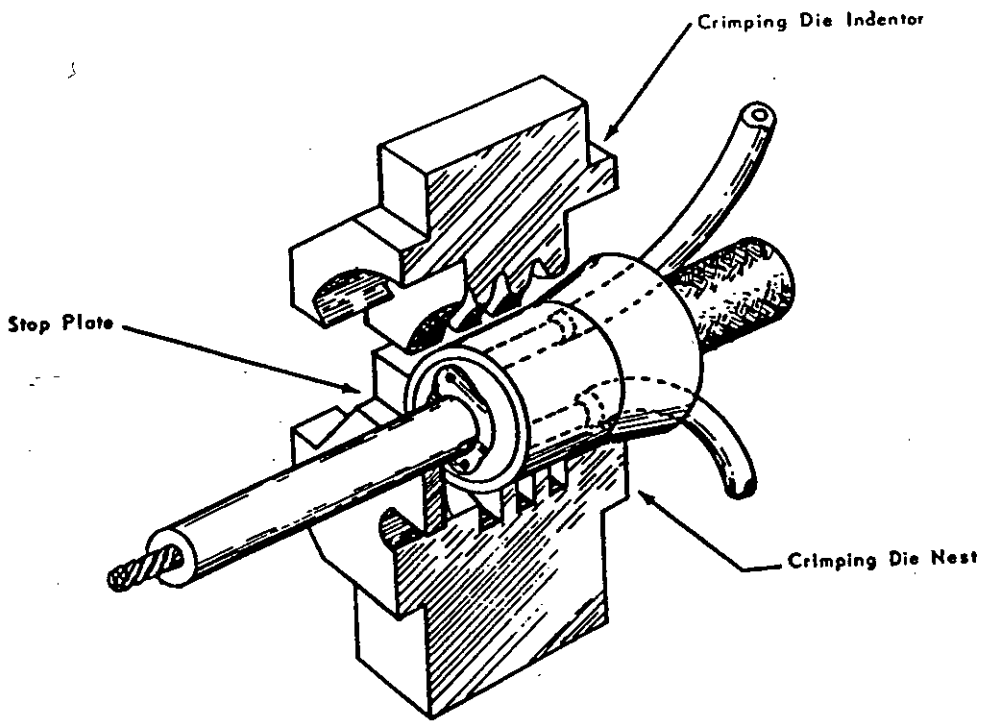


FIGURE 6. Cross section of crimping die with preassembled ferrule in crimping position.

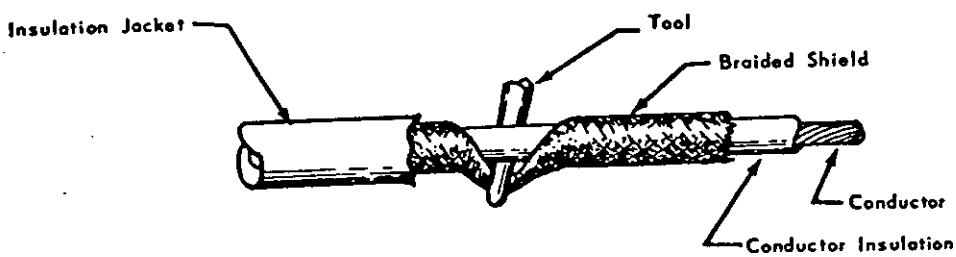


FIGURE 7. Shield separation.

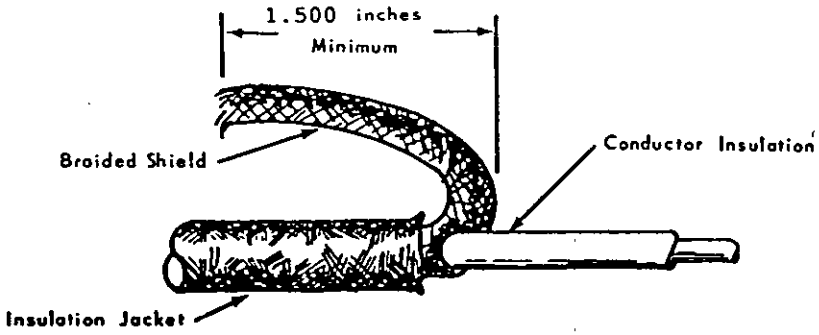


FIGURE 8. Braid preparation.

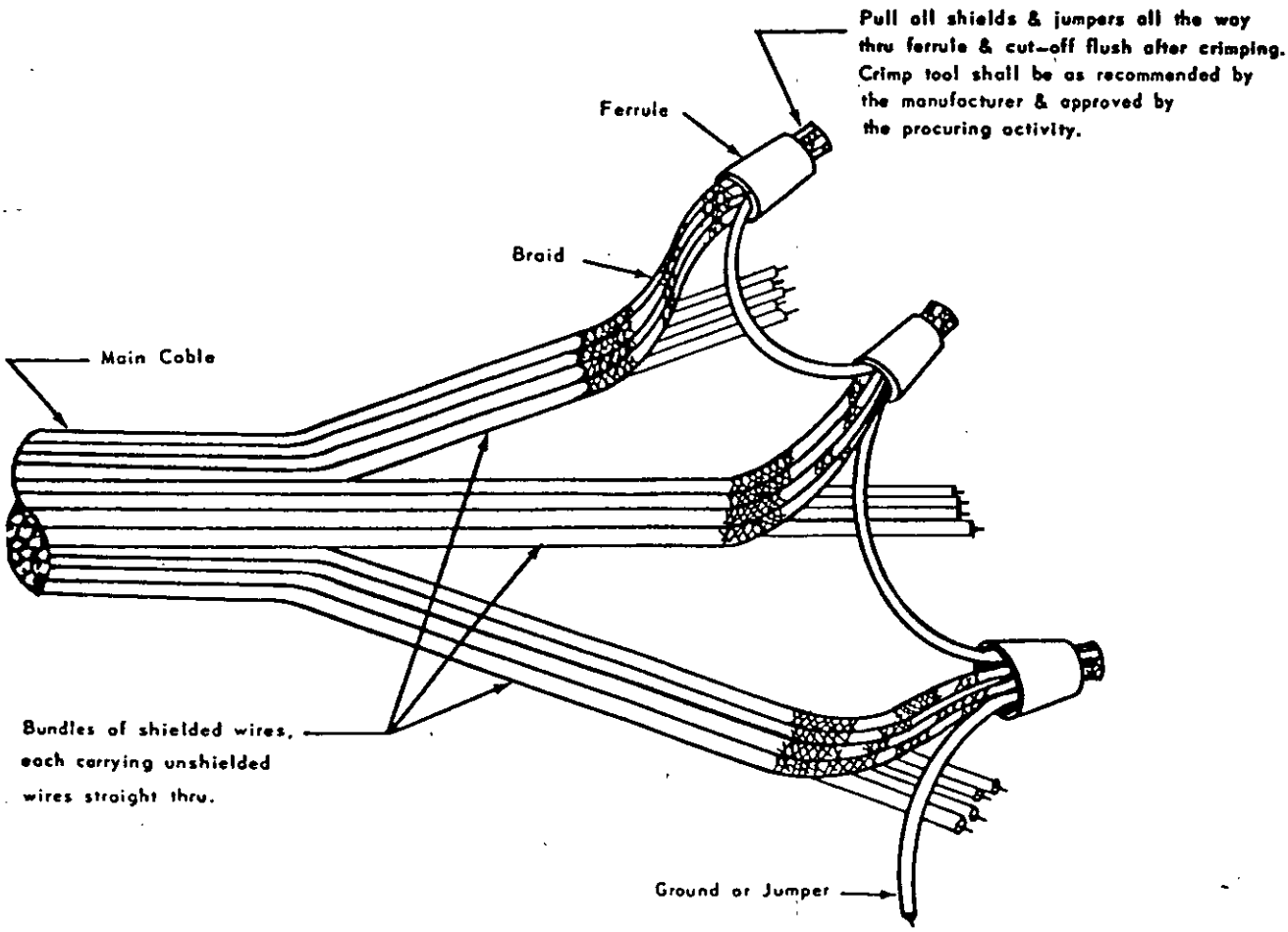


FIGURE 9. Application of ferrules.

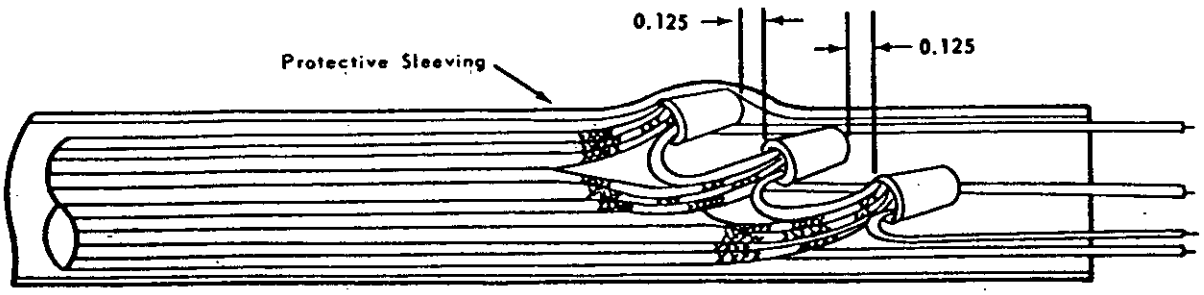
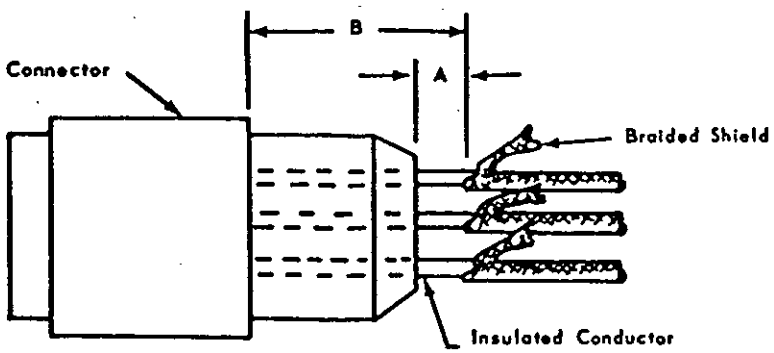


FIGURE 10. Multiple ferrule application.



A - Potted connectors - 0.250 ± 0.125 inch
B - Unpotted connectors - 0.875 to 1.500 inches normal
The B dimension of "E" type environment resisting military standard connectors to shell size 24 shall be two inches and shell size 24 to 36 inclusively shall be 3.500 inches

FIGURE 11. Potted and unpotted applications.

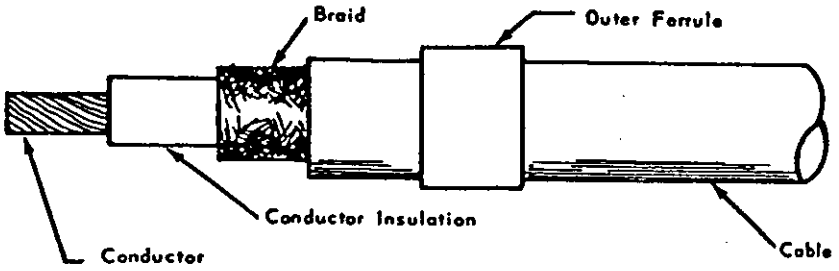


FIGURE 12. Conductor preparation.

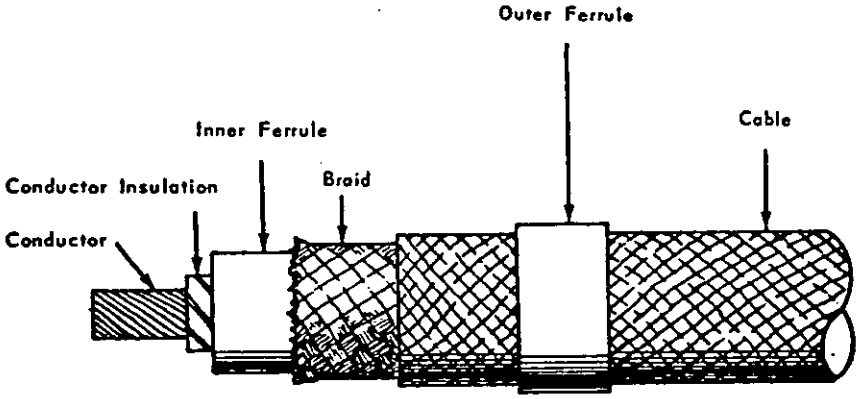


FIGURE 13. Cable preparation for inner ferrule.

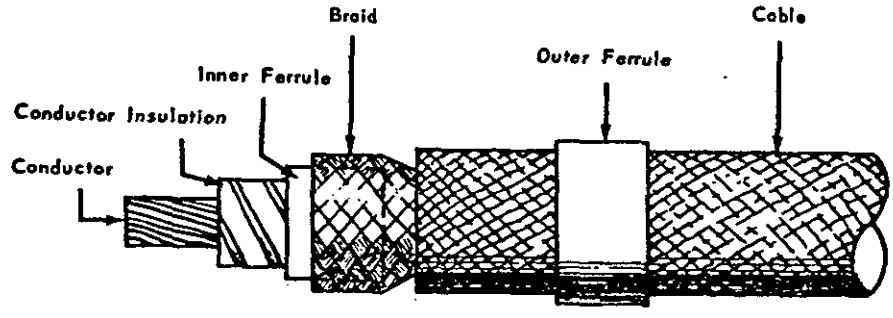


FIGURE 14. Position of inner ferrule.

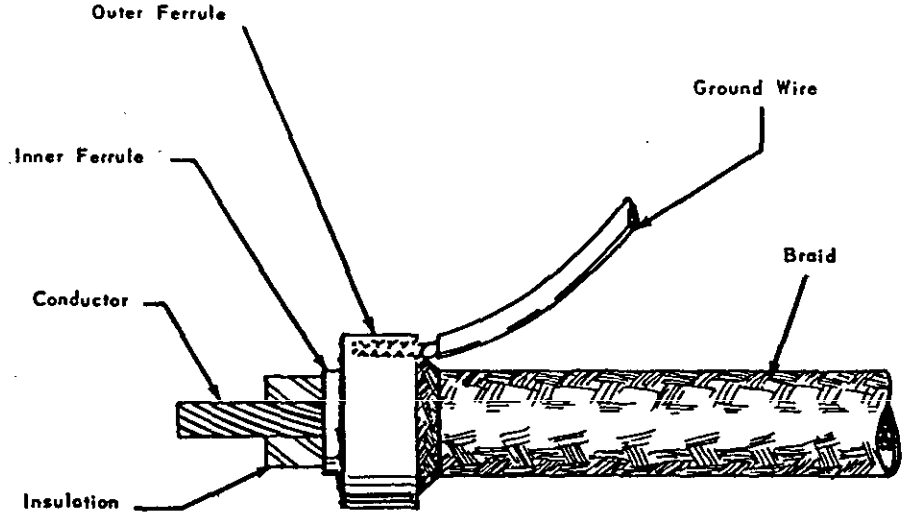


FIGURE 15. Ground wire assembly.

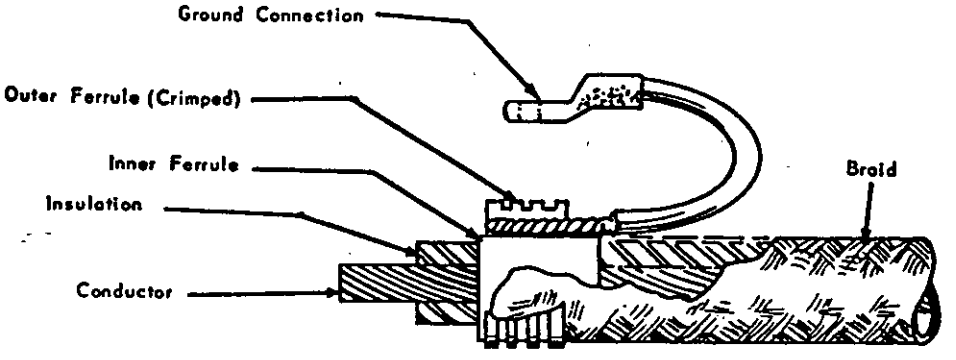


FIGURE 16. Crimped two-piece ferrule, single conductor.

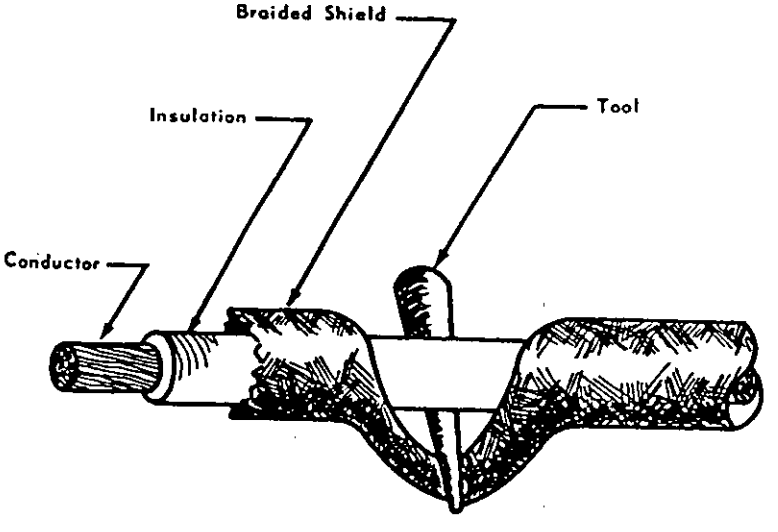


FIGURE 17. Preparation of individually shielded wire.

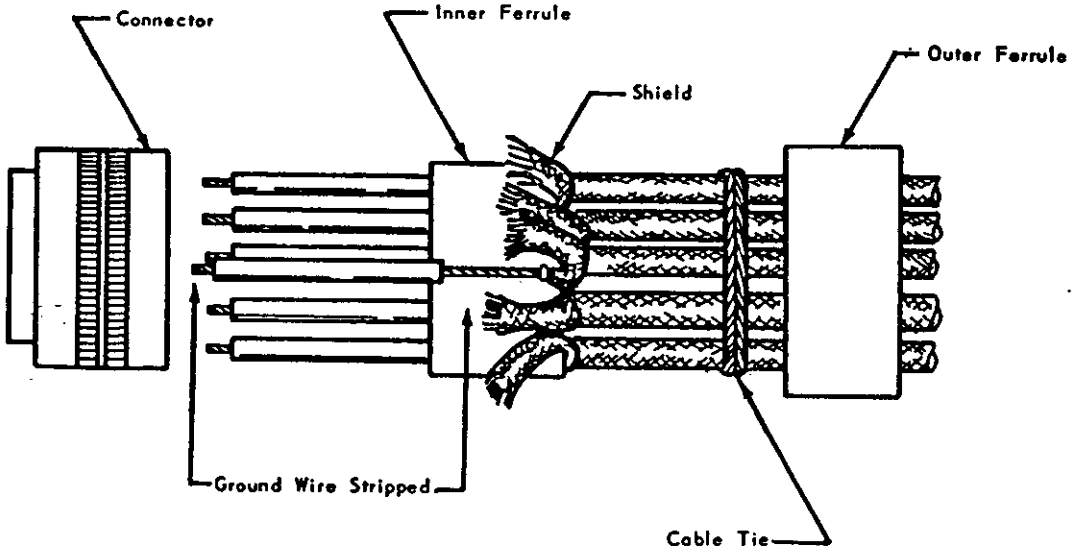


FIGURE 18. Positioning of inner ferrule sleeve.

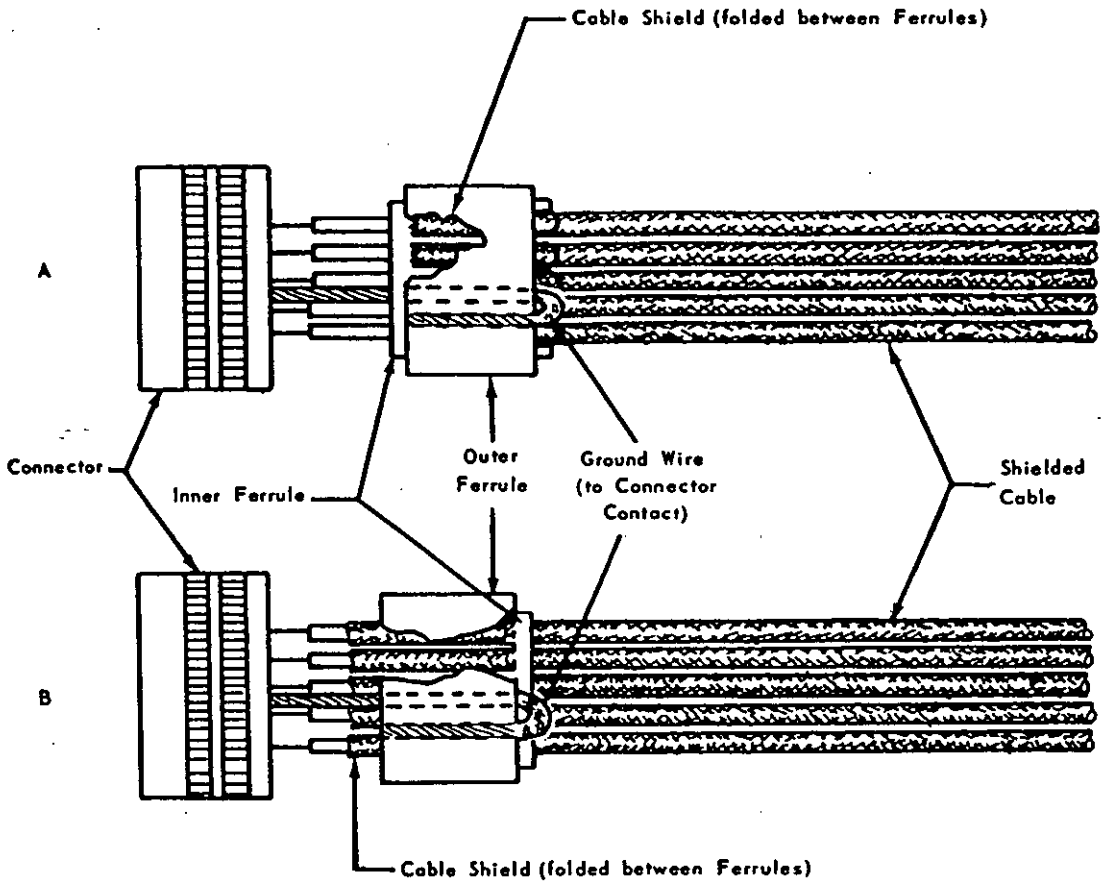


FIGURE 19. Positioning of inner and outer ferrule sleeves.

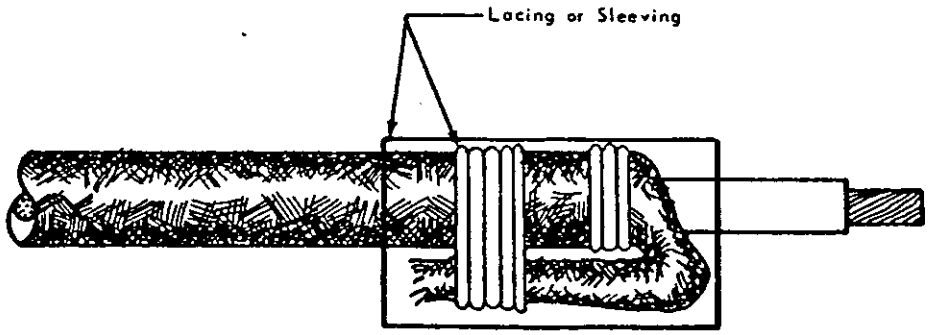


FIGURE 20. Position of insulation sleeving.

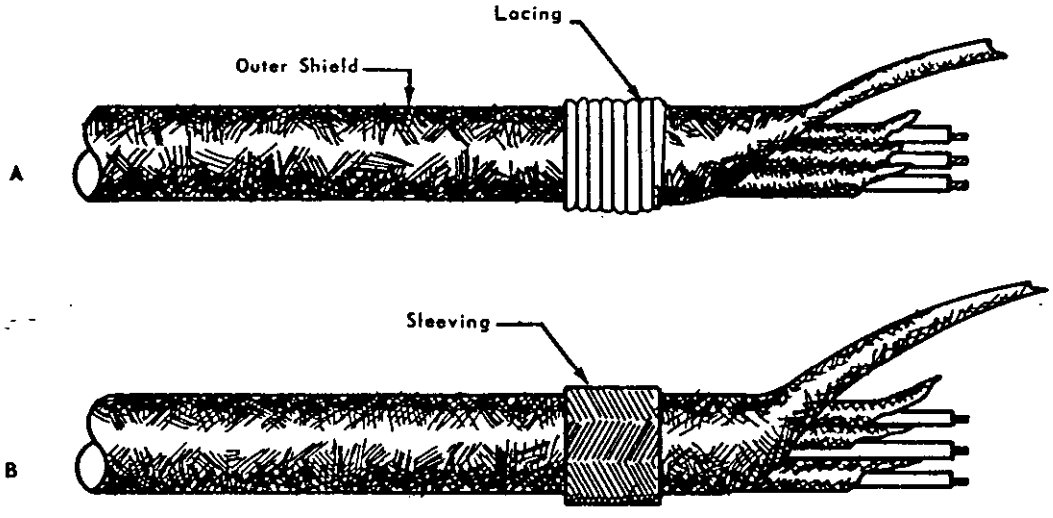


FIGURE 21 Preparation of shielded conductors containing an outer shield.

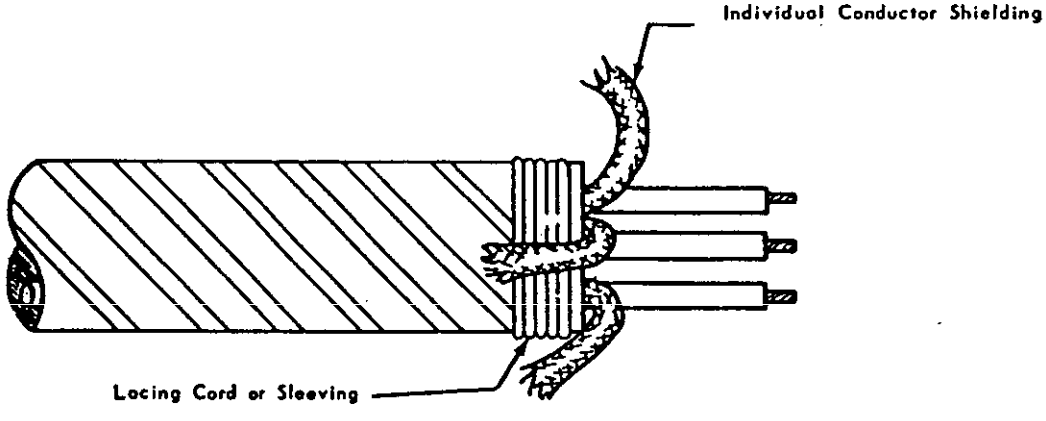


FIGURE 22. Breakout of shields of individual conductors.

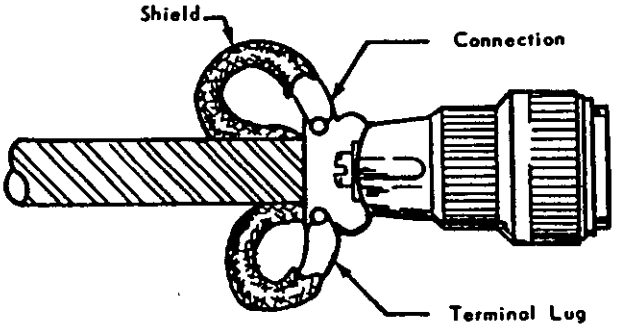
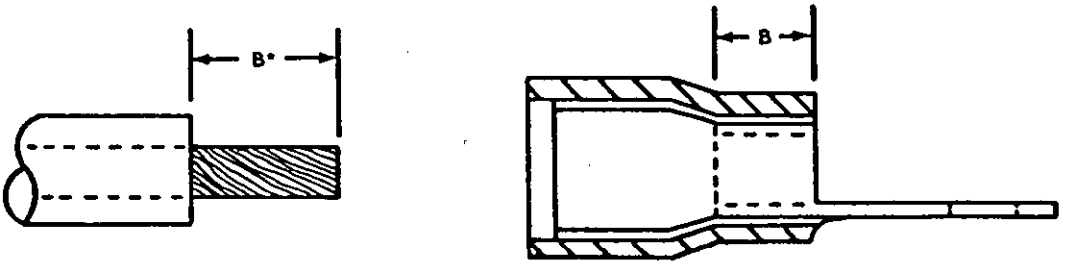
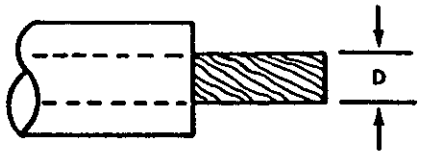


FIGURE 23. Shield connection to cable clamp.



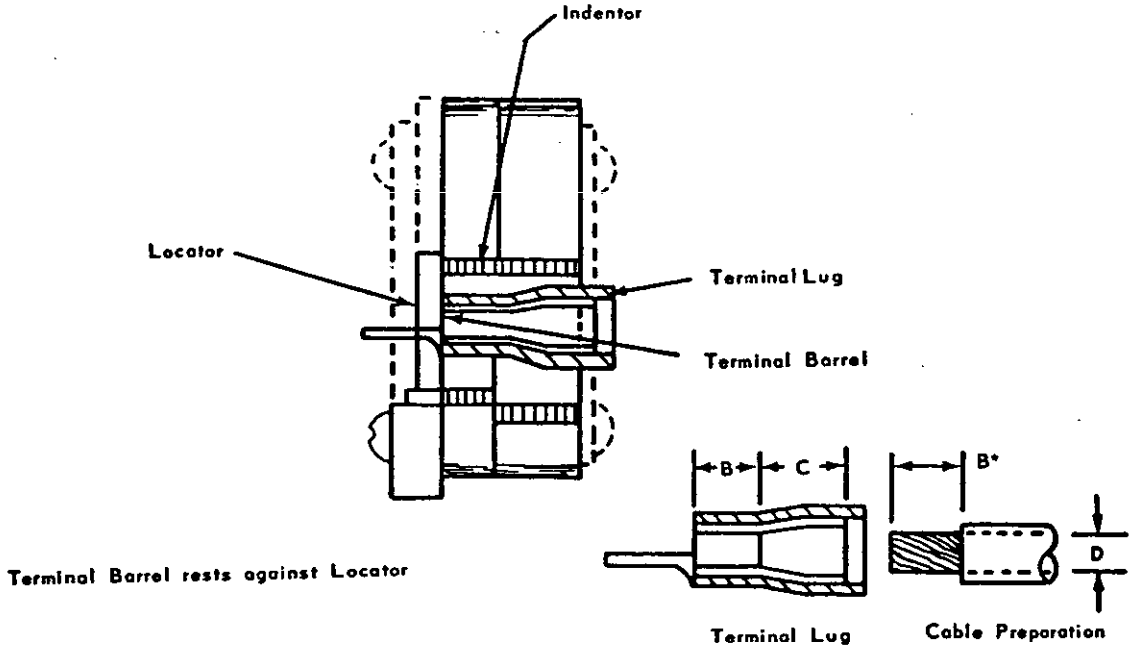
B - Length of terminal lug crimping barrel (inches)
B*- Strip length - not less than 0.0312, or greater than 0.0468

FIGURE 24. Insulation strip length.



D – Diameter of conductor

FIGURE 25. Conductor diameter.



B - Barrel length
C - Insulation grip
D - Diameter of conductor (bare)
B*- Strip length - not less than 0.0312, or greater than 0.0468

FIGURE 26. Preparation of terminal lug termination, typical.

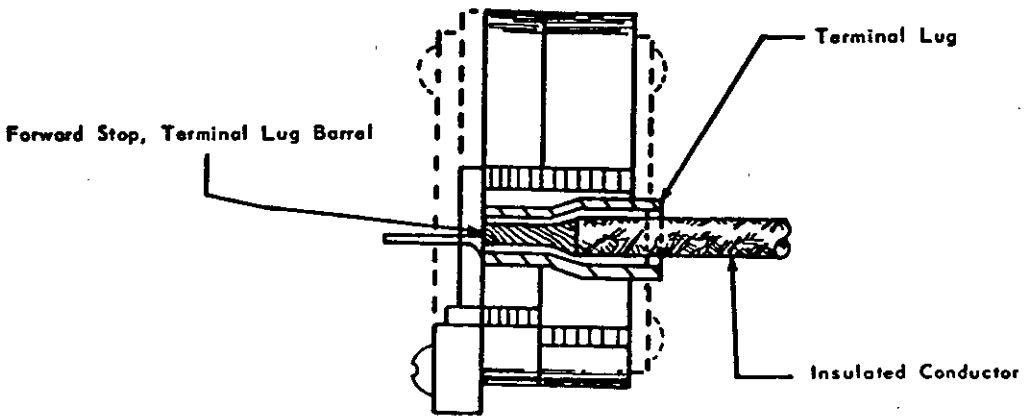
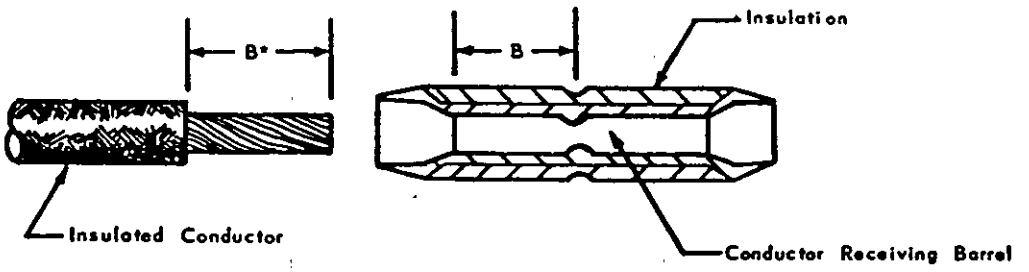


FIGURE 27. Conductor position prior to crimping.



B - Length of conductor receiving barrel
B*- Insulation strip length - not less than 0.0312, or greater than 0.0468

FIGURE 28. Conductor strip length.

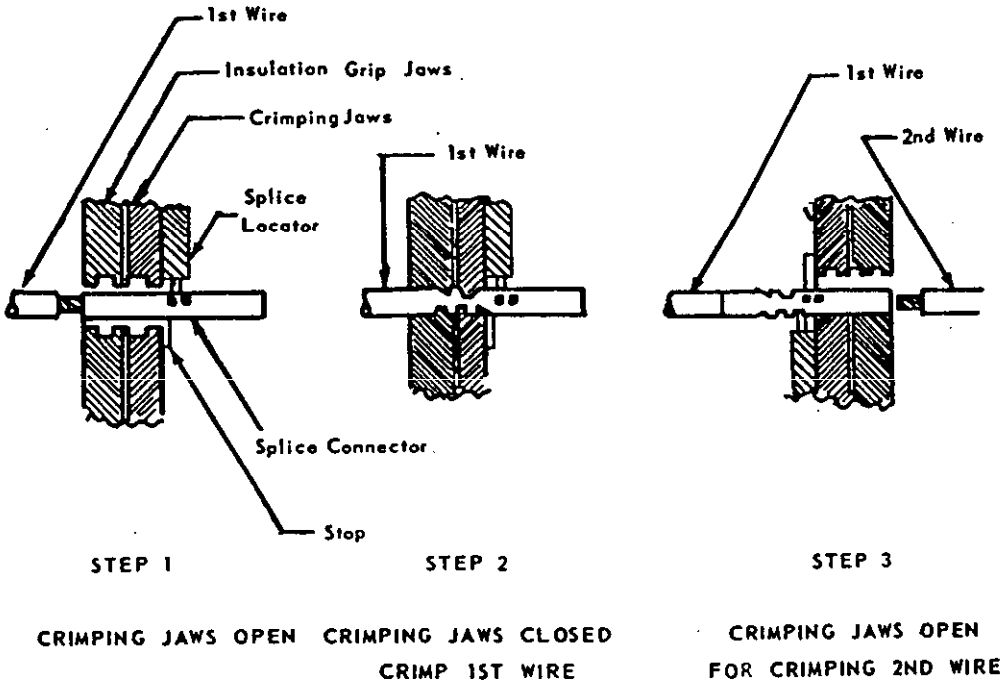


FIGURE 29. Typical splice connector crimping procedure.

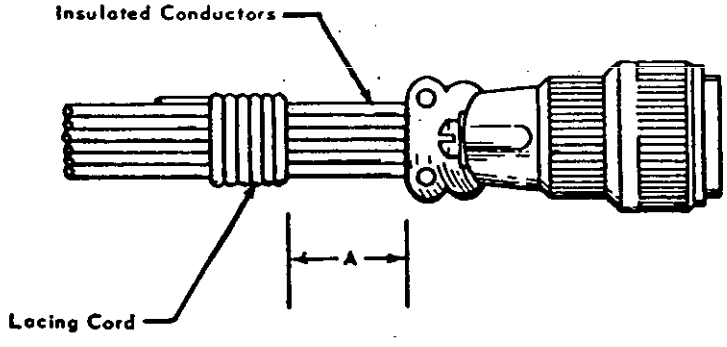


FIGURE 30. Distance between component and terminating section.

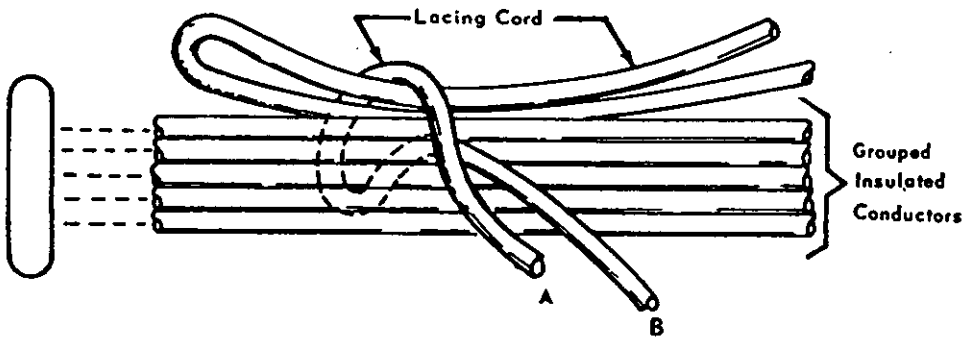


FIGURE 31. Method of beginning starting section.

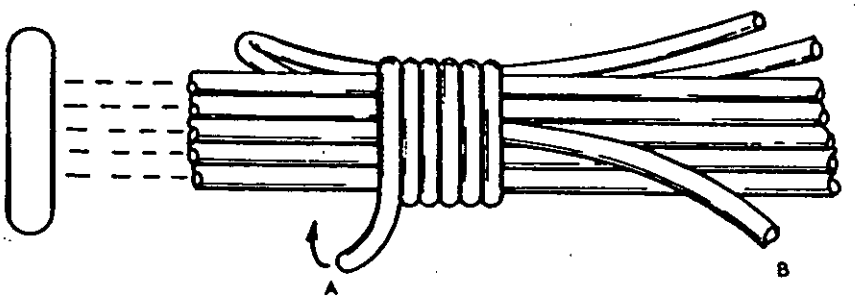


FIGURE 32. Wrapping starting section.

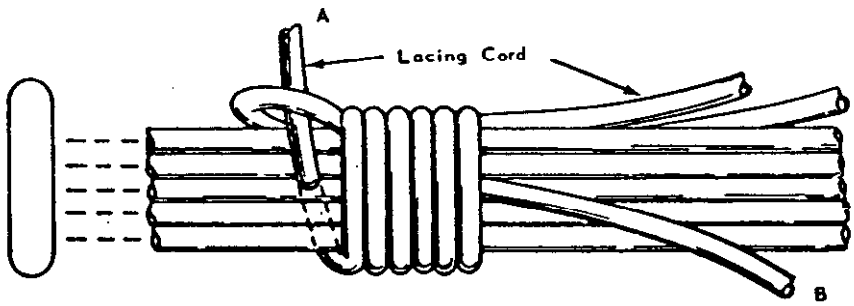


FIGURE 33. Tying starting section.

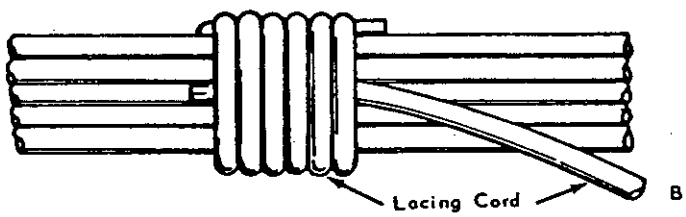


FIGURE 34. Finished starting section.

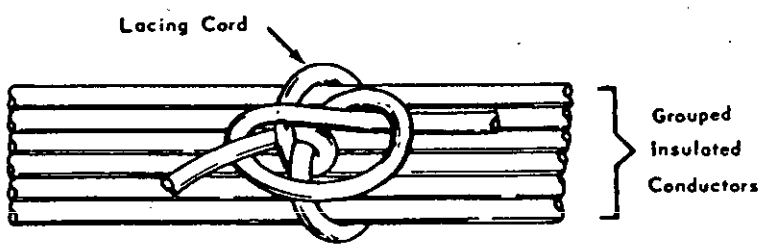


FIGURE 35. Double-lock stitch plus running stitch.

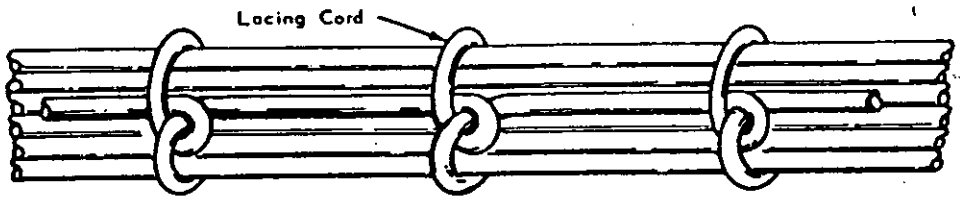


FIGURE 36. Single-lock stitch.

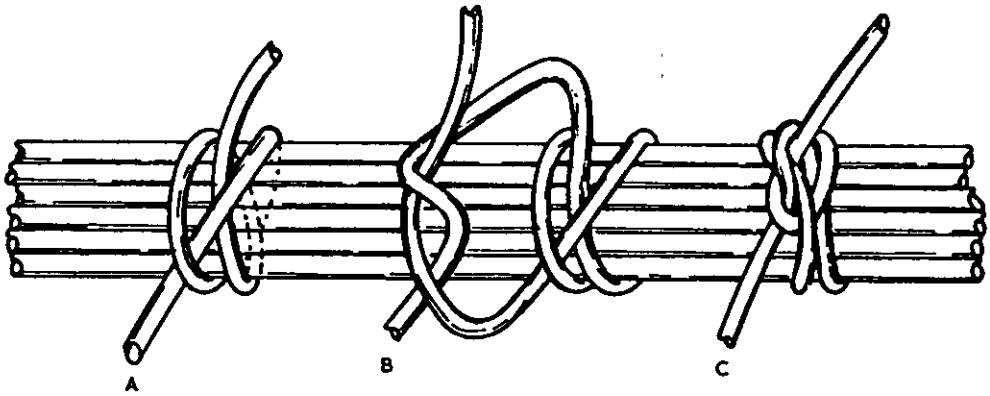


FIGURE 37. Lacing ties.

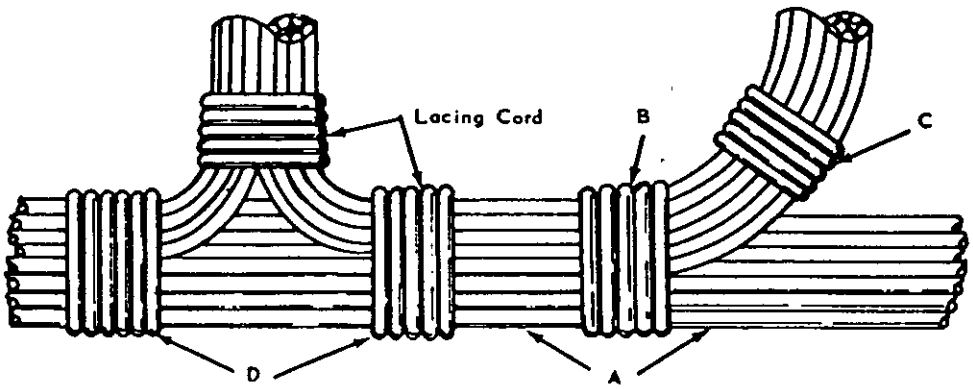
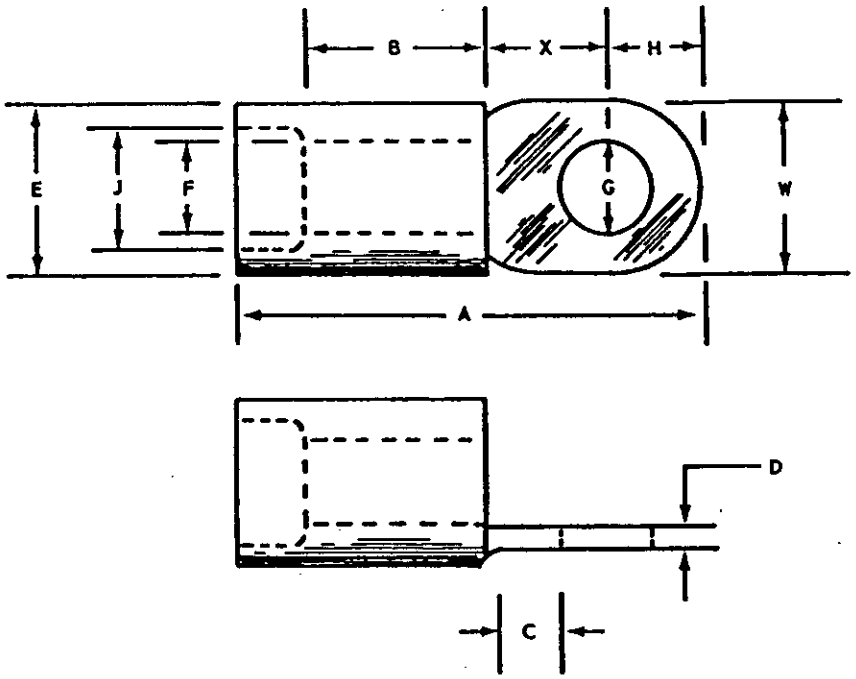
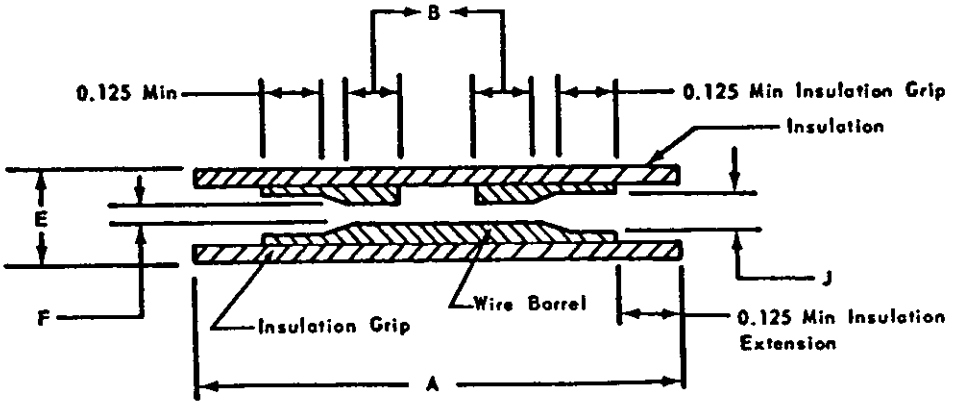


FIGURE 38. Lacing branches or breakouts.



A - Overall length
B - Length of barrel (crimping)
C - Radius tongue flat surface
D - Thickness of tongue
E - Outside diameter of insulation
F - Inside diameter of barrel
G - Diameter of stud hole
H - Radius of terminal lug flat
J - Inside diameter of insulation grip
W - Width of tongue
X - Center of stud hold to insulation on barrel of terminal lug

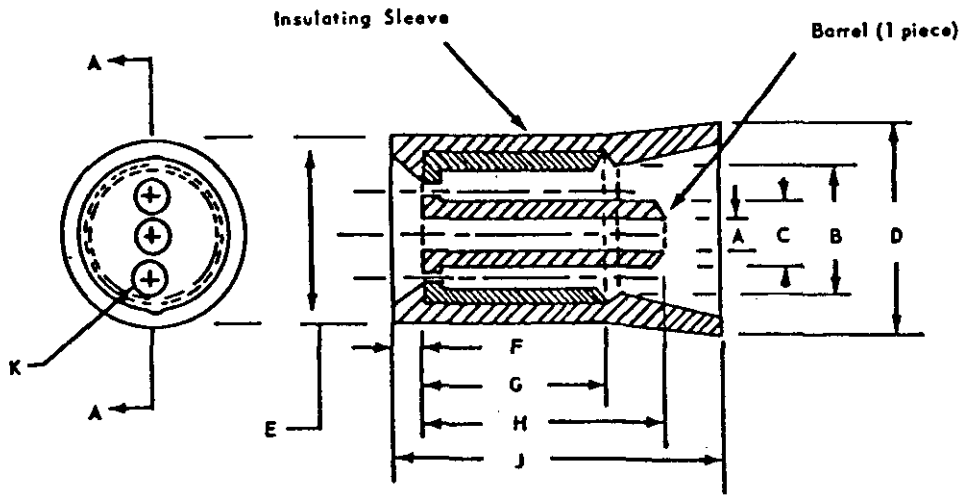
FIGURE 39. Terminal lug dimensions.



A - Overall length of splice connector
B - Length of wire barrel
E - Outside diameter of splice connector (may be exceeded by .060 ± .005 to provide locator)
F - Diameter of wire barrel (determined as average of two diameters measured at right angles)
J - Diameter of insulation barrel
Dimensions in inches

NOTE: This splice is not acceptable for coaxial cabling

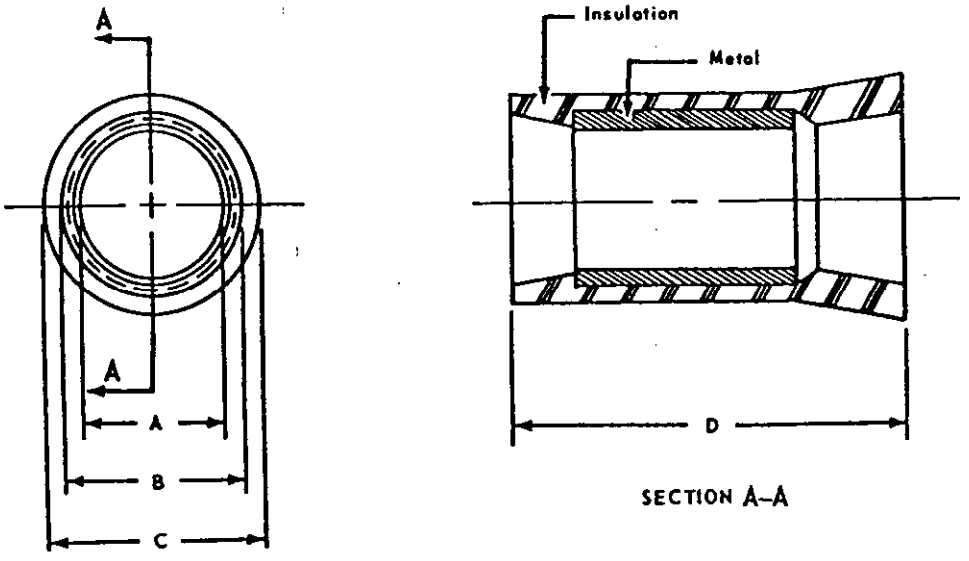
FIGURE 40. Dimension of splice connector.



SECTION AA

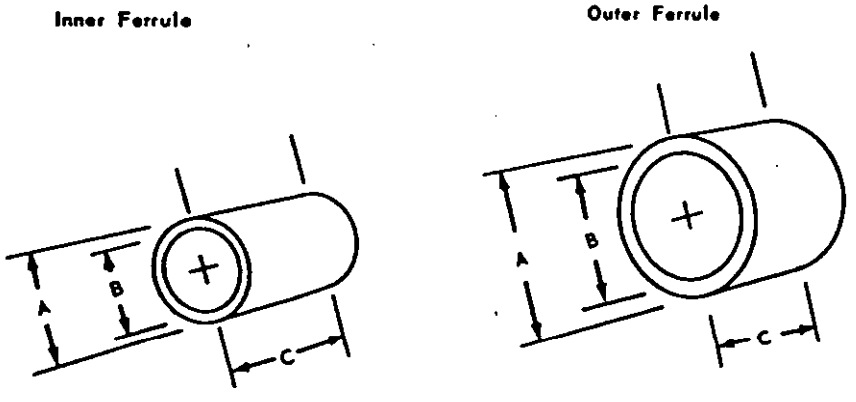
A - Inside diameter barrel (conductor receiver)
B - Inside diameter meter crimping surface
C - Outside diameter conductor receiving barrel
D - Outside diameter insulating sleeve (flared end)
E - Outside diameter insulating sleeve (unflared end)
F - Length of insulation overhang (unflared end)
G - Length metal crimping surface (barrel)
H - Length of conductor receiving barrel
J - Overall length of one-piece ferrule
K - Diameter of inspection hole

FIGURE 41. One-piece ferrule dimensions.



A - Inside diameter barrel (shielding receiver)
B - Inside diameter insulating sleeve
C - Outside diameter insulating sleeve
D - Overall length

FIGURE 42. Shielding ferrule dimensions.



A - Outside diameter
B - Inside diameter
C - Overall length

FIGURE 43. Two-piece ferrule dimensions.

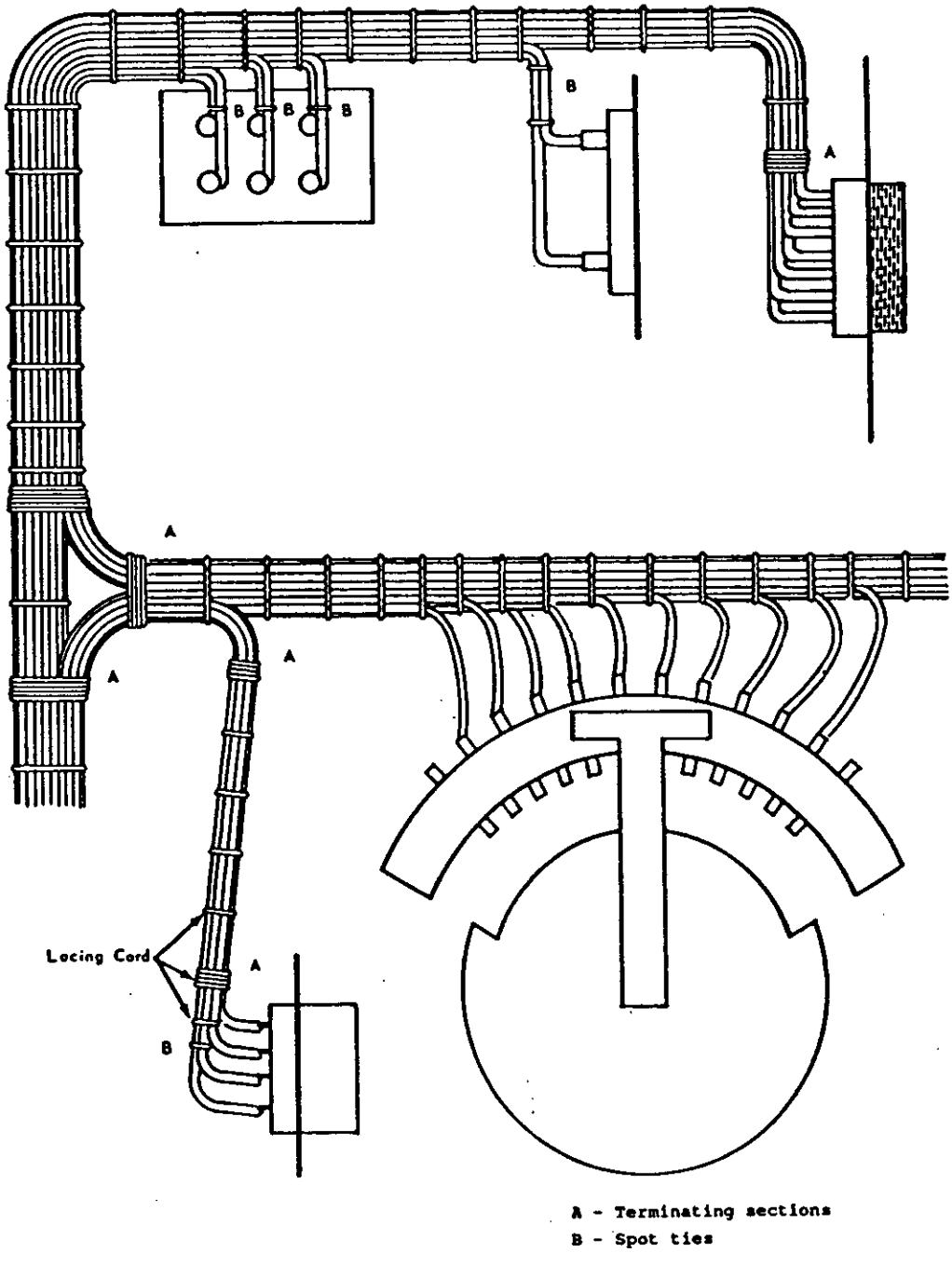
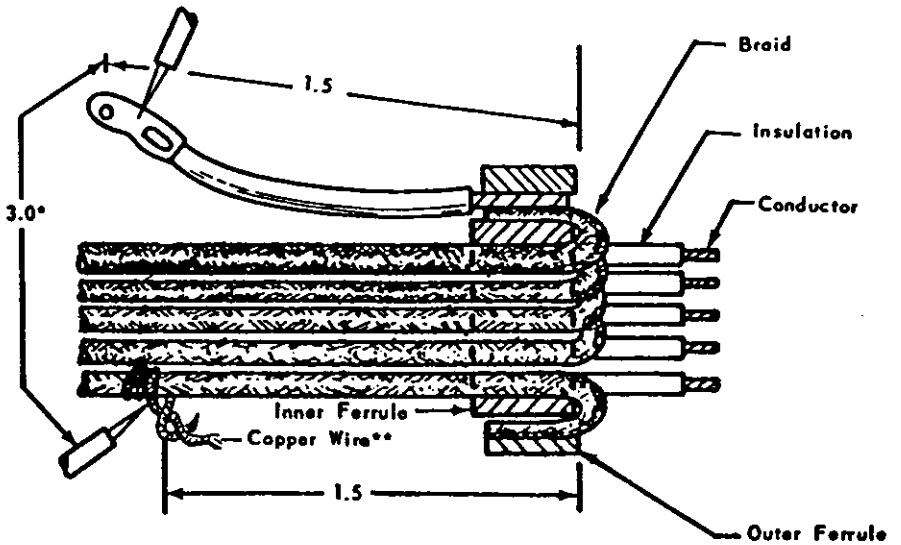


FIGURE 44. Acceptable wiring and routing.



* Probe distance, approximately three inches.
** AN-30 to AN-26 copper wire tightly wound around each conductor braid as shown.

FIGURE 45. Voltage drop test setup.

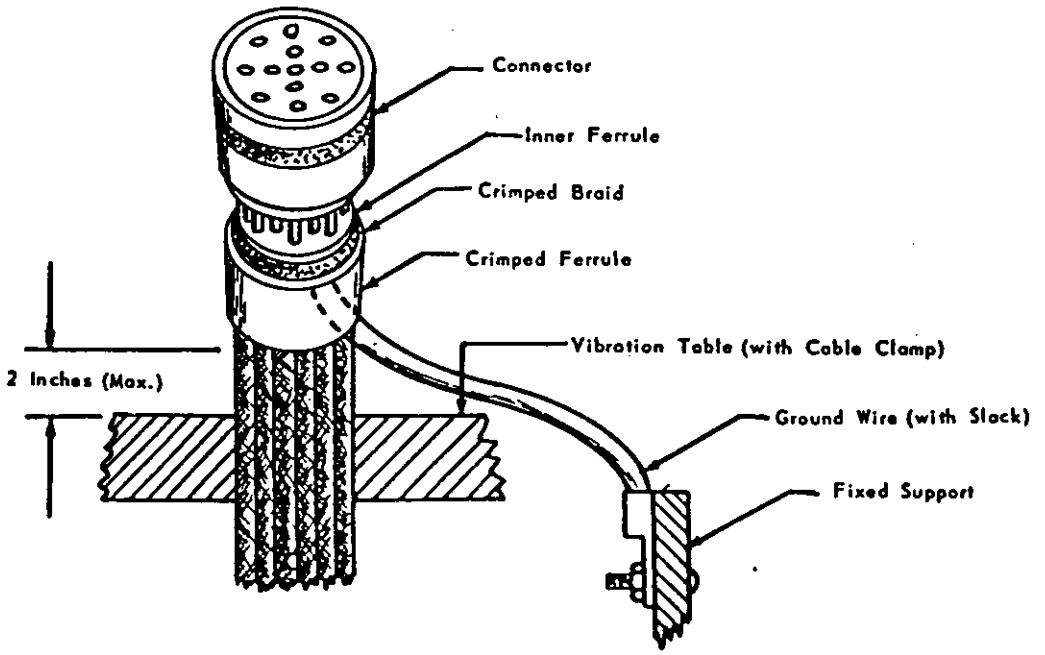


FIGURE 46. Vibration test setup.

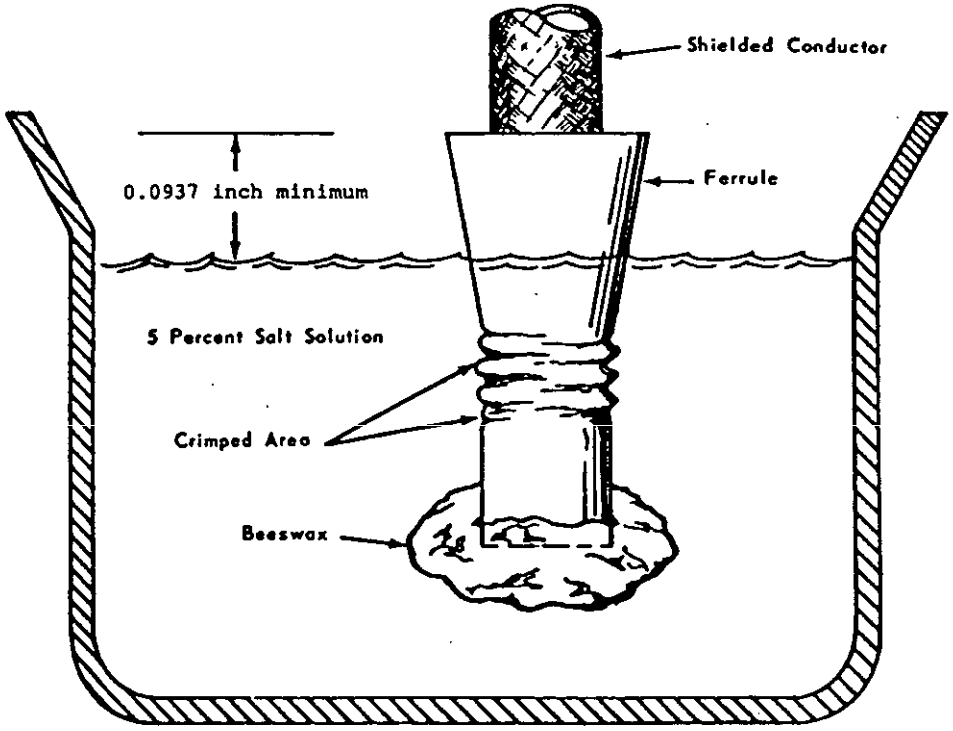


FIGURE 47. Ferrule dielectric test setup.

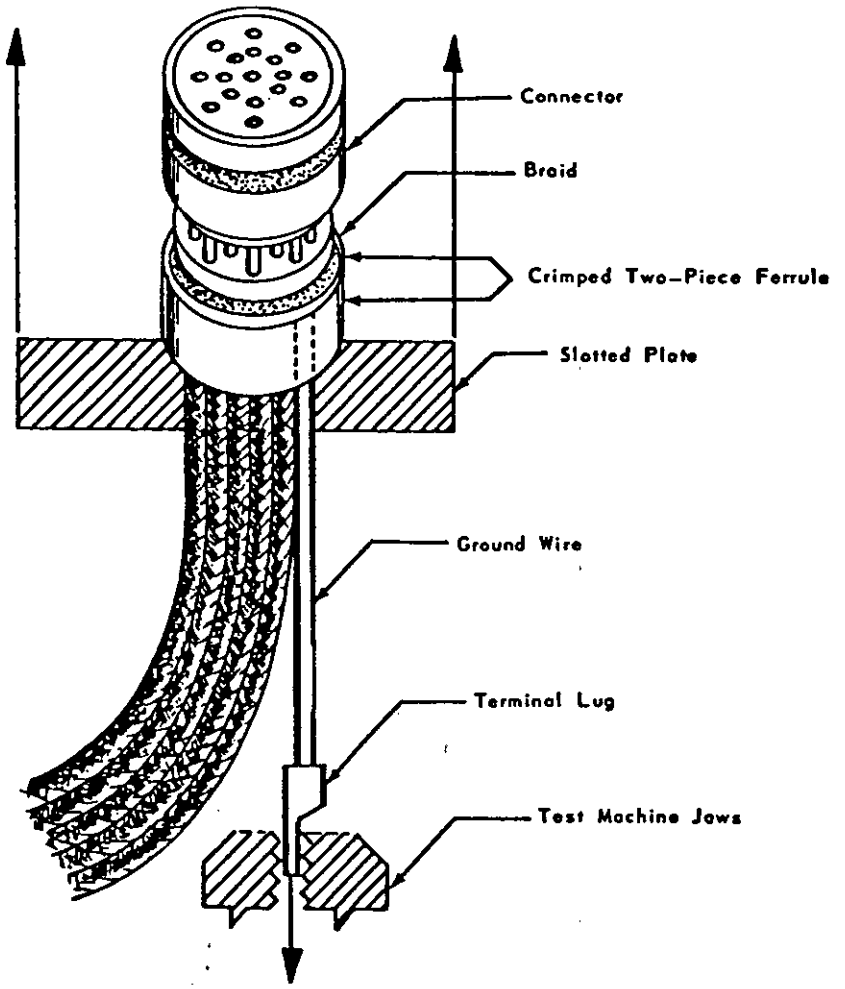


FIGURE 48. Tensile strength test setup two-piece ferrule.

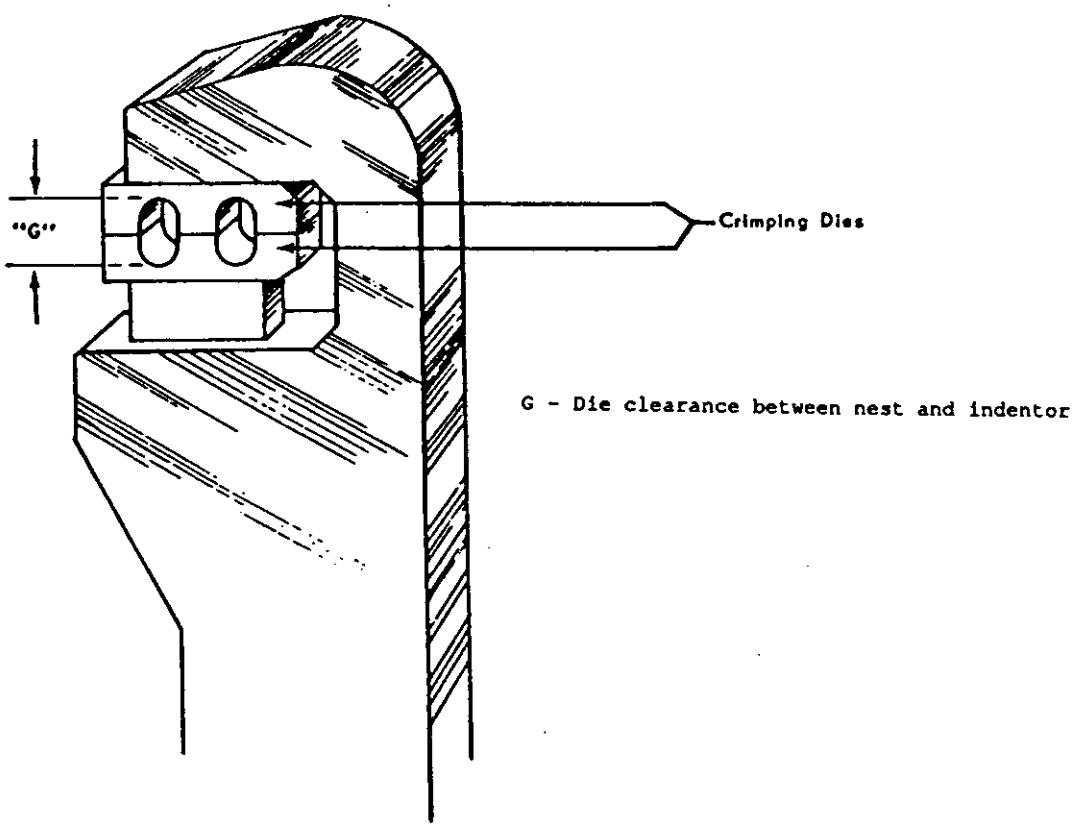


FIGURE 49. Gage dimensions hand tools.

Custodian:
Army - MI
Navy - AS
Air Force - 70

Review Activities:
Army - CR, ER
Navy - [illegible] SH
Air Force - 19, [illegible] 80

User Activities:
Army - AR
Navy - OS, MC

Preparing Activity:
Army - MI

Project No. 1430-A143

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.
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	2. DOCUMENT DATE (YYMMDD)
MIL-E-45782C	930827

3. DOCUMENT TITLE

ELECTRICAL WIRING, PROCEDURES FOR

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

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 (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
COMMANDER U.S. ARMY MISSILE COMMAND	(1) Commercial (205) 876-6980	(2) AUTOVON 746-6980
c. ADDRESS (Include Zip Code) ATTN: AMSMI-RD-SE-TD-ST REDSTONE ARSENAL, AL 35898-5270	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	