

SOLDERED CONNECTIONS  
BASIC CONNECTING INFORMATION

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1. GENERAL

1.1 Scope of Section

1.1.1 This section outlines the preparatory steps to be taken when performing a soldering operation and the associated basic requirements. It also includes a listing, description and the use of associated soldering coppers and tips.

1.1.2 Each figure in this section illustrates conditions to which reference is made in the text, and shall not be considered as covering other requirements that may be involved.

1.1.3 For the general maintenance and repair of soldering coppers, refer to Handbook 28, section 501.

1.2 Precautions Against Personal Injury, Equipment Damage, and Service Interruptions

1.2.1 General precautions to be taken against personal injury, equipment damage, and service interruptions are covered in Handbook 0 and are to be observed as they apply to the operations being performed. Specific precautions, if applicable, are included in this section with the associated method.

1.3 Verification

1.3.1 Items for the verification of equipment installed by the operations covered in this section, are listed in Table A. These items may also be used as a self-check guide when performing the operations covered in this section.

2. INSTALLATION EQUIPMENT

2.1 Tools and Test Sets

R-1138	Adapter, Polarized Plug
R-2738	Bag, General Connecting
R-3353	Bag, Scrap Cable and Wire
R-2563	Bracket, Lamp
R-4265	Cable Ties, Nylon
R-2731	Clamp, MC Relay Soldering
R-1748	Clamp, 3" "C"
R-2733	Copper, Soldering
KS14440-L16	(Old R-3007) Copper, Soldering Lightweight
R-3295	Cord, 3 Conductor Extension
R-3055	Goggles, Plastic Safety
R-2719	Holder, Soldering Copper
R-3400	Holder, Soldering Copper Adapter
R-3873A	Lamp, 15 Watt Fluorescent Hand
R-4226	Lamp, 30 Watt Fluorescent Hand
R-2211	Light, Trouble

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NOTICE

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R-1682	Scissors, 5" Electricians
R-2434	Scissors, 8"
R-3145A	Seat, Rolling Ladder
R-2764	Shield, Face
KS16346-L2	Iron, Miniature Soldering
R-5460	Stool, Three Position
R-3949	Tip, Insulated Soldering Copper (Use With R-2733)
R-2735	Tip, Soldering Copper (Use With R-2733)
R-2793	Tip, Soldering Copper (Use With R-2733)
R-4463	Tip, Soldering Copper (Use With R-2733)
R-4464	Tip, Soldering Copper (Use With R-2733)
R-5169	Soldering Station, Tempera- ture Controlled
R-5169	Detail 1 3/16" Tip (Use With R-5169)
R-5169	Detail 2 1/16" Tip (Use With R-5169)
R-4827	Tool, Cable Tie Fastening
ITE-4442A	Voltmeter
R-2973	Wiping Pad, Tin Plate
R-2851	Wiping Pad, Flameproof Can- vas
KS14440-L35	Tip, Small Chisel
KS14440-L36	Tip, Small Chisel Insulated
KS14440-L37	Tip, Large Chisel
KS14440-L38	Tip, Large Chisel Insulated

## 2.2 Supplies

RM-626122	Canvas, 40" Wide Flameproof
KS20406-L1	Cleaner, Spray
RM-583101	Fiber, Sheet, 1/64" Gray
R-4585	Flux, Type 3 Liquid Rosin
R-2131	Lamp, 75 Watt Rough Service
90320631	Solder, .070" Diameter Rosin Core (Mildly Activated)
RM-728225	Solder, .070" Diameter Rosin Core
R-5091	Solder, .040" Diameter Rosin Core
R-3429	Trichloroethane
R-2916	Twine
SD48-125 thru 127A	Wire and Cable Assign- ment Sheets
RM-628645	No. 48 Twine

## 3. EQUIPMENT PROTECTION AND PREPARATION

### 3.1 Protection

3.1.1 The R-2738 Connecting Bag, as shown in Figure 1, should be used whenever possible to protect the equipment and apparatus below a work location from molten solder, loose wire ends, and clippings. If the flap of the connecting bag cannot be placed directly under the work location to protect the equipment, cut a section of RM-583101 sheet fiber and insert it between two mounting plates, and then overlap it into the connecting bag. This will close any gap between the bag and equipment mounting plates to provide protection.

3.1.2 Where the use of the R-2738 Connecting Bag is not practicable and equipment is mounted below a work location, a section of sheet fiber can be stapled to a protective length of RM-626122 canvas. Then, the sheet fiber can be inserted between two mounting plates directly below the work location. When this type of protection requires moving to other work locations, use care so as not to shake adhering solder and wire clippings into the equipment. When reusing, always be sure the same side of the canvas is placed in toward the equipment.

### 3.2 Preparation

3.2.1 Temporarily remove framework details or stitches which secure cables and forms that may block the connecting and soldering operations.

3.2.2 When it is necessary to modify the local wiring at the rear of four wire terminating units mounted on double sided duct type bays, or to change apparatus on "L" type carrier channel bank panels and similar types on back to back or double sided bays, use the maintenance brackets, available on the job, as covered in drawing ED63343-70.

3.2.3 Support the legs of horizontal forms to be connected to insure that the connected wires will not be moved due to sagging of the leg. Loop twine around the leg to be connected midway between the butt and tip, and tie the free end of the twine to a fixed support such as the main form, framework, etc., so that the skimmers will be in their proper position with respect to the terminals.

## 4. ARRANGEMENT OF TOOLS AND SUPPLIES

### 4.1 General Information

4.1.1 Prior to starting connecting and soldering operations, the tools, supplies, drawings, and other items required should be arranged at the work location so as to minimize fatigue and inconvenience when handling. Any shifting about by the installer in attempting to reach tools, other items, or to obtain information from the drawing may result in moving connected wires, excess fatigue, and unnecessary lost motion.

4.1.2 Where the operations at a work location will continue for an appreciable period, remove tools from the 168 KIT and place them in the compartment of the ladder seat, or in the pocket of the connecting bag (refer to Figure 1).

4.1.3 Where the operations involve frequent changes from one work location to another, the 168 KIT should be secured to the belt at the front by means of the flap, thereby, making the tools readily accessible.

4.1.4 The pointed ends of tools, such as screwdrivers and spudgers, or other pointed objects, should be placed in the 168 KIT Case or in the pocket of the connecting bag with the point toward the bottom of the

case or pocket, respectively, to avoid injury to the hands.

4.1.5 Whenever soldering coppers and lamps are left unattended, they shall be disconnected so they will not overheat and become a fire hazard. When disconnecting cords or leads from an outlet located above the floor, grasp the cord or lead at the plug to prevent it from striking personnel or equipment. Store the disconnected cords, leads, or extensions, if they are not returned to the storeroom, in such a manner as to prevent their becoming a tripping hazard.

#### 4.2 Location of Soldering Coppers and Lamps

4.2.1 Locate the soldering copper holder so that it is not in contact with the wiring, or other equipment parts, and so that it will have proper air circulation in and around the cage to prevent its overheating.

4.2.2 Soldering copper holders, wherever practicable, should be fastened to their support at the angle most convenient for withdrawing the copper from and returning it to the holder. Shifting the position of the body when resting the copper increases fatigue and the risk of personal injury when working above the floor, such as from ladder seats, step ladders, etc.

4.2.2.1 Rolling Ladders: Attach the R-2719 Holder to rolling ladder steps by means of the spring clamp attached to its base. Where it is necessary to fasten the holder at an angle to avoid shifting the position of the body, use the method specified in the following paragraph for clamping the holder to other supports.

4.2.2.2 Step Ladders, Etc.: When soldering from positions other than rolling ladder steps, such as from step ladders, scaffolds, etc., attach the R-2719 Holder by means of the spring clamp to a block of wood of the width and thickness of a rolling ladder step (5-3/4" X 7/8") and of sufficient length (approximately 7") to permit the assembly to be clamped to the support at the desired angle with a R-1748 "C" Clamp.

<p><b>CAUTION:</b> USE EXTRA CARE TO CLAMP THE ASSEMBLY SECURELY TO THE SUPPORT TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE THAT MAY BE CAUSED BY IT FALLING.</p>
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4.2.3 Place the R-2733 soldering copper in the R-2719 Holder so that the flare of the handle is between the guard and the cage, as shown in Figure 2, to prevent the copper from sliding out of the holder. This procedure will decrease the risk of personal injury and fire. When the R-2733 Copper is equipped with a 4" tip the flare of the handle cannot be placed between the guard and cage. Extra care should be exercised in placing the

holder and copper at the work location to prevent the copper from being accidentally pulled from the holder.

4.2.4 When using the KS14440-L16 or other smaller size soldering coppers, the R-3400 Adapter shall be mounted on the R-2719 Holder. This adapter can be secured to the holder in any position between the guard and the cage with the metal clip used for holding the wiping pad in place. The adapter functions in the same manner as the fixed guard. For the KS14440-L16 Soldering Copper, the adapter should be positioned approximately midway between the fixed guard and cage. For other size coppers, the adapter should be positioned as required in relation to the cage. The flare of the soldering copper handle should be placed between the adapter and cage to prevent the copper from sliding out of the holder.

4.2.5 Attach the R-2563 Lamp Bracket or either the R-3873A or the R-4226 Fluorescent Hand Lamps at a proper position above the work location for proper lighting of the work area. Secure the cords in a position TO ELIMINATE POSSIBLE SERVICE INTERRUPTIONS.

**PRECAUTION:** WHEN USING THE R-3873A OR R-4226 FLUORESCENT HAND LAMPS IN THE VICINITY OF ESS PROCESSORS, THE LAMPS SHOULD BE OUTSIDE THE PROCESSOR FRAME AREA WHILE BEING CONNECTED OR DISCONNECTED. THE CORD SHOULD BE PLUGGED INTO A RECEPTACLE OUTSIDE OF THE PROCESSOR FRAME AREA. THIS IS TO PREVENT POSSIBLE VOLTAGE SPIKES FROM CAUSING INTERFERENCE IN THE PROCESSOR.

#### 4.3 Supporting Soldering Copper and Lamp Cords

4.3.1 Support soldering copper cords, lamp leads, and extensions to eliminate the possibility of the soldering copper pulling out of the holder, or the lamp lead becoming disengaged from the bracket. Use nylon cable ties or a double strand of twine made as a starting stitch and ended with a square knot to tie soldering copper cords, lamp leads, and extensions to the ladder rails or framework. Allow only enough slack to permit the free use of the copper and for the shifting of the lamp as the work progresses. Any excess weight between the point of support of the cord and the soldering copper increases the fatigue incidental to the soldering operations.

**CAUTION:** DO NOT SUPPORT THE FLUORESCENT HAND LAMPS BY ONLY ONE HANGER OR PERMIT THE BALLAST TO BE UNSUPPORTED. TO DO SO ADDS EXCESS WEIGHT TO A HANGER WHICH CAUSES ITS DISTORTION AND EVENTUAL FAILURE. POSSIBLE INJURY OR EQUIPMENT DAMAGE COULD OCCUR.

4.3.2 Store cords, leads or extensions between the supporting tie and outlet to prevent them from becoming a tripping hazard. Use a double strand of twine, made as a starting stitch and ended with a square knot, or ties as required.

4.3.3 If the hangers on the R-3873A or R-4226 Fluorescent Hand Lamps are broken or distorted, do not use the lamps. Return them to the Installation Material Distribution and Repair Center (IMDARC).

#### 4.4 Shipping Bags (Scrap Wire)

4.4.1 R-3353 Shipping Bags are provided for accumulating, storing, packing and shipping scrap such as switchboard wire, distributing frame wire, switchboard cable, rubber covered power wire and other reclaimable scrap wire.

4.4.2 The bags shall be placed in the terminal room convenient to the cabling and connecting operations, so that the contents of connecting bags can be frequently emptied into them.

4.4.3 The filled bags shall be closed by threading No. 48 Twine or scrap jumper wire through the holes in the top of the bags and storing them in the basement or other storage space specified by the Telephone Company prior to shipment to the distributing house.

### 5. SOLDERING COPPERS AND TIPS

#### 5.1 General Information

5.1.1 The following sub-paragraphs provide a brief description of the available soldering coppers and their associated tips. However, to eliminate possible personal injury or service interruption, each soldering copper should be tested for electrical leaks prior to use on Central Office equipment.

5.1.2 Soldering coppers having electrical leaks in excess of 1 megohm are an accident hazard and may cause personal injury or damage to certain apparatus. Leaks are caused by breakdown of the insulation between

the element and casing of the heating unit. Leaks may not be disclosed by tests made before the copper is heated.

5.1.2.1 Make frequent tests for leaks between the element and shell of the copper.

5.1.2.2 Tests should be made with the copper plugged into an AC service outlet and after the copper is thoroughly heated.

5.1.3 ITE-4442 Voltmeter: Make the test connections as shown in Figure 3. Use the 300V AC range and test for leaks on each side of the line. (TMO-4442 which describes the operation of ITE-4442 is included in Handbook 100.) Coppers shall not be used when readings are in excess of 55 volts.

5.1.4 Tag any defective soldering copper having excessive electrical leaks and return it to the Installation Material Distribution and Repair Center (IMDARC).

#### 5.2 R-2733 Soldering Copper

5.2.1 The R-2733 Soldering (Iron) Copper is equipped with a 110 watt heater assembly and a 20' two wire cord. This soldering iron should be used for general purpose soldering where constant use is a requirement. This iron, when ordered from IMDARC, is furnished with an R-2793 Tip, however, other tips are available.

#### 5.2.2 Soldering Tips

5.2.2.1 The R-3949 is an aluminum oxide coated "chisel type" tip with an iron clad undercoating. This tip is 2-3/8" long and can be used on live equipment.

5.2.2.2 The R-4463 is a one piece "banjo wire" tip. This tip is 7/32" in diameter and 2-3/8" long with a 90° bend at the tip end.

5.2.2.3 The R-4464 is a straight one piece "banjo wire" tip. This tip is 7/32" in diameter and 2-5/8" long.

5.2.2.4 The R-2793 has a sharp calorized "chisel type" tip that is approximately 2-3/8" long.

5.2.2.5 The R-2735 is a calorized copper "chisel type" tip that is approximately 4" long.

#### 5.3 KS14440-L16 Soldering Copper

5.3.1 The KS14440-L16 Soldering (Iron) Copper is equipped with a 45 watt heater (fast heating) assembly and a 20' two wire cord. This iron should be used where quick service, short term use is required. A tip must be ordered separately from the following details to equip or replace parts of this iron:

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	<u>Description</u>	<u>Order Number</u>
List 35	Small Chisel Tip 1/8"	23144435
List 36	Small Insulated Chisel Tip 1/8"	23144436
List 37	Large Chisel Tip 3/16"	23144437
List 38	Large Insulated Chisel Tip 3/16"	23144438

**5.4 R-5169 Soldering Station**

5.4.1 The R-5169 Soldering Station is temperature controlled. It is used for bench type printed wiring board modifications only. It is a 3 wire unit designed to prevent voltage spikes of transients from being transmitted to the circuit. This station should not be used when working on live circuits. The detail 2 tip is furnished with the soldering station. An additional tip is available.

**5.4.2 Soldering Tips**

- R-5169 Detail 1 3/16" tip
- R-5169 Detail 2 1/16" tip

**5.5 KS16346-L2 Soldering Iron**

5.5.1 The KS16346-L2 Soldering Iron is a miniature 6 volt iron. It is equipped with a 19' long 2 wire cord connected to a KS16368 transformer for use on a 120 volt power supply. It is 10" overall in length. The heating unit and tip are 1/8" dia. X 4-1/2" long for use in close spaces.

**6. SOLDERED CONNECTIONS**

**6.1 Fundamentals**

6.1.1 Soldering is the process of fusing three metals (wire, terminal, and solder) together and is brought about by the application of molten solder in the presence of flux. This bond is accomplished by raising the temperature of the wire and terminal to the melting point of solder. The rosin flux in the solder minimizes oxidation during heating by excluding air. Most of the wires and terminals to be soldered have been pretinned to permit the soldering action to take place at temperature permissible for soldering coppers (irons) used on telephone apparatus. Before soldering, the terminals and wires must be free of enamels, grease, dirt, and oxides.

**6.2 Preparatory Operations**

6.2.1 Check to make sure that the soldering surfaces of the terminals are clean and properly tinned. Untinned surfaces or surfaces not completely tinned should be tinned before the wires are connected.

6.2.2 Spread closely spaced flexible terminals, such as on flat Y and U type relays and 224 type terminal strips, before the wires are connected to facilitate connecting, and so that the clearance requirement (1/64" between the solder of adjacent connections) will be met after the connection has been soldered. Engage pliers near the pile-up using care to avoid damaging fiber strips that may protrude from the pile-up.

6.2.3 When sleeving is required for the protection of skinners and apparatus terminals as covered in Section 360 of this handbook, place sleeving before connecting wires to terminals.

6.2.4 Test common leads of additional wiring such as battery feeders, tone leads, etc., to assure that they are free from circuit trouble before connecting to live circuits. Provide temporary battery feeders, tone leads, etc., for this test.

**6.3 Position of Wire on Terminal**

6.3.1 Connect wires so that the bare portion will have as large a contact surface as practicable with soldering surface of the terminal and rest firmly against it throughout, as shown in Figure 4.

6.3.2 Connect wires to apparatus terminals in such a manner as to provide the best maintenance conditions, usually with a clockwise wrap on the terminal and for top or right-hand soldering for the maintenance man, except where it is necessary to double up on terminals where the shop has soldered "left" or "bottom". In such cases, connect the wires to conform with those connected by the shop.

6.3.2.1 On shop wired equipment, particularly at switches and multicontact relays of crossbar frames, there may be few cases of "left" and "bottom" soldering due to shop soldering "right" and "top" with the frame laid on its side. Such connections are limited to as few cases as possible.

6.3.2.2 Clockwise wrapping and top or right-hand soldering may be disregarded on bench wired subassemblies where such subassemblies are relocated in main assemblies, and on self-contained equipment units, such as box type test sets or "plug in" units like L1 carrier amplifiers, which are removed from the frame for maintenance.

6.3.2.3 Non-standard equipment will occasionally have connections soldered on the left or bottom sides of the terminals. If this equipment is being modified, conform to the existing solder pattern. However, if new apparatus is being added onto these equipment units, the connections should be soldered in the normal position, i.e., either the top or right sides of the

terminals.

6.3.3 Wires should not be pulled taut around terminals to which they are not connected. This is necessary to prevent insulation breakdowns.

#### 6.4 Position of Insulation

6.4.1 The insulation of wires connected to terminals (except rubber, neoprene and plastic insulated wires) should extend close to the point of soldering, but should be excluded, as far as practicable, from the holes of perforated and tubular terminals, the notches of notched terminals, and from underneath the screw head of screw type terminals. In no case should any of the insulation extend completely through the hole of the terminal, around the notch of a notched terminal, or on the soldered side of a wrapped connection, so as to prevent a good soldered connection.

6.4.2 Connect wires so that the length of the bare portion ("shiner") between the point of connection to the terminal and the end of the insulation is not greater than the clearance between the adjacent terminals at that point, except for strap wires, but in no case should it exceed 1/8".

6.4.3 Keep neoprene, plastic or rubber insulation slightly away from the terminal (approximately 1/32") to avoid damage to the insulation when soldering the connection.

#### 6.5 Number of Wires on a Terminal

6.5.1 Not more than three 22 gauge or smaller diameter wires should be connected at the same hole or notch of a terminal. Where more than three 22 gauge or smaller diameter wires terminate at a single terminal, wrap the additional wire or wires around the shank of the terminal. Refer to SEC. 323 of the handbook for method of making shank connections.

6.5.2 Where practicable, not more than two 20 gauge or larger diameter wires should be connected at the same hole or notch of a terminal, although three such wires are permitted when necessary. Where more than two 20 gauge or larger diameter wires terminate at a single terminal, wrap the additional wire or wires as described above for 22 gauge wire.

#### 6.6 Soldering Difficulties

6.6.1 Occasionally, modifications or additions must be performed on equipment that has been installed for quite a few years and, unfortunately, the terminals, banjo wire, etc., have become excessively dirty and/or oxidized. Normally, the standard Rosin Core solder (RM-728225 or R-5091) will not provide a quality soldered connection. Therefore, the following methods are recommended:

6.6.1.1 Where dirt and grime are the only soldering problems to be considered, the installer should first remove these foreign substances by using either the KS20406-L1 Spray Cleaner (where permissible) or R-3429 Trichloroethane to clean the surfaces; however, this method will not remove oxidation.

6.6.1.2 Where a slight amount of oxidation on the terminal, banjo wires, etc., becomes a problem, the recommended method is to use the 900320631 Mildly Activated Solder. This mildly activated Type 3 Rosin Flux Solder, will in most cases, breakdown a slight oxidation and permit a qualified connection. Also, it will not cause any high resistance shorts from any caustic salts normally found in most types of commercial fluxes.

6.6.1.3 Where a heavy amount of oxidation is present on the terminals, etc., it may be necessary to first remove this oxidation by light sanding them with a fine grade of crocus cloth (purchase locally). However, before attempting this extreme method, first, try the following: be sure the terminals are clean and free of dirt and grime; if necessary, clean with the KS20406-L1 Spray Cleaner or R-3429 Trichloroethane, then proceed to solder with a Mildly Activated 900320631 Solder. If this method does not prove to be successful, apply a drop of R-4585 Type 3 Liquid Rosin Flux to each connection. Be sure to use a very hot soldering copper to dissipate this liquid flux.

<p><b>CAUTION:</b> THE KS20406-L1 SPRAY CLEANER, THE R-3429 TRICHLOROETHANE, AND R-4585 LIQUID FLUX ARE CONSIDERED HAZARDOUS MATERIALS AND REQUIRE SPECIAL HANDLING. REFER TO HANDBOOK U, SECTION 52.</p>
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**PRECAUTION:** UNDER NO CIRCUMSTANCE SHOULD ANY NON-STANDARD NON-APPROVED COMMERCIAL CLEANER BE USED IN AN ATTEMPT TO REMOVE OXIDATION. THESE CLEANERS OR FLUXES GENERALLY CONTAIN CORROSIVE MATERIALS WHICH WILL EVENTUALLY FORM CAUSTIC SALTS THAT DAMAGE EQUIPMENT AND FORM HIGH RESISTANCE SHORTS VIRTUALLY IMPOSSIBLE TO REMOVE.

#### 7. CONTINUITY TEST

7.1 Following completion of the connecting and wiring operations, a complete continuity verification test should be made of all wiring connected by the installer.

NOTE: Prior to performing any continuity tests on transistorized equipment, refer to Handbook 50, Section 2.

No arrowed lines due to extensive changes.

] Indicates information subject to verification.

Engineer Planning Manager  
(Installation)

**Attachments:**

Figure 1 through 4  
Table A

**Reason for Reissue:**

Added soldering tools KS16346-L2 and R-5169.  
Deleted soldering tools R-4121 and R-2972.  
Replaced soldering tools R-3007 and details with KS14440 list numbers and RM728226 with R-5091.  
Added R-3873A Fluorescent Lamp and caution notes regarding use.

TABLE A. VERIFICATION

Verification Items and Brief Statement of Requirements	Reference	
	Paragraph Number	Figure Number
<u>Position of Wire on Terminal</u>		
Wires connected with bare portion having largest practicable contact with soldering surface of terminal.	6.3.1	4
Wires connected with clockwise wrap and for top or right-hand soldering, except as covered in handbook instructions.	6.3.2	
Wires not pulled taut around terminals to which they are not connected.	6.3.3	
<u>Position of Conductor Insulation</u>		
Insulation excluded from hole or notch of terminal.	6.4.1	
Length of "shiner" not greater than the clearance between adjacent terminals at that point. Not to exceed 1/8". Rubber or Pe insulation approximately 1/32" away from terminal.	6.4.2, 6.4.3	
<u>Number of Wires on a Terminal</u>		
Not more than three wires connected at hole or notch of terminal. (Where practicable, not more than two 20 gauge or larger diameter wires.)	6.5.1, 6.5.2	
Wires terminated at a single terminal in excess of permissible number that may be connected in hole or notch, wrapped around the shank of the terminal.	6.5.1	

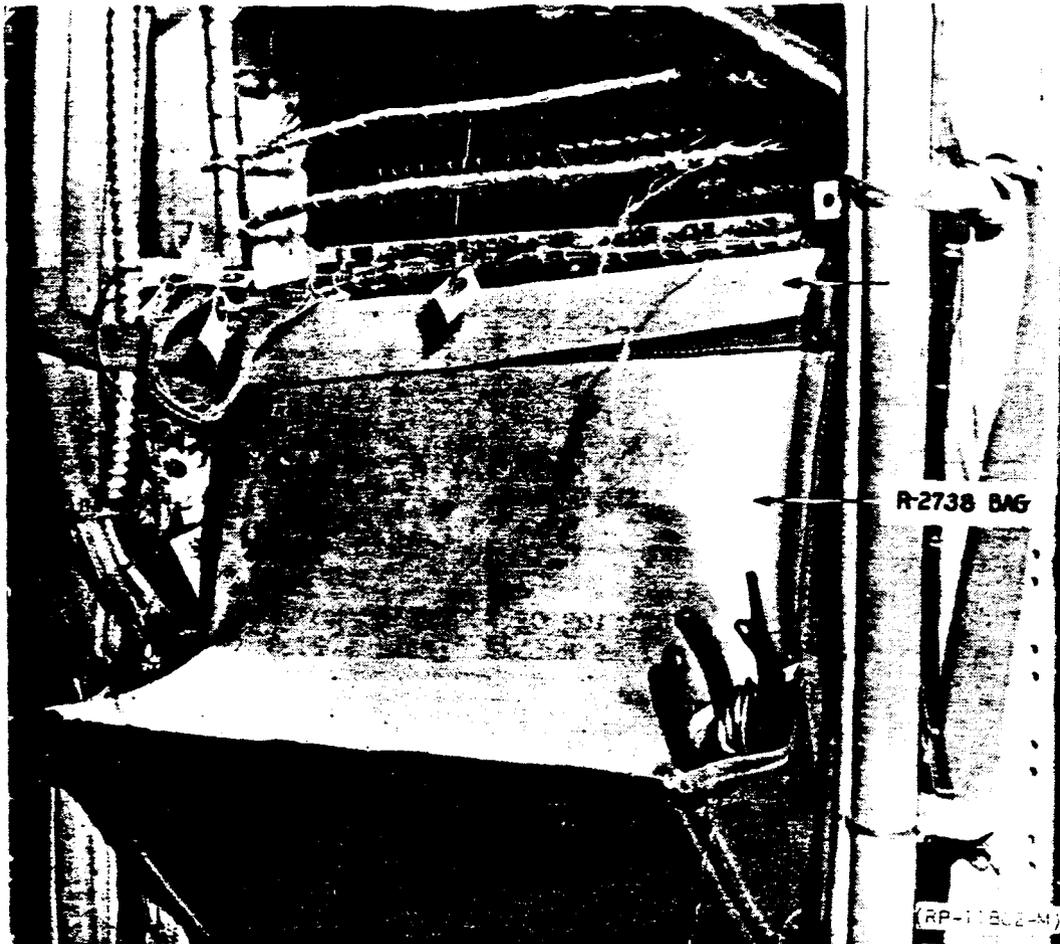


FIG.1 PROTECTING EQUIPMENT UNDERNEATH  
WORK LOCATION WITH R-2738  
CONNECTING BAG (PAR.3.1.1, 4.1.2.)

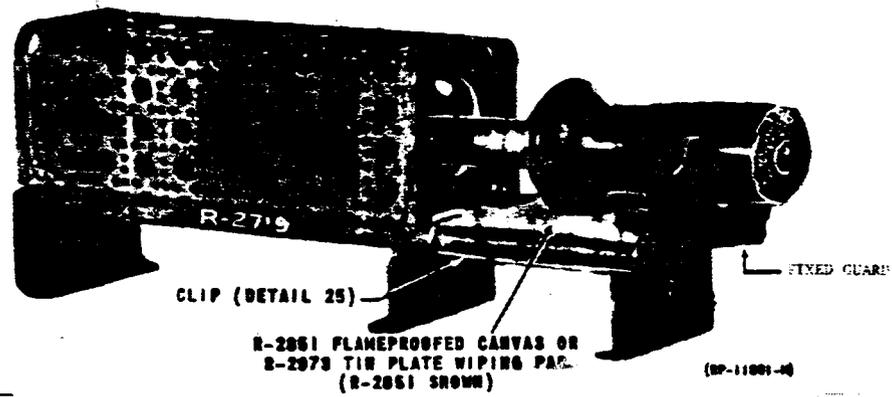


FIG. 2 POSITION OF SOLDERING COPPER IN  
R-2719 HOLDER (PAR. 4.2.3)

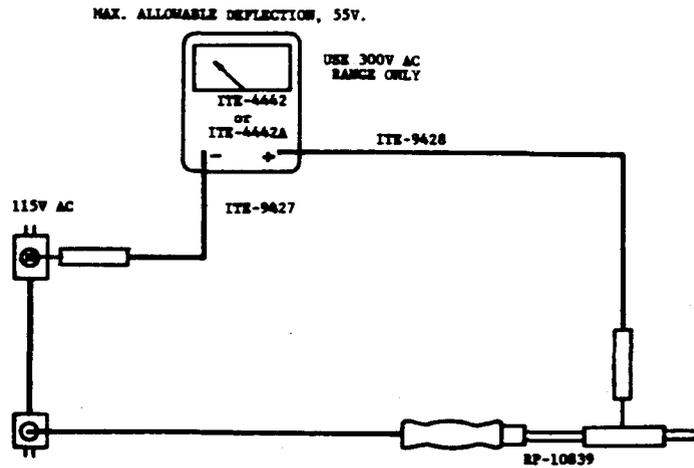


FIG. 3 CHECKING SOLDERING COPPER FOR LEAKS OR GROUNDS (PAR. 5.1.3)

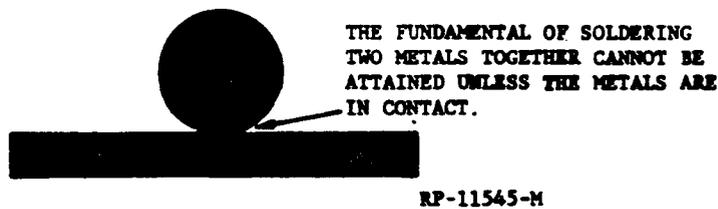


FIG. 4 CROSS SECTION OF POSITION OF CONNECTED WIRE ON TERMINAL (PAR 6.3.1)