AMPLAS ASSEMBLIES
GENERAL EQUIPMENT REQUIREMENTS

CONTENTS PAGE

1. GENERAL 1

2. DESIGN RECOMMENDATIONS AND CONSIDERATIONS 2
A. Common to All Assemblies 2
B. Assemblies Using Pencil Wiring . . . 3
C. Assemblies Using Flexible Printed Wiring 4

3. REQUIREMENTS COMMON TO ALL AMPLAS ASSEMBLIES 4
A. Substrate 4
B. Mounting and Positioning of Components 5
C. Designations and Stamping 6

4. REQUIREMENTS FOR ASSEMBLIES USING PENCIL WIRING 6
A. Wiring and Connecting 6
B. Soldering 7

5. REQUIREMENTS FOR ASSEMBLIES USING FLEXIBLE PRINTED WIRING 8
A. Flexible Printed Wiring Prior to Assembly 8
B. Assembly of Wiring to Substrate . . 8
C. Soldering 8

6. REPAIRS COMMON TO ALL ASSEMBLIES . 9

7. REPAIRS FOR ASSEMBLIES USING FLEXIBLE PRINTED WIRING 9

1. GENERAL

1.01 This section covers engineering requirements, and design recommendations and considerations for Amplas assemblies.

1.02 This section shall apply to products either apparatus coded or equipment coded.

1.03 The requirements in this section shall be followed for all Amplas assemblies, except as modified by applicable drawings and specifications.

1.04 The design recommendations and considerations serve as a guide for BTL design engineers toward having their products meet the engineering requirements contained in other parts of this section. For a more extensive survey of design considerations, consult Design Standards Book I.

1.05 The term ***Amplas*** refers to components mounted in a plastic or epoxy substrate. Wiring may be either pencil or flexible printed circuitry.

1.06 The term ***pencil wiring*** refers to a manual method of wiring accomplished by feeding uninsulated, tin-plated copper wire through a hollow cylinder which resembles a pencil. Using this tool, the operator runs wire from one terminal to another, securing each end by wrapping the wire around the terminals.

1.07 The term ***flexible printed wiring*** refers to a copper foil conductor pattern on a flexible insulating base material. This section covers only those applications where the flexible printed wiring is bonded to the Amplas substrate.

1.08 The term ***conductor pattern*** refers collectively to printed conductor paths and terminal areas. When information pertains separately to either conductor paths or terminal areas, it will be so specified.

1.09 The term ***terminal area*** refers to any enlarged portion of the printed conductor pattern to be used for making soldered connections.

1.10 The term ***Mass Punch-Thru*** refers to the method being used to assemble flexible printed wiring to Amplas. By this method, the flexible printed wiring and Amplas are manufactured separately. Then, the two parts are pressed together, after applying a suitable bonding agent, so that all of the terminals penetrate their associated terminal areas at approximately the same time.

2. DESIGN RECOMMENDATIONS AND CONSIDERATIONS

A. Common to All Assemblies

2.01 *Thermal properties*

(a) The Amplas substrate is expected to be able to withstand the maximum environmental temperatures for which Bell System equipments are usually designed. If an equipment will be subjected to higher temperatures, the substrate merits consideration to safeguard against possible eventual distortion. As a rough guide, the average environmental temperature should not exceed the nominal oven temperature during the curing process.

(b) Components bonded to the substrate should be capable of withstanding the exothermic temperature which the epoxy temporarily develops during the curing process. In the case of 0.125-inch thick substrates cured in an oven at 150 F, the temperature temporarily reaches 220 F.

(c) Components which dissipate a high amount of heat, such as vitreous enamel resistors at rated power, may require special mounting considerations.

2.02 Manufacturing Process Specification 50016, Table V, lists the melting temperature of various solders. The normal soldering techniques specified in 4B and 5C employ lead-tin alloys which melt at 360 to 370 F, and the temperatures of solder baths are appreciably higher. When unusually heat-sensitive components are used, it may be desirable to consult MPS 50016 for solders with lower melting temperatures which, if employed, must be specified in the design information.

2.03 Present applications for Amplas indicate that the thickness of the substrate should be 0.125 inch or greater. The thickness for any particular design is, of course, dependent upon several considerations, among which are:

(a) Size, weight, and concentration of components.

(b) Area of substrate.

(c) Number of components to be bonded to the substrate.

(d) Need for increased shock and vibration protection.

2.04 Amplas assemblies are usually designed on 0.050-inch modules.

2.05 When component bodies are not bonded to the substrate, the layout on the component side should allow for possible component displacement due to handling. Such displacements could cause shorting by bringing a pigtail lead into contact with metal surfaces or other pigtail leads.

2.06 It is recommended that components should be positioned so that one surface of the component body is either parallel or perpendicular to the long dimension of the substrate. All axial-lead components should, when practicable, be parallel to one another.

2.07 A meniscus of up to 0.094 inch may be expected about bonded components and leads on the component side since this condition is inherent to the manufacturing process.

2.08 Inherent in the manufacturing process is a variation in substrate thickness of approximately ± 0.031 inch.

2.09 For any application where flatness must be held within specific limits, the tolerances must be specified in the design information.

2.10 It is the responsibility of the designer to specify, whenever practicable, hardware or terminals (including terminals of components) that are capable of meeting MS17000, Section 1065 if soldered connections are to be made to them.

2.11 Electron tube sockets should be mounted in a way that permits the terminal movement needed when inserting electron tubes. The two methods shown in Fig. 1 are designed to allow such movement. The method of mounting electron tube sockets should be specified in the design information. Two acceptable methods are:

(a) In Fig. 1a, the seat is molded in the substrate, and the tube socket is fastened to the substrate after the curing process is completed.

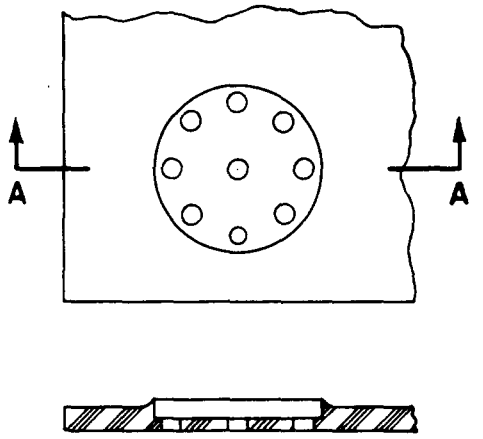

Fig. 1 – Mounting of Electron Tube Sockets

(b) In Fig. 1b, the terminals are embedded in the substrate, but the body remains clear of the epoxy. This allows adequate, although slightly restricted, terminal movement.

2.12 Small transistors are usually mounted in an assembly to protect their fragile leads (see Fig. 8a). Large transistors are usually mounted by embedding their leads in the substrate (see Fig. 8b). The method of mounting transistors should be specified in the design information.

2.13 Components whose size or weight prohibits suspension by their leads may, in general, be bonded to the substrate.

2.14 General mounting requirements for various types and shapes of components are covered in Part 3B of this section. When a component is not one of the types covered in Part 3B, the method of mounting should be specified in the design information.

2.15 Wiring and conductors should be far enough from the edge of the substrate to permit gripping for the soldering process.

B. Assemblies Using Pencil Wiring

2.16 There should be at least 0.200 inch between centers of adjacent terminals on the wiring side (unless the terminals are electrically common per 4.06) in order to maintain clearance requirements per 4.04.

2.17 When locating components in board layouts, consideration should be given to component placement tolerances (3.08 and 3.09) and conductor clearance requirements (4.04). It should be noted that pencil wiring clearances vary, depending upon the direction in which the wires are wrapped around the terminals, as shown in Fig. 2.

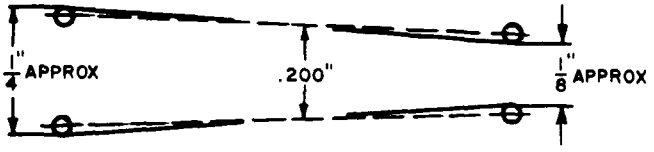

Fig. 2 – Clearance Variations

2.18 Stand-off and jumper terminals (see Fig. 3 and 4) may be used, if necessary, to maintain adequate wiring clearances (see 4.04). Feed-through terminals are used for interfacial connections. When stand-off or jumper terminals are mounted under a component that is bonded to the substrate, adequate clearance should be

provided by the designer between the terminal and the body of the component to prevent shorting. When feed-through terminals are used, adequate clearance should be provided between the terminal and components on the component side of the substrate.

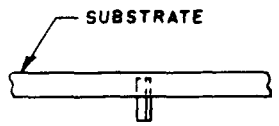

Fig. 3 – Stand-Off Terminals

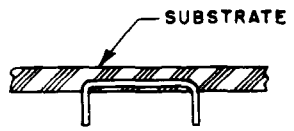

Fig. 4 – Jumper Terminals

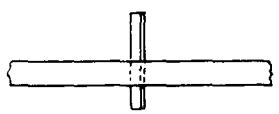

Fig. 5 – Feed-Through Terminals

2.19 Nominal terminal protrusion on the wiring side is usually 0.125 inch. Both the nominal dimension and tolerances, where necessary, for terminal protrusion must be specified in the design information. Tolerances should not be tighter than ±0.031 inch (see 2.08).

C. Assemblies Using Flexible Printed Wiring

2.20 The flexible printed wiring base material must be bondable to the Amplas substrate using the epoxy cement specified in the design information.

2.21 The flexible printed wiring base material must be capable of withstanding the heat to which it is exposed (backed up by the Amplas substrate as a heat sink) during the soldering process. The minimum solder temperature is 450 F.

2.22 The thickness of the base material is dependent upon the type of material used, and the application. At present, single-ply epoxy glass is the only base material employed. For the Mass Punch-Thru wiring method, 0.004 inch is the maximum base material thickness used because of the force required for this method, and the type of terminals involved.

2.23 A nominal dimension of 0.050 inch or greater is recommended for clearances between printed conductors at their closest position and printed conductor widths. For additional information concerning current-carrying capacity and voltage breakdown for various printed conductor widths and spacings, consult Design Standards Book I.

2.24 When the flexible printed wiring is affixed to the Amplas substrate by the Mass Punch-Thru method, terminal areas having at least 0.200-inch diameters are recommended.

2.25 There should be at least 0.250 inch between centers of adjacent terminals on the wiring side, unless the terminals are electrically common.

3. REQUIREMENTS COMMON TO ALL AMPLAS ASSEMBLIES

A. Substrate

3.01 The materials employed in the fabrication of the substrate shall be as specified in the design information.

3.02 The substrate shall be free of foreign matter.

3.03 Voids on the wiring side of the substrate shall meet the following requirements. These voids can be recognized by either a lightening in color (translucence) or absence of epoxy under a bonded component.

(a) Terminals, terminal holes, and component leads shall not be contained either within the void or nearer than 1/8 inch to the perimeter of the void.

(b) Each void shall not extend outside the perimeter of a 1/2-inch circle. Voids on the wiring side which do not meet the above conditions are acceptable if repaired in accordance with 6.01.

3.04 Indentations, such as those caused by air bubbles, shall not exceed 1/16 inch in depth. Indentations greater than 1/16 inch in depth are acceptable provided they are filled with epoxy.

3.05 Fractures in the subtrate are acceptable if repaired in accordance with 6.02.

B. Mounting and Positioning of Components

3.06 Component code and electrical value markings need not all be oriented in the same direction. It is preferable, although not a requirement, for these markings to be visible.

3.07 In order to avoid impairment of the seal in sealed components and to avoid breakage of pigtail leads, it is recommended that pigtail leads be as straight as practicable, without bends for a distance of 1/16 inch from the body of the component. In the following cases, it is a requirement that the bend in the pigtail lead shall not start closer than 1/16 inch from the point of attachment to the component.

(a) Lead emerges from sealed glass bodies.

(b) Lead is soldered or welded to any tubulation, such as in the case of 426-type diodes. No part of the tubulation extending from the glass end shall be bent or stressed.

(c) Lead is soldered or welded to the component lead-out wire.

3.08 Minimum clearances on the component side of the substrate (except for electrically common terminals per 4.06) shall be:

(a) 1/16 inch between any two conducting surfaces except as covered in (b) and (c).

(b) 1/32 inch between soldered stand-off terminals or between a soldered stand-off terminal and a fixed, rigid apparatus case bonded to the substrate.

(c) 1/64 inch between metallic portions of any two fixed, rigid apparatus cases bonded to the substrate.

3.09 In order to meet the clearance requirements in 3.08 and 4.04, the diameter of the lead shall be wholly within a circle whose diameter is 1/16 inch greater than the diameter of the lead.

3.10 Electron tubes shall be mounted as specified in the design information. However, the following requirements apply for all units.

(a) In no case shall both the body of the socket and its terminals be bonded to the substrate.

(b) Except for unused terminals, there shall be no epoxy within the terminal cavities of the socket body, or on the terminals within the cavities. Neither shall the epoxy bond a terminal to the body of the socket at any point.

(c) When the socket terminals are to be embedded in the substrate, Star Expansion Products Co. JE-9 or JE-10 wiring plugs or equivalent shall be placed in the socket prior to installing the socket in the flexible mold, and shall remain in the socket until the curing process is completed.

3.11 Cylindrical pigtail components may touch, but shall not be bonded to the substrate unless otherwise specified. The maximum clearance between the bodies of such components and the substrate shall be 3/16 inch (see Fig. 6).

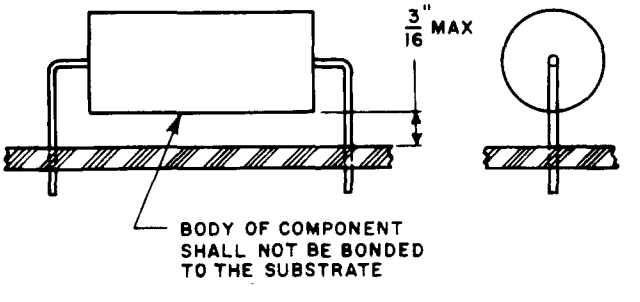

Fig. 6 – Mounting of Cylindrical Pigtail Components

3.12 Rectangular pigtail components, when mounted on edge, shall be bonded to the substrate unless otherwise specified (see Fig. 7).

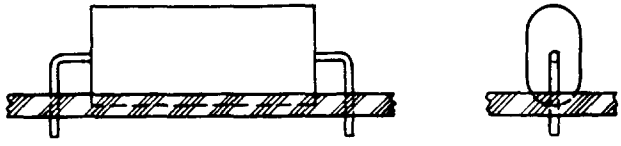

Fig. 7 – Mounting of Rectangular Pigtail Components

3.13 Transformers shall be bonded to the substrate unless otherwise specified.

3.14 Transistors shall be mounted as shown in Fig. 8, depending upon the information shown on the design drawings.

3.15 Relays, inductors, shielded networks, and other component types for which mounting arrangements are not covered in this part shall be mounted as specified in the design information.

3.16 When using jumper terminals, the crosspiece between the two terminal projections shall be covered with epoxy.

C. Designations and Stamping

3.17 Rubber-stamped numbers and characters shall not reduce conductor pattern clearances below the specified minimum spacings.

3.18 Rubber stamping shall be per WL-2151, using 1/8-inch characters. When space does not permit the use of 1/8-inch characters, a smaller size may be used.

3.19 The color of the stamping ink shall be in contrast to the background.

3.20 Obliterated and otherwise missing characters shall be replaced with rubber-stamped characters of approximately the same size.

3.21 Component designations such as R101, L101, C101, A1, B1, C1, etc, are for reference only, and need not be stamped.

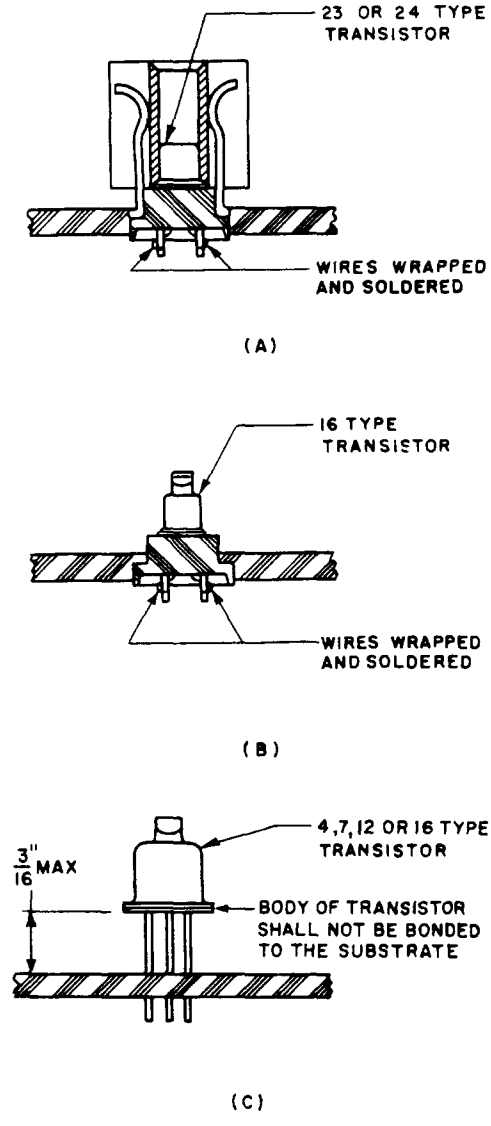

Fig. 8 – Mounting of Transistors

3.22 Terminal designations on the conductor side of the substrate shall be located approximately as shown on the individual drawings.

3.23 Date stamping, when required, shall be as specified on the individual drawings.

4. REQUIREMENTS FOR ASSEMBLIES USING PENCIL WIRING

A. Wiring and Connecting

4.01 All wiring shall be bare wire unless otherwise specified. Insulated wires may be used, however, for selected spans when clearance per 4.04 cannot be maintained.

4.02 The gauge of wire shall be as specified in the design information.

4.03 Wires shall be run direct from terminal to terminal without slack, but not so taut as to impose strain that may distort the terminal or prevent movement of floating terminals such as unembedded terminals of electron tube sockets.

4.04 The following clearances shall be maintained on the wiring side of the substrate.

(a) At least 1/32 inch between any two soldered connections (other than common terminals in accordance with 4.06), and at least 1/16 inch between a soldered connection and any other conducting surface.

(b) The minimum clearance between a bare wire and any conducting surface shall be as follows.

BARE WIRE SPAN (inches)	MIN CLEARANCE (inches)
1-1/2 or less	1/16
Over 1-1/2, through 3	1/8
Over 3	3/16

No span of bare wire shall exceed 4-1/2 inches.

4.05 It is permissible to anchor bare wiring to the substrate with epoxy resin in order to meet clearance requirements.

4.06 Closely spaced (0.100 inches or less) terminals of adjacent components may be joined to form a common terminal, where specified, by one turn of wire prior to soldering.

4.07 All connections shall be made with at least one complete turn of wire around the terminal or protruding pigtail lead.

4.08 It is preferable, although not a requirement, that no more than two connections be made to one terminal. In no case shall more than three connections be made to one terminal.

4.09 Wiring plugs, such as the Star Expansion Products Co. JE-9 and JE-10, or equivalent, should be placed in electron tube sockets for the duration of wiring and soldering operations.

B. Soldering

4.10 All soldering shall be in accordance with Manufacturing Process Specification 50016. Fluxes in accordance with MS-17000, Section 1135 are permissible.

4.11 The soldered connection shall show evidence of good wetting on the surfaces being joined and, after cooling, form a firm metallic bond between the terminal and at least one complete turn of wire.

4.12 The surface of the soldered joint shall have a smooth appearance.

4.13 Excess solder such as globules, drips, and runs shall not:

(a) Project more than 3/16 inch from the wiring side of the substrate, unless otherwise specified.

(b) Be liable to cause bridging if deformed.

(c) Be hazardous to personnel.

4.14 Solder webs not exceeding 3/16 inch formed from a terminal along an essentially V-shaped conductor path (see Fig. 9) are acceptable provided minimum terminal dimensional tolerances per 4.04 are met.

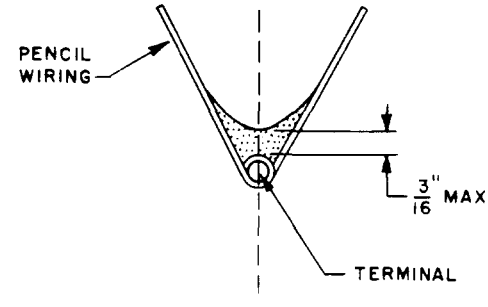

Fig. 9 – Solder Webs

4.15 The use of heat sinks is recommended when soldering heat-sensitive components such as diodes, thermistors, and transistors.

5. REQUIREMENTS FOR ASSEMBLIES USING FLEXIBLE PRINTED WIRING

A. Flexible Printed Wiring Prior to Assembly

5.01 The flexible printed wiring shall be in accordance with 800-610-159, Part 3.

5.02 The flexible wiring base material shall be free of wrinkles and tears.

5.03 The conductor pattern shall be electroplated with solder, 60 per cent tin — 40 per cent lead, 0.001 inch thick, ±0.0005 inch.

B. Assembly of Wiring to Substrate

5.04 The epoxy cement used to bond the flexible printed wiring to the Amplas substrate shall be as stated on the manufacturing drawing.

5.05 The flexible printed wiring base material shall not protrude beyond the edges of the Amplas substrate after bonding.

5.06 Bonding agents shall be fully cured before any soldering operations.

5.07 After curing, the perimeter of the flexible printed wiring base material shall be completely bonded to the Amplas substrate, judged visually.

5.08 Air bubbles or separations between the Amplas substrate and the flexible printed wiring base material, if not situated on the perimeter (see 5.07), shall meet all of the following requirements.

(a) At least 80 per cent of the flexible printed wiring base material shall be bonded to the Amplas substrate, judged visually.

(b) No single air bubble or separation shall exceed 1/4 inch in diameter.

(c) The spacings between component terminals which are not electrically connected by the circuit pattern, shall not be reduced to less than the specified minimum dimension.

Air bubbles or separations which do not meet the above conditions are acceptable if repaired in accordance with 7.02.

5.09 Terminals shall be positioned so that after the flexible printed wiring base material is affixed to the Amplas, they protrude through and past the plane of the terminal area, judged visually. Any terminal that is not located wholly within the terminal area shall be clinched. However, all such terminals shall at least touch the associated terminal area prior to clinching.

5.10 A broken conductor path where the discontinuity is greater than 1/8 inch is not acceptable. Where the discontinuity is 1/8 inch or less, it shall be repaired in accordance with 7.03

5.11 Lifted portions of conductor paths shall be repaired in accordance with 7.04. However, such portions subject to repairs shall not exceed 1/2 inch in length, judged visually.

5.12 Lifted terminal areas are acceptable provided they are repaired in accordance with 7.04.

5.13 Cracks in the printed wiring base material shall be repaired in accordance with 7.04.

5.14 Scratches on the surface of the printed wiring base material shall be repaired in accordance with 7.05.

5.15 The conductor pattern shall be free of nicks that reduce the conductor pattern width to less than 80 per cent of the specified minimum dimension.

5.16 Scratches on the surface of the metallic finish, if furnished, are permissible provided the copper conductor is not affected.

C. Soldering

5.17 All soldering shall be in accordance with Manufacturing Process Specification 50016, Method D or L. Fluxes in accordance with MS-17000, Section 1135 are acceptable.

5.18 Spines, bulges, or droplets of solder are acceptable provided:

(a) They do not project more than 1/8 inch from the conductor side of the board.

(b) They are not liable to cause bridging if deformed.

(c) They are not hazardous to personnel.

5.19 All soldered joints shall be free from cracks. Surfaces of soldered joints shall not show evidence of being rough, pasty, or coarsely granular.

5.20 For connections that are not clinched, the fillet shall show evidence of good wetting of both lead and terminal area, and shall extend at least 180 degrees, judged visually. It is also acceptable to have two fillets of solder extending a total of at least 180 degrees about the periphery of the wire.

5.21 For clinched connections, the fillet shall show evidence of good wetting of both lead and terminal area, and shall extend for a distance equal to at least one-half of the clinched portion of the lead, judged visually. Also acceptable are two fillets of solder holding the lead to the terminal area for a total of at least one-half of the clinched portion of the lead.

5.22 After soldering, clearances between adjacent conducting surfaces based upon nominal spacing dimensions, shall be

+ Not restricted

−0.015 inch

6. REPAIRS COMMON TO ALL ASSEMBLIES

6.01 Voids may be repaired as follows.

(a) Voids under solid components or components potted in high-temperature melting compounds may be repaired by filling the void with epoxy.

(b) Voids under adjustable components or components potted in low-temperature melting compounds may be repaired as in (a) provided the body of the component is isolated from the epoxy.

6.02 Cracks in the substrate may be repaired by applying epoxy the entire length of the fissure. If the crack occurs under an adjustable component or a component potted in a low-temperature melting compound, the body of the component shall be isolated from the epoxy.

6.03 Deviation of any repaired area from the surface plane of the substrate shall not exceed 1/32 inch.

6.04 After repairs are completed, no terminal shall be obstructed in a manner that necessitates modification of the wiring pattern.

7. REPAIRS FOR ASSEMBLIES USING FLEXIBLE PRINTED WIRING

7.01 The edges of flexible printed wiring base material which have failed to bond to the Amplas substrate may be repaired by applying epoxy cement of the type specified on the manufacturing drawing. Light pressure should be applied until the cement cures.

7.02 Air pockets or bubbles greater than 1/4 inch, that are not on the perimeter of the flexible printed wiring base material, may be repaired by filling them with epoxy cement of the type specified on the manufacturing drawing, using a hypodermic-type dispensing needle.

7.03 A broken conductor path with a discontinuity of 1/8 inch or less may be repaired by reinforcing the damaged area with either a 24- or 26-gauge bare tinned copper wire fastened to the conductor path by a fillet of solder extending the entire length of the wire. The wire and solder fillet shall extend at least 1/8 inch on each side of the damaged area. (See Fig. 10.) No repair shall reduce the clearance between any two portions of the conductor pattern to less than the specified minimum dimension. All soldering shall be in accordance with Part 5C. Alternate methods per Fig. 11 and 12 may be used when necessary.

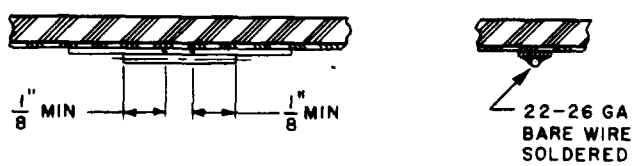

Fig. 10 – Repair of Conductor Discontinuity

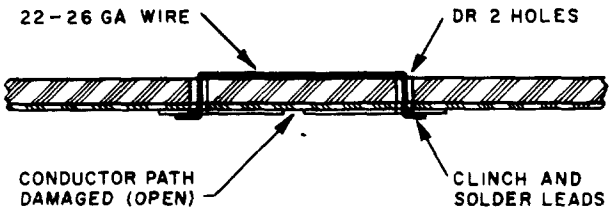

Fig. 11 – Alternate Method

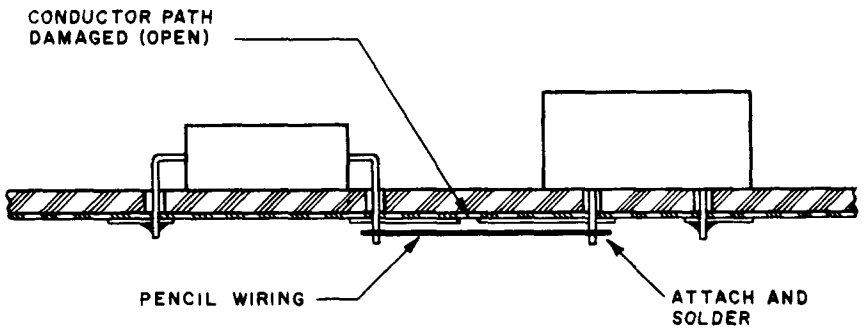

Fig. 12 – Surface-Wired Connection

7.04 When a portion of a conductor path is lifted 1/2 inch or less, a terminal area lifted, or the insulating base material cracked, the following repair procedure shall be employed.

(a) The damaged area should be cleaned. The repaired area and a surrounding area of at least 1/8 inch shall be covered with an epoxy compound per Material Specification 58456, Type 5A, or approved equivalent. Repaired units shall not be handled until cured.

7.05 Scratches may be repaired either as covered in 7.04 or by applying 642A finish instead of the epoxy specified in 7.04.