SOLDERLESS WRAP CONNECTIONS
METHODS, REQUIREMENTS, AND TOOLS

CONTENTS

1. GENERAL

1.1 Scope of Section

1.1.1 This section covers the methods, tools and requirements for applying soldered and Solderless Wrap (SW) connections to terminals designed and approved for accepting the wire wrap method of termination.

1.1.2 The requirements covered in this section shall be followed except where modified by applicable drawings or specifications.

1.1.3 Each figure in this section illustrates only condition to which reference is made in the text and is not to be considered as covering other conditions that may also be illustrated.

1.2 Non-Standard Non-KS Apparatus

1.2.1 SW connections applied to non-standard non-KS (outside supplied) equipment and apparatus previously required the application of solder unless the Bell Operating Company (BOC) specifically waived the requirement. The application of solder to these connections created a degradation of quality particularly in congested high terminal areas of wiring.

1.2.2 Do not solder SW connections applied to non-standard non-KS equipment and apparatus unless the BOC specifically requests these connections be soldered. This soldering request, if so required, should be stated in the associated installing specification such as the X92.

1.2.2.1 SW connections applied to this equipment or apparatus shall meet the requirements of this section. Unqualified connections should be replaced or soldered.

1.3 Cautions - Precautions

CAUTION:	ALL METAL HOUSED ELECTRICALLY DRIVEN (A-C) TOOLS SHALL BE EQUIPPED WITH 3-CONDUCTOR CORDS AND 3-PRONG PLUGS. CHECK THESE TOOLS TO BE SURE THE HOUSING IS GROUNDED PRIOR TO USE WITH THE ITE-6118 GROUND TESTER. A RED LIGHT INDICATES A DEFECT. DO NOT USE THIS TOOL. A GREEN LIGHT INDICATES THE TOOL IS PROPERLY GROUNDED.

1.3.1 General precautions to be taken against personal injury, equipment damage, and service interruptions are covered in Handbook 0 and are to be observed at all times as they apply to the operations being performed. Specific precautions are included in this section with the associated methods or instructions.

1.4 Reference Sections

1.4.1 Listed below are various Handbook 9 sections that cover the scope of solderless wrap connection.

Section 300 - Skinning Tools, Methods, and Requirements
Section 312 - Wire Wrapping at Specific Apparatus
Section 314 - Coded Apparatus Approved for A-Z Solderless Wire Wrapping
Section 315 - Pigtail Components Approved for Solderless Wire Wrapping
Section 350 - Disconnecting and Reconnecting Solderless Wrapped Connections
Section 900 - Continuity Testing

1.5 Pre-wiring Information

1.5.1 Prior to using a wrapping tool, check the index (alignment of the bit wire feed slot with the flare of the sleeve) of the nose assembly. On all tools, the bit feed slot and the flare of the wrapping sleeve should be perfectly aligned with the top side of the tool. A slight misalignment can be adjusted by loosening the collet nut of the nose assembly, rotating the bit in the sleeve by depressing the tool trigger, then when aligned, retighten the collet nut.

NOTE: Misaligned bit-sleeve combinations bay result in "shiners" on the termination, thereby, resulting in demeritable items.

1.5.2 Pneumatic wire wrapping tools should be run in the range of 70 psi (minimum) and 100 psi (maximum). These tools should be lubricated daily by applying one drop of No. 10 Oil in the quick-disconnect coupling before using.

1.5.3 When working on a ladder, the tool cord (air or electric) should be supported from above to prevent and reduce the impact of a tool on the floor if accidentally dropped. Secure to the ladder superstructure with twine or nylon cable ties.

2. SW CONNECTIONS - SCOPE

2.1 General Information

2.1.1 The life expectancy of a SW connection made with tinned wire is approximately 40 years. The use of untinned wire will reduce the life of the connection by approximately one-half. In addition, under certain environmental conditions, the use of untinned wire may result in noisy and unreliable connections, therefore, the use of untinned wire for SW connections is limited to certain applications in specifically authorized equipment and apparatus.

2.1.1.1 Where untinned connector cable has been specified by the telephone company, System Equipment Engineering must obtain a waiver of BSP connecting requirements and notify Installation via an Installers note in the formed cable spec which is cross-referenced against the running information in the route column. The note should read: "Letter/TWX dated confirms the usage of the untinned connector cable(s) for the associated cable run(s) with the BOC."

2.1.1.2 Where there are standard circuit drawings specifying usage of these untinned connector cables without being modified by other notes, these cables shall be treated the same as if it were a standard tinned connector cable.

NOTE: When untinned cable leads appear on a job site and authorization of use is in question, the Regional Technical Assistance Center (RTAC) should be contacted.

2.1.2 A SW connection having partially plated wire is acceptable provided that when the completed connection is viewed from any one side, there shall be a minimum number of turns, not necessarily adjacent, as listed below, with no copper showing on the surface of the wire as gauged by the unaided eye:

1. 20, 22, and 24 Gauge Wire - 3 turns
2. 26 Gauge Wire - 5 turns
3. 28, 30 Gauge Wire - 3 turns

2.1.3 Where apparatus terminals are approved and authorized (Handbook 9, Section 314) for SW connections, the termination of wire on these terminals shall be made using the wire wrap technique.

2.1.4 When an unqualified SW connection has been applied to a terminal in a highly congested wiring area, and the soldering of this connection may cause shorts, crosses or

insulation damage, the preferred method of repair is to remove the connection, cut back the lead about 2" and splice in accordance with Section 370, Reterminate as a Qualified SW Connection.

2.2 Wire Gauges

2.2.1 SW connections are presently restricted to 20, 22, 24, 26, 28, and 30 Gauge tinned wire except as indicated in Paragraph 2.1.2. These gauges of wire will provide satisfactory connections when they are applied with a standard wire wrapping tool equipped with an approved wrapping bit and sleeve combination.

2.3 Terminals

2.3.1 The successful solderless wrapped connection depends partially upon the design of the terminal to which they are to be applied. These terminals are characterized by their cross sections, that is, flat punched, punched embossed, square wire, flattened and serrated, and twin wire twisted-coined.

2.3.2 All connections of 20 through 26 Gauge wire not specifically approved with regard to wire size and terminal configuration as listed in Sections 314 and 315 of this handbook shall be soldered. For exception, refer to Paragraph 1.2.

2.3.3 Apparatus terminal ends having color dye markings, usually red, do not meet requirements for solderless wrapping, and all connections to such terminals shall be soldered. These markings usually indicate repaired apparatus but may also appear on non-conforming terminals of new apparatus.

2.3.4 The working length (straight portion) of any terminal to be solderless wrapped shall be essentially straight and free of angular bends, crimps, or twists. However, a small amount of bowing is permissible provided the width of the bowed portion of the terminal does not exceed 0.075" when measured along the working length in line with the position assumed by the terminal (see Figure 1). This can be checked when using any solderless wrapping bit having a 0.075" terminal hole, such as KS-16734L-1, 24 Gauge Bit. The terminal must fit freely into the bit without bending or binding in any way.

2.3.5 It is permissible to solderless wrap a connection on an approved terminal from which previous solderless wrapped connections have been removed, by unwrapping with an unwrapping tool with the exception of .009" embossed crossbar switch crosspoint terminals, other apparatus using the .009" embossed terminals or .010" embossed terminals used on various apparatus.

2.3.5.1 Any connection applied to .009" or .010" embossed terminals that have been previously wrapped, repaired or where a second connection is added shall be soldered.

2.3.5.2 The twist, or set, left in .009" and .010" embossed terminals shall not be disturbed by attempting to straighten the terminal after a connection has been applied. A terminal twist of less than 180° is acceptable. Twists beyond 180° are not acceptable and must be soldered. (Refer to Handbook 261, Section 315.11 for ESS exception.)

2.3.6 Since SW connections applied over solder tend to loosen in service, it is not permissible to apply a SW connection to a terminal that has previously been soldered or had an adhering solder splash. Any SW connection applied over solder must be soldered. (Refer to Handbook 261, Section 315.11 Paragraph 3 for soldering exceptions in ESS.)

NOTE: An inadvertent solder splash on a finished connection or on the portion of the terminal not involved in the connection does not require soldering.

2.3.7 If a strap has been soldered beyond the working length of the terminal (straight portion), a SW connection may be applied to the terminal providing the solder was applied first. A thin film of rosin is permissible and will not affect the integrity of the connection.

2.3.7.1 If is permissible to solder a single prong of a two prong connection without having to solder a qualified connection on the other prong. Care should be exercised when soldering.

2.3.8 Some terminals do not have a tool stop at the back end; these terminals are usually formed round in this area. If turns are inadvertently placed in this area, they shall not be counted towards meeting the turns requirement. If you have insufficient turns, solder the connection.

2.4 Shiner Lengths

2.4.1 The shiner length is that portion of the wire from which the insulation has been removed. The shiner is placed into the wire feed slot of the wrapping bit and is mechanically wrapped around the terminal. The number of turns of 20 through 30 Gauge wrapped connections are, therefore, controlled by the shiner length.

2.4.2 Refer to Table "A" for a list of common usage type SW terminals and the associated "shiner" lengths that will provide sufficient bare wire to turn out qualified connections. Refer to Section 300 of this handbook for skinning tools and methods.

2.4.3 Care should be exercised not to distort that skinned portion of the wire as a bent wire is difficult to slide into the wire feed slot of the wrapping bit. A bent wire also causes excessive wear on the wrapping bit and sleeve resulting in reduced wrapping bit life or a scored sleeve. This often prevents the wrapping bit from indexing and in time

will prevent the tool from making a satisfactory wrapped connection.

2.5 Cross-Connections

2.5.1 A cross-connect solderless wrap connection that does not meet the requirements should not be soldered except in cases where there is solder on the terminal. An unqualified connection should be removed and replaced with a new qualified connection.

2.5.2 When a switchboard or local cable lead is connected to the same end of a terminal as a cross-connection, solder the faulty cable lead connection if it cannot be replaced. In such cases, the cross-connection must also be soldered.

2.6 Placement on Terminal

2.6.1 On a terminal designed to accommodate two solderless wrapped connections, the first connection shall be placed in far enough on the terminal to permit a second solderless wrapped connection to be made.

2.6.1.1 On a terminal designed to accommodate three or more solderless wrapped connections, the first connection shall be placed in far enough on the terminal to permit the second and third colderless wrapped connection to be made.

2.6.1.2 On terminals on which both the shop and the installer is required to place solderless wrapped connections, the shop connection should be placed to permit at least one installer made solderless wrapped connection.

NOTE: These terminals should be designated by the convention (SH) or a qualifying note on the associated wiring diagram.

2.6.2 Each 6 turn wrapped connection takes approximately 1/4" of terminal length. Therefore, in order to apply a 6 turn second and third connection, approximately 1/4" or 1/2", respectively of terminal length must be available (see Figure 2).

2.6.3 Where there is insufficient terminal length to make the number of qualified connections required on the terminal, the extra connection(s) may be placed on the end of the terminal or overwrapped with 1-1/4 turn connection. All connections on that terminal must be soldered.

2.6.4 When wrapping a succeeding solderless wrapped connection, the wrapping tool should be positioned slightly away from the preceding connection. Although it is not a defect if the succeeding connection touches, it is desirable to allow space between each connection to avoid the possibility of overlapping connections. In cases where the succeeding connection overlaps the preceding one, it is not a defect if the additional connection meets the requirements for overlapping turns and the previous connection has at least the required minimum number of successive non-overlapping turns before the point of overlap.

2.6.5 When there is not approximately 1/4" or 1/2" of terminal length available, 3 or 1-1/4 turn wrapped connections should be applied depending upon the remaining terminal length (see Figure 2). Connections on these terminals require the application of solder.

3. SOLDERLESS WRAP REQUIREMENTS

3.1 Number of Turns

3.1.1 26 Gauge Wire

3.1.1.1 A solderless wrapped connection made minimum of 7 or 8 consecutive turns of bare wire. Seven full turns of bare wire applied to flat punched and square drawn wire terminals will make a qualified connection. While 8 full turns of bare wire is required for all other terminals - refer to Section 314 for terminal configurations (see Figure 3).

3.1.2 24 Gauge Wire

3.1.2.1 A solderless wrapped connection made with 24 Gauge wire shall consist of a minimum of 6 consecutive non-overlapping helical turns of bare wire in contact with the terminal (see Figure 3). More than 6 turns is permissible, but not advisable.

3.1.3 22 and 20 Gauge Wire

3.1.3.1 A solderless wrapped connection made with 22 and 20 Gauge wire shall consist of a minimum of 5 consecutive non-overlapping helical turns of bare wire in contact with the terminal (see Figure 3). More than 5 turns is permissible, but not advisable.

3.1.4 28 and 30 Gauge Wire

3.1.4.1 A solderless wrapped connection made with 28 or 30 Gauge wire shall consist of a minimum of 7 consecutive non-overlapping helical turns of bare wire plus a minimum of 3/4 turns (3 corners) of insulated wire in contact with the terminal (see Figure 4). The insulated portion must be in contact with at least 2 of the corners of the terminal and the allowable clearance between the insulated wire and the third corner is .015" gauged by eye. Soldering is not an approved method of repair.

3.2 Separation Between Turns

3.2.1 20, 22, 24 Gauge Wire

3.2.1.1 The minimum number of turns of a connection may be separated, providing the spaces between 4 adjacent turns of bare wire does not exceed .005" each as viewed from at least one side of the terminal (gauge by eye). In no case shall the specified number of turns be interrupted by separations in excess of .010". That is, if a separation

in excess of .010" exists anywhere in the connection, the turns count shall be considered interrupted (refer to Figures 5, 6C, and 6E).

3.2.2 26 Gauge Wire

3.2.2.1 The minimum number to turns of a connection may be separated providing the spaces between 6 adjacent turns of bare wire does not exceed .005" each, as viewed from at least one side of the terminal (gauge by eye). In no case shall the number of turns specified in Paragraph 3.1.1.1 be interrupted by separations in excess of .010" (refer to Figures 5 and 6C).

3.2.3 28, 30 Gauge Wire

3.2.3.1 The minimum number of turns of a connection may be separated providing the spaces between 5 adjacent turns of bare wire does not exceed .003" as viewed from at least one side of the terminal. In no case shall the number of turns specified in Paragraph 3.1.4.1 be interrupted by separations in excess of .005" (refer to Figures 5 and 6G). Do not solder defective 28 or 30 Gauge connections.

3.3 Overlapping Turns

3.3.1 Although not desirable, overlapping turns (wire not in contact with the terminal) before the start of the count or after the end of the count of the minimum consecutive turns are permissible. However, the overlapping and overlapped turns shall be discounted when determining the number of turns of a connection. (Refer to Figure 6F).

3.4 Bulged Turns

3.4.1 There shall be no more than one bulged turn within the minimum successive turns of a connection. a "bulged turn" is defined as the start of an overlap where the wire is away from the terminal not more than one-half the circumference of the turn. More than one-half the circumference shall be considered overlapping (refer to Figure 6D).

3.5 Shiners

3.5.1 A "shiner" is the bare portion of the wire between the point of connection on the terminal and the insulation of the wire and is caused by not inserting the wire into the wrapping bit up to the insulation.

3.5.2 While it is desirable that there be no "shiners", they shall be less than the clearance between adjacent terminals at that point, and in no case shall the shiner be longer than 1/8". It is not objectionable if the insulation overlaps the terminal (refer to Figure 6B).

3.6 Clearance

3.6.1 In no case shall the clearance between adjacent terminals, and/or the turns of the connection on the same or adjacent pieces of apparatus be less than 1/64". Where practicable, maintain 1/32" clearance.

3.6.2 Clearance between terminals, or the turns of the connection and adjacent metalwork such as mounting plates, mounting details, etc., shall not be less than 1/32".

3.6.3 On 286F Relays, a minimum clearance of 1/32" shall be maintained between adjacent connections on stationary contact terminals and between these and other terminals at the left and right.

3.6.4 While it is not a requirement that the wire end lie flat against the terminal, it should in no case project to the extent that the required 1/64" clearance cannot be maintained, and in no case shall the wire end project more than half the distance to the closest terminal or a 1/8" maximum away from the terminal.

3.6.5 Where the clearance between the wire end and the adjacent connection and/or terminal is not the required 1/64" or the wire end extends 1/8", the wire end can be wrapped down using the wire wrapping tools, pliers, spudger or similar tool. This connection shall be soldered.

3.6.5.1 Apparatus which has closely spaced punched-type terminals approved for solderless wrapped connecting such as EA, U, Y, and similar types of relays, should have terminals sufficiently spread so that the connection can be placed on the terminals to meet the clearance requirements. The spreading of these terminals should be done prior to connecting to eliminate disturbing the finished connections.

3.7 Connection Conformance

3.7.1 Prior to terminating wire ends via the solderless wrap method, the installer should visually inspect the bit and sleeve to be used for excessive wear, rust or other defects. Should a defect be discovered, discard the bit and/or sleeve and obtain a new one.

3.7.1.1 When wiring is performed by experienced wiremen, the initial (20) connections should be visually inspected for conformance to requirements before additional connections are applied. A bit/sleeve producing unqualified connections should be discarded and replaced with those producing qualified connections.

3.7.1.2 Inexperienced wiremen should terminate leads on non-working equipment with scrap wire until the proper technique is attained and qualified connections are produced.

3.8 Soldering Wrapped Connections

CAUTION:	DO NOT TRY TO FIX AN UNQUALIFIED WRAPPED CONNECTION IN AN ATTEMPT TO MAKE IT LOOK LIKE A QUALIFIED SOLDERLESS WRAPPED CONNECTION. UNQUALIFIED OR REPAIRED CONNECTIONS MUST BE SOLDERED TO INSURE A GOOD CONNECTION. WHERE THE SHINER LENGTH PERMITS, AN UNQUALIFIED CONNECTION SHOULD BE REMOVED, THE WIRE RE-SKINNED, AND A NEW CONNECTION MADE.

3.8.1 A minimum of 1-1/4 turns is required for a soldered wrapped connection. However, it is desirable to use a connection with approximately 3 turns to facilitate machine wrapping and/or removal of the connection. Shiner length of 3/4" will, in most cases, provide sufficient skinned wire to make a 3 turn soldered wrapped connection.

3.8.2 Use a 3/8" shiner length for making soldered wrapped connections with 20 Gauge wire. This will provide approximately a 2 turn connection which will facilitate maintenance removal of the wire.

3.8.3 On a wrapped connection consisting of two or more turns that requires soldering, a minimum of any two adjacent turns must be soldered. However, to insure that solder adheres to both the wire and the terminal, it is recommended that the end turns be soldered. Normally, solder will flow completely around the wire, but it is only necessary that the solder cover the turns on the soldered side of the connection. When a connection has less than two adjacent turns, the entire connection shall be soldered.

3.8.4 A 1/32" clearance between the solder and adjacent bare wire, terminal, or solder of an adjacent connection shall be maintained wherever practicable, but in no case shall the clearance be less than 1/64".

3.8.5 Solder a wrapped connection using the R-3007 Midget Soldering Copper or the R-2733 Soldering Copper equipped with an R-2972 Tip.

3.8.6 Exercise extreme caution to prevent dropping solder and to prevent the barrel of the copper from burning skinner insulation. The terminal and wrapped connection are small, requiring only a small amount of time to reach soldering temperature.

4. MAKING A CONNECTION

4.1 Wrapping a Lead

CAUTION:	THE METAL HOUSED, ELECTRICAL MOTOR DRIVEN WIRE WRAPPING TOOL, INCLUDING THE BIT AND SLEEVE, IS GROUNDED THROUGH THE CORD OF THE TOOL AND AS SUCH CAN CAUSE DAMAGE TO EQUIPMENT OR CAUSE SERVICE INTERRUPTION, IF USED ON WORKING EQUIPMENT. IN NO CASE SHALL THE METAL HOUSED, ELECTRICAL MOTOR DRIVEN WIRE WRAPPING TOOL BE USED WHEN CONNECTION AT TERMINALS ASSOCIATED WITH WORKING EQUIPMENT, REGARDLESS OF WHETHER THE EQUIPMENT HAS OR HAS NOT BEEN RELEASED BY THE TELEPHONE COMPANY. SEE HANDBOOK 0, SECTION 10, FOR DEFINITIONS OF WORKING OR LIVE EQUIPMENT. IN ALL CASES, CONNECTIONS MADE AT WORKING EQUIPMENT SHALL BE APPLIED ONLY WITH THE WIRE WRAP TOOLS SPECIFIED IN THIS SECTION.

NOTE 1: When it is necessary to connect 20 Gauge wire and an approved bit and sleeve is not available, the lead should not be wrapped around the terminals with a pair of pliers. The lead should be wrapped around a rectangular terminal, a round toothpick, or a nail of suitable diameter, removed, placed on the terminal, and soldered. The same method should be used for 19 Gauge or larger wire. Solder all connections made in this manner.

NOTE 2: On terminals where solderless wrapped connections have been applied (30, 28, 26, 24, 22, and 20 Gauge wire), care shall be exercised that no testing fixture (either push-on or spring clip type) touches or comes in contact with the connection. This is to assure that after a solderless wrapped connection has been made with the wire wrapping tool equipped with the proper bit and associated sleeve, the connection will not be disturbed.

4.1.1 To wrap a wire, insert the skinned portion of a 20 through 30 Gauge wire into the wire feed slot of the correct wrapping bit in the wire wrapping tool, taking care to insert the wire up to the insulation.

4.1.1.1 If the wire is not inserted in the wrapping bit up to the insulation, a "shiner" (bare wire between the insulation and terminal) may result (see Paragraph 3.5.1).

4.1.1.2 To wrap a 28 or 30 Gauge wire end, the shiner plus approximately 1/8" of insulated wire must be inserted into the wrapping bit. This insulated portion of wire inserted into the wrapping bit will provide the 3/4 turn of insulation requirements (refer to Figure 4).

NOTE: The R-4183 (30 Gauge) and R-4435 (28 Gauge) Wrapping Bits have a recess about 1/8" long at the end of the wire slot. This recess allows the insulation to enter the wire slot to provide a modified wrap. Be sure to place the wire into the slot as far as it will go.

4.1.2 Holding the wire with the fingers, bend the insulated portion of the lead into the anchoring notch in the tool sleeve, and push the tool toward the terminal, holding the wire taut in the anchoring notch.

4.1.2.1 The wire may be held taut in the anchoring notch by holding the wire between the fingers and pulling the wire slightly toward the back end of the tool, or by holding the wire against the sleeve immediately in front of the knurled collet nut.

4.1.2.2 Use the right or left anchoring notch in the sleeve, as determined by the direction of approach of the lead, i.e., a lead dressed to the left of a terminal should be placed in the left anchoring notch of the tool.

4.1.3 Insert the wrapping tool on the terminal. Be sure that the tool is held straight and parallel to the terminal.

4.1.3.1 Some apparatus terminals, such as the 288 Type Relay, were designed without a shoulder or tool stop. This will allow the wrapped connection to be placed beyond the wrapping portion of the terminal, thereby, creating an unqualified connection - Be careful, with draw the tool far enough to wrap on the approved portion of the terminals.

4.1.4 Hold the tool on the terminal and squeeze the trigger to wrap the wire on the terminal. The tool will automatically recede as the wire coils on the terminal.

4.1.4.1 Insufficient pressure can cause excessive separation between turns (see Figure 6C).

4.1.4.2 Excessive pressure on the tool can cause overlapping turns (wire not in contact with terminal) (see Figure 6F).

5. CONTINUITY TESTS

5.1 Following completion of the connecting operation, a complete continuity verification shall be made of all wiring connected by the installer. Care should be taken not to disturb the wrapped connections while verifying the continuity. Refer to Handbook 9, Section 900 for continuity methods and tools.

6. WIRE WRAPPING TOOLS

6.1 General

6.1.1 A wire wrapping device is essentially a two part mechanism consisting of a wrapping tool and a wrapping bit and sleeve combination. The wrapping tool drives a bit, which is held in the tool nose assembly and supported by the stationary sleeve. The bit and sleeve, in conjunction, wrap the wire on the terminal.

6.1.2 Prior to connecting an electric wire wrapping tool into the AC power supply, visually check the tool, cord, and plug for any apparent defects or damage. Refer to Paragraph 1.3.1 and check for ground.

6.1.3 Use the R-3184 Adapter when plugging into a 2-wire receptacle, place the adapter into the receptacle, and attach the ground wire clip to the framework or the receptacle mounting plate screw before inserting the tool plug into the adapter. Withdraw the plug before disconnecting the adapter ground lead.

6.1.3.1 Plastic housed electric wire wrapping tools are double insulated and equipped with 2-wire cords and plugs. These tools shall be stamped "double insulated".

6.1.4 There are four types of wire wrapping tools approved for installation use. They are the electric (A-C), Battery (D-C), pneumatic, and manual. A brief description of the various standard tools is provided in Table D.

6.1.5 Several wire wrapping tools have recently been rated Manufactured Discontinued (MD). They are the R-3060, R-3060A, R-3263, R-3263A, R-3777, and R-4006 Tools. An MD rating does not mean to discontinue its use, it simply means that the model is no longer being purchased. Therefore, continue using these tools as long as they provide qualified connections.

6.1.5.1 When an MD tool, or any other wire wrapping tool fails to provide qualified SW connections, it should be returned to Stockkeeping with a defective tag attached to the tool.

7. WRAPPING BITS AND SLEEVES

7.1 Wrapping Bits

7.1.1 A wrapping bit is basically a metal rod with an axial hole in one end and an axial slot cut in the surface. The hole is a recess for the terminal on which a wrapped connection is to be applied. The slot is a

feed slot for the skinned portion of the wire. See Figure 8.

7.2 Wrapping Sleeves

7.2.1 Wrapping sleeves are thin walled steel (long life) or plastic (short life) tubes with a flare and two notches at one end. The sleeve acts to hold the bit and the wire in position during the wrapping operation. Each notch is used to hold the insulating portion of the wire, preventing the insulation from wrapping around the terminal. The flare guides the skinned portion of the wire into the bit feed slot. (Refer to Figure 8).

7.2.2 Bits and sleeves are available in sizes to wrap 20, 22, 24, 26, 28, and 30 Gauge wire. They can be used interchangeably in all approved wrapping tools. Refer to Table C for a complete list of bit/sleeve combinations and usages.

8. VERIFICATION

	VERIFICATION ITEM AND BRIEF STATEMENT OF THE REQUIREMENT	REFERENCE PAR NO	REFERENCE FIG NO
8.1	Unqualified Connections Replaced or Soldered.	1.2.2.1	
8.2	All metal housed tools check for proper grounding.	1.3.1	
8.3	Untinned wire limited to specifically authorized equipment.	2.1.1	
8.4	Partially tinned wire acceptable when no copper is showing on wire surface. 3 turns (20, 22, 24 Ga.), 5 turns (26 Ga.), and 3 turns (28, 30 Ga.)	2.1.2	
8.5	SW apparatus terminals approved in Sections 314A-Z or Section 315.	2.1.3 2.3.2	
8.6	Dyed apparatus terminal ends do not meet requirements.	2.3.3	
8.7	Terminals free of bends, crimps, and kinks.	2.3.4	
8.8	second connection added - solder.	2.3.5.1	
8.9	.009" and .010" embossed terminals not twisted over 180°.	2.3.5.2	
8.10	Do not apply SW connection over solder.	2.3.6	
8.11	Discount turns applied on round portion of terminal.	2.3.8	
8.12	Replace unqualified cross-connect SW connections.	2.5.1	
8.13	Unqualified cable lead soldered - soldered cross-connect too.	2.5.2	
8.14	2-Connection terminal - Allow space for second connection.	2.6.1	
8.15	3-Connection terminal - Allow for second and third connection.	2.6.1.1	
8.16	Insufficient space - Apply 1-1/4 turns and solder all connections.	2.6.3 2.6.5 3.8.1	2
8.17	Turns requirements:		

Gauge	Turns	Terminals		
26	7	Flat Punched and Square Drawn Wire	3.1.1.1	3
26	8	All Others	3.1.1.1	3
24	6	All	3.1.2.1	3

	VERIFICATION ITEM AND BRIEF STATEMENT OF THE REQUIREMENT	REFERENCE PAR NO	REFERENCE FIG NO
	20, 22 5 All 28, 30 7 + (3/4 Insul) All	3.1.3.1 3.1.4.1	3 4
8.18	Separation between turns:	3.2	
8.18.1	20, 22, 24 Ga. - Space between 4 adjacent turns does not exceed	3.2.1.1	5, 6C, 6E
8.18.2	26 Ga. - Space between 6 adjacent turns does not exceed .005" - in no case over .010" viewed by eye.	3.2.2.1	5, 6C
8.18.3	28, 30 Ga. - Space between 5 adjacent turns does not exceed .003" - in no case over .005" viewed by eye.	3.2.3.1	5, 6G
8.19	Bulged turns - No more than 1/2 the circumference.	3.4.1	6D
8.20	Shiners - No more than 1/8".	3.5.2	6B
8.21	Clearance - Never less than 1/64" - Maintain 1/32" on terminals of same or adjacent apparatus.	3.6.1	
8.22	Clearance - Not less than 1/32" on terminals and adjacent metalwork.	3.6.2	
8.23	Clearance - W/S relays 1/32" minimum.	3.6.3	
8.24	Clearance - Wire ends 1/8" maximum away from terminal and maintain 1/64" clearance.	3.6.4	
8.25	Clearance - Wire end to close, wrap down, and solder.	3.6.5	
8.26	SW connection requires solder - 2 adjacent turns (minimum) must be completely soldered.	3.8.3	
8.27	Clearance - Between soldered connection and adjacent terminal, bare wire or soldered connection - 1/64" (minimum).	3.8.4	

1 Indicates information subject to verification.
← Indicates new or changed information.

Engineering Planning Manager
(Installation)

Attachment:
Tables A through C
Figures 1 through 9

Reason for Reissue:
1. To change verbal tool descriptions to easy to read table. Paragraphs 6.2 through 6.7.4 and 9. through 9.7 removed and included in Table B.
2. To remove unwrapping tool information (Paragraphs 8. through 8.6.3) which is duplicated in Handbook 9 Section 350.
3. To add Paragraphs 2.1.1.1 and 2.1.1.2 to clarify information about untinned connector cable.
4. To reference continuity test sections in Paragraphs 1.4.1 and 5.1

TABLE A. SHIVER LENGTH LENGTHS/WIRE GAUGE
(PAR. 2.4.2)

Terminal Type	Wire Gauge 20	22	24	26	28	30
Flat Punched .030" x .060"	1-5/8"	1-5/8"	1-5/8"	2"	2"	2"
Square .045"	1-5/8"	1-5/8"	1-5/8"	2"	2"	2"
Square .025"	X	X	X	1-1/8"	1-1/8"	1-1/8"
Embossed .009" or .010"	X	X	1-1/2"	1-5/8"	X	X
Twisted and Coined	X	1-5/8"	1-5/8"	X	X	X

TABLE B. WIRE WRAP TOOLS AND ACCESSORIES
(PAR. 6.1.4)

TOOLS FOR SWW CONNECTIONS

TOOL CODE	RAMAC NO	DESCRIPTION	NOTES
WIRE WRAPPING TOOLS			
R-4348	6828806	Pneumatic WW gun	SP 666-8 or GD-2613AA4
R-4358	6843946	Continuous Strapping Bit (Reqs. KS 20963L1 R-4361)	For all Term. exc. .025 Sq.
R-4361	6843086	Pneumatic Continuous Strapping Gun	GD 14TA1
R-4437	0480475	Battery operated Wire Wrap Gun w/Charger and Case	For CN's, light Duty wiring Jobs 30 Ga. mods.
R-4437 Det 1	6862912	Battery for GD Guns	GD 525635
R-4437 Det 2	6862896	Charger for GD Guns	GD 517140
R-4437 Det 5	1615518	Charger for OK Mach. Guns	OK BC-3-115
R-4437 Det 6	1615526	Battery set for OK Guns	OK RB-20
R-4496	6873711	Electric Wire Wrap Gun E/W 20 ft. cord	GD 27178AA1 or SP 615 B-2
TK-512	0470684	Continuous Strapping Kit	R-4358 & R-4361
KS 16363 L3.	6876607	Hand Squeeze WW Gun	
COMPRESSORS			
R-4092	0480418	Air Compressor - 3/4 H.P.	Eight guns max.
R-4378	0480392	Air Compressor - 1/3 H.P.	Three guns max.
R-4440	0478149	Air Compressor - 1 H.P.	Ten guns easily

TABLE B. WIRE WRAP TOOLS AND ACCESSORIES
(PAR. 6.1.4)

TOOLS FOR SWW CONNECTIONS

TOOL CODE	RAMAC NO	DESCRIPTION	NOTES
ACCESSORIES			
R-4236	0482455	Air Hose Manifold	Two 24 ft X 1/4 Dia Air Hose Eq. with 10 outlets
R-4349A	6878496	Flexible Air Hose	
R-4438 L1	6856799	Two Inch Bit Extension	OK Mach. EXT-2
R-4438 L2	(1st Q 83)	Four Inch Bit Extension	OK Mach. EXT-4

NOTE 1: GD = Gardner Denver Cat. No. SP = Standard Pneumatic Cat. No.
OK = OK Machine and Tool Co. Cat. No.

NOTE 2: FIELD MAINTENANCE is limited to plug replacement on Electric guns. (R-2178/RAMAC 6763600 for 2 wire cords and R-3185/RAMAC 6733840 for three wire cords.) For Pneumatic guns, only preventive maintenance is required. (Add one drop of R-4021/RAMAC 6697300 oil to the quick disconnect on the gun daily.) Battery and Manual wire require no maintenance. If they become defective they should be replaced.

NOTE 3: Refer to Figure 7 for Method of Replacing Electrical Plugs and Figure 9 for Manifold Air Distribution System.

TABLE C. BIT AND SLEEVE COMBINATIONS
(PAR 7.2.2)

WIRE WRAP BITS AND SLEEVES

BIT	SLEEVE	GA.	RAMAC	SUPPLIERS CATALOG NUMBERS				REMARKS
				GD	OK	OB	HFW	(see note 4)
R-4495	KS 20963 L1	20/22	6859504 6859587	Note 1 "	note 1 "	Note 1 "	Note 1 "	For all terms. exc. .025 Sq.
KS 16734 L1	KS 20963 L1	22/24	6786426 6859587	Note 1 " 1&2	Note 1 " 1&2	Note 1 " 1&2	Note 1 " 1&2	For all terms. exc. .025 Sq.
R-4917	R-4793	24/26	1624619 6873943	502129	KB2466 P3032LN	25105* 40202	4793	For all terms. exc. .025 Sq.
R-3711	R-3710	24	6684480 6753822	Note 1 "	Note 1 "	Note 1 "	Note 1 "	5"L all terms. exc. .025 Sq.
R-4792	R-4793	24	6873844 6873943	502134 502129	KB2444 P3032LN	24504 40202	4792 4793	For .025 Sq. Terms.
R-3786	R-3710	26	6684506 6753822	Note 1 "	Note 1 "	Note 1 "	Note 1 "	5"L all terms. exc. .025 Sq.
R-4660	R-4184	26	6865428 6753848	505279 507100	KB2639 P26LN	26114 40301	4660 4184	For .025 Sq Terms.
R-4435	R-4184	28	6852756 6753848	509278 507100	WB28SHM P26LN	28502 40301	4184	For .025 Sq. Terms. Mod.Wrap
R-4604	KS 20963 L3	28	6864157 6859579	505412 Note 1	Note 1	Note 1	Note 1	For all Terms. exc. .025 Sq.
R-4471	R-4472	30	6855312 6855288	501381 512056	WB30MLD* P2426*			For all Terms. exc. .025 Sq.
R-4183	R-4184	30	6684548 6753848	507063 507100	WB3032M P26LN	31500 40301	4183 4184	For .025 Sq. Terms. Mod. Wrap
R-4924 Equipped With Sleeve		30	1628610					Spec. Cut,Strip & Wrap Tool For Backplane Mods.

R-5160	30	1627620	SB30SHB5 31500-5 70186	5" lg. for .025
R-5161		1627448	P-3032-5 40301-5 70500	Sq. Terminals.

NOTE 1: Manufactured and Inspected to Western Electric Drawing Standards. "R" or "KS" identifying code is stamped on tool. KS 16734 L1 is identified by a Red band on the shank.

NOTE 2: The KS 20963 L1 Sleeve is marked "20-22 Gauge" but is also used for "22-24 Gauge".

NOTE 3: An all plastic sleeve (R-3220, RAMAC 6753764 may be used in place of the KS 20963 L3 Sleeve. This sleeve is intended for limited application on live equipment and has a useful lifespan of only 1500 connections.

NOTE 4: GD = Gardner Denver Co. OK = OK Machine and Tool Corp.
OB = Ostby and Barton Co. HFW = H.F. Wilson Co.

* Indicates an approved Manufacturers Number not listed on the Engineering Specification.

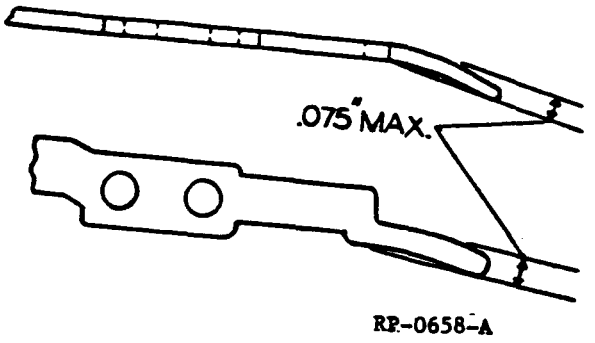

FIG. 1 PERMISSIBLE BOW IN TERMINALS (PAR. 2.34)

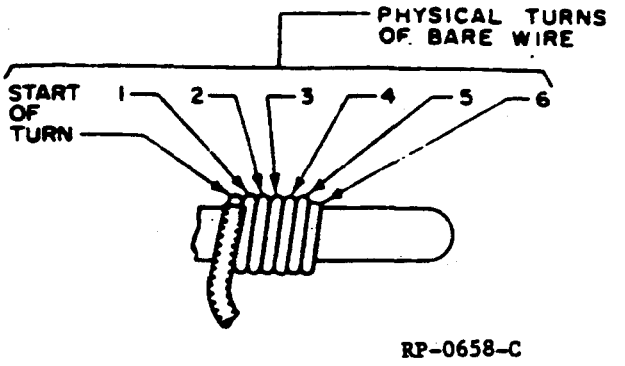

FIG. 3 A SOLDERLESS WRAPPED CONNECTION (6 TURNS SHOWN) (PARS. 3.11, 3.121, 3.131)

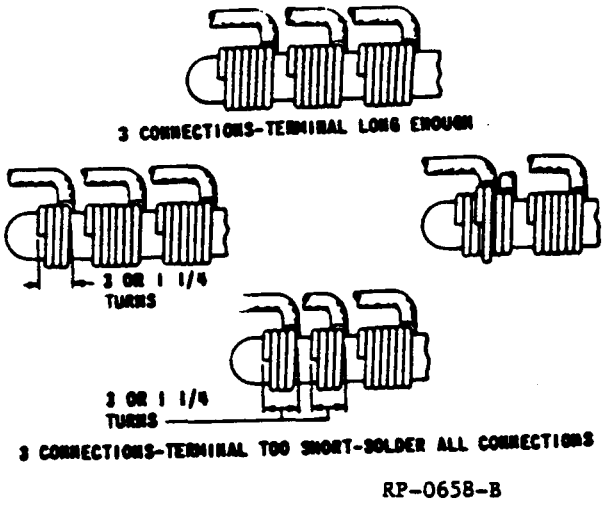

FIG. 2 MORE THAN ONE WIRE ON A TERMINAL (PARS. 2.62, 2.65)

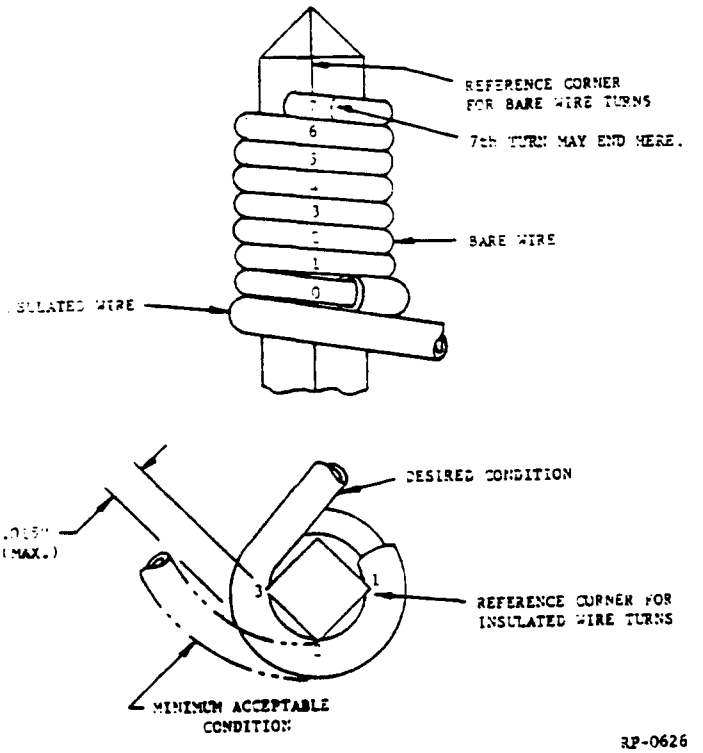

FIG. 4 28 OR 30 GAUGE CONNECTION
(PARS. 3.141, 4.112)

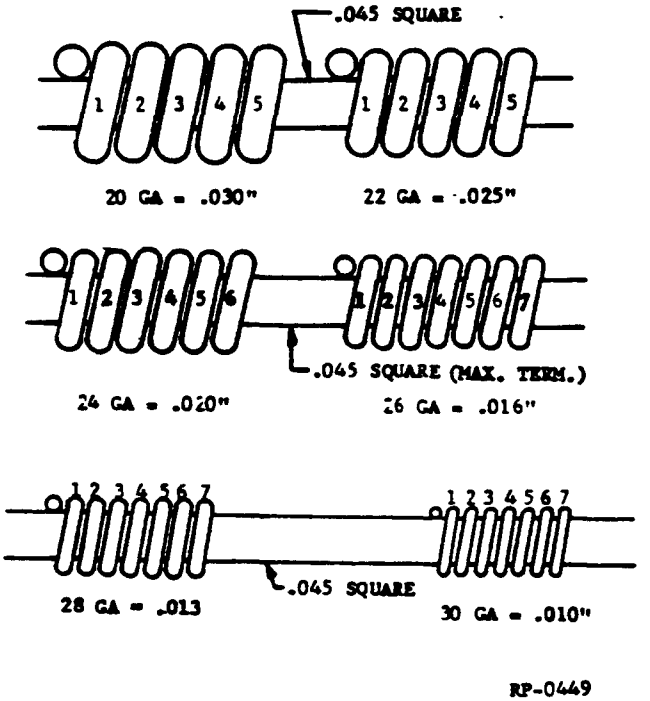

FIG. 5 SCALED SKETCH INDICATING NUMBER OF TURNS OF 20, 22, 24, AND 26 GAUGE WIRE WITH SPACINGS OF .005". ALSO, 28 AND 30 GAUGE WIRE WITH SPACING OF .003"
(PARS. 3.211, 3.221)

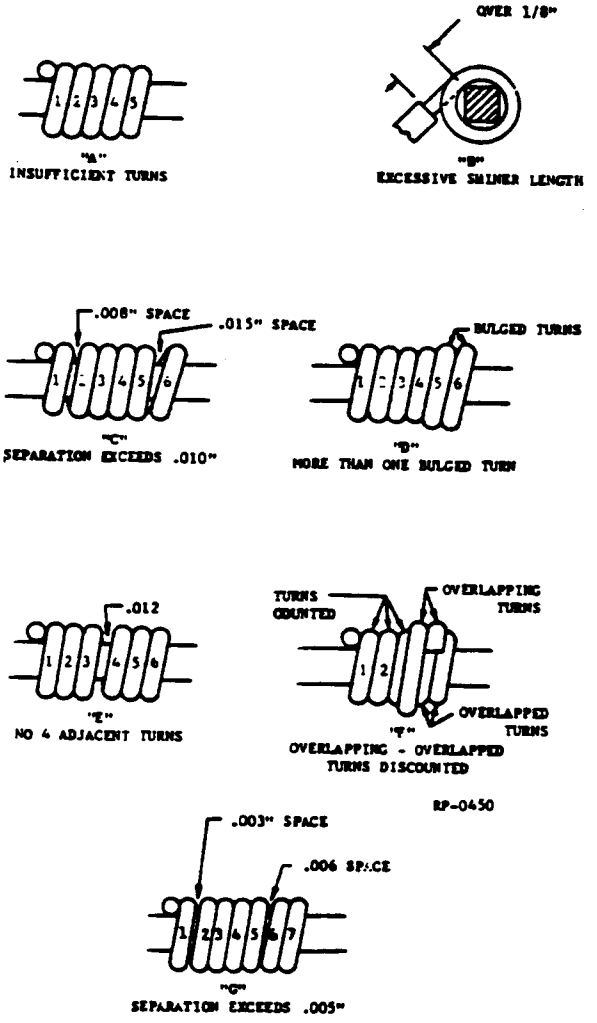

FIG. 6 A SCALED SKETCH DEPICTING TYPICAL SOLDERLESS WRAPPED CONNECTION 24 GAUGE DEFECTS A THRU F, 28 GAUGE DEFECT SHOWN IN "G" (PARS. 3.211, 3.221, 3.231, 3.31, 3.41, 3.52, 4.151, 4.152)

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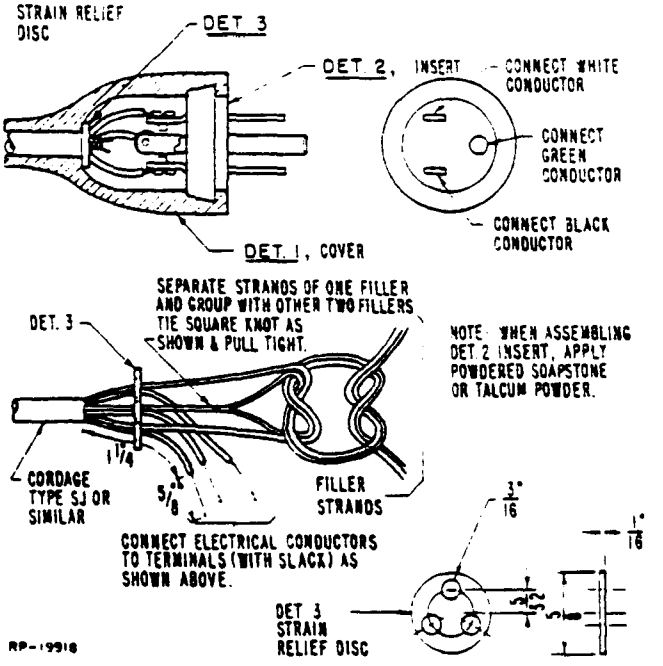

FIG. 7 METHOD OF REPLACING PLUG
(TABLE C, NOTE 3)

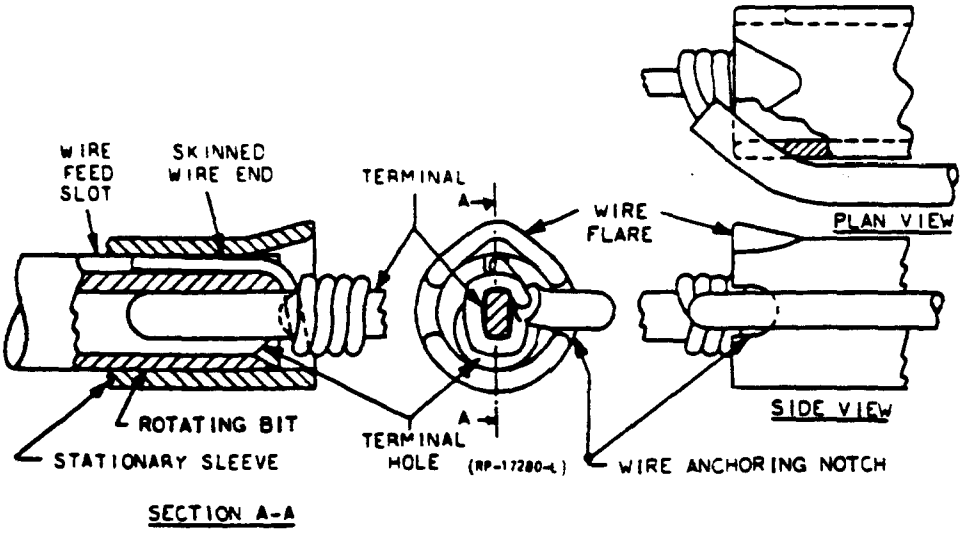

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FIG. 8 (PAR. 7.11, 7.21)