

Cabling Methods Connecting Wires (Solderless Wrap Methods)

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1. General

- 1.1 Purpose** This addendum was issued to update information for wire wrapping of **20** and larger gauge wire contained in GTE Telephone Operations Addendum 256-050-211, Issue 1.
- 1.2 Filing Instructions** File this addendum with the practice in numerical order in your GTE Telephone Operations Practices set.
- 1.3 Copyright and Responsibility** This addendum was published by the GTE Telephone Operations Administrative Services Department. For more information about this practice contact the Headquarters COE Construction Department.
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- 1.4 Disclaimer** This addendum was prepared solely for the use of GTE Telephone Operations. It must be used only by its employees, contractors, customers and end users, when installing, operating, maintaining, and repairing GTE Telephone Operations' equipment, facilities and services. Any other use of this practice is forbidden. The information contained in this practice may not be applicable in all circumstances and is subject to change without notice. By using this practice the user agrees that GTE Telephone Operations will have no liability (to the extent permitted by applicable law) for any consequential, incidental, special, or punitive damages that may result.

2. Adding the Revised Pages to Practice 256-050-211

2.1 Replace the revised pages as follows:

Page Replacements	Revised Pages...	Action...
	1 and 2	Remove old pages 1 and 2 and replace with new pages (single sheet).

2.2 Revision bars mark all parts of the practice which are changed by this addendum.
Revision Bars

**CABLING METHODS
CONNECTING WIRES
(SOLDERLESS WRAP METHODS)**

1. GENERAL

1.01 This section presents the recommended methods and procedures to be utilized when connecting wires to and removing connected wires from solderless-wrapped terminal blocks. The methods of connection repair are also explained or referenced, as applicable, within this section. The information presented within this section applies, as indicated, to both electronic and non-electronic installations.

1.02 This section is reissued to add information to part 2. Because of the numerous changes involved, change indicators are omitted. Remove the previous issue of this section from the binder or microfiche file and replace it with this issue.

1.03 Refer to Section 256-050-208 for the recommended methods of connecting wires by using the wrap and solder method. Refer to Section 256-152-200 for the recommended methods of connecting wires to the quick-connect type terminal blocks. Section 075-630-101 describes the wire-wrapping tools bits, and sleeves that are required to accomplish the solderless-wrapping methods explained within this section.

1.04 GTE AE practices are used by GTE employees for operating and maintaining the equipment GTE AE manufactures and sells. These practices may change or may not be suitable in a specific situation and so are recommended as suggested guidelines only. GTE AL hereby disclaims any responsibility and/or liability for any consequential or inconsequential damages that may result from the use of such practices unless such practices are utilized in conjunction with the operation and maintenance of original equipment manufactured or supplied by GTE AE and covered by its standard warranty. GTE AE acknowledges that the customer's special requirements policy/practices may take precedence over those supplied by GTE AE if conflicts develop during installation and ongoing operation.

1.05 This document is provided with the understanding that it shall not be copied or reproduced in whole or in part or disclosed to others without the prior written permission of GTE Automatic Electric Incorporated.

2. RECOMMENDED TOOLS AND MATERIALS

2.01 The following tools and materials are recommended to facilitate the various connecting operations described in this section:

- (a) Connecting bag.
- (b) Installer's mat.
- (c) Wire stripper.
- (d) Wire-wrapping tool.
- (e) Wire-wrapping bit.
- (f) Wire-wrapping sleeve.
- (g) Mechanically powered unwrap tool.
- (h) Electric-powered unwrap tool

CAUTION: Because of the static discharges produced by the tool, its use should be limited to electromechanical regrades-- and removals only. Under no condition, should this tool be used on electronic offices.

3. PREPARATION

3.01 The individual wires must be connected in accordance with the color codes called out in the appropriate 702 Specification or job drawing, or in the manner prescribed in the GTE Practice applicable to the equipment being used. To avoid errors, the color code should be verified each time a specific conductor is handled.

3.02 Framework details that may block or hinder the necessary solderless wrap operations should be temporarily removed or relocated, as applicable. For example, terminal board protectors, decorative panels, and other hindrances on the frames or around the terminal blocks being accessed must be removed to permit the appropriate solderless wrap tools to be used. Doing so also provides the installer with visual access to a connection point.

3.03 All equipment beneath and adjacent to a work location is to be protected from falling stripped wire ends and insulation. The use of a connecting bag and an instalkrls mat to catch the falling particles and scrap wire ends is recommended. When making connections to terminal blocks carrying working circuits, be especially careful to see that trimmed wire ends do not come in contact with, or fall upon, the working connections.

3.04 Prior to connecting wires to solderless-wrapped terminals of working circuits, contact the appropriate supervisor to have the associated equipment released from service, if possible. When making connections to terminals near other working terminals, use all possible care to avoid damaging the working equipment or the solderless wrap tools by grounding or shorting the tools to these working terminals. Follow the appropriate safety precautions outlined in the 200-001 subdivision of GTE Practices.

3.05 When solderless-wrapped connections have been applied, no testing fixture, either push-on or spring clip type, is to come in contact with the wrapped wire. Either type of test fixture will tend to loosen the connection, making replacement or solder repair necessary.

4. TYPES OF SOLDERLESS-WRAPPED CONNECTIONS

4.01 There are two types of solderless-wrapped connections; the conventional and the modified solderless-wrapped connection. The two types of connections and the different gauge wires each is associated with are described in the following paragraphs.

Conventional Solderless-Wrapped Connections

4.02 A conventional solderless-wrapped connection is a spiral of continuous and solid uninsulated wire that is wrapped around a terminal to produce a mechanically and electrically stable connection (Figure 1). A conventional connection is automatically made when terminating a 20, 22 and 24-gauge wire.

NOTE: when connecting a 20 gauge wire, an electric wire wrap gun with the correct bit must be used.

Modified Solderless-Wrapped Connection

4.03 A modified solderless wrapped connection is a conventional connection, as described in paragraph 4.02, with the insulated connection lead wire wrapped around at least three corners of the terminal (Figure 2). A modified connection is automatically made when using a wire-wrapping tool to connect 26- or 28-gauge wire in electronic systems.

5. STRIPPING THE INSULATION

5.01 Each conductor is to be stripped of the insulating cover at the correct length as recommended in Table 1. This table also provides the minimum quantity of wrapping turns that are recommended for the various gauges of wire. The number of turns of wire in a connection is directly proportional to the length of the skinned wire, and inversely proportional to the terminal size and wire size. The quantity of turns are counted from the point where the skinned wire touches the first terminal corner. For example, a skinned length of 1-9/16 inches is sufficient to provide the required quantity of turns (six) of 24-gauge wire (Figures 1, 2, and 3).

5.02 care should be exercised when skinning conductors for solderless-wrapped connections. Although minor surface nicks, scratches, plating on the conductor, burnishes, or similar defects of the stripped (skinned) wire are permissible, they must not be of a nature to induce subsequent failures.

NOTE: Prior to skinning any conductors from cables, the cables must be properly tied or laced in their permanent positions on the frames or other applicable locations. The required maintenance loop allowance for the particular relationship between the fanning strip and the main cable drop must be maintained also.

5.03 When stripping plastic-insulated conductors, use the wire-stripping tool which is designed for the gauge of wire to be stripped. The use of the wrong gauge wire-stripping tool may cause either incomplete cutting of the insulation or may cut the wires as well as the insulating cover.

5.04 For more detailed information concerning the proper methods of skinning and fanning conductors, refer to Section 256-050-205.

6. CONNECTING THE WIRES

6.01 Acceptable solderless-wrapped connections must be able to permanently provide a connection with the following characteristics:

(a) Mechanical stability.

- (b) Metal-to-metal, gastight, corrosion-free contact area.
- (c) Correct quantity of turns per wire gauge.
- (d) No overlapping of turns.
- (e) No straddled connections.
- (f) No excessive space between inside turns.

6.02 Connections that have been properly made with the standard solderless-wrapping tools will normally meet the requirements for solderless-wrapped wires. However, to ensure that the solderless-wrapped connections are being made properly, each connection should be visually checked by the installer as it is completed. All connections which do not visually meet the recommended specifications must be either soldered, as referenced in part 8, or replaced as may be applicable. An acceptable solderless-wrapped connection is shown in Figure 4.

Wrapping 18- Through 14-Gauge Wire

6.03 In some instances, it may become necessary to connect 18-gauge wire to terminals that are designed to accept larger gauge wrapped connections. In those instances the following rules should be applied:

- (a) The terminal should be a minimum of one wire size larger than the thickness of the wire. For an 18-gauge wire, the terminal size should be the size of a 16-gauge wire or larger.
- (b) A hand wrap 18-gauge tool should be used to make the connection. The wrap should be soldered in accordance to procedures defined in paragraph 8.
- (c) No wire wrap connection should be made with wire larger than 18 gauge. Any manufacturer directions that are contrary to this statement should be brought to the attention of COEI Headquarters Staff.

Wrapping 74-u Wire to Relays

6.04 When making wrapped connections on the spring pileup terminals of electromechanical relays, use only 24-gauge wire, wrapped with the wrapping bit designated in Section 075-630-101.

NOTE: Do not use a combination 22-24 gauge bit and associated sleeve on relay spring pileups, because sufficient access clearance is not available for the combination bit and sleeve. The use of this combination bit and sleeve in the specific application will damage the adjacent wrapped connections and terminals.

Use of the Wrapping Tool

6.05 The skinned portion of the wire is to be inserted into the solderless wrapping bit wire feed slot. Insert the wire or skinner up to the remaining insulation. Figure 5 shows the proper method of inserting the wire (Figure 5a, b, and c) by anchoring the lead (Figure 5d), placing the tool over the terminal (Figure 5e), and wrapping a wire (Figure 5f). If the wire is not inserted up to the insulated portion of the conductor, an exposed skinner condition may result as shown in Figure 6a. This condition may also cause an insufficient quantity of turns on the connection which would be considered unsatisfactory and unacceptable. A slight exposed skinner condition is allowable;

however, such exposed skinner must not exceed 1/8 inch.

NOTE: On items such as relays, where the terminals are very close together, the maximum allowable exposed skinner length must be held to 3/32 inch. If the exposed skinner is not more than 1/16 inch over its maximum allowable length, it may be carefully "wiped" around its own terminal manually. Although this creates a modified wrap, it is acceptable.

6.06 After inserting the wire into the wire feed slot of the wrapping bit, anchor the conductor into the bit by bending the insulated portion of the lead into the sleeve anchoring notch as shown in Figure 5d. Either the left or right anchoring notch can be used as required. The use of either the left or right notch is to be determined by the direction that the conductor is to feed off of the terminal into the fanning area, i.e., a conductor that is to feed to the left of the terminal (right side of terminal block), is to be anchored in the left notch of the sleeve, and a conductor that is to feed to the right of the terminal (left side of terminal block), is to be anchored in the right notch of the sleeve.

6.07 Hold the wire taut in its anchoring slot and insert the wrapping tool onto the terminal as shown in Figure 5e. If the terminal shoulder is exposed, the wrapping tool should not be pushed down upon the shoulder of the terminal. This will cause straddling as shown in Figure 6b. If straddling occurs, the wrapped wire will be nicked by the shoulder of the terminal, causing an unsatisfactory condition that may necessitate replacement of the connection and possibly a damaged terminal. Likewise, if there is already one connection made on a terminal, the wrapping tool should not be placed directly upon the previous wrapping, because this may cause overlapping as shown in Figure 6c. When an overlap condition exists, both connections must be replaced or, in some cases, can be soldered on nonelectronic systems.

CAUTION: It is important that the wrapping tool be kept in line with the terminal prior to and during wrapping operation. If the wrapping tool is not properly aligned with the terminal, the terminal may be bent or broken and/or the wrapped wire may be damaged in the wrapping operation.

6.08 The wrapping tool will automatically recede as the coils are wrapped around the terminal as shown in Figure 5f. This requires that a pressure of approximately 2 pounds be exerted upon the wrapping tool to keep the wrapped turns in a closely wound connection. If insufficient pressure is exerted upon the wrapping tool during the wrapping operation, a condition called "open spiraling" will result as shown in Figure 6d. The spaces between any of the inside turns of a wrapped connection must not exceed 0.005 inch or one-fourth of the diameter of the wire being used, as gauged by eye. Any connection exceeding this spacing must be soldered or replaced. In electronic systems, where soldering is not generally permitted, such a connection must be replaced.

NOTE: If the terminal can be seen between the wrapped turns, the connection should be replaced or soldered as applicable.

6.09 Reapplying the wrapping tool to a connection (called "regunning") is never acceptable. This method may serve to close up an open spiral condition or complete an incomplete wrap, but it also loosens and damages the wrapped connection, as shown in Figure 6e. The connection must either be repaired by soldering or replaced.

6.10 Applying excessive pressure on the wrapping tool during the wrapping operation will cause a condition called overwrapping or overriding as shown in Figure 6f and g. This will loosen and disturb the turns that are already made and can cause extensive damage to the last turns of the wrapped connection. This type of connection is, of course, unsatisfactory; it must be related if overwrapped, as in Figure 6g, or repaired by soldering.

6.11 Removing power from the wrapping tool too quickly, not maintaining sufficient pressure when approaching the end of the wrap, or an excessively worn or raised section on the face of the wrapping bit around the wire feed slot and terminal hole may cause an incomplete wrap or excessive pigtail protruding from the wrapped terminal, as shown on Figure 6h and i. The wire end does not have to be left against the terminal but the protruding wire end (pigtail) must not exceed 3/32 inch.

NOTE: A 1/64-inch clearance between the tip of the pigtail and any adjacent terminal must be maintained at all times. If over a 1/64-inch pigtail exists, the pigtail should be wrapped around its terminal to eliminate the condition. Soldering or replacement is not required on this wrapped portion of the pigtail. Never clip the pigtail off because the action of the clipping may tend to loosen the other wrapped portions of the wire.

Multiple Connections per Terminal

6.12 It is not unusual for more than one connection per terminal to be necessary. In these instances, the method of wrapping the second or third connection is determined by the terminal length remaining after making the first wrapped connection. For example, each six-turn wrapped connection occupies approximately 1/4 inch of the terminal. If another connection is to be made on that terminal, at least 1/4 to 1/2 inch of terminal must remain to apply the necessary second and/or third wrapped connection of the same gauge wire.

6.13 When applying more than one connection to a single terminal with the solderless-wrapping tool, the connections should be closely placed as shown in Figure 7a. They should not overlap each other as shown in Figure 6c. If sufficient terminal length is not available to accommodate the required quantity of wrapped connections per terminal, two to three turn connections, as shown in Figure 7b, may be applied. Where this modification is necessary, these terminations must be soldered by the

method applicable to the equipment or system being installed. The soldering methods are given in part 8.

6.14 In some instances, sufficient terminal length will not be available to accomplish the modification explained in paragraph 6.13. In this instance, a two- to three-turn connection can be manually wrapped around the last or outside wrapped connection, as shown in Figure 7d, and then soldered.

CAUTION: Extreme caution must be exercised in this operation so that adjacent terminations do not become damaged and the terminal being wrapped does not become twisted or damaged. This procedure is not recommended if it can be avoided by any other method or utilization of another terminal that is common with the terminal being used.

NOTE: Where terminals designed for solderless-wrapped connections are provided and jumper wire terminations are used, any defective solderless-wrapped connections cannot be repaired by soldering but must be removed and replaced.

7. REMOVING AND REPLACING WRAPPED CONNECTIONS

7.01 When it becomes necessary to remove a soldered-wrapped connection, the mechanical and electrical unwrapping tools are not to be used. The unwrapping tool is a precision tool, and solder on the metal bit can permanently damage the tool. Heat from the soldering iron may also warp or melt the insulating material covering the sleeve of the unwrapping tool. Whenever the wrapped connection to be removed has been soldered, a soldering iron must be applied to the connection and the spiral unwound with pliers. Care must be taken to prevent damage to adjacent terminals and to keep solder from dripping on adjacent terminals and connections.

7.02 The spiral of a solderless-wrapped connection may be unwound with the standard unwrapping tool (Figure 8). No attempt should be made to remove the wrap from the terminal by pulling on the lead. This may bend the terminal or break the wire and make the wrap difficult to remove.

7.03 When unwrapping a solderless-wrapped connection, keep the unwrapping tool aligned with the longitudinal axis of the terminal and apply only a slight amount of pressure against the connection. Excessive pressure against the connection or improper alignment of the unwrapping tool (with respect to the terminal) will bend or otherwise damage the terminal.

7.04 The electric unwrap tool is used to assist the installer in the removal of large quantities of wire wrapping during major equipment regrades and the removal of equipment designated for a reuse program. The electric unwrap tool is powered by 115 Vac. There is no need to store this tool in a recharge base when not in use or to stop production for recharge during heavy usage.

CAUTION: Because of the static discharges produced by the tool, its use should be limited to electromechanical regrades and removals only. Under no conditions, should this tool be used on electronic offices.

7.05 Whenever solderless-wrapped connections must be removed and then reconnected, proceed as follows :

- (a) When there is sufficient slack in the lead to obtain the proper skinned length for a solderless-wrapped connection, remove the connection cut the previously connected lead back, and reconnect the lead. The strength of the previously wrapped skinned length of the lead has been reduced by the first connection and should never be reused when reconnecting the lead.
- (b) Where there is insufficient slack in the lead to make a solderless-wrapped connection, a soldered-wrapped connection may be applied or, where permissible, the lead can be spliced and a solderless-wrapped connection applied.
- (c) In the case of a jumper, if there is sufficient slack in the lead for a solderless-wrapped connection, remove the connection, cut the previously connected lead back, skin the lead, and reconnect the wire by the prescribed solderless-wrap method. If there is insufficient slack in the jumper, replace the entire jumper length.

7.06 Solderless-wrapped connections that have been removed, properly cut back, skinned, and rewrapped on previously unsoldered terminals do not require soldering, provided they meet the acceptability requirements outlined in paragraph 6.01. If, however, the previous connection on a terminal was soldered, the new connection will also require soldering.

8. SOLDER REPAIR OF WRAPPED CONNECTIONS

8.01 It is recommended that defective solderless-wrapped connections be replaced whenever possible. Soldering should be avoided because it tends to burn wires, cause shorts, and creates difficulty in accomplishing circuit changes, modifications, and field conversions. Although soldered-wrapped connections, if done properly, will meet the requirements of wrapped connections and may even add to the mechanical stability of a connection, they also add the undesirable characteristic of a localized stress concentration at the point where the wire exits the solder point. The type of defect, the remaining terminal length available, as well as the terminal use, access, clearance, and location are some of the factors to be considered prior to making a solder repair or initial connection with the use of solder.

NOTE: In general, soldering is not permitted in electronic systems, except on some of the associated electromechanical frames. The small-gauge wire, and proximity of associated integrated circuit components and their sensitivity to heat, as would be generated by the use of a soldering iron, prohibits its use.

8.02 When terminal usage is constant and not subject to foreseeable changes and when insufficient access clearance exists for removing and replacing the connection without damage to adjacent terminals and connections, the defective solderless-wrapped connection may be soldered. In general, once a terminal connection is soldered, all wrapped connections added to that terminal must be soldered, unless the remaining terminal length is free of solder.

8.03 To make a soldered-wrapped connection, a skinned length of approximately 3/4 inch of wire is normally sufficient to provide two to three turns of wire around the terminal as shown in Figure 9. Three turns should normally be used to make an acceptable soldered-wrapped connection. Care should be taken when making a soldered-wrapped connection so that no solder shorts to an adjacent terminal falls onto other terminals or equipment.

TABLE 1. RECOMMENDED SKINNER. LENGTH ($\pm 1/16$ INCH) AND QUANTITY OF TURNS PER WIRE GAUGE.

WIRE GAUGE (AWG)	SKINNER LENGTH (INCHES)	QUANTITY OF TURNS
22	1-9/16	5
24	1-9/16	6
26	1-15/16	7
28	1-1/16	7

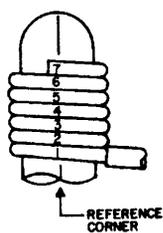


Figure 1. Conventional Solderless-Wrapped Connection.

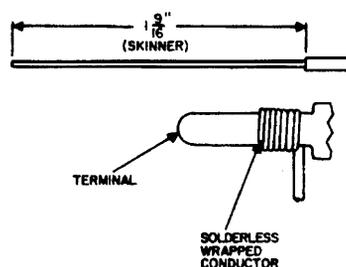


Figure 3. Example of Skinner Length and Wrapped Terminal.

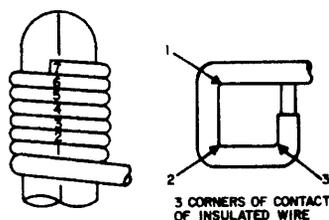


Figure 2. Modified Solderless-Wrapped Connection.

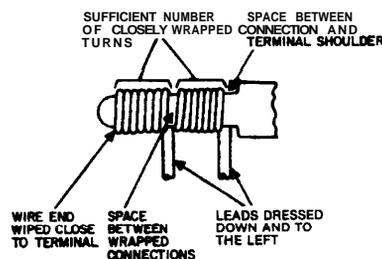


Figure 4. Example of Visually Acceptable Solderless-Wrapped Connections.

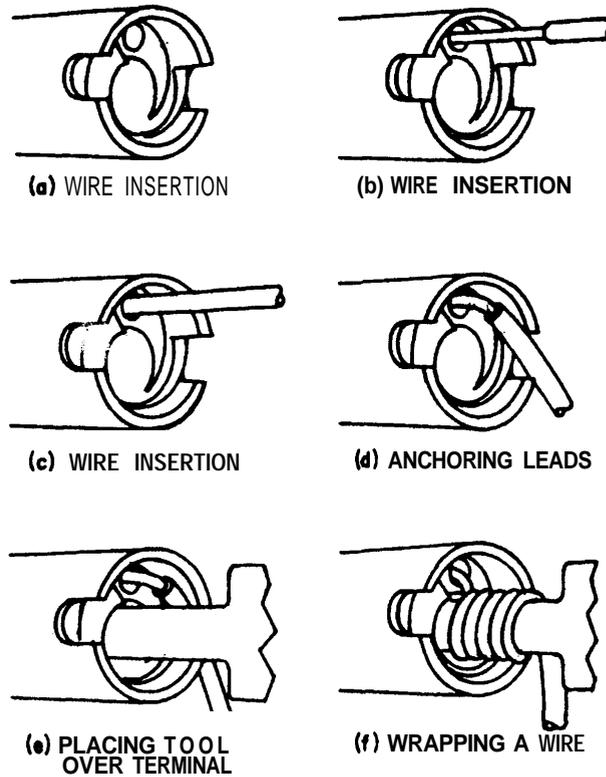


Figure 5. Wrapping Operation Procedure.

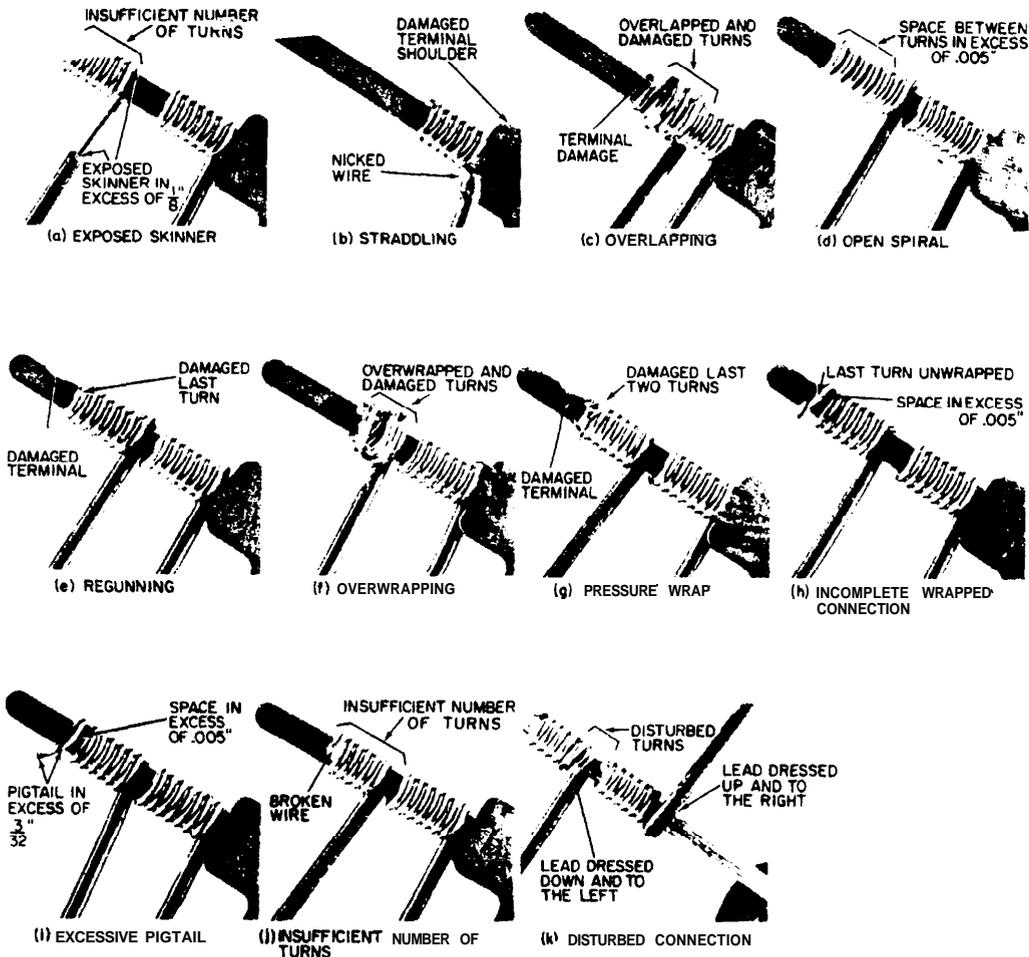


Figure 6. Example of Defective Solderless-Wrapped Connections.

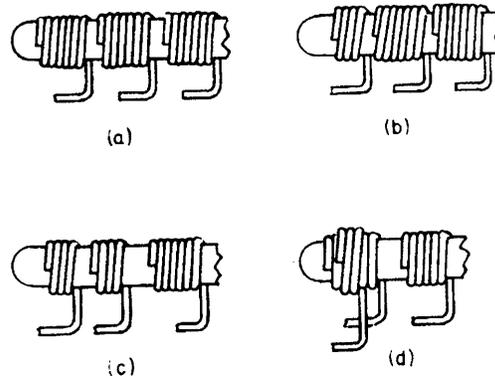


Figure 7. Example of More Than One Connection Per Terminal.

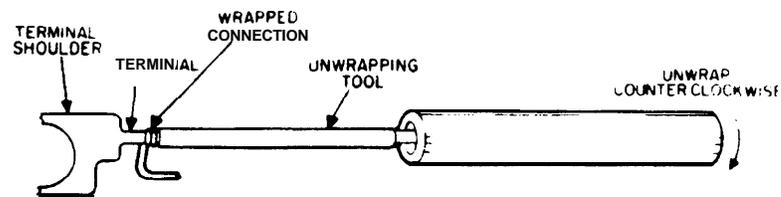


Figure 8. Removing a Solderless-Wrapped Connection.

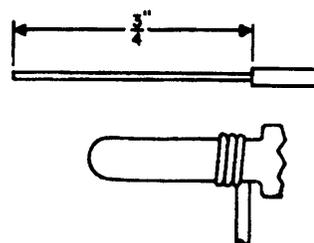


Figure 9. Example of Skinner Length and Soldered, Wrapped Connection.