

3M MODULAR SYSTEM SPLICING
 SWITCHBOARD AND ABAM CABLE

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1. GENERAL

1.1 The purpose of this section is to provide instructions for using the 3M Modular System Splicing (3M/MS²) Method to splice switchboard cables having polyethylene, PVC, or a serving of cotton over PVC insulated conductors and multiconductor cables having common external shields (ABAM type cable). 3M/MS² will splice up to 25 pairs of conductors at one time.

1.2 The 3M Modular System is approved for splicing the following types of cables:

<u>Type of Cable</u>	<u>Gauge</u>
CL	22, 24
A	22, 24
M	22, 24, 26
R	22, 24

1.3 Other types of shielded cable (coaxial or types with individually shielded pairs) and other gauges are not covered by this method.

1.4 Splicing, recabling, etc., may be done only if authorized in Telephone Company or Western Electric specifications, by other instructions from the Equipment Engineering Organization, or by a Telephone Company letter applying to the particular cables involved.

1.5 3M/MS² Module Contacts which have been used shall not be reused under any conditions.

2. INSTALLING EQUIPMENT

2.1 Tools and Supplies

2.11 The R-4374 Modular Connector (for end-to-end splices) consists of a base, body, and cover as illustrated in FIG. 1. It can be used to splice up to 25 pairs of conductors.

2.12 For half-tapping (Y-splice) only, the R-4375 Modular Connector is used. It is the same as the R-4374 Modular Connector except that the base lacks the wire cut-off knives (see FIG. 1).

2.13 To perform the crimping operation on the R-4374 and R-4375 Modular Connectors, the R-4373 Splicing Rig is required. It consists of the following:

<u>Detail Number</u>	<u>Description</u>	<u>Figure</u>
1	Hand/Hydraulic Crimp Unit	2
2	Splicing Head	3
3	Cut Closed Tool	4
4	Pair Test Plug	4
5	Check Comb	4
6	Cover Removal Tool	4

**NOTICE - NOT FOR USE OR DISCLOSURE OUTSIDE THE BELL
 SYSTEM EXCEPT UNDER WRITTEN AGREEMENT**

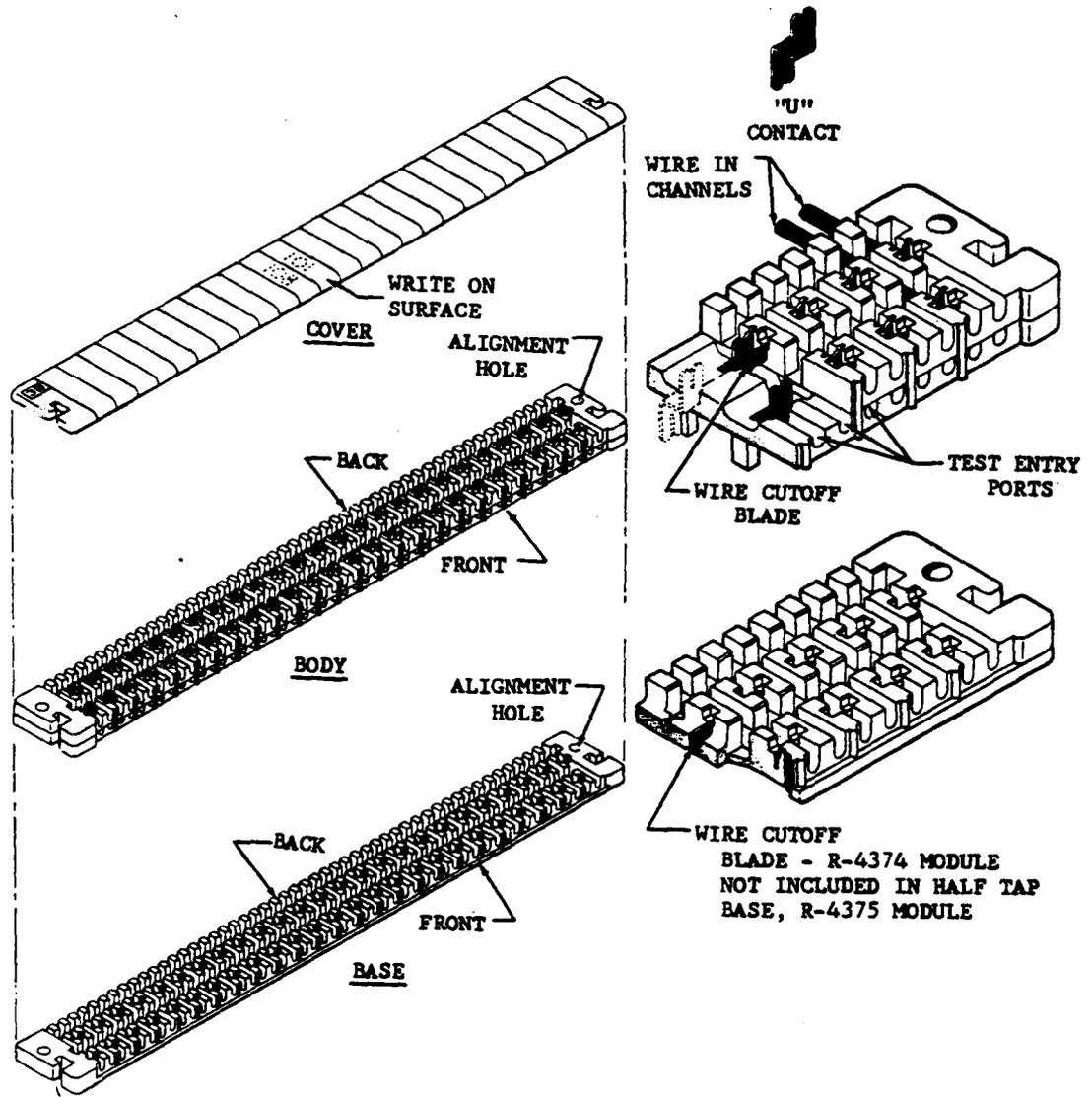


FIG. 1 R-4374 CONNECTOR ASSEMBLY COMPONENTS:
CONNECTOR BASE, BODY AND COVER
(PAR. 2.11, 2.12, 3.72, 3.722)

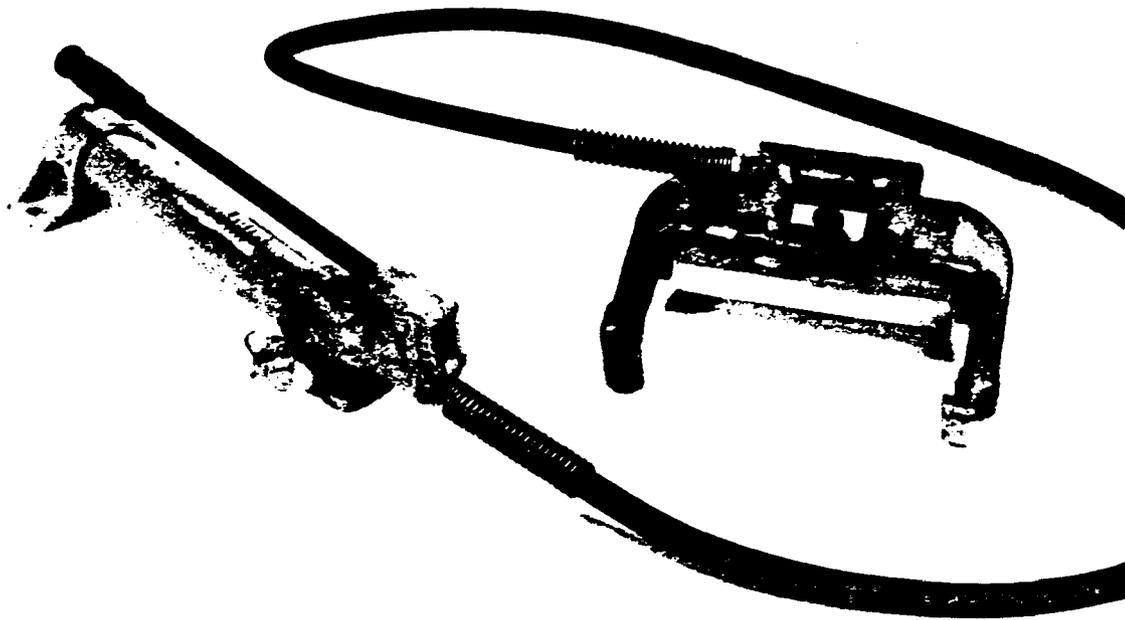


FIG. 2 R-4373, DET. 1 HAND HYDRAULIC CRIMPING UNIT (PAR. 2.13, 3.52) RP-0556

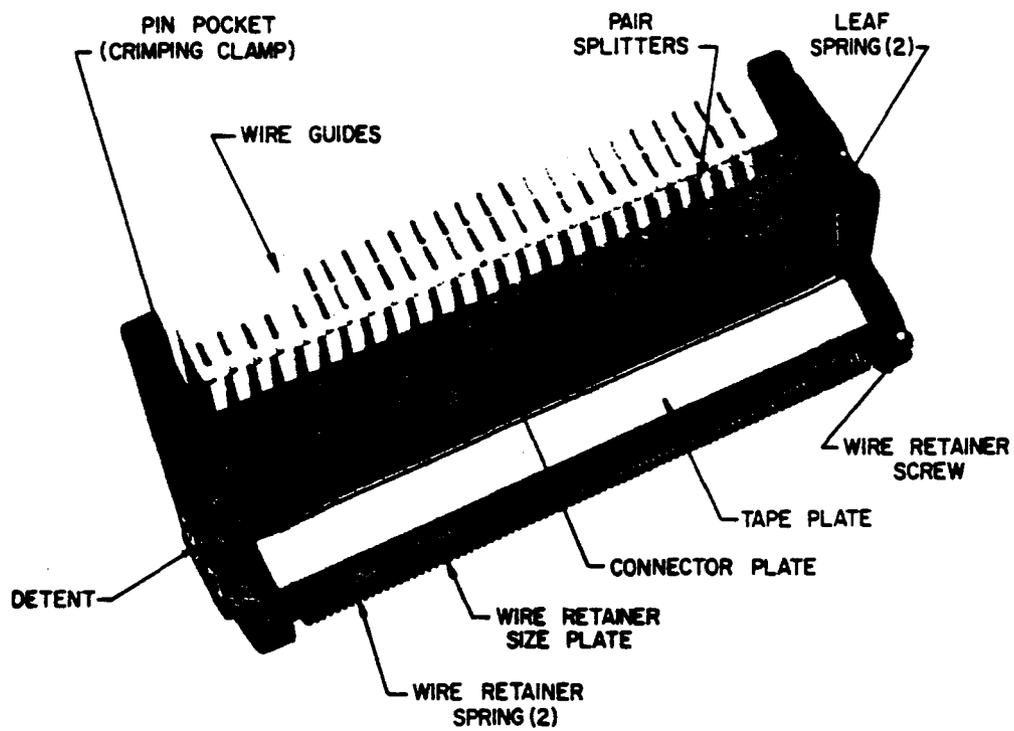
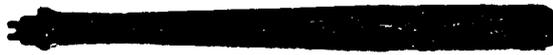


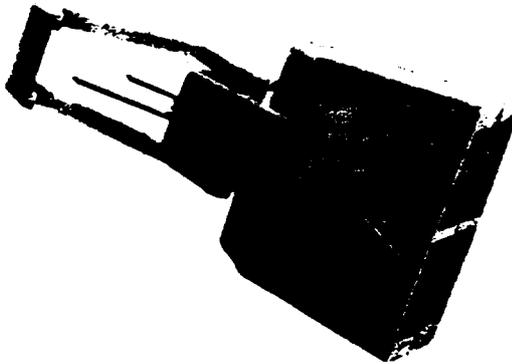
FIG. 3 R-4373, DET. 2 SPLICING HEAD PARTS IDENTIFICATION (PAR. 2.13, 3.442, 3.611) RP-0557

**PRODUCT
ILLUSTRATION**

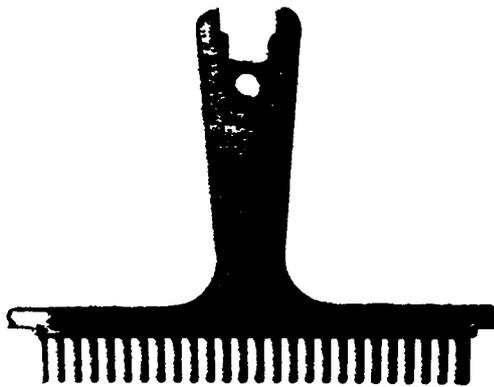
**PRODUCT NO.
AND DESCRIPTION**



**DET. 3 R-4373
CUT CLOSED TOOL**



**DET. 4 R-4373
PAIR TEST PLUG**



**DET. 5 R-4373
CHECK COMB**



**DET. 6 R-4373
COVER REMOVAL TOOL**

FIG. 4 MISCELLANEOUS SPLICING RIG ACCESSORIES (PAR. 2.13)

2.14 Additional tools required for mounting the splicing head assembly on cable rack stringers when splicing is done on cable racks are the following:

<u>Tool</u>	<u>Description</u>	<u>Figure</u>
R-4373, Det. 9	Head Clamp	6
R-4373, Det. 10	Mounting Fixture	5, 6
R-4108	Midget Diagonal Cutter	

2.15 The supplies required for operations covered in this section are listed below, and are in addition to the supplies listed in Handbook 8, Section 400, covering cable butting and stripping operations:

R-2916,	Twine
R-3428,	3/4" Wide Gray Plastic Tape
R-3359,	1/2" Wide Gray Plastic Tape
R-4376,	Sealing Tape (for Half-Tap, Y-Splice Only)

3. REQUIREMENTS AND METHODS

3.1 Preparation of Cable

3.11 Switchboard and ABAM (or ABMM) cable in non-grounded applications shall be butted and stripped in accordance with Handbook 8, Section 400, 410, and 411.

3.12 In toll applications, where uninterrupted shield grounds are mandatory, ABAM (or ABMM) cable shall be prepared with the strict assurance that the aluminum shield shall not be cut until the ground is extended to by-pass the stripped portions of the cable. For the method of preparation which assures ground continuity, consult the job specifications and drawings which will indicate the standard drawing which contains the applicable instructions (i.e., ED-97270-10).

3.13 When heat shrink tubing is used, the correct length should be cut and shipped over the cable before the splicing operation begins. To determine the correct length of tubing, add 4" to the cables stripped length as specified in PARS. 3.32 and 3.731.

3.2 Splicing Rig Set-Up

3.21 For splicing on cable racks, use the R-4373, Detail 10, Mounting Fixture. The splicing head and pedestal can be inserted into the cable rack mounting block to position the head 2 to 20" of the rack (see FIG. 5). By using the L-shaped mounting bar and head-clamp, the splicing-head can be positioned above and over the cable rack (see FIG. 6).

3.3 Positioning Splicing Head Along Stripped Length of Cable

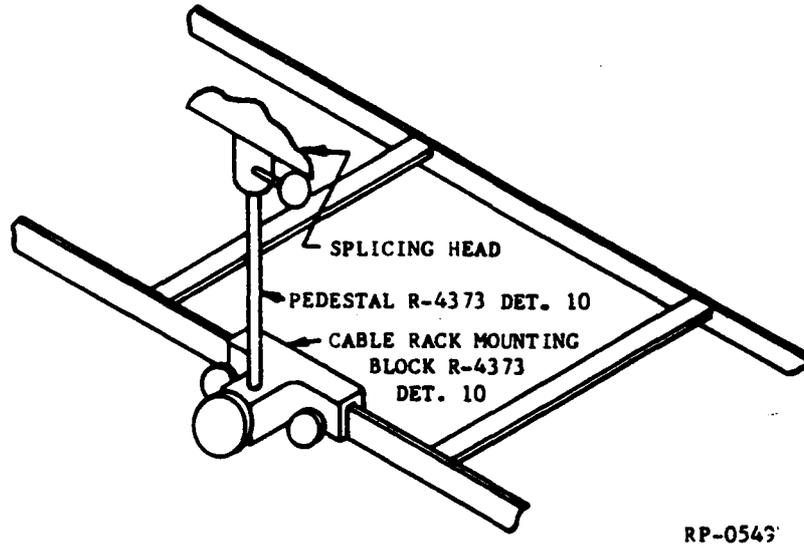
3.31 Straight Conductor Splice: As shown in FIG. 7, the initial value of X, the distance between the splice-head and the butt of Cable A, should be the minimum required to fan the leads through the wire guides on the splicing head (approximately 6"). Leads from Cable B should be long enough to extend approximately 10" beyond the splicing-head.

3.32 For recommended stripped lengths of cables, perform the following calculations: For each splice, allow approximately 10" for each module plus an additional 12": e.g., for 62 conductor cable, two modules are required and consequently:

- A. 10" x 2 (modules) = 20"
- B. 20" + 12" = 32" stripped conductor length required.

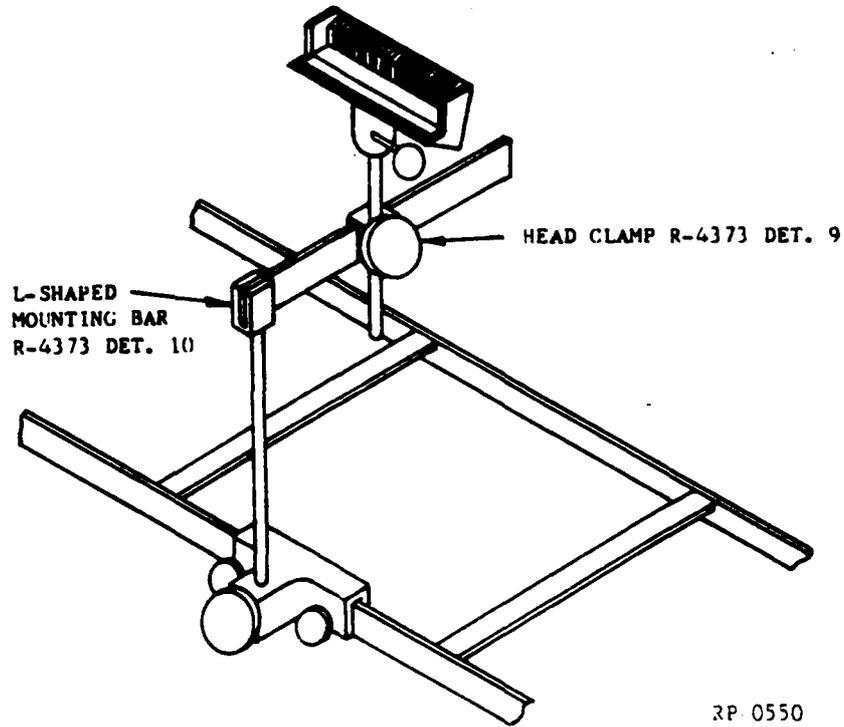
3.33 For cables with more than 150 conductors, modules shall be placed in a line down one side of the cable until three modules are crimped. Then, the next module (No. 4 in FIG. 8) shall be placed next to the butt of Cable A on the opposite side of the conductors from Module No. 1.

3.34 After each crimping operation, move the splicing-head away from the butt of Cable A (as indicated by arrow in FIG. 7) a distance of approximately 10" before beginning with new modules. This will stagger the splice point, and minimize the cable diameters.



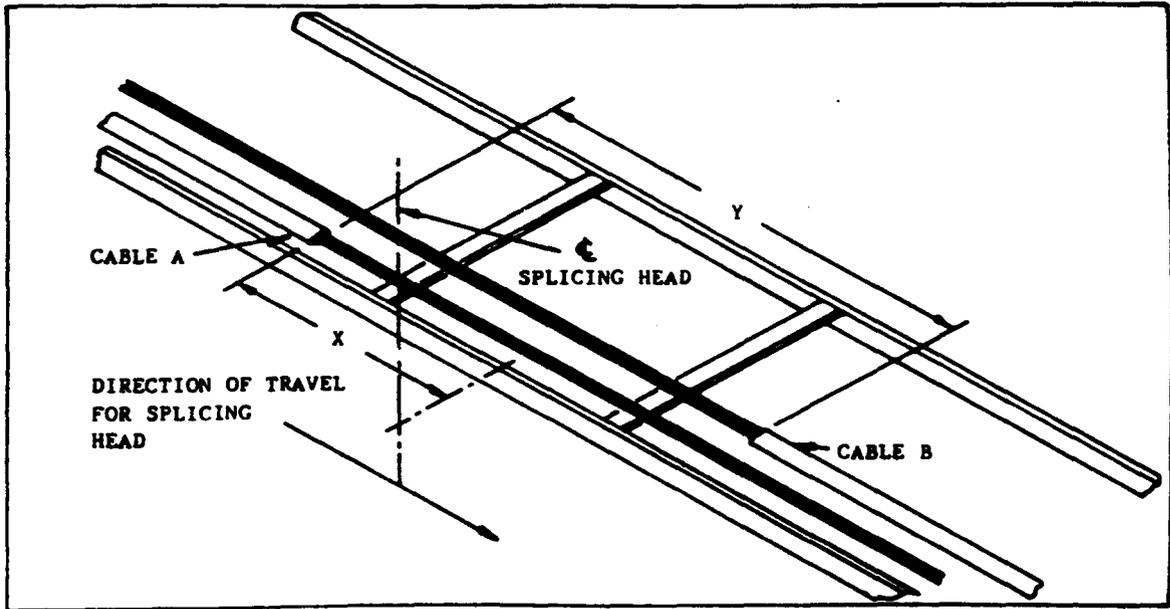
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FIG. 5 MOUNTING AND ARRANGEMENT OF SPLICING HEAD AND RIG ABOVE CABLE RACK (PAR. 2.14, 3.21)



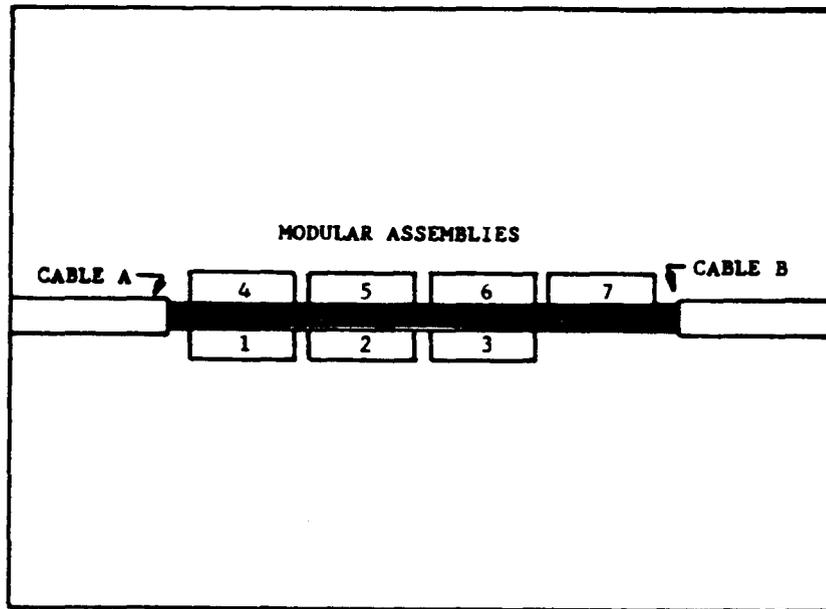
RP-0550

FIG. 6 MOUNTING ARRANGEMENT OF SPLICING HEAD AND RIG OVER AND ABOVE CABLE RACK (PAR. 2.14, 3.21)



RP-0551

FIG. 7 POSITIONING OF SPLICING HEAD WITH RESPECT TO CABLE BUTTS (PAR. 3.31, 3.34)



RP-0552

FIG. 8 ARRANGEMENT OF PAIRED MODULAR ASSEMBLIES (PAR. 3.33)

3.35 Half-tap or Y-splice:

3.351 As in the straight conductor splice, the splicing head should be located as close as possible to the butt (1) of Cable A shown in FIG. 9. If more than one set of modules is required per cable, move the splice head toward the butt (2) of Cable A a distance of 7" per module. (For complete instructions on Y-splice, see PAR. 3.7).

3.4 Wire Handling

3.41 The wire retaining spring is adjustable for two ranges of wire gauges. The adjustment is made by loosening the wire retainer screw, and rotating the spring assembly to the desired range (FIG. 11). The ranges as shown on the spring assembly face plate are:

- A. All 22 gauge wires and 24 gauge PIC wire.
- B. All 26 gauge and 24 gauge pulp or paper insulation wire.

3.42 Place Base (R-4374 Module for a straight splice, or R-4375 Module for half-tap or Y-splices) into the leaf spring tracks of splicing head so the base alignment holes are toward the head wire guides and cut-off blades are towards the Installer.

3.43 Before fanning the conductors through the wire guides, tie or clamp the cables to an available anchor point.

3.44 Wires should be fanned into the splicing head in consecutive color code wherever possible so that like-colored conductors of each cable are spliced together.

3.441 When one type of cable has been replaced by another, or when equipment arrangements necessitate associating unlike types of cables, splice the conductors together in the order of the color sequence in each cable.

3.442 When splicing paired tip and ring leads, place the tip lead to the left of the pair splitters (see FIG. 3), and the ring to the right. This will permit use of the Check Comb (R-4373, Det. 5) to check proper wiring order (see FIG. 12).

3.45 Grasp each wire to allow 1" of pair slack behind the splicing head. Use the thumb and forefinger of each hand to guide the conductors over the pair splitters (see FIG. 13). Take up the slack by pulling each wire firmly into the wire channel on the base into the wire retainer spring.

NOTE: More than 1" of slack can cause adjacent conductors to knot as they are pulled over the pair splitters. Tugging on the knotted pair can then cause shiners (see FIG. 14 thru 17).

3.46 After fifty conductors are in place check to see that all wires are completely in each channel by running a finger over them.

3.461 For paired conductors, use the check comb (PAR. 3.442) to assure that there are no tip and ring reversals.

3.47 Place a Body (R-4374 for straight splice) into the leaf spring tracks of the splicing head so that the body alignment pins line up with the alignment holes of the base. Press the body into place so that it rests on the base (FIG. 18).

3.48 Take the matching binder group of Cable B (or the leads corresponding to those formed into the base) and fan the leads through the wire guides over the pair splitters and the body, and into the wire retaining spring in the same manner as accomplished for the base in PAR. 3.43 and 3.44.

3.481 For paired conductors, use the check comb (PAR. 3.442) to assure that there are no tip and ring reversals.

3.482 Place a cover into the leaf spring tracks of the splicing-head with the alignment pins towards the head wire guides and matching body alignment holes (see FIG. 19).

3.483 Crimp the connector module (PAR. 3.5).

3.5 Crimping

3.51 Crimping Unit: The R-4373, Detail 1, Hand/Hydraulic Tool is the only approved tool for crimping the modules.

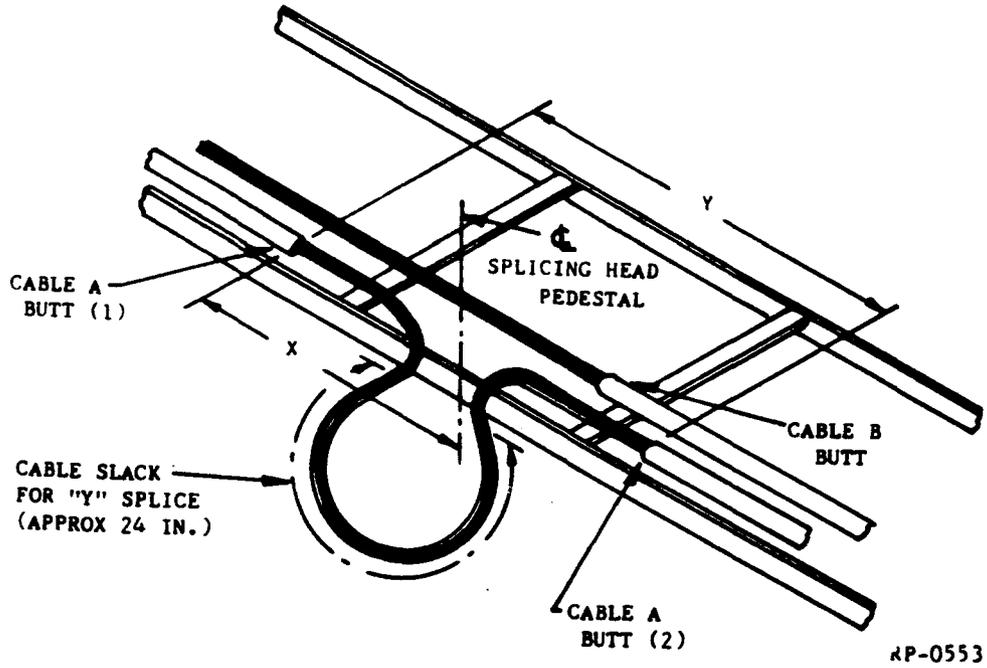


FIG. 9 POSITION OF CABLES AND SPLICING HEAD IN "Y" SPLICE
(PAR. 3.35, 3.71, 3.731, 3.75A, B, E)

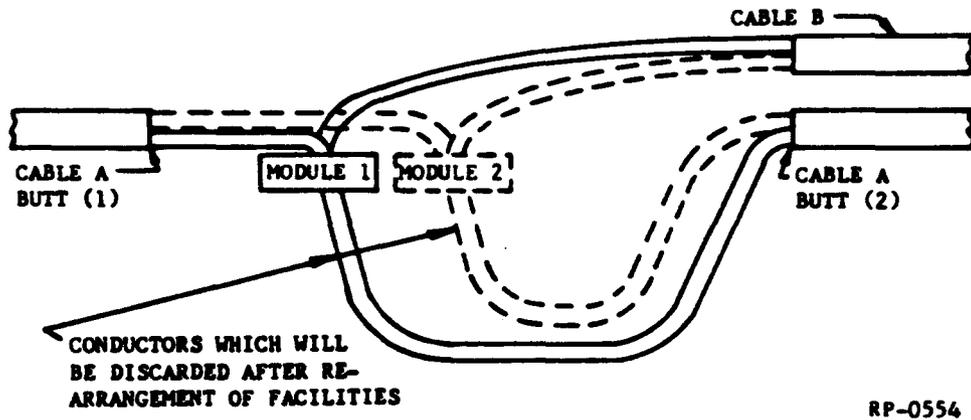
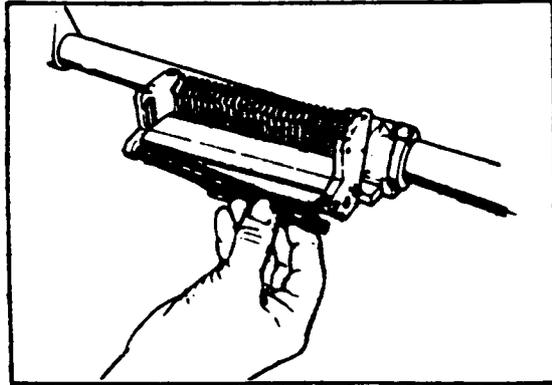
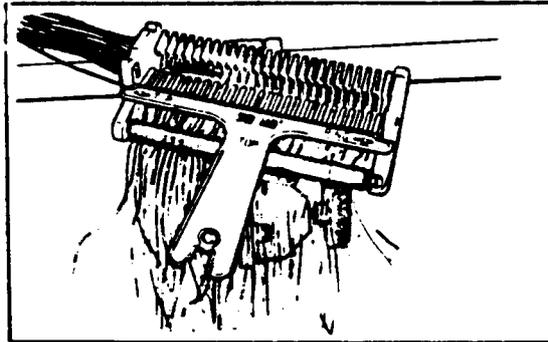


FIG. 10 ARRANGEMENT OF HALF-TAP OR "Y" SPLICE
(PAR. 3.731, 3.75B, E)



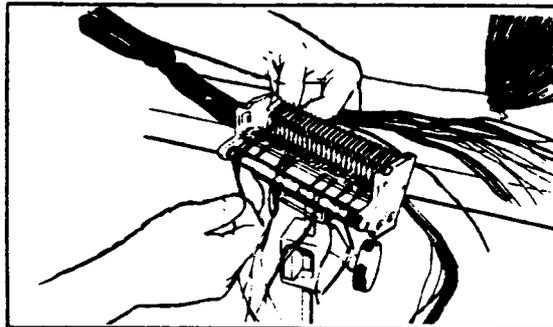
RP-0558

FIG. 11 ADJUSTMENT OF WIRE RETAINING SPRING
(PAR. 3.41)



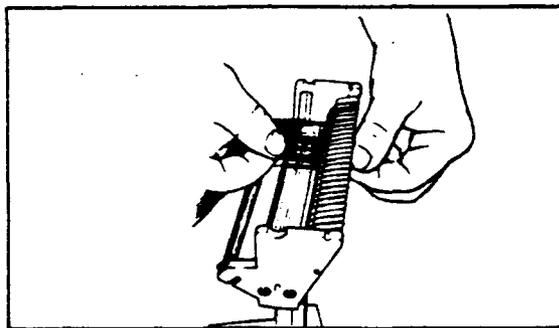
RP-0559

FIG. 12 USE OF CHECK COMB FOR DETECTING REVERSALS LEFT POSITION SHOWS TIP
LEADS: RIGHT POSITION SHOWS "RING" LEADS
(PAR. 3.442)



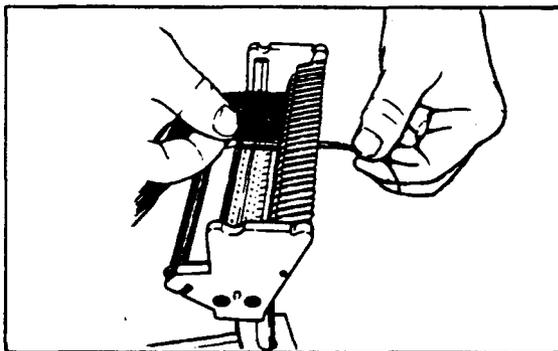
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FIG. 13 PLACING WIRES IN BASE MODULE
(PAR. 3.45)



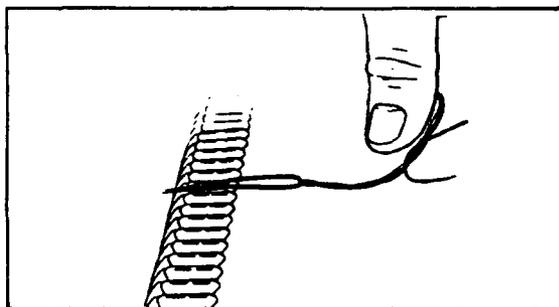
RP-0561

FIG. 14 CORRECT POSITION OF GUIDE THUMB NEAR SPLICING HEAD
(PAR. 3.45)



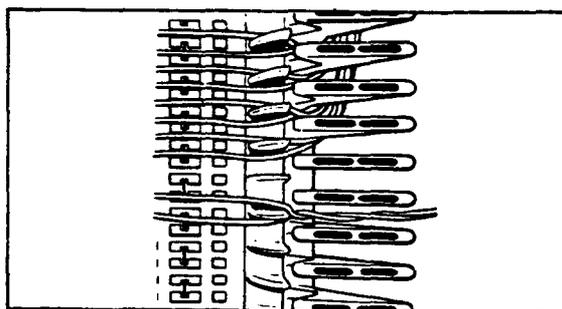
RP-0562

FIG. 15 ILLUSTRATION OF GUIDE THUMB HELD TOO FAR FROM SPLICING HEAD
(PAR. 3.45)



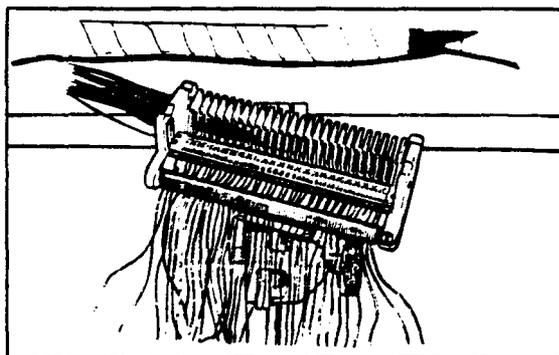
RP-0563

FIG. 16 ILLUSTRATION OF KNOT BEING CAUSED BY EXCESS SLACK
(PAR. 3.45)



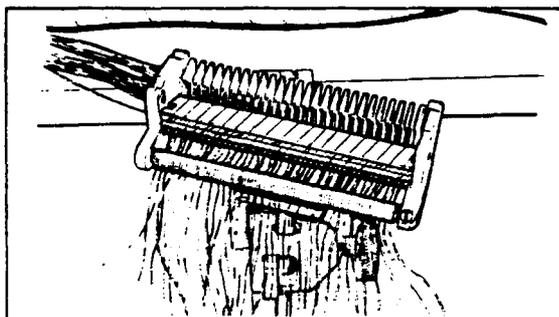
RP-0564

FIG. 17 ILLUSTRATION OF SHIVER BEING CAUSED BY TIGHT KNOT
(PAR. 3.45)



RP-0565

FIG. 18 MODULE BODY ON FILLED BASE
(PAR. 3.47)



RP-0566

FIG. 19 COVER PLACED IN PREPARATION FOR CRIMPING
(PAR. 3.482)

3.52 The crimping clamp (see FIG. 2) is designed to crimp the connector module to the proper height with a force that assures proper connections for all conductors.

3.53 The hand/hydraulic system has a by-pass which permits it to idle when the clamp "bottoms" and exerts sufficient pressure to complete the crimping.

3.6 Crimping Operation

3.61 Place the crimping clamp on the splicing-head with the Hydraulic hose towards either the right or left.

3.611 The crimping clamp has pins on the inside surfaces of its vertical members. The clamp is placed on the head at an angle (FIG. 20) so that the pins rest on the pin sockets of the splicing-head (see FIG. 3 - "Splicing-Head Parts Identification").

3.612 Rotate the clamp until it is locked into a vertical position by the splicing-head detents. If the detents do not lock or prevent rotation, they can be adjusted with a screwdriver.

3.62 Close the release valve on the side of the pump.

3.63 Work the hand pump until the connector module appears closed, then complete an additional five strokes. Keep the output end of the hand pump level or lower than the rear. This will keep air out of the hydraulic lines. If the pump does not operate properly, proceed as indicated in the following "bleeding" instructions:

3.631 Bleeding Instructions: If the crimping bar does not move towards the module, bleed the hand/hydraulic unit by placing the clamp lower than the pump and tilt the output hose of the pump down. Actuate the pump handle until the clamp resumes normal operations.

3.64 With clamp in the closed position, check to see if the crimp is complete. Grasp one-quarter of the wire ends and pull them out of the modules. If the crimp is complete, all wires will be cut and easily removed.

3.641 Any uncut wires shall be taken as an indication that the crimp is incomplete. To complete the crimp, add pressure by working the pump handle. Continue stroking until all the wires are cut.

3.65 After completing the crimp, remove the clamp by performing the following:

3.651 Release the pressure by opening the valve on the side of the hand pump (FIG. 21).

3.652 Rotate the clamp about the pins and pin pockets (FIG. 22) and lift the clamp up off the head.

3.66 Lift the crimped module from the head by pushing up and back with the thumbs (FIG. 23).

3.661 If the incoming wires have been pulled too tightly into the wire guide, rotate the splicing head to relieve tension.

3.7 Y-Cable Splice or Half-Tap

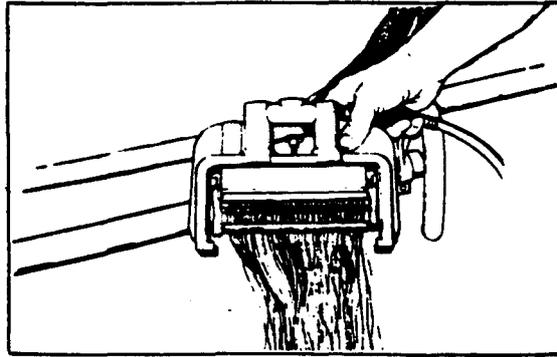
3.71 The Y-cable splice or half-tap is used when a cable end (designated Cable B in FIG. 9) is to be spliced to continuous cable (designated Cable A) and the cables are parallel or at a slight angle to each other.

3.72 To use 3M/MS² for Y-splices, an R-4375 Half-Tap Base must be used (see FIG. 1).

3.721 Before attempting a Y-splice, the Installer shall be fully competent in the operations described in the preceding paragraphs in this section.

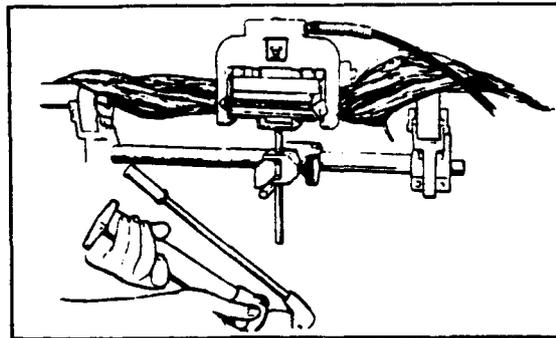
3.722 Before placing a half-tap base into the splicing head, the Installer shall verify that there are no wire cut off blades in the base (see FIG. 1).

NOTE: Half-tap bases are distinguishable from the R-4374 Base with the wire cut off blades because they (the half-tap bases) are covered with a strip of green tape. Despite this identification, verification by Installer that the knives have been omitted must be completed on each module.



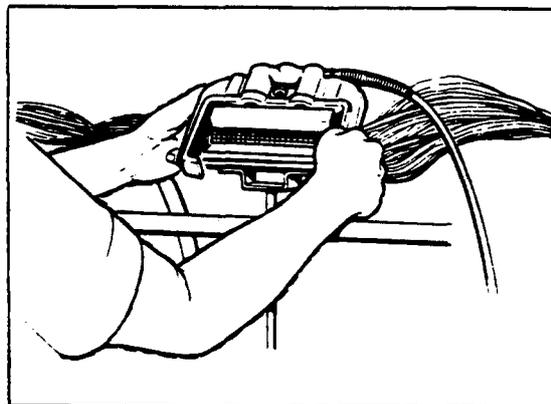
RP-0567

FIG. 20 PLACEMENT OF CLAMP ON SPLICING HEAD
(PAR. 3.611)



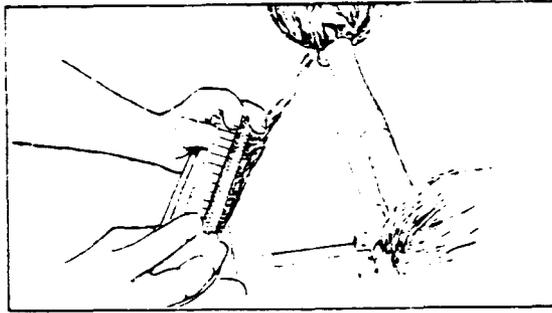
RP-0568

FIG. 21 OPENING VALVE TO RELEASE HYDRAULIC PRESSURE
(PAR. 3.651)



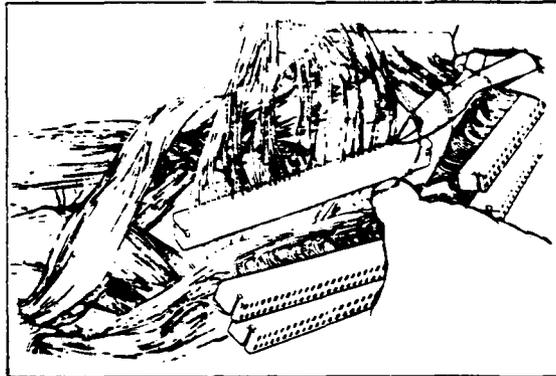
RP-0560

FIG. 22 REMOVING THE SPLICING CLAMP FROM THE HEAD
(PAR. 3.652)



RP-0570

FIG. 23 LIFTING THE CRIMPED MODULE FROM THE HEAD
(PAR. 3.66)



RP-0571

FIG. 24 USING DIAGONAL CUTTERS TO CUT OFF DISCARDED LEG OF "Y" SPLICE
(PAR. 3.762)



RP-0572

FIG. 25 APPLYING SEALING TAPE TO MODULE TO INSULATE CUT ENDS
(PAR. 3.771)

3.723 The continuous cable (Cable A) is always fanned into the Half-Tap Base first.

3.73 When the location of the splice has been determined (Handbook 9, Section 371, Paragraph 4.3), the cable shall be butted and stripped in accordance with instructions in Handbook 8 and this section.

3.731 For the distance between the butts on Cable A (Distance Y in FIG. 9), allow approximately 10" for each module plus 12", (as in PAR. 3.32). In addition, add approximately 24" which will be used for slack in order to simplify manipulating wires; e.g., for Y splicing 62 conductor cable, two modules are required and consequently:

A. $10" \times 2 = 20"$
 B. $20" + 12" = 32$ (which will be the final length between butts on the completed splice)

C. $32" + 24" = 56"$ free conductor length required.

NOTE: At the completion of the splice, the distance from butt to butt on the completed splice shall be 24" less than the total free conductor length. The excess slack will be eliminated when the unwanted leg of the initially continuous cable is removed. (See FIG. 10 and PAR. 3.75 for specific details.)

3.732 The stripped length of the end Cable B shall be determined in the same manner as the cable ends in PAR. 3.32.

3.74 The splicing head shall be located in accordance with instructions in PAR. 3.3.

3.75 Recommended Procedure for Half-Tapping

A. With the splicing head in place, pull the slack until there is a 24" loop of slack in the stripped portion of the continuous cable (see FIG. 9).

B. Position the slack so that it is towards the cable butt which will be removed. (Butt (2) of Cable A in FIG. 9 and FIG. 10). The first module will be located approximately 3" from butt (1), the portion of the continuous cable which will be retained.

NOTE: Additional modules should be placed so that they will be 1" to 3" apart and the slack will always be towards butt (2) of Cable A.

C. Identify the binder groups.

D. Remove the tape from the Half-Tap Base (R-4375) and place the base into splicing head.

E. Fan wires into the base in the same manner as that employed in PAR. 3.4 of this section. The slack should be kept toward the leg which will be removed (see FIG. 9 and 10).

F. After fanning all wires into the base module, insert the Body (R-4375) onto the base.

G. Fan the leads from the end of Cable B, the tap cable, directly into the body, leaving no slack.

H. When the body has been completed, place a cover on the assembly and crimp the assembly as specified in PAR. 3.6.

I. Move the splicing head to the next location when additional modules are required.

3.76 Tying Y-Splice Modules

3.761 After the crimping operation in a Y-splice, temporary ties may be required until authorization to remove the unwanted leg is received from the local Telephone Company.

3.762 When the unwanted leg is removed at the module, use Midget Diagonal Cutters, R-4108, to cut leads off close to the modules so that they cannot bend over and short. Individual leads shall be cut off singly to prevent shorting working pairs (see FIG. 24).

3.77 Taping Y-Splice Modules

3.771 After cutting individual leads from the Y-splice module, apply R-4376 Sealing Tape to the exposed wire ends (see FIG. 25).

3.772 Dress the modules back against the cable and tie them back with nylon twine into a tight form.

3.8 Tying and Covering Modules

3.81 Tying and covering modules can be accomplished after the splicing-head is moved to another position, or at the completion of the total splice.

3.82 Connectors shall be dressed compactly against the remaining conductors and banded securely with R-2916 Nylon Twine.

3.83 After the connectors are placed in a tight form, the entire length of splice shall be covered by Heat Shrink Tubing (KS-21766).

3.831 Cut two, 7" long strips of adhesive tape 10-1/2", if the cables are less than 1/2" diameter. Remove the adhesive tape from the backing paper. The adhesive tape is supplied with the heat shrink tubing.

3.832 Wrap the strip of adhesive upon itself 1/2" away from the cable butt on the sheathing. Do not stretch the adhesive (see FIG. 26).

3.833 Slide the heat shrink tubing, PAR. 3.13, over the splice so that it overlaps the rolled adhesive at each end.

3.834 Use the R-4444 Heat Gun or approved equivalent to shrink the tubing for the last 2" of each end. Do not shrink the entire tubing (see FIG. 27).

3.835 If heat shrink tubing cannot be used, the splice may be covered by wrapping the entire length of the splice with scrap cable sheathing and then a half-lap of gray plastic tape on top of the sheathing.

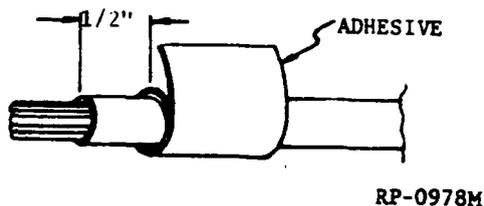


FIG. 26 ADHESIVE WRAPPED 1/2" FROM BUTT OF CABLE (PAR. 3.832)

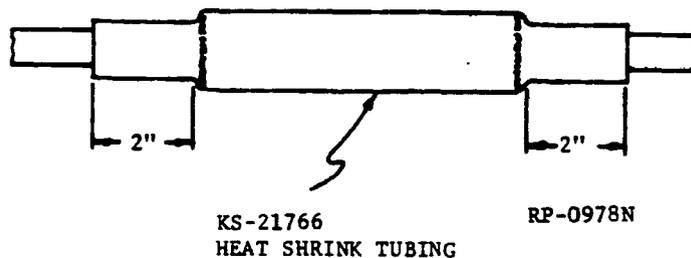


FIG. 27 TUBING SHRUNK AT LAST 2" ONLY (PAR. 3.834)

4. VERIFICATION

VERIFICATION ITEMS AND BRIEF STATEMENT OF REQUIREMENTS		REFERENCE	
		Paragraph Number	Figure Number
4.1	Requirements and Methods		
4.11	Codes of Switchboard Cable Approved	1.2	
4.12	Place heat-shrink tubing on before splice	3.13	
4.13	Correct base used for half-tap splice	3.722	1
4.14	Continuous cable fanned into half-tap base	3.723	
4.15	Unwanted leg of half-tap splice cut off singly with R-4108	3.762	24
4.16	R-4376 Sealing Tape applied over exposed wire ends of half-tap	3.771	25
4.17	Adhesive tape wrapped around sheathing	3.832	26
4.18	Heat Shrink Tubing shrunk for last 2" of each end	3.834	27

Vertical lines at side of Paragraph indicate a Requirement.

Engineering Planning Manager
Common Installation and Services