

BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

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CABLE SPLICING

SPIRAL-FOUR DISC-INSULATED CABLE

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1. GENERAL

1.01 This section covers the method of splicing and testing single and multi-quad spiral-four disc-insulated cables designed for use in type J carrier telephone systems. Maintenance operations in working cables should be conducted as outlined in Part 8.

2. TOOLS AND MATERIALS

2.01 The special tools and materials listed below are required in addition to the splicing tools and material generally carried by splicers.

2.02 Tools:

Extractor, Insulator (For removing disc insulators at ends of tapes.)

Mandrel, Sleeve (For forming outer connecting sleeve and for splice measurements.)

Pliers, Cutting, Shield (For cutting the copper tapes of disc-insulated quads.)

Pliers, Ring, Crimping (For placing crimping rings over steel tapes and outer connecting sleeve.)

2.03 Materials:

Disc, Splice, Multiple Drawing 47-M-642, 2 required
(For use in making wiped joint between a multi-quad cable and seven 1-quad cables.)

Separator, No. 3 (For insulating disc-insulated quad from shield.)

Ring, Crimping, No. 5 (For securing outer connecting sleeve and steel tapes before soldering.)

Sleeve, Tinned-Copper, 16-Gauge (For joining conductors of disc-insulated quads.)

Sleeve, Shield, No. 5 (For joining shields of disc-insulated quads.)

Sleeve, Lead

1-1/2" x 15" sleeve for straight splice in 1-quad cable.

4-1/2" x 22" sleeve for straight splice in 7-quad cable.

2-1/4" x 17" sleeve for split quad splice in 1-quad cable.

4" x 18" sleeve for submarine loading coil splice.

4" x 20" sleeve for loading coil splice.

5" x 26" sleeve for multiple splice in 7-quad cable.

3. ONE-QUAD CABLE

3.01 In racking a one-quad cable in a manhole or setting it up on a pole, the radius of curvature of the bends should be not less than 12 inches and wherever practicable a greater radius should be used. Mark the location of the splice on the sheaths. The distance between the sheath opening marks should be 12 inches. By means of a chipping knife and hammer, cut each cable at a point about 12 inches from the splice mark. **Disc-insulated cables should never be cut with a saw.** Prepare a 1-1/2-inch by 15-inch lead sleeve and slip it over one of the cable ends.

3.02 At the sheath opening marks ring the cables, clean the surfaces where the joints will be wiped and coat with stearine. Cut the sheath lengthwise with a chipping knife. Then bend the cable gently back and forth until the sheath parts and remove the sheath from the core. The sheath should not be pulled from the core without splitting as to do so may damage the disc-insulated quad. After the core has been exposed, remove the core wrapping paper to within one inch of the cable sheath taking care to prevent unwinding of the tapes.

3.03 The sleeve mandrel is marked with circumferential grooves, as shown in Fig. 1 in Paragraph 3.04, at points 1-1/8, 3-1/4, 4-7/8, 6-3/4 and 8-3/8 inches from one

end. The 1-1/8, 3-1/4, and 4-7/8-inch grooves are for use in making splices in one-quad cables. The remaining markings are for use in making splices in multi-quad cables.

3.04 Place the mandrel against the end of the cable sheath as shown in Fig. 1. Make a scratch mark across the top of the steel tape at the 3-1/4-inch mark. Then wrap the end of the sheath with 1-inch cotton tape, as shown in Fig. 2. The cotton tape should not be tucked under the sheath.

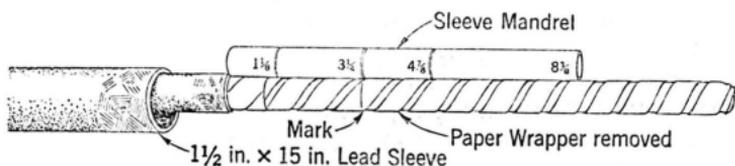


Fig. 1

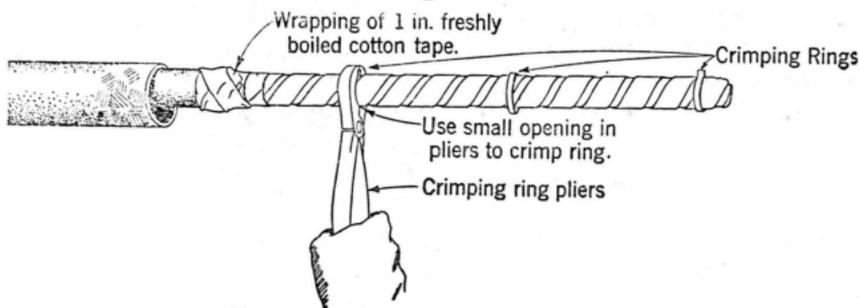
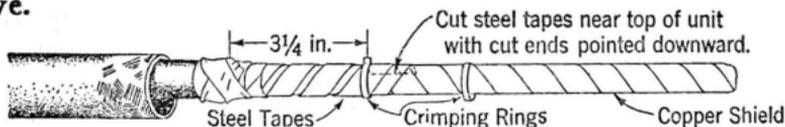


Fig. 2

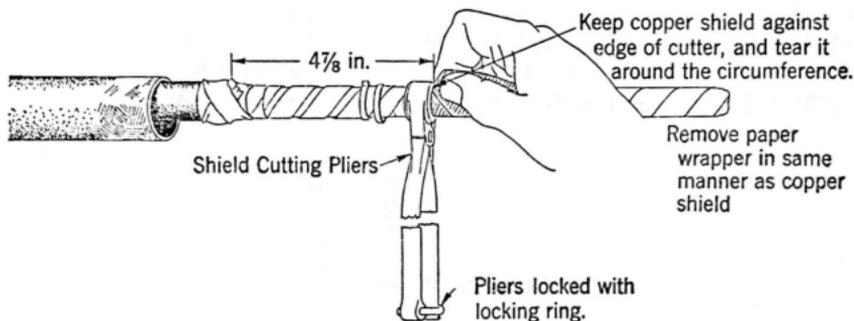
3.05 Round the end of the quad with the shield cutting pliers so that crimping rings can be placed on the unit, taking care not to loosen the steel tapes. Slide three crimping rings over the quad, crimping the last ring placed about 1/2 inch from the end to prevent unwinding of the steel tapes. Use the smaller opening of the crimping ring pliers in this operation.

3.06 Slide the ring nearest to the end of the sheath to the 3-1/4 inch mark. The figure below shows the desired position of the ring over the outer steel tape. If placing the ring at the 3-1/4 inch mark does not cover the outer steel tape, as shown, move the ring to the right or left until the desired position is obtained. Hold the crimping ring pliers in a vertical position with the jaws uppermost and, using the smaller opening, crimp the ring in place, as shown in Fig. 2 above.



3.07 Cut the crimped ring at the end of the unit. Loosen the steel tapes and unwind them up to the crimped ring. Cut the steel tapes as shown in the figure in Paragraph 3.06.

3.08 Mark the copper shield at the $4\frac{7}{8}$ inch mark. Grasp the quad with the shield cutting pliers on the sheath side so that the pliers are at the edge of the mark. Lock the pliers in place with the locking ring. Unwind the copper shield to the shield pliers. Using the thumb and forefinger, as shown in the following sketch, grasp the shield tightly close to the pliers edge, and pull the shield over the edge of the pliers until it tears. Keep the shield against the edge and tear it around the circumference. The paper wrapper should be removed in the same manner. Then remove the shield cutting pliers.

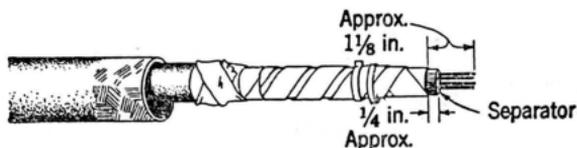


3.09 Cut the disc-insulated wires with a pair of diagonal pliers approximately $1\frac{3}{4}$ inches from the edge of the copper shield, staggering the ends about $\frac{1}{8}$ inch. Then remove the exposed insulators. Using the insulator extractor, remove any disc-insulator that is within approximately $\frac{1}{2}$ inch of the cut end of the copper shield. To remove an insulator push the extractor end equipped with teeth into the quad until it butts against the insulator. Turn the tool and at the same time press it lightly inward until the teeth engage the slots in the insulator. Pull the tool outward slowly, moving the end of the handle in a circle so as to impart a rocking motion to the insulator.

3.10 A separator with the rounded end foremost should be placed on the quad. The separator used should be free of moisture. This may be done by dipping the separator in hot paraffin immediately before use or by keeping it in a closed can with desiccant for about 2 hours prior to use. The dry separator should be handled with a pair of gas pliers. It should project about $\frac{1}{4}$ inch beyond the copper

shield. If the end of the copper shield overlaps the adjacent turn, tack it with solder after the separator is in place. If the end is overlapped by the adjacent turn, the shield need not be soldered.

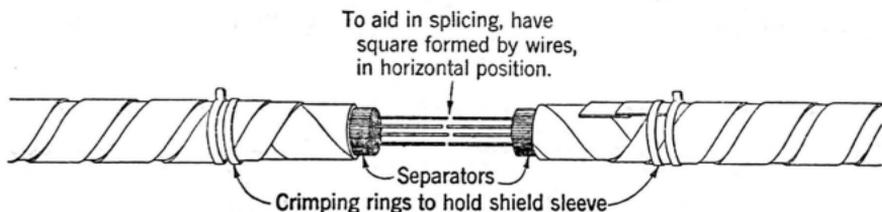
3.11 Place the end of the mandrel against the copper shield and cut the disc-insulated wires at the 1-1/8 inch mark. The end of a quad with separator in place and wires cut is shown in the illustration.



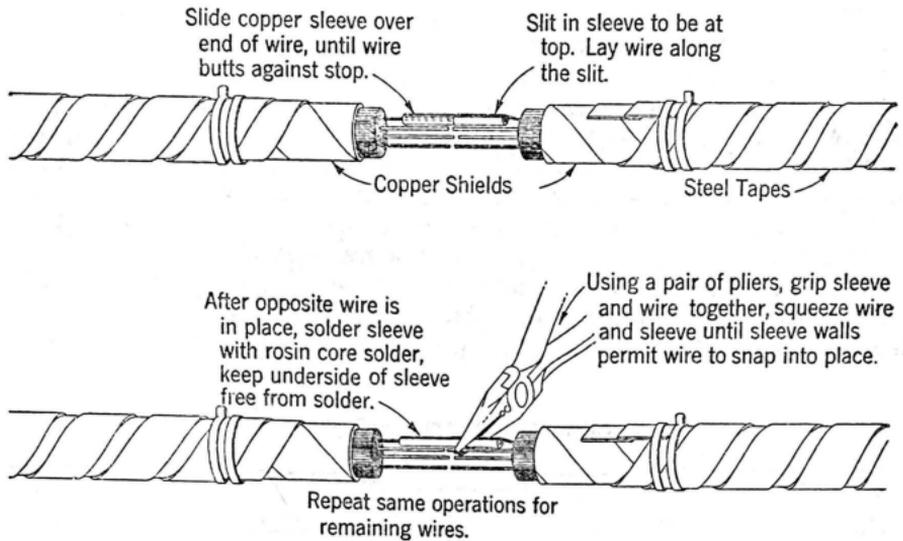
3.12 Prepare the other end in the same manner.

3.13 Test the conductors as outlined in Part 7.

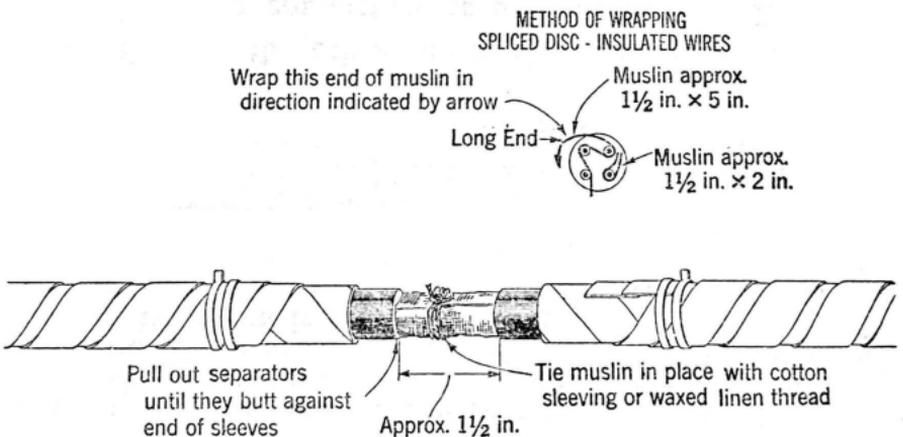
3.14 To facilitate splicing the conductors, twist the quads so that the conductors are in alignment as indicated in the following sketch. The diagonally opposite conductors of a quad are used as pairs.



3.15 Place a 16-gauge tinned-copper sleeve over a wire on one side of the splice until the wire butts against the stop in the sleeve. The slit in the sleeve should be at the top. Lay the opposite wire along the slot. Grasp the sleeve and the wire with a pair of long nose pliers and squeeze the sleeve and wire together until the wire spreads the sleeve walls sufficiently to snap in place, as shown in the following sketch. Repeat these operations for the remaining wires. Starting at the top, solder the sleeves with low content rosin core solder. The use of this solder will be facilitated if the solder is flattened to permit its insertion between the wires. Make sure that the under sides of the sleeves are free from sharp projections of solder.

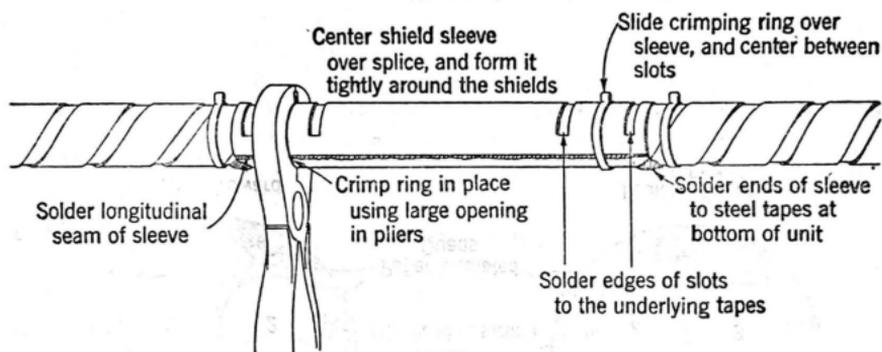


3.16 Pull out each separator with a pair of pliers until it butts against the ends of the sleeves. The fingers should not touch the separator. Then insulate each conductor with freshly boiled muslin. The dimensions of the muslin strips and the method of wrapping the conductors are shown in the following diagram.



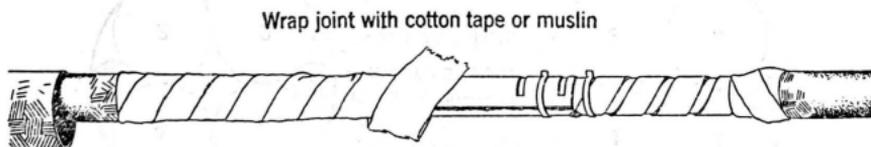
3.17 Place a shield sleeve lengthwise on the sleeve mandrel and roll the sleeve into a cylindrical form. Open the sleeve so that it can be placed over the quad. Center the sleeve over the splice and press it tightly around the shields. The outer overlapped edge of the sleeve should be slightly above the bottom of the splice and on the side of the splice at which the soldering operations will be carried out.

3.18 Slide the free crimping rings over the ends of the sleeve until they are located approximately half-way between the rows of slots at each end. Crimp the rings in place, using the large opening in the crimping ring pliers. These operations are illustrated below.



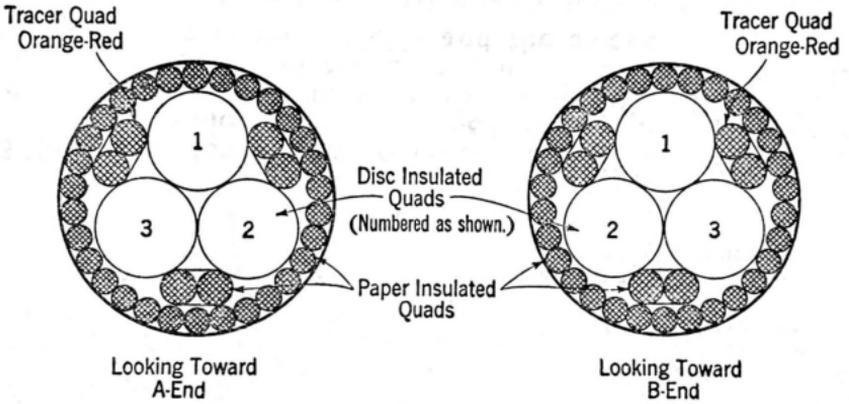
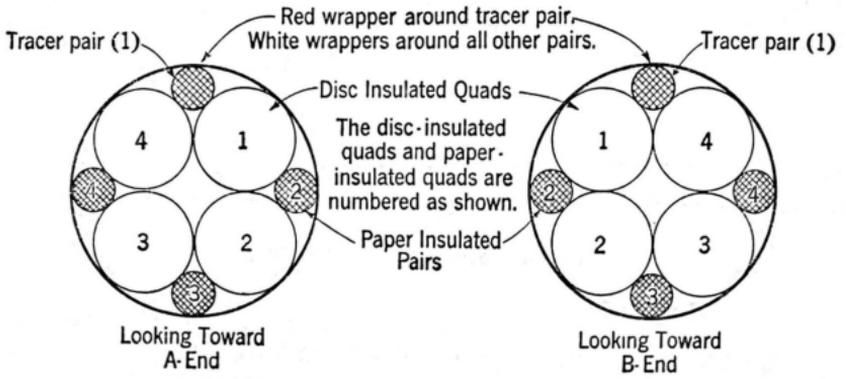
3.19 Using low content rosin core solder, solder the shield sleeve along the overlapped edge, at the bottom ends and at the slots as shown in the above illustration. Make sure that a good soldered connection is made between the steel tapes, the copper shields and the sleeve.

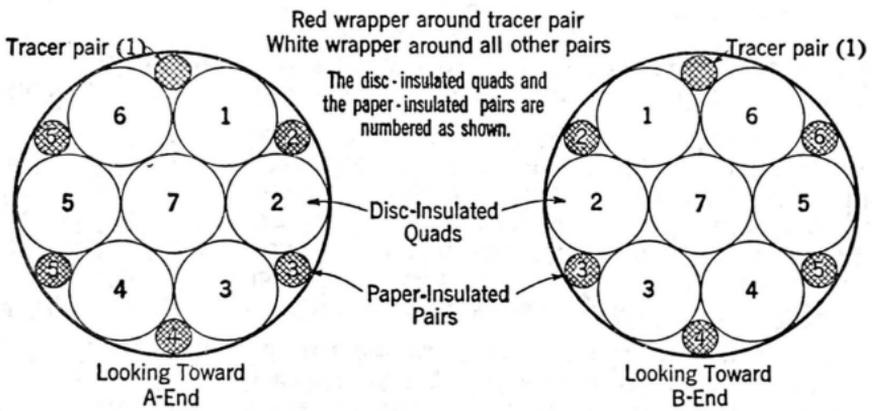
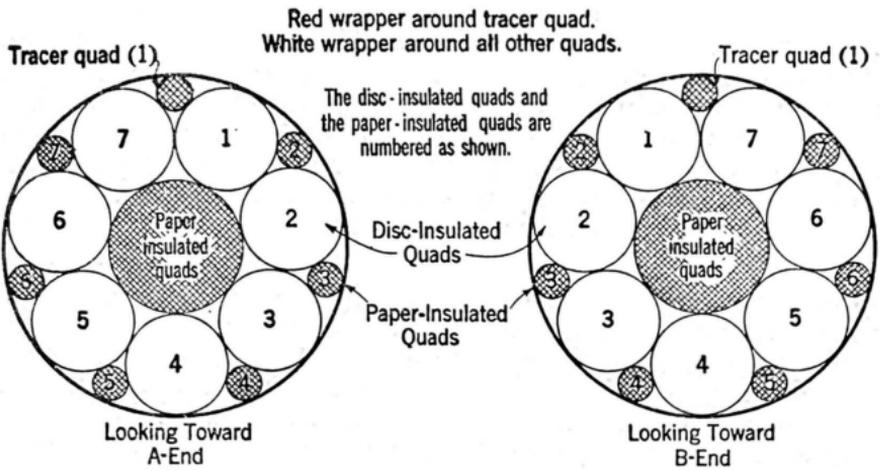
3.20 Unless the splice is dried with desiccant, boil it with hot paraffin and wrap the splice with freshly boiled muslin or cotton tape, as shown in the following sketch. Then place the lead sleeve and wipe it.



4. MULTI-QUAD CABLE

4.01 **Straight Splice:** Multi-quad disc-insulated cables are of four types. The make-up of each is shown in the following illustrations.





4.02 In splicing multi-quad cables, one terminating point should be designated the "A" end and the other the "B" end. The spiral-four quads are numbered with reference to the paper insulated tracer pair or quad, as shown in the diagrams on pages 8 and 9. The quads should be spliced in accordance with their numerical designation, that is, splice quad No. 1 to quad No. 1, quad No. 2 to quad No. 2, etc. The cores should not be twisted to bring like designated quads at the two ends of the splice opposite each other.

4.03 Rack the cable using a spring cable bender or a bender made of No. 109 S tree wire. The radius of curvature of the bends should be not less than 18 inches and where practicable a greater radius should be used. Mark the location of the splice on the sheaths. The distance between the sheath opening marks should be 19 inches. Using a chipping knife cut each cable at a point about 19 inches from the mark. A saw should not be used to cut disc-insulated cable.

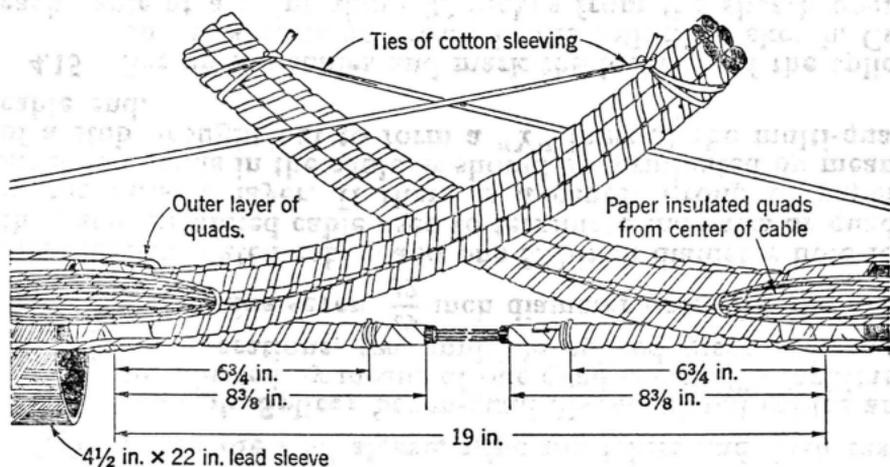
4.04 Ring each cable at the sheath opening mark, clean the sheaths where the joints are to be wiped and coat with stearine. Remove the sheath by cutting it lengthwise with a chipping knife. The sheath should not be pulled from the core without slitting as this may damage the disc-insulated quads. After the sheaths have been removed, place a prepared lead sleeve over one of the cable ends.

4.05 Wrap freshly boiled cotton tape over the core wrapping paper at the end of the sheath and secure it by means of a slip tie. The cotton tape should not be tucked under the sheath. Then remove the core wrapping paper taking care to prevent unwinding of the shielding tapes.

4.06 Round the end of each quad with the shield cutting pliers so that crimping rings can be placed. Care should be taken not to loosen the steel tapes. Slide three rings over each quad, crimping the last ring placed about 1/2 inch from the end in order to prevent unwinding of the steel tapes. Tag each quad with a linen tag on each side of the splice to indicate its number.

4.07 Bend the paper-insulated quads or pairs in the outer layer over the sheath and tie them so that they will not interfere with splicing operations on the disc-insulated quads. Tie the disc-insulated quads so that the outer ends are higher than the butt ends, as illustrated below. Boil the paper insulated quads throughout their length but carefully avoid pouring paraffin on the exposed disc-insulated quads except for a few inches at the butt ends of the splice.

4.08 If the cable contains a center group of paper-insulated quads, tag the quads designated for carrier operation. Wrap the center quads at the butts with freshly boiled cotton tape or muslin to form a group and bring them out so that they will be convenient for splicing, as shown in the following sketch.

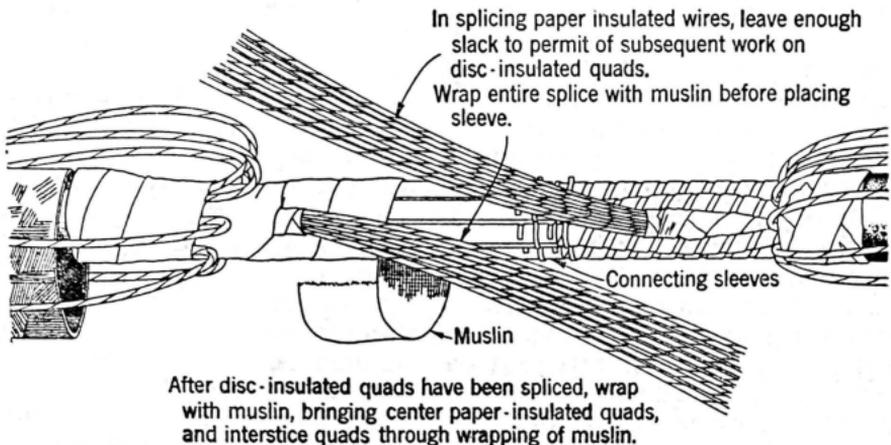


Splice each disc-insulated quad in a multi-quad cable the same as in a 1-quad cable. Starting with the quad nearest bottom, on side away from splicer, and work toward the quad on top nearest the splicer.

4.09 Using the sleeve mandrel, mark the steel tapes at the 6-3/4-inch point to indicate the location of the crimping rings and at the 8-3/8-inch point to indicate where the copper shields are to be cut. In other respects the quads should be prepared as outlined in Paragraphs 3.04 to 3.12. The rings should be crimped so that the crimped tips of the lower quads will not damage the upper quads when the splice is wrapped with muslin. While working on one quad, tie up the others. Each quad should be tested for crosses, grounds, etc., and completely spliced, before another quad is worked on. Apply a temporary wrapping of muslin to each quad as soon as it is spliced to protect it against falling solder. These wrappings should be removed before the final wrapping of muslin is applied. In a cable having paper-insulated quads in the center, first splice the disc-insulated quad nearest the bottom on the side away from the splicer and work toward the quad on top nearest the splicer.

4.10 In case the cable contains a disc-insulated quad in the center, it should be brought into the layer with the other six quads. To provide slack for this purpose, mark the center quad at points 7 inches and 8-5/8 inches from the sheath.

4.11 After the disc-insulated quads have been spliced, wrap them with muslin bringing out any paper-insulated quads, as shown in the following sketch.

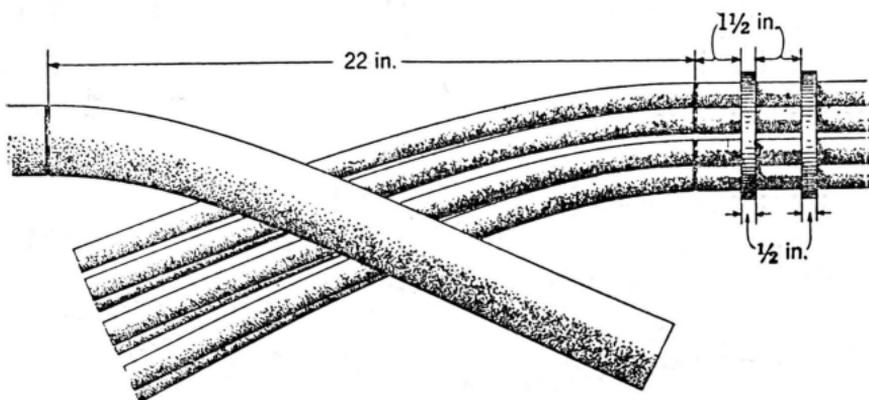


4.12 Splice the paper-insulated wires leaving sufficient slack to permit future maintenance work on the disc-insulated quads. Unless the splice is to be dried with desiccant, boil the wires and wrap the entire splice with freshly boiled muslin.

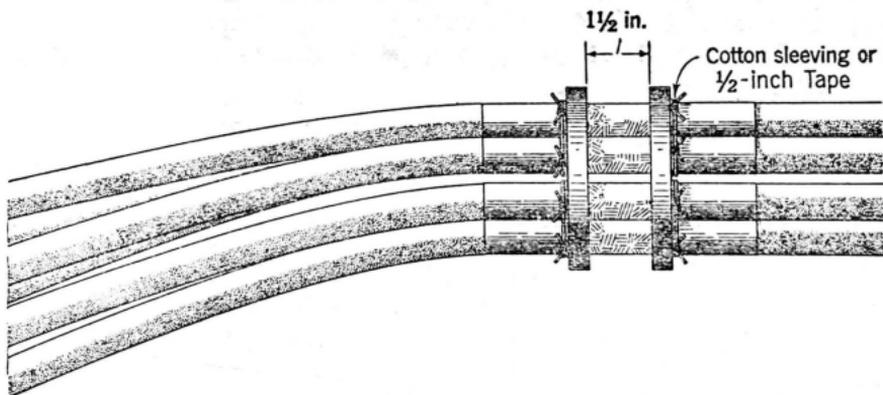
4.13 Place the lead sleeve, wipe the joints and flash test.

4.14 **Multiple Splice:** Seven-quad disc-insulated cables are terminated by means of one quad cables. To facilitate the wiping operations, two multiple spliced discs are used. Each disc contains seven $\frac{29}{32}$ -inch diameter holes for the one-quad disc-insulated cables and one $\frac{5}{8}$ -inch diameter hole for the paper-insulated cable used to terminate the pairs or quads in the outside layer. If there is a center group of paper-insulated quads in the cable, it should be terminated by means of a stub brought out to form a "Y" joint at the multi-quad cable end.

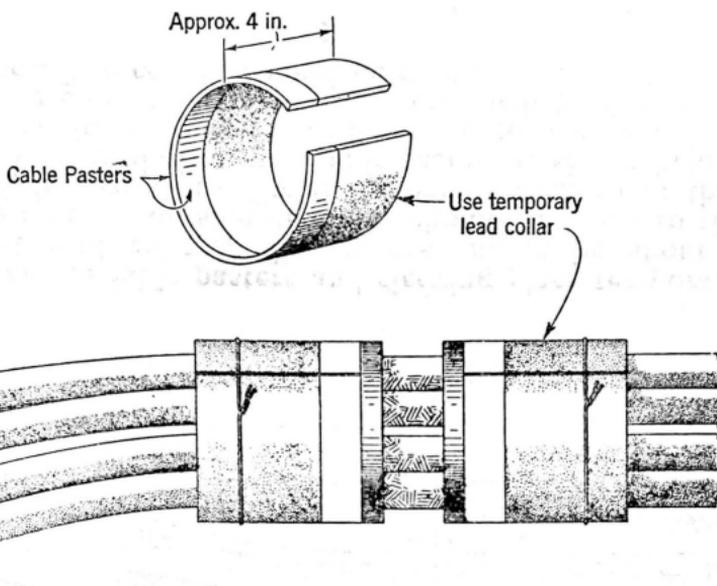
4.15 Set up the cables and mark the location of the splice on the sheath, as shown in the following sketch. Cut each cable at a point about 22 inches from the sheath opening marks using a chipping knife. Clean the sheaths at the location of the wiped joints and coat the surfaces with stearine. Place the multiple splice discs over the one-quad cables. If the other end of the splice will be a straight joint, place a prepared 5-inch by 26-inch lead sleeve over the multi-quad cable.



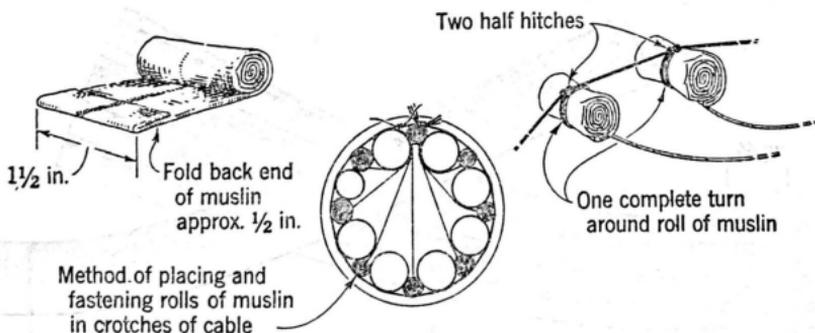
4.16 The separation between the discs should be 1-1/2 inches. Each cable outside the discs should be wrapped with two or three layers of cable paster. Then place two turns of cotton tape or sleeving around the cables as close to the discs as practicable, as shown in the sketch.



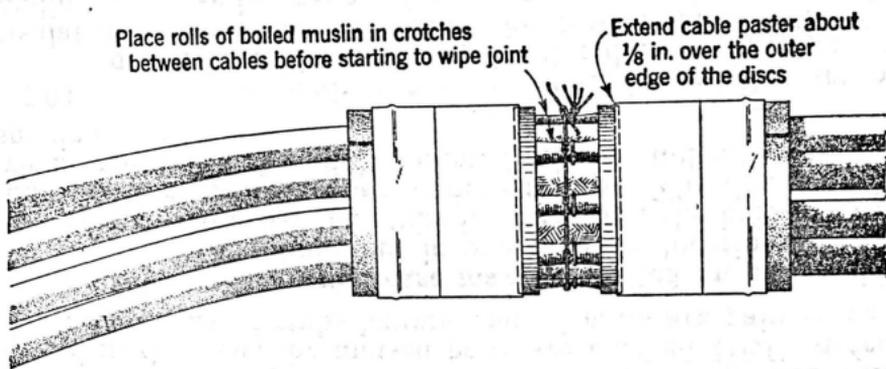
4.17 Over the cable pasters and sleeving place temporary split lead collars. The collars should be about 4 inches long and the outside diameter should be equal to the diameter of the lead discs. Cover the end of each collar that butts against the lead discs with cable pasters as shown below. The cable should be built up with muslin to such a height that when the collars are in position, they will be flush with the lead discs. The collars should be held in place with lashing wire.



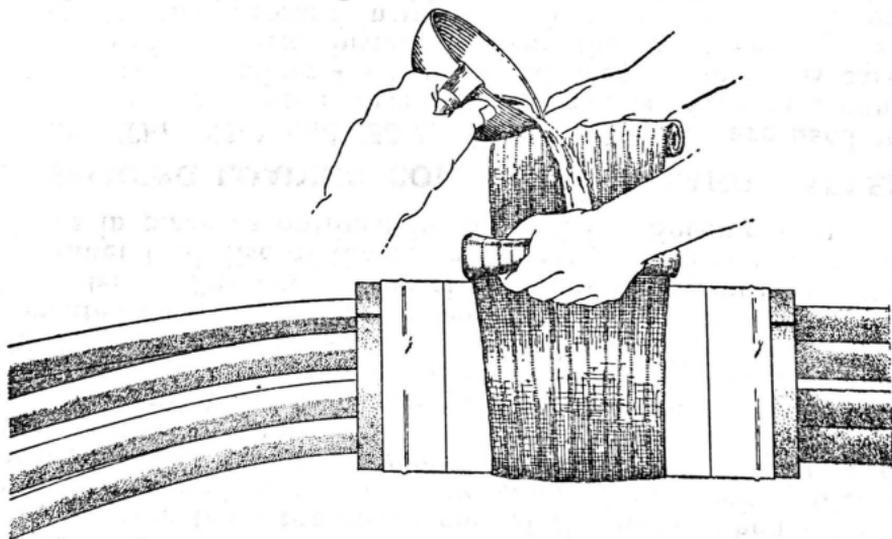
4.18 Fill the crotches with rolls of muslin. The method of making the rolls and of placing them in the crotches is shown in the sketch below. Waxed linen thread is used to hold the rolls in place. The knots in the inner and outer threads should be made at the top of the joint to facilitate cutting them for removal just prior to filling the joint with solder. The rolls should be removed in one operation by pulling on the outer thread with a pair of long nose pliers.



4.19 The temporary collars should be covered with cable pasters, as shown below. The pasters should extend about $1/8$ inch over the outer edges of the lead discs.



4.20 In wiping the discs, the standard large catch cloth will be found satisfactory for catching the solder while heating the joint. A catch cloth for use in filling the joint can be made from a large catch cloth. The stitches in the cloth should be cut and the cloth opened. The material should then be folded to form a cloth 7 inches wide and 18 inches long. The method of holding the cloth in filling the joint is illustrated below. The cloth should not be moved until the solder in the bottom of the joint has solidified. The joint should then be reheated to remove any excess metal. The joint should be wiped flush with the discs.



4.21 Remove the temporary collar, muslin and cable passers from the splice end of the joint. Then remove the sheath and core wrapping paper from each cable. A crimping ring should be placed on one of the top quads of the multi-quad cable 3 inches from the sheath. This ring should be used as a reference point in marking the quads for splicing. The disc-insulated quads should be spliced as outlined in Paragraphs 4.04 to 4.12. Then splice the paper-insulated quads. After the splice has been wrapped, place the lead sleeve. The end of the sleeve should be centered over the inner lead disc of the multiple disc joint. Then wipe the sleeve in place as outlined in the Splicing Specifications.

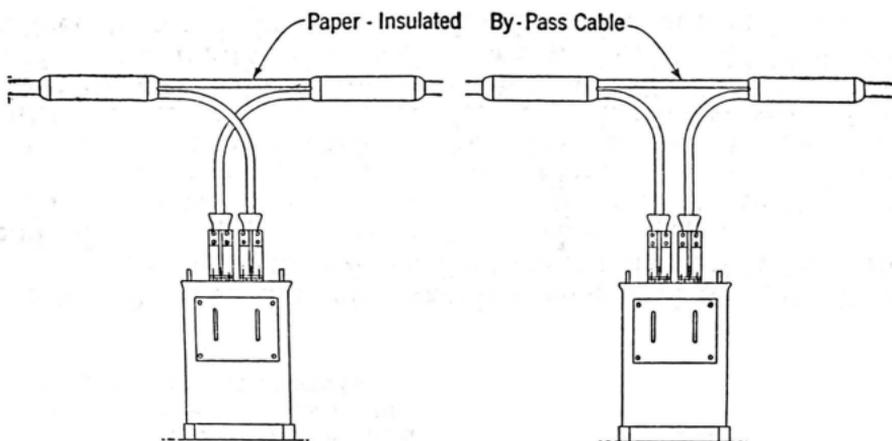
5. SPLICING LOADING COIL CASES IN LAND CABLES

5.01 The 152-A and 252-A loading coil cases are used to load spiral-four disc-insulated cables. Each case contains coils for loading 4 disc-insulated quads. The 152-A case is designed for aerial installation and the 252-A case is designed for underground installation. The cases are equipped with IN and OUT stub cables. Racks are provided in the cases for mounting building-out units. The racks are accessible through openings in the side of the cases. The opening is covered by means of a gasketed steel plate.

5.02 Each stub is composed of eight shielded paper-insulated 19-gauge pairs; two pairs are in the center and the remainder in the first layer. Underneath the shields the paper pair wrappings have distinguishing colors for counting the pairs. The starting pair in the first layer is orange and the direction pair is green and following these blue and white pairs alternate. The center has an orange pair and a green pair. When less than eight coils are contained in the case, the unused pairs are marked DEF (defective). The ends of stubs having unused pairs are painted red.

5.03 The underground case may be located on either side of the manhole, but in one of these locations it will be necessary to cross the stubs in order that the building-out units will be in the proper loading section. The direction in which the stubs should be pointed will be indicated on the splicing plans.

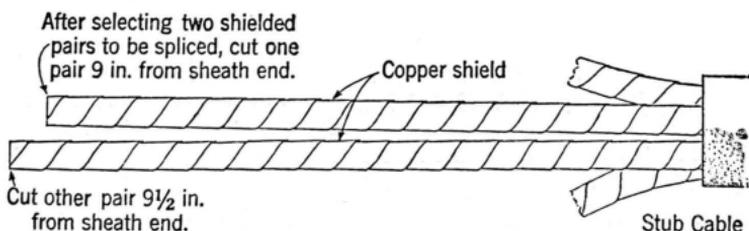
5.04 Where the main cable has paper-insulated pairs or quads in addition to disc-insulated quads, the paper-insulated pairs or quads should be by-passed around the loading coil case by means of a paper-insulated by-pass cable, as shown in the sketch on the following page. The by-pass cable and stub should enter the splice from the same end.



5.05 The sheath opening for the splice should be made 17 inches long. A 4-inch by 20-inch lead sleeve should be used to cover the splice. Prepare the ends of the stub cables for splicing in the usual manner.

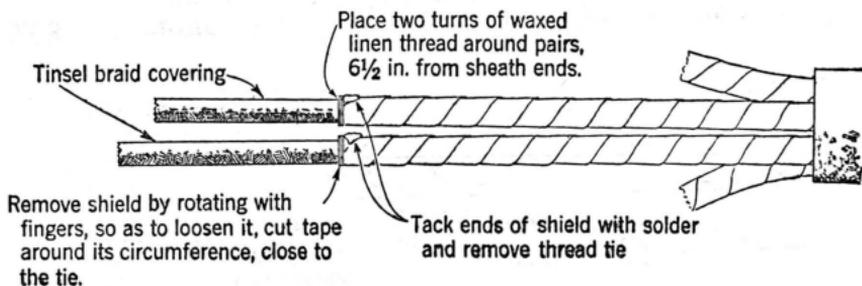
5.06 Prepare a disc-insulated quad as outlined in Paragraphs 3.03 to 3.11 inclusive, except that 2 in place of 3 crimping rings should be used and the tape should be marked 5-1/4 inches from the sheath for locating the crimping rings and 6-7/8 inches from the sheath for cutting the copper shield.

5.07 Select the two shielded pairs that are to be spliced to the disc-insulated quad. Cut off one of the pairs 9 inches from the sheath end and the other, 9-1/2 inches from the sheath, as shown.

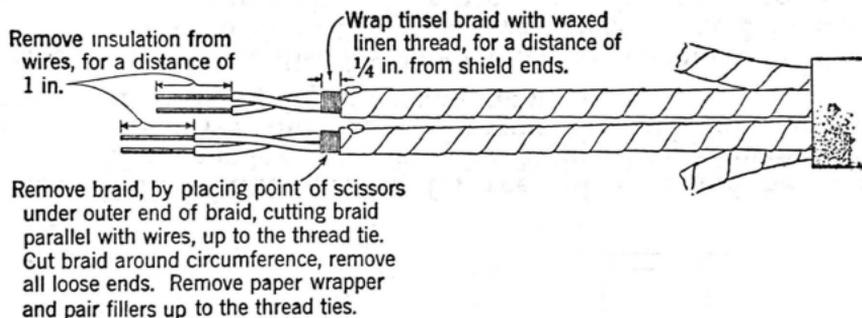


5.08 Remove the shielding tape from the end of each pair as follows: Tie two turns of waxed linen thread around each pair 6-1/2 inches from the sheath end. Rotate the shielding tape with the fingers in the direction that will loosen it. Slip the point of a pair of scissors between the

turns of tape close to the tie and cut the tape around its circumference. Solder the end of the tape and remove the thread tie, as shown below.

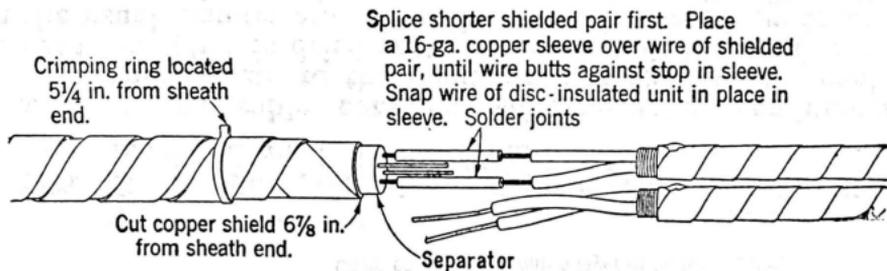


5.09 **Wrap the exposed tinsel braid with waxed linen thread for about 1/4 inch directly adjacent to the tape end, as shown in the figure below. Slip the point of a pair of scissors under the outer end of the braid and cut the braid up to the thread tie in a direction parallel to the pair. Then cut the braid around the circumference taking care to remove all loose ends.**

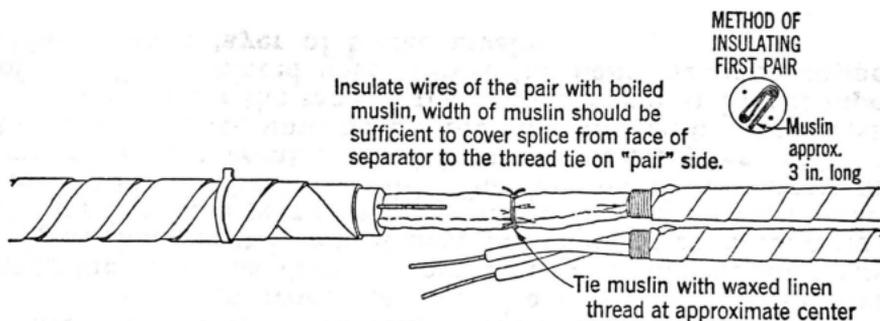


5.10 **Remove the pair wrapping paper and the pair fillers up to the thread tie. Remove the insulation from the end of each wire as shown in the above figure.**

5.11 **Splice the shorter shielded pair to a pair in the disc-insulated quad as follows: Place a 16-gauge tinned-copper sleeve over each of the wires of the shielded pair until the wires butt against the stops in the sleeves. Snap the wires of the disc-insulated quad in place in the sleeves and solder the joints with rosin core solder. A shielded pair spliced to a pair in a disc-insulated quad is shown below.**



5.12 Insulate the wires of the first shielded pair with a piece of freshly boiled muslin as shown below. The width of the muslin should be sufficient to cover the splice from the face of the insulating plug on the "quad" side to the thread tie on the "pair" side. Tie the muslin in place with waxed linen thread at the midpoint.



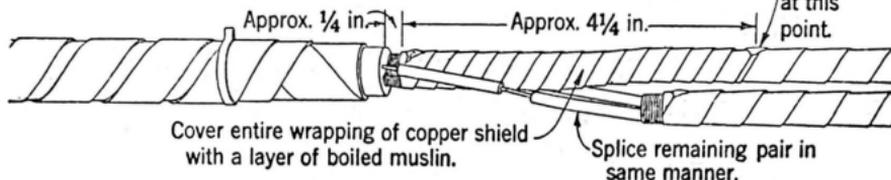
5.13 Wrap the spliced conductors with 1/2 inch copper tape. Starting on the "pair" side, carry the shield to within approximately 1/4 inch of the separator, and solder to the preceding turn. This operation is illustrated in Paragraph 5.14.

5.14 Splice the second pair with 16-gauge tinned-copper sleeves, solder and insulate them as shown in the following sketch. Tie the muslin at each end with waxed linen thread.

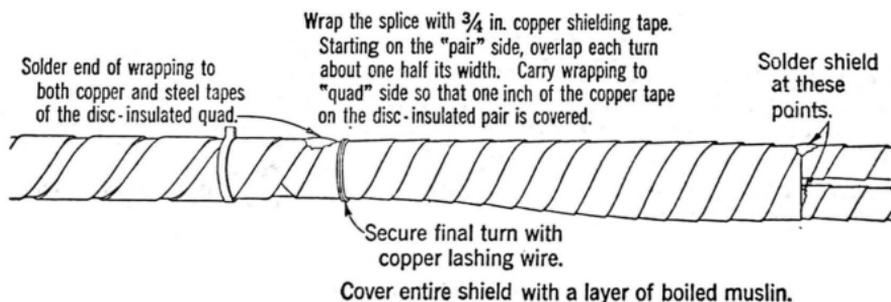
METHOD OF INSULATING SECOND PAIR

Muslin approx. 3 in. x 2 in.  Muslin approx. 3 in. x 6 in.

Wrap splice with $\frac{1}{2}$ in. copper shield. Starting on "pair" side, carry wrapping to approximately separator and solder to preceding turn. Solder shield at this point.



5.15 Cut a $\frac{3}{4}$ inch strip from a copper shielding tape removed from the end of a cable. Wrap this strip over the splice, as shown below. Start wrapping at the "pair" side so that about 1 inch of each pair shield is covered. Solder the tape to each pair shield at the starting end. Overlap each turn about one-half its width. On the "quad" side carry the wrapping to a point about 1 inch over the copper shield of the disc-insulated unit. Secure the final turn with copper lashing wire. Solder the tape to the copper shield and steel tapes of the disc-insulated quad. Cover the hand wrapped copper shield with a layer of boiled muslin.



5.16 Splice the remaining shielded pairs to the disc-insulated quads in the same manner.

5.17 If the cable contains paper-insulated conductors, splice them to the conductors in the by-pass cable. Unless the splice is dried with desiccant, boil the conductors in the usual manner and wrap the paper-insulated quads first as a group and then the entire splice with muslin. Place the lead sleeve and wipe the joints in the usual manner.

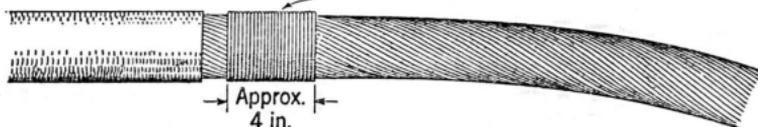
6. SPLICING SUBMARINE LOADING COIL CASES

6.01 Submarine loading coil cases are equipped at each end with identical stubs. The stub consists of seven spiral-four 19-gauge paper-insulated quads each individually shielded with copper tapes, and six 19-gauge paper-insulated pairs that are laid up in the interstices of the first layer of spiral-four units. Each quad has one pair insulated with blue conductor insulation and the other pair with white conductor insulation. The voice-frequency pair which serves as a marker has orange and red insulation and the other five voice-frequency pairs have blue and white insulation. The two pairs of a disc-insulated quad are connected to two adjacent loading coils in the case. One coil is connected to the blue pair of a quad in one stub and to the corresponding blue pair of a quad in the other stub. Similarly, the adjacent coil is connected to the white pairs of the same quad. The quads are connected to the coils so that the count of the quads in one stub is opposite to that in the other stub. The quads in the stubs, therefore, should be identified and marked with linen tape before splicing.

6.02 The temporary clamps, armor wire clamping rings, temporary spacing brackets and wrenches required in splicing are contained in a separate packing box.

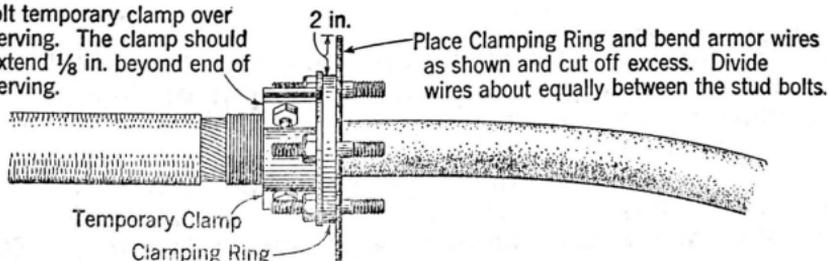
6.03 Remove the splice chamber from the case and slide it over the main cable. Serve the armor wires about 30 inches from the end with .109 or .091 galvanized steel wire and solder using soldering paste, as shown in the sketch.

Serve cable with .109 or .091 Galv.
Steel Wire and solder ends.

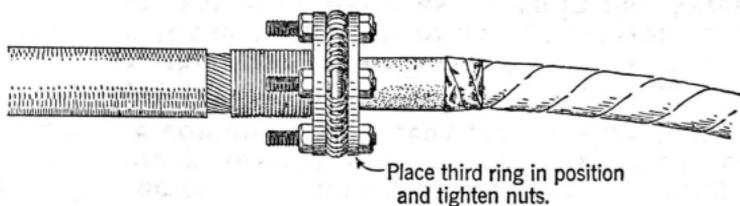
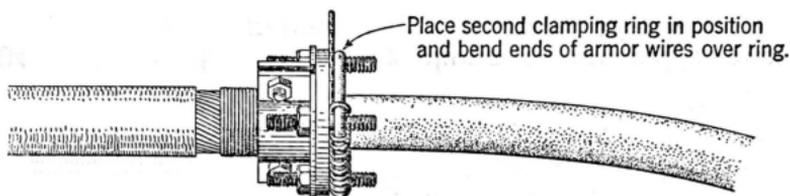


6.04 Attach the temporary clamp to the cable over the serving of galvanized steel wire, as shown below.

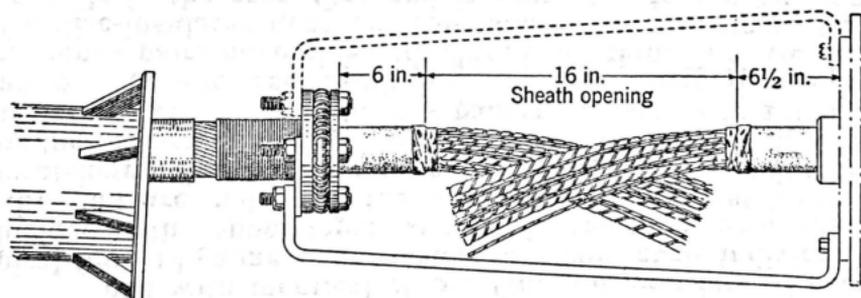
Bolt temporary clamp over serving. The clamp should extend $\frac{1}{8}$ in. beyond end of serving.



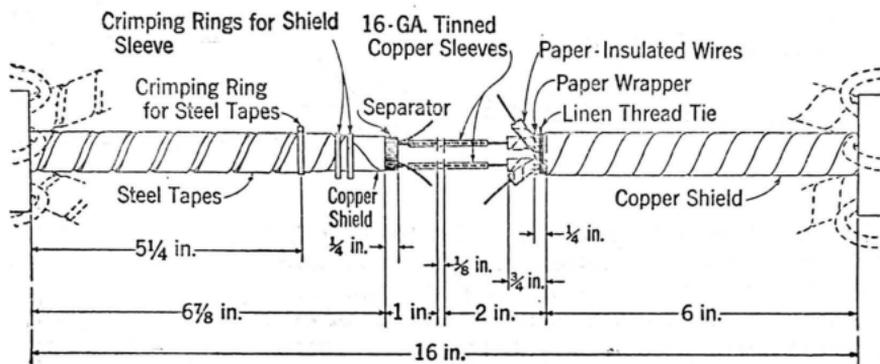
6.05 Bolt the armor wire clamping rings with the stud bolts to the temporary clamp. Bend the armor wires against this ring. Then bolt the clamping ring with rounded edges to the temporary clamp. Cut off the armor wires about two inches from the rings and bend them over the ring. Bolt the third ring to the temporary clamp and turn the nuts up tightly. These operations are illustrated in the sketches below.



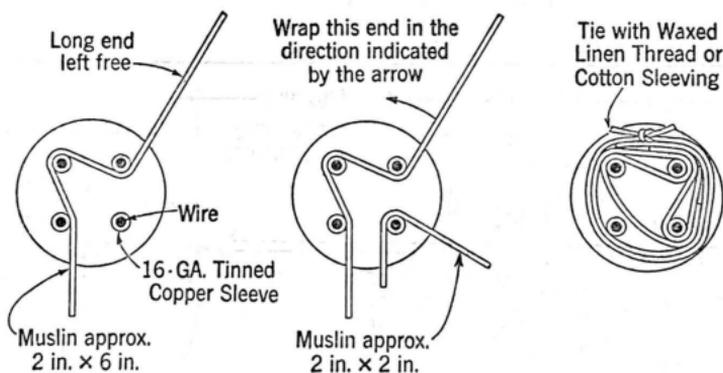
6.06 Remove the temporary clamp and prepare the main cable and stud for splicing. The points at which the sheath should be removed are indicated in the sketch below. Then connect the main cable to the case by means of the temporary spacing brackets.



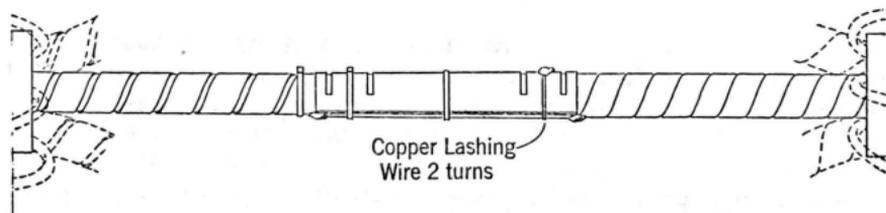
6.07 The method of arranging the splice in quads which do not require building-out is shown in the following sketch. In splicing care must be taken so that there is no movement between the cable and the stub, when the conductors are soldered.



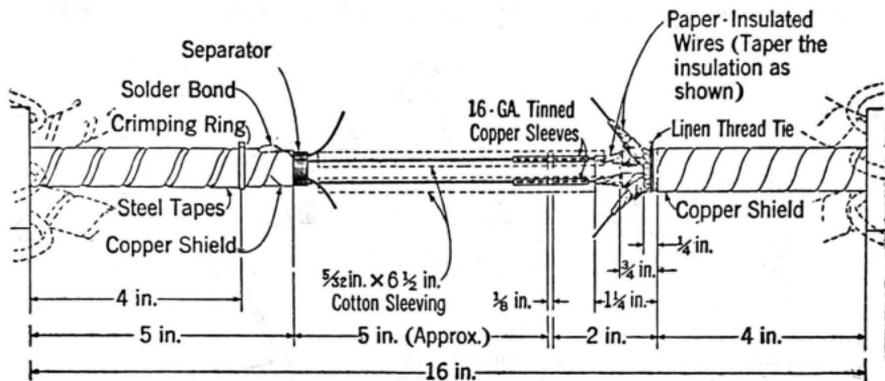
6.08 After the tinned-copper sleeves have been soldered, the conductors should be insulated with muslin strips. The dimensions of the strips and the method of placing them are shown in the sketch below.



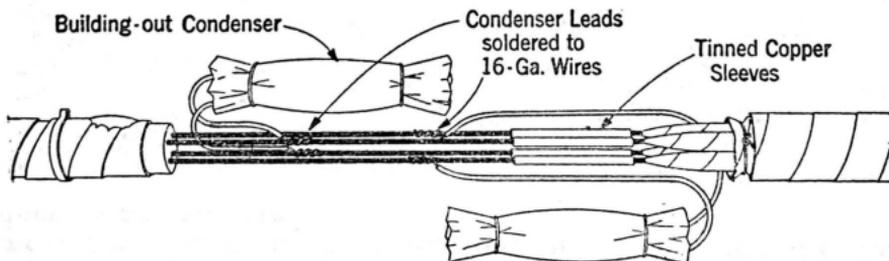
6.09 The outer connecting sleeve should be placed and soldered to the quad shields as shown below.



6.10 The quads requiring building-out and the sizes of condensers to be used will be determined by electrical measurements made before splicing. Quads that require building-out should be prepared for splicing as shown in the following sketch. A 6-1/2 inch length of 5/32 inch cotton sleeving should be used to insulate each conductor joint.



6.11 The condensers required for building-out should be adjusted to proper capacitance as outlined in Section G71.133. The leads should then be soldered to the quad at the location illustrated below. Then spread the quad wires and lay the building-out condensers end to end between the conductors, pour some desiccant between the conductors and wrap with 1-inch cotton tape. Over the cotton tape place a wrapping of copper tape removed from a cable end. Overlap the tape one-half its width. The copper tape should be soldered to the copper shield of the paper-insulated unit and to the copper shield and steel tapes of the disc-insulated quad.



Note:-

For clearness the cotton sleeves used to insulate the conductors are not shown.

6.12 Splice the paper-insulated wires leaving about 6 inches of slack in them to permit future maintenance work on the disc-insulated quads.

6.13 Splices containing building-out condensers should be dried by means of desiccant. Others may be dried by boiling with hot paraffin. Cover the splice with a 4-inch by 18-inch split lead sleeve. After the joints are wiped and the seam soldered, the sleeve should be pressure tested. The seam should then be covered for its entire length with a piece of lead sheath about 2 inches wide held in place by wrapping the sleeve with 2 inch friction tape overlapped one-half its width.

6.14 Boil the wooden cable support in paraffin and place it over the cable between the armor clamping rings and the outer wiped joint. The wooden cable support is used to prevent movement of the cable after the splice chamber has been bolted in place. Remove the temporary spacing brackets and slide the splice chamber over the splice. Bolt the chamber to the case. The slack in the armor wires should be taken up by adjusting the set screws in the outer end of the splice chamber. After the set screws are adjusted, the lock nuts should be tightened.

6.15 Fill the splice chamber with terminal compound heated to a temperature not in excess of 300° F. The use of compound heated above this temperature may damage the seam. About 45 pounds of compound are required for each splice chamber. Should any of the galvanizing or asphalt finish on the case become damaged, the surface should be covered with hot terminal compound.

7. TESTING

7.01 **Clearing Ends for Test:** Insulation resistance measurements and tests for defective conductors shall be made at the time of splicing. In making these tests the cable ends away from the splice must be cleared. The methods of clearing the ends are outlined below.

7.02 **One-Quad Cable:** Cut off about 6 inches of the cable using a chipping knife and hammer. Remove about 6 inches of sheath. Protect the sheath butt with cotton tape but do not tuck the tape under the sheath. Remove the core wrapping paper up to the tape binding. Loosen the steel tapes and cut them as close as practicable to the cotton tape. Cut the copper shield about 2-1/2 inches from the sheath butt. If the copper shield has a tendency to unwind, wrap the end with friction tape. Remove the paper wrapper from the disc-insulated wires and cut the wires about one inch from the

end of the shield. Remove the exposed insulator and, if necessary, the first insulator inside the shield. Boil out a separator and insert it in the end of the unit using a pair of pliers. Cut the exposed wires about 1/8 inch from the separator. Wrap the end with freshly boiled muslin. The end should then be capped with a lead sleeve or rubber end seal or it may be wrapped with rubber and friction tapes and painted with No. 2 asphalt paint.

7.03 Multi-Quad Cable: Cut off about 6 inches of the cable and then remove 12 inches of sheath. Protect the sheath butt with cotton tape but do not tuck the tape under the sheath. Remove the core wrapping paper up to the tape binding. If the center of the core contains paper-insulated quads, cut the conductors about 10 inches from the sheath, staggering the ends. Cut the steel tapes as close as practicable to the cotton binding. Cut the copper shield of each quad about 7 inches from the tape binding. If the shields have a tendency to unwind, tie the ends of the shields with cotton tape. Remove the wrappers around the quads. Cut the disc-insulated wires about 1 inch from the ends of the shields. Remove all exposed insulators and, if necessary, the first insulator inside the shield. Insert a freshly boiled separator over the end of each quad using a pair of pliers. Cut the wires about 1/8 inch from the insulating plugs and the pairs or quads in the outer layer about 4 inches from the sheath, staggering the ends. Wrap the end with freshly boiled muslin and cap it with a lead sleeve or rubber end seal, or wrap it with rubber and friction tapes and paint with No. 2 asphalt paint.

7.04 Tests at Splices: At each splice, measure the insulation resistance between each disc-insulated wire and the other three wires connected to the shields as well as the insulation resistance between the shields and the cable sheath.

7.05 At carrier load points, measure the insulation resistance as indicated in Paragraph 7.04 and also measure the insulation resistance between each paper-insulated conductor and all other paper-insulated wires connected to the shields and the sheath.

7.06 The insulation resistance in any test (of cable with terminations) shall be equivalent to 500 megohm-miles or more. A 400 volt megger shall be used to make the insulation resistance tests.

7.07 At the carrier load points, or at more frequent intervals when necessary, test the disc-insulated units and the paper-insulated conductors for opens, grounds,

crosses, split pairs and split quads. Also test the disc-insulated quads for correctness of numerical designation.

7.08 At the final splice in a cable, identify the disc-insulated and paper-insulated wires in both directions and splice the wires according to their numerical designations.

8. OPENING CABLE FOR MAINTENANCE PURPOSES

8.01 The procedures described below should be followed in opening disc-insulated cable for testing purposes or for clearing faults at splice points or sheath openings.

8.02 **Opening One-Quad Cable at Splice:** Remove the lead sleeve and muslin wrapping. Cut the crimped tips of the rings using a pair of diagonal pliers, then heat the sleeve and rings with the soldering copper to melt the solder and pull the rings from the sleeve. Place the tip of the soldering copper against the bottom of the sleeve, moving the copper back and forth until the solder has melted from the seam; then open and remove the sleeve.

8.03 Remove the muslin wrapping around the disc-insulated wires. Unsolder the four 16-gauge sleeves and disengage the ends of the wires.

8.04 **Sheath Opening in a One-Quad Cable:** Mark off a distance of 12 inches on the sheath where the cable is to be opened. Remove the 12-inch length of sheath, protect the sheath ends with freshly boiled cotton tape, and remove the core wrapping paper up to the cotton tape serving.

8.05 Using a chipping knife and hammer, cut the disc-insulated unit at the center point of the opening. This method of cutting the quad will flatten the cut ends and prevent the steel tapes from unwinding.

8.06 Prepare the quad on each side of the opening as follows: Measure a distance of 2-3/4 inches from the cut end. Looking at the top of the unit, select a steel tape spiral the center of which is on the sheath end side of the 2-3/4 inch point. Mark the steel tape at this point and crimp a ring over it. Loosen the steel tapes and cut them at the ring.

8.07 Grasp the quad with the shield cutting pliers so that the cutting edge is 1-1/8 inches from the end and remove the copper shielding tape and the paper wrapper. This will expose 1-1/8 inch lengths of disc-insulated wires.

8.08 Place a boiled separator in the end of the quad, extracting a disc-insulator if necessary.

8.09 Resplicing One-Quad Cable: After tests have been made and the trouble cleared, the cable should be spliced as outlined in Part 3. In some cases, as in clearing a fault, the length of exposed quad wires may be such that an outer connecting sleeve will not cover the opening. In such a case, two of the sleeves should be soldered together to form a single long sleeve. This sleeve should be placed over the opening and soldered to the steel tapes and copper shield, as well as along its seam as outlined in Paragraph 3.18.

8.10 Opening Multi-Quad Cables: If at a splice, remove the lead sleeve and muslin wrappings. If the sheath must be opened, make a 19-inch opening and remove the lead sheath and core wrapping paper.

8.11 Pull slack in the cable to permit the disc-insulated quads and paper-insulated wires to be ballooned sufficiently to provide access.

8.12 Identify the quad to be opened by locating the tracer quad or pair, then count in a clockwise or counter-clockwise direction, depending on the direction in which the cable is viewed, until the desired quad is located.

8.13 Open the quad as described in Paragraph 8.02 or 8.04 depending on whether the opening is at a splice or in a section.