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Outside Plant Construction and Maintenance

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SUBMARINE CABLE SPLICING
WELDED ARMOR WIRE METHOD

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1. GENERAL

1.01 The instructions contained in this section cover the method of splicing submarine cables in which the armor wires from one cable end are wound spirally around the splice and are welded to the armor wires on the other cable end.

1.02 This section deals primarily with the method of handling the armor wires and jute in joining submarine cables by the welded armor wire method. The other splicing operations can be carried on in substantially the same manner as that followed in land cable splicing.

2. TOOLS AND MATERIAL

2.01 The following special tools and materials will be required for the various operations in splicing submarine cables. Ordinarily these items can be obtained locally. The other tools and materials required are the same as those generally used for land cable splicing:

Serving board
Wooden horses or other suitable supports
Hacksaw with special blades to cut armor wires
Bolt cutter
Files
Wooden mallet
No. 12 lacing twine
Special submarine cable serving tool
1/2-in. manila rope for use with serving tool
Metallic arc welding apparatus
1/8-in. electric welding rods

3. PREPARING CABLE FOR SPLICING

3.01 The end of the cable from which the armor wires will be wound spirally around the splice is designated as the "long end." The other cable end is designated as the "short end." When double-armored cable is to be spliced to single-armored cable, the double-armored cable should be designated the "long end" and the single-armored cable designated the "short end."

3.02 If the cable is protected with an outer covering of jute the jute should be unwound from the cable for sufficient distance to make the splice. The jute should not be cut but wound on a stick so that it can later be replaced on the cable.

3.03 Locate the center point of the splice on each cable end and mark the location on the armor wires with chalk. These points are used as reference points for all later measurements. The location of these points should be determined as follows:

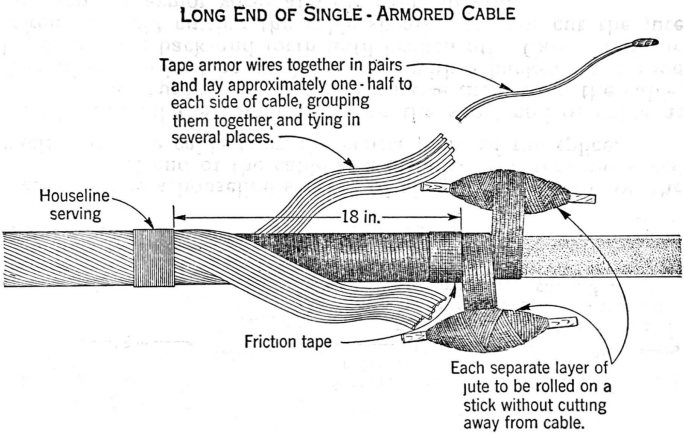
(a) Long End of Cable: Select the point nearest the end of the cable where the armor wires are all straight and in good condition. Measure back along the cable and mark the center of the splice at a point 6 feet from the end for single-armored cable and 10 feet for double-armored cable.

(b) Short End of Cable: Measure back from the end of the lead sheath and mark the center of the splice 2-1/2 feet from the end of the lead sheath.

3.04 Bring the cable ends into splicing position with the center points of the splice together and lash in place on horses or other suitable supports. Use a sufficient number of supports to keep the cable fairly straight over the entire section being worked on.

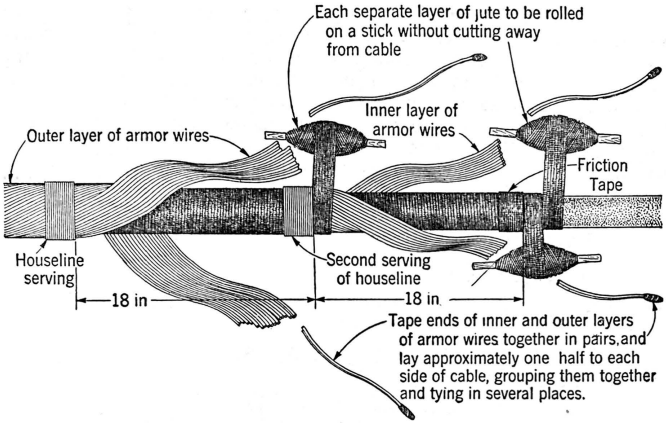
3.05 Place a houseline serving of about twenty turns on the long end of cable 6 feet from the center of the splice for single-armored and 10 feet for double-armored cable.

3.06 Tape the armor wires on the long cable end together in pairs at the outer end and then unwrap the wires back to the houseline serving. Lay half of the armor wires on each side of the cable leaving space for working on the splice. Care should be taken not to cut, bend or kink the wires, nor disturb the original set or lay of the armor wires. After the armor wires have been laid aside, they should be grouped together and tied in two or three places so that they will not be stepped upon. Place a friction tape serving of five turns over the jute approximately 18 inches from the houseline serving. Unwrap the jute covering from around the lead sheath up to the serving of friction tape. Wind each layer of jute on a stick in preparation for rewinding around the cable in its original position after the splice has been completed. Do not cut the jute covering away from the cable.



3.07 Place a second houseline serving on the "long end" of double-armored cable instead of a wrapping of friction tape over the jute covering of the inner layer of armor wires, and unwrap the outer jute covering and inner layer of armor wires in the same manner as outlined in Paragraph 3.06. The jute covering around the cable sheath should be served with friction tape and then unwrapped in the same manner as outlined in Paragraph 3.06.

LONG END OF DOUBLE ARMORED CABLE

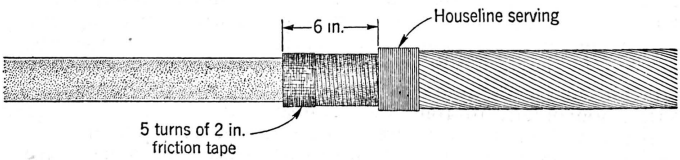


3.08 Place a houseline serving of about twenty turns on the short end of the cable at a distance of 3 feet measured back along the cable from the center point of the splice.

3.09 Cut all the armor wires on the short end of cable at the houseline serving and remove them from the cable. The wires can best be cut by scoring with a hacksaw and then bending them back and forth until broken off. Care should be taken to avoid cutting the cable sheath. Do not cut the jute between the armor wires and the cable sheath.

3.10 Wrap five turns of friction tape around the jute at a point about 6 inches from the cut-off ends of the armor wires. Cut the jute at this point and remove from the cable.

SHORT END OF SINGLE - ARMORED CABLE



3.11 On double-armored cable, cut off and remove both layers of armor wires and the jute wrapping between the two layers of armor wires at the houseline serving, then wrap five turns of friction tape around the inner jute covering of the cable sheath at a point about 6 inches from the cut-off ends of the armor wires and remove the jute as outlined under Paragraph 3.10.

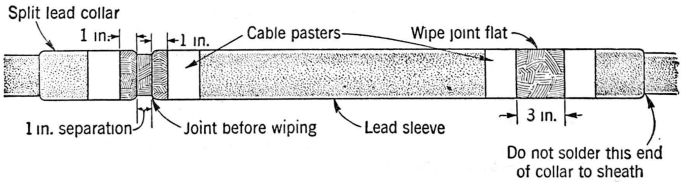
4. MAKING SPLICE IN CABLE

4.01 Mark the center point of the splice on each end of the cable sheath. Then cut off a section of cable from the long end so that the overlap of the two cable ends will be four or five feet.

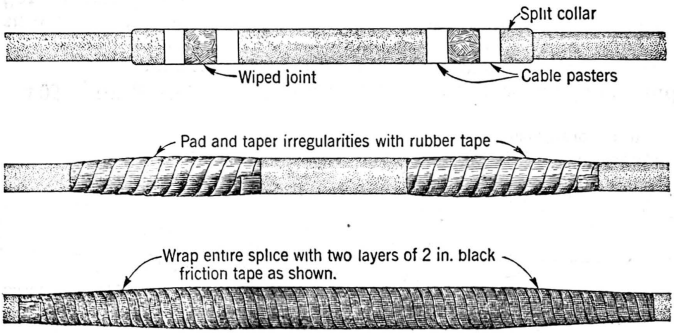
4.02 Strip off the sheath from each cable end so that the distance between the butts of the sheaths when the center point marks of the splice are brought together will be 3 inches less than the length of the lead sleeve which will be used to cover the splice.

4.03 After the conductors have been spliced and the lead sleeve placed over the splice and the ends beat in prepare two split lead collars 6 inches long and of the proper diameter to fit tightly over the cable sheath on each side of the lead sleeve. Clean the ends of the collars which will be placed next to the lead sleeve and coat the cleaned surfaces with stearine. Place a lead collar over the cable sheath on each side of the lead sleeve and solder the seams in the collars. Space the collars one inch from the sleeve and beat in both ends of each collar.

4.04 Place cable pasters on the lead sleeve and collars and wipe the joints as shown in the following figure.



4.05 Fill in the irregularities caused by the wiped joints and lead collars with rubber tape and cover the lead sleeve, collars and adjacent cable with two layers of friction tape, as shown in the following figure. The joints should be wiped as flat as practicable.



5. PREPARING ARMOR WIRES ON SHORT CABLE END FOR WELDING

5.01 The armor wires should be prepared for the welding operation while the testing and splicing work is in progress.

5.02 To prepare the armor wires for welding, it is necessary to place additional servings of houseline around single and double-armored cables as follows:

(a) Single or Double-Armored Cables: Place a second serving of houseline 3 feet back of the first serving.

(b) Double-Armored Cable: Place a third serving of houseline 4 feet back of the second serving, the one placed under (a).

5.03 On single-armored cable the armor wires on the short end should be prepared for welding as follows:

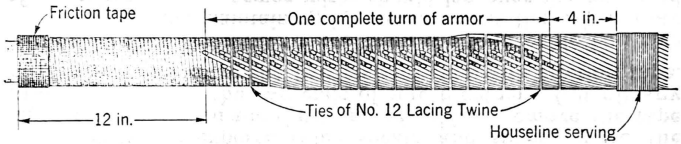
(1) Remove the houseline serving at the end of the armor wires.

(2) Unwind one armor wire to a point about 4 inches from the second houseline serving and cut off the wire at an angle with a hacksaw. The face of the saw cut should slope toward the splice. Tie the cut end into place about the cable with three turns of No. 12 lacing twine. To facilitate the welding of the wires, all cuts should be made along the top of the cable.

(3) Unwind and cut one of the adjacent armor wires at a point about 2 inches, measured along the wire, toward the splice from the first cut. The remaining armor wires should be cut in a similar manner, the succeeding cuts

being staggered so that when all wires are cut there will be two rows of wire ends running parallel along the top of the cable with the ends of each pair approximately 2 inches apart measured along the wire. Place ties of No. 12 lacing twine around the cut ends, as outlined under (2), using one tie for each pair of wires. The fully prepared end is illustrated below.

SHORT END OF SINGLE-ARMORED CABLE
ARMOR WIRES PREPARED FOR WELDING



5.04 On double-armored cable the armor wires should be prepared for welding as outlined below:

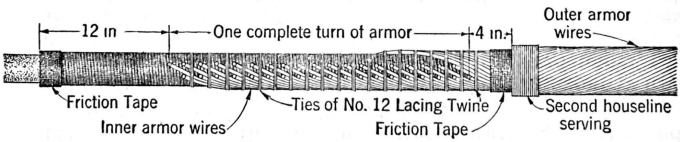
(1) Remove the houseline serving at the end of the armor wires.

(2) Cut all the armor wires in the outer layer at the second houseline serving and remove them from the cable.

(3) Wrap several turns of friction tape around the jute covering over the inner armor wires at the cut ends of the outer armor wires. Cut the jute at the end of the tape serving and remove from the cable.

(4) Unwind, cut and prepare the inner layer of armor wires for welding in the same manner as outlined under (2) and (3) in Paragraph 5.03 for single-armored cable. Make the first cut in the armor wire at a point about 4 inches from the second houseline serving.

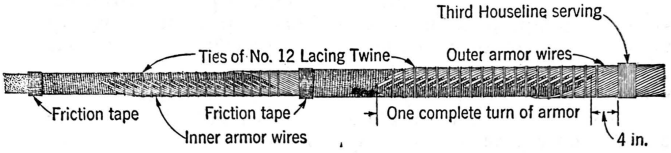
SHORT END OF DOUBLE-ARMORED CABLE
INNER ARMOR WIRES PREPARED FOR WELDING



(5) Then remove the second houseline serving at the end of the outer layer of armor wires.

(6) Unwind, cut and prepare the outer layer of armor wires for welding in the same manner as outlined under (2) and (3) in Paragraph 5.03 for single-armored cable. Make the first cut in the armor wire at a point about 4 inches from the third houseline serving. A fully prepared short end of a double-armored cable is illustrated below.

SHORT END OF DOUBLE-ARMORED CABLE
INNER AND OUTER LAYERS OF ARMOR WIRES PREPARED FOR WELDING



5.05 When double-armored cable is to be spliced to single-armored cable, the armor wires of the single-armored cable ("short end") should be prepared for welding in the same manner as outlined under Paragraph 5.03.

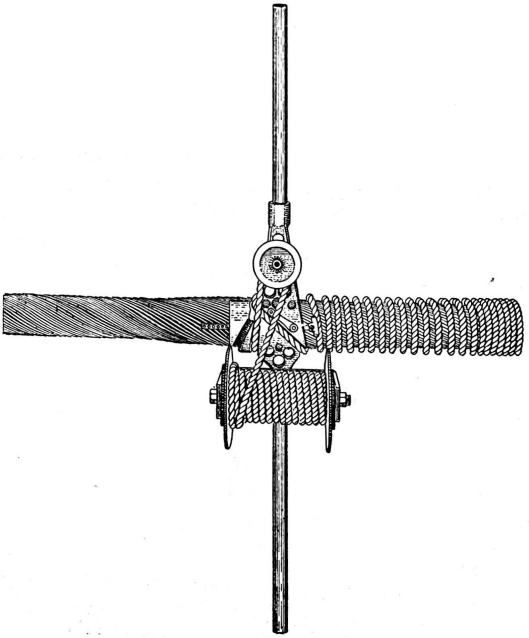
6. REPLACING AND WELDING ARMOR WIRES ON SINGLE-ARMORED CABLE

6.01 Rewind the jute covering left on the long cable end over the exposed cable sheath and splice, up to the taped end of jute on the short end of cable. Remove the tape wrapping and butt the two ends of jute together. Cut off any surplus jute and serve the two ends of jute with friction tape.

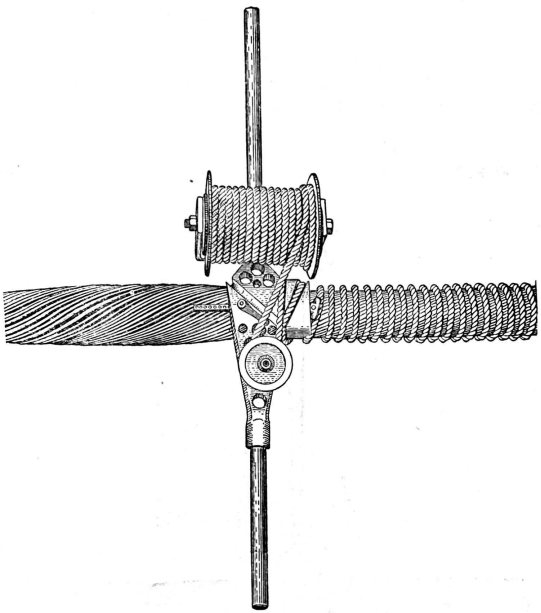
6.02 Replace the armor wires from the long cable end two at a time, maintaining by measurement the original lay of the wires. These armor wires should lap over the prepared ends of the armor wires on the short cable end. In relaying the armor wires around the lead sleeve, care should be taken to ensure that the space between the wires is approximately equal.

6.03 Place a tight serving of 1/2-inch manila rope over the armor wires with a serving tool similar to that shown in the following figures winding in the same direction as the lay of the armor wires. The rope serving should extend from a point back of the houseline serving on the long cable end to within 6 inches of the first end of armor wire on the short cable end.

SUBMARINE CABLE SERVING TOOL
SERVING ARMOR WIRES WITH RIGHT-HAND LAY

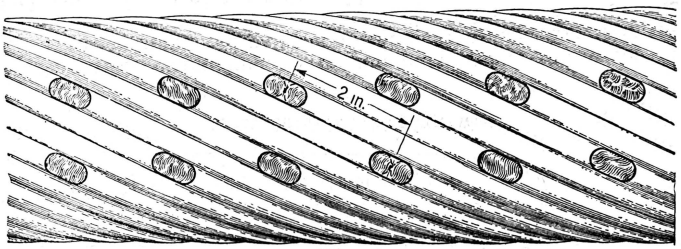


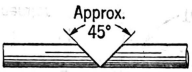
SUBMARINE CABLE SERVING TOOL
SERVING ARMOR WIRES WITH LEFT-HAND LAY



6.04 Match the armor wires from the long cable end with those on the short cable end. Cut off the wires and butt weld the ends together with an electric-arc weld. In cutting off the armor wires, the face of the cut should be sloped toward the weld to provide a V-shaped space for properly building up the weld.

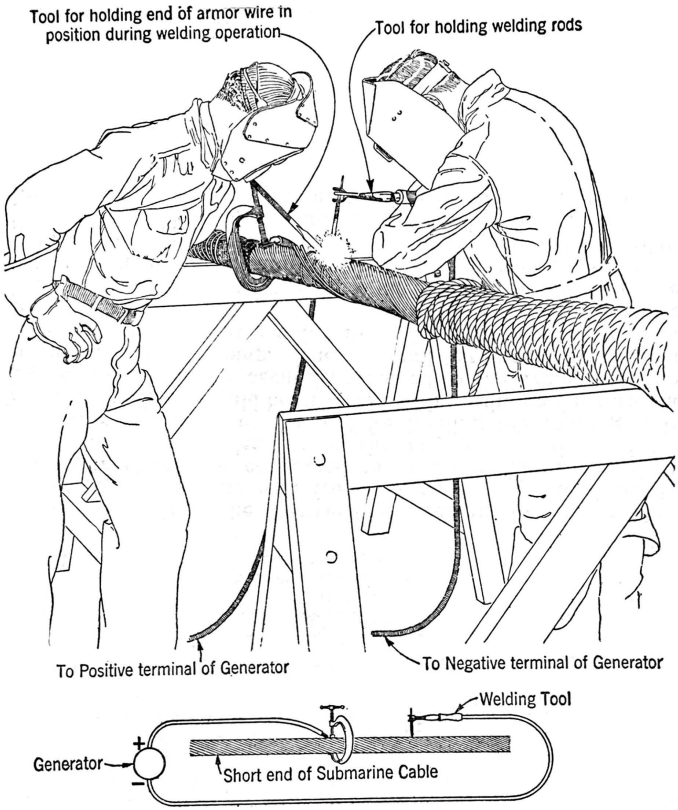
BUTT WELDS IN ARMOR WIRES





SIDE VIEW
Showing ends of armor wires
butted ready for weld

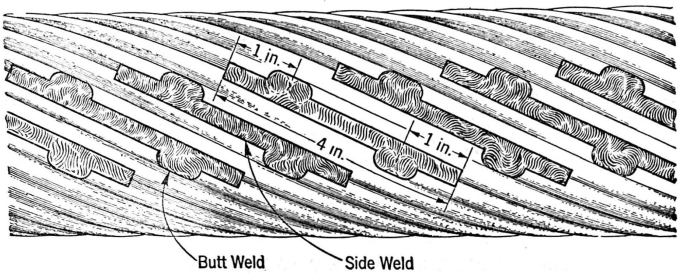
6.05 In making the electrical connections for the welding operation, the lead from the positive terminal of the generator should be connected to armor wires on the short cable end and the lead from the negative terminal of the generator connected to the tool for holding the welding rods. The positive lead should be provided with a suitable flat terminal lug so that it can be securely attached to the armor wires by means of a screw-clamp. The terminal lug should be clamped to the armor wires at a point about 6 inches beyond the weld located at the greatest distance from the center of the splice. A special tool consisting of a 12-inch piece of 3/8-inch steel rod with a flattened and notched end should be used for holding the armor wires from the long cable end in place during the welding operation. The following figure illustrates the welding of armor wires at a splice in submarine cable.



Schematic Circuit for Welding Armor wires

6.06 After completing all of the butt welds, the wires of each staggered pair should be side welded together for a distance of about 4 inches. The weld should start about one inch back of one of the butt welds and continue past the two butt welds of the pair to a point about one inch beyond the second butt weld, as shown in the following figure.

SIDE WELDS IN ARMOR WIRES



6.07 After completing the welding operation, remove the rope serving.

7. REPLACING AND WELDING ARMOR WIRES ON DOUBLE-ARMORED CABLE

7.01 The inner layer of jute and armor wires of double-armored cables should be replaced and the armor wires welded in the manner described under Part 6 for single-armored cables.

7.02 The jute between the two layers of armor wires should be rewound over the inner layer of armor wires and the outer layer of armor wires replaced and welded in a similar manner.

8. REPLACING AND WELDING ARMOR WIRES; DOUBLE-ARMORED CABLE SPLICED TO SINGLE-ARMORED CABLE

8.01 The inner layer of jute on the double-armored cable should be rewound over the cable and the inner layer of armor wires replaced and welded to the armor wires of the single-armored cable in the manner described under Part 6 for single-armored cable.

8.02 Rewind the outer layer of jute of the double-armored cable around the armor wires extending it to a point about 24 inches beyond the butt welds in the armor wires. Cut off any surplus jute and serve the end of the jute with friction tape.

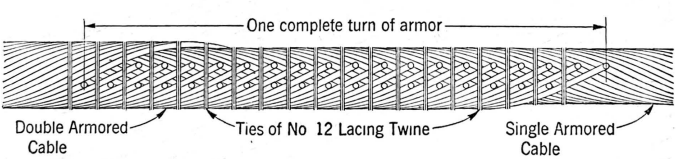
8.03 Replace the outer armor wires of the double-armored cable two at a time, maintaining by measurement the original lay of the wires. These armor wires should extend for their full length over the single-armored cable.

8.04 Place a tight serving of 1/2-inch manila rope over the armor wires with the serving tool as outlined under Paragraph 6.03. The rope serving should extend from a point back of the houseline serving on the double-armored cable to within about 30 inches of the ends of the armor wires.

8.05 The ends of the armor wires of the double-armored cable should be prepared for welding to the armor wires of the single-armored cable as follows:

(1) The end of one of the armor wires of a pair should be cut off at an angle with a hacksaw. The saw cut should have a long taper and the face of the cut should slope away from the splice point. Tie the cut end into place with three turns of No. 12 lacing twine. The end of the other armor wire of the pair should be cut off at a point about 2 inches, measured along the wire, beyond the end of the first wire. To facilitate welding, the ends of the wires should terminate along the top of the cable. The remaining armor wires should be cut in a similar manner, the succeeding cuts being staggered so that when all wires are cut there will be two rows of wire ends running parallel along the top of the cable with the ends of each pair approximately 2 inches apart measured along the wire. A fully prepared end is illustrated below:

SPLICING DOUBLE ARMORED CABLE TO SINGLE ARMORED CABLE
OUTER DOUBLE ARMOR WIRES PREPARED FOR WELDING



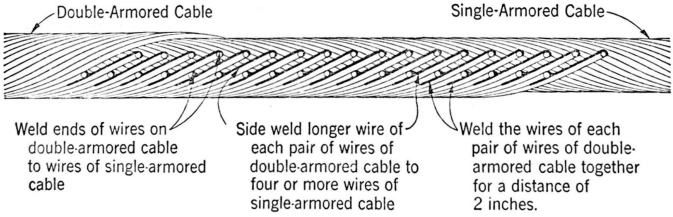
8.06 The end of the wires of the double-armored cable should be welded to the armor wires of the single-armored cable as outlined and illustrated below:

(1) Weld the end of each armor wire to the armor wires of the single-armored cable. Care should be taken to ensure that the welds are smooth and free from any projections so as to prevent any likelihood of the welds catching on tackle during placing or underrunning operations.

(2) As the outer layer of armor wires of double-armored cable have a left-hand lay and the armor wires of single-armored cable have a right-hand lay, it is desirable to side weld the longer armor wire of each pair of wires of the double-armored cable to four or five wires of the single-armored cable at the points where they cross.

(3) After completing the welding described under (1) and (2), the wires of each pair of armor wires of the double-armored cable should be welded together. The weld should start at the end of the shorter armor wire of each pair and extend back on the wire for a distance of about 2 inches.

SPLICING DOUBLE-ARMORED CABLE TO SINGLE-ARMORED CABLE
LAP WELDING OUTER DOUBLE ARMOR WIRES TO SINGLE ARMOR WIRES



(4) After completing the welding operation, remove the rope serving.

8.07 If the cable is protected with an outer serving of jute the jute should be rewound onto the cable and held in place by a close serving of spun yarn. The entire serving should be given a liberal coating of hot asphalt.