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TECHNICAL MANUAL

CABLE ASSEMBLIES CC-345 (5-Pair), CC-355-A (10-Pair) AND ASSOCIATED EQUIPMENT

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CABLE ASSEMBLIES CC-345 (5-PAIR), CC-355-A (10-PAIR) AND ASSOCIATED EQUIPMENT

SECTION I

DESCRIPTION

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1. **Purpose.**—This manual describes Cable Assemblies CC-345 (5-pair), CC-355-A (10-pair) and associated equipment, and sets forth standard and recommended methods of employment for the guidance of personnel responsible for the installation and maintenance of wire lines with these assemblies.

2. **Cable assemblies and cable stubs.**—*a.* Cable Assembly CC-345 (5-pair) consists of a length of Cable WC-534 (5-pair) equipped with a connector (Plug PL-163) on each end. The cable conductors are connected identically to the plugs and sockets of each connector, according to the detailed wiring method shown in figure 1 and the color code in paragraph 3*a*. The rubber compound of the connector is vulcanized securely to the cable jacket. This cable assembly is available in nominal lengths of 100 feet, 200 feet, 500 feet, and ½ mile. Each length is identified by a metal tag, bearing the type number and length in feet, fastened around the cable at each end (fig. 1).

b. Cable Assembly CC-355-A (10-pair) consists of a length of Cable WC-535 (10-pair) equipped with two staggered connectors (Plug PL-163) on each end. The conductors connected to the plugs and sockets of the long connector at one end are then connected identically to the plugs and sockets of the short connector at the other end, and vice versa. Figure 1 and the color code in paragraph 3*b* show the details of the connection of the conductors. The rubber compound of the two connectors on each end is vulcanized securely to the cable jackets of the two short pieces of Cable WC-534 (5-pair). The jackets of these short pieces are vulcanized at their opposite ends to the jacket of Cable W-535 (10-pair) in a pothead, where the two short Cables WC-534 are spliced to Cable WC-535 (fig. 1). This cable assembly is available in nominal lengths of 100 feet, 200 feet, 500 feet, and 1,000 feet. Identifying marking is similar to that of Cable Assembly CC-345 (5-pair).

c. Cable Stub CC-344 (5-pair) consists of 10 feet (nominal length) of Cable WC-534 (5-pair) with a connector (Plug PL-163) on only one end. It is otherwise identical with Cable Assembly CC-345 (5-pair).

d. Cable Stub CC-354 (10-pair) and Cable Assembly CC-355 (10-pair) are no longer produced. They consist of Cable WC-535 (10-pair) with a 10-pair connector, rather than the present termination of two 5-pair connectors.

3. **Cables and molded terminals.**—*a.* Cable WC-534 (5-pair) has 10 solid copper wire conductors, each of which has a colored rub-

ber insulation. The conductors are paired according to the following color code:

Pair No.	*Color code*
1	Red—natural
2	White—natural
3	Blue—natural
4	Black—natural
5	Green—natural

The conductors of each pair are twisted together with a left-hand lay. With cotton cord as the center and as filler between the pairs, the five pairs are twisted together with a right-hand lay. A cotton yarn separator is applied over the assembled conductors, and tough, black vulcanized rubber is molded around the outside to form the cable jacket. Electrical and physical characteristics of Cable WC-534 may be found in table I.

b. Cable WC-535 (10-pair) is similar to Cable WC-534, except that it is made up of 10 pairs of conductors which are paired according to the following color code:

Pair No.	*Color code*	
1	Red—natural	
2	White—natural	
3	Blue—natural	
4	Black—natural	core
5	Green—natural	core
6	Red—white	
7	Red—green	
8	Blue—white	
9	Black—green	
10	Green—white	

Electrical and physical characteristics of Cable WC-535 also may be found in table I.

c. The molded terminal (Plug PL-163) is a molded rubber, hermaphrodite connector, made up of a male plug section and a female socket section (fig. 1). There are five plugs in the male section and five sockets in the female section. Each of the sockets can expand because the metal is split into three segments. The pressure on the socket walls is maintained by a small spiral spring around each socket, combined with the squeezing action of the molded rubber. Provision is made at the base of each plug and socket for the connection of the conductors of the cable. (See *a* and *b* above for details.) The connector is reinforced and constructed to remove strain from the conductors and connections in the event of severe bending, pulling, or twisting. Note in figure 1 that within the connector the conductors pass through strain insulators. The method of joining connectors (par. 14) relieves strain at the connection. When two connectors are joined, but not taped and tied together, a straight pull of from 25 pounds to 40 pounds is required to separate them.

d. Some of the first 5- and 10-pair cable produced was not completely color coded. In this old cable the rubber insulation of only one pair is color coded; this pair has one black conductor. This fact should be borne in mind when opening cable for repair and matching conductors for splicing.

4. Shipping reels.—Cable assemblies in lengths of 500 feet or greater are furnished on wooden reels. A plywood cover wrapped around the reel and nailed to its flanges protects the outside turns of cable. The connectors of both ends of a length of cable assembly are fastened securely and in such a manner that both ends are available for testing the cable on the wooden reel. Cable stubs and 100-foot and 200-foot lengths of cable assemblies are furnished in coils, securely tied and wrapped in heavy paper. All reels and coils are marked with the quantity, type of cable, and length, in addition to the order number and the name and address of the manufacturer. The direction of rotation of the cable on the reels is indicated by arrows on the reel heads. When the protecting cover of plywood is removed, it should be saved so that it may be used again whenever cable is to be transported any considerable distance on the wooden reels.

Section II

INSTALLATION AND OPERATION

5. General.—*a.* The use of these cable assemblies permits the laying of 5 or 10 circuits simultaneously, with a minimum of men, vehicles, and equipment. At command posts of higher headquarters, and in other areas where there is a tendency for wire communication lines to become congested, these cables may be employed to reduce the time of installation and to consolidate overhead circuits in one or more cables.

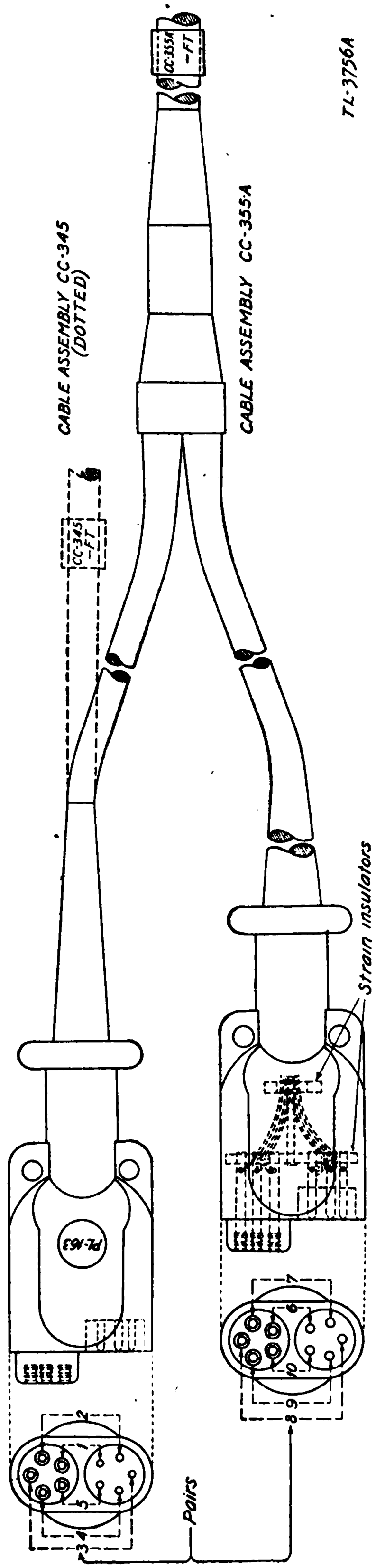

FIGURE 1.—Method of terminating Cable Assembly CC–355XA (10-pair) and Cable Assembly CC–345 (5-pair) and Cable Stub CC–344. The complete illustration represents the termination of CC–355–A, and the upper molded terminal with dotted-line extension represents the termination of CC–345 and CC–344.

b. Figure 2 shows diagrammatically how cable may be used at a division command post. This example represents the use of cable at the command post or rear echelon of any unit to which cable is available. If carrier system terminal equipments are located at the switchboard instead of at a construction center, these cables are not to be used as part of the trunk lead-in line.

c. A short section of line of either of these cables may be used through a wooded area as part of an open-wire line. Because of the effect of cross-talk on telegraphic communication, such a section should never exceed ½ mile in length, unless careful consideration is given to all transmission characteristics of the complete line. This use of cable is an expedient and such a section will be replaced with open wire as soon as there is time to clear trees or reroute the line. If carrier systems are used on the line, cable assemblies should not be used.

6. Capabilities.—*a. Telephone.*—The satisfactory transmission distance or talking range is given in table I as 18 miles for both

TABLE I.—*Physical and electrical characteristics of 5-pair and 10-pair cable.*

Characteristic	Cable WC-534	Cable WC-535
Conductors	(1)	(1)
Thickness of conductor insulation, inch	0.015	0.015
Number of conductors	10	20
Thickness of jacket, inch	1/16	5/64
Outside diameter, inch	0.5	0.7
Weight, pounds, per 1,000 feet	125	250
Minimum tensile strength, pound	425	750
D-c resistance, ohms per 1,000 loop feet of conductor	8.7	8.7
Mutual capacitance at 1,000 cycles per second μf per 1,000 feet	0.03	0.03
Insulation resistance, megohms per 1,000 feet at 60° F	1500	1500
Attenuation at 1,000 cycles per second, db per mile:		
Unloaded—dry	1.65	1.65
Unloaded—wet	1.65	1.65
Satisfactory transmission distance, miles (30-db circuit*):		
Unloaded—wet	18	18
Unloaded—dry	18	18

[1] Solid No. 19 AWG annealed copper.
*See paragraph 6.

5- and 10-pair cable. Each connection which is not made perfectly reduces the talking range appreciably, due to the introduction of cross-talk and noise. This effect is greater in wet weather. It is increased further by the repeated connection and disconnection of the terminals. The total effect of these conditions is to reduce the talking range to such an extent that these cables should not be used in the construction of any trunk lines, but should be used only for the purposes discussed in paragraph 5.

b. Telegraph and teletypewriter.—Cross-talk and noise reduce the transmission range for telegraph and teletypewriter communication as indicated for telephone communication. The transmission range may be reduced to such an extent that these cables may be used only as discussed in paragraph 5. As an example of the effect of cross-talk and noise, a teletypewriter operating over one pair of conductors may activate a telegraph set connected to another pair. A circuit of these cables more than ½ mile in length should never be used as a part of a simplexed or phantomed group, such as will usually be found on a trunk line, and in some instances on a trunk lead-in line. The insu-

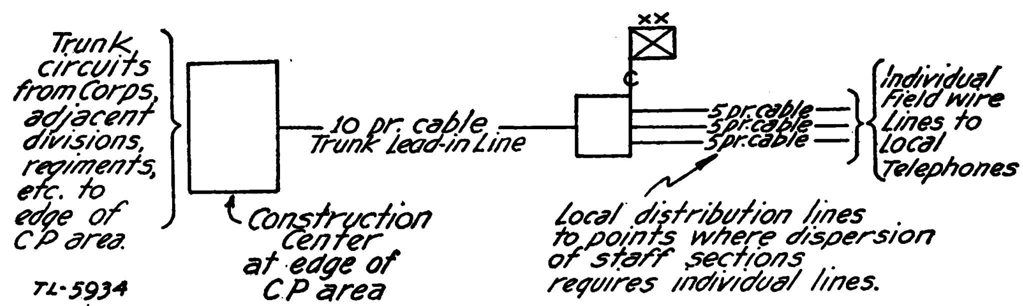

FIGURE 2.—Examples of use of 5- and 10-pair cable.

lation resistance unbalance between conductors which are phantomed or simplexed is too great to permit satisfactory use of simplex coils for greater distances.

c. Carrier systems.—Five- and 10-pair cable must not be used as a part of any line on which a military carrier system is to be used, as the electrical characteristics of the cables are not suitable for the frequencies involved. If the carrier-system terminal equipment is located at the construction center, 5- or 10-pair cable may be used as the lead-in from the center to the unit switchboard (fig. 2).

7. Line construction.—*a. General.*—In general, the basic principles for constructing lines with 5- and 10-pair cable assemblies are similar to those for construction with field wire. As cable lines are normally laid on the surface of the ground, any such line that parallels a road should be placed at least 100 yards from it, unless placement closer to the road is unavoidable. Where a cable line crosses a road, or at any other point where it may be damaged by vehicular traffic, the cable must be buried or supported overhead. It is desirable to make road crossings through culverts. Where a cable line crosses a railroad, the cable must run under the tracks. The general rules of tying, tagging, and testing field wire lines during construction apply also to cable lines.

b. Camouflage.—Construction activities in and around headquarters areas must be concealed. If the area is heavily wooded, the problem is not difficult. Whenever possible, all construction should be accomplished under the cover of darkness. The lines themselves must be camouflaged against enemy observation. Such camouflage must blend into the surroundings well enough to make certain that no change in terrain may be noted from aerial photographs taken before and after the installation is completed.

c. Reel units.—Reel Unit RL-31 with Reels DR-4, DR-5, or DR-7 is best adapted for use with 5- and 10-pair cable assemblies. Axle RL-27 and Reel Cart RL-16 are also suitable. Reel DR-7 or the wooden shipping reel must be used for long lengths of the cable assemblies. An improvised reel unit should be constructed for use with the wooden reel. Reel Unit RL-31 may be used either on the ground or mounted on a vehicle. An improvised reel unit will normally be mounted on a vehicle. For details of using reel units and reels see paragraphs 11, 12, and 13.

d. Terminal strips.—Five- and 10-pair cable lines are connected to switchboards, switchboard mainframes, construction center and test station frames, and lines of other types of construction through cable stubs. The connector on the stub is connected to the cable assembly, and the conductors on the other end of the stub may be connected to terminal strips or directly to the mainframe. Units made up of cable stubs connected to terminal strips, according to the color code, can be prefabricated. Also, cable stubs may be connected according to the color code to all terminal strips that receive circuits from 5- and 10-pair cable and become an integral part of a frame or switchboard. These cable stubs should be left connected to the terminal strips during moves between installations, whenever practicable. A special unit for testing anywhere along a cable line is described in paragraph 21*e*.

e. Precautions.—This type of cable must be handled carefully. The soft solid-wire conductors are easily damaged and faults may be difficult to locate. Connectors are a primary source of trouble, and must be carefully connected and disconnected to avoid damaging pins, sockets, or wires. The cable laying truck should be operated smoothly at a speed of 5 miles per hour or less. Field wire and marline ties and special grips or hangers for support of this cable must be used with care to prevent excess pull on the cable, sharp bends, or pinching. Conductors may be broken without any indication of the breakage on the jacket. This often happens when trucks or tanks run over the cable.

f. Testing prior to use.—All cable assemblies should be tested and tagged before installation. The tests can be made at the construction center or supply point prior to loading on trucks. Tests on the assemblies should cover short circuits, open circuits crosses, or grounds. (See par. 21 for methods of testing.)

g. Repair.—All cable assemblies are tested frequently and the necessary repairs made in bivouac in preparation for future construction. New cable assemblies may have split pairs and crosses. If the testing is done properly, and if there are no mishaps during construction, every circuit will test through satisfactorily when a line is first completed. After that, cable lines must be constantly patrolled and maintained to keep all circuits working. If more than two circuits in any cable assembly become defective and another cable assembly is available, the faulty length should be replaced. Use the longer cables of each nominal length for replacement, if they are available. If one or two circuits go bad, the bad length may be replaced, or field wire circuits laid. Every faulty cable assembly should be tagged with the date, the nature of the fault, its cause, and its location. Except when unavoidable, never repair the cable on the line. When necessary, the temporary field splice discussed in paragraph 22 may be used on the line, or where 500 watts of power at 110 volts, alternating current, is not available to make the more permanent vulcanized splice. When such a 110-volt supply is available, the vulcanized splice discussed in paragraph 23 should be used. No facilities are available for vulcanizing any part of a connector. Therefore, such connectors cannot be satisfactorily repaired, and any faulty connector must be cut off and replaced with a cable stub spliced to the cable by means of a permanent splice.

8. Construction of local distribution lines.—The cable assemblies involved in the construction of local distribution lines are short enough to be within the capacities of Reels DR-4 and DR-5. These reels may be used with Reel Unit RL-31 set up on the ground near the switchboard.

9. Construction of trunk lead-in lines.—A short trunk lead-in line may be installed as described in paragraph 8. However, any line long enough to require the use of the longest length of the cable assembly (5- or 10-pair) should be laid from a wire-laying vehicle with an RL-31 mounted on it. If no Reels DR-7 are available, an improvised reel unit may be used.

538334°—43——2

10. Construction of short sections in open wire trunk lines.—*a. General.*—The construction of such sections is similar to that of long trunk lead-in lines. Lines are constructed between terminal strips mounted at the ends of the open wire lines to be connected.

b. Special considerations.—If such a section is built over terrain impassable to vehicles, the cable must be pulled in by hand. An improvised reel cart, made so that it will carry a DR-7, or the wooden reel, can be used in some instances. While pulling in the cable, the men should be spaced not more than 100 yards apart (for 5-pair cable) along the length of the cable. If a second ½-mile length must be pulled in, the reel unit and reel of cable may have to be carried to the far end of the first ½-mile length. Though this work requires many men, it usually will not be necessary to take time for overhead or buried construction.

SECTION III

DETAILED TECHNIQUES OF CONSTRUCTION

11. Reels.—*a.* When laying either 5-pair or 10-pair cable, the wooden shipping reel or any of the Reels DR-4, DR-5, or DR-7 may be used. In any case, the cable must be wound on the drum so that it will not be damaged during transport and so that both ends of the cable assembly will be exposed for testing. Table II shows the capacities of these reels.

TABLE II.—*Capacities and weights (reel plus cable) of 5-pair and 10-pair cable on standard reels and wooden reel*

Reel	WC-534		WC-535	
	Length	Weight	Length	Weight
DR-4	300 feet	59.5 pounds	200 feet	72 pounds.
DR-5	500 feet	96.5 pounds	300 feet	109 pounds.
DR-7	½ mile	350 pounds	1,000 feet	270 pounds.
Wooden reel	½ mile	405 pounds	1,000 feet	325 pounds.

b. The method of fastening the connectors of a cable assembly to the flanges of any of the three types of metal reels is illustrated in figure 3 which shows a 1,000-foot length of 10-pair cable on a Reel DR-7. Tie the terminals well in from the outer edge of the flanges. Thread the field wire or marline through the holes of the connectors and pull the connectors firmly against the flanges. This method makes the inner ends available for testing and also keeps the connectors from

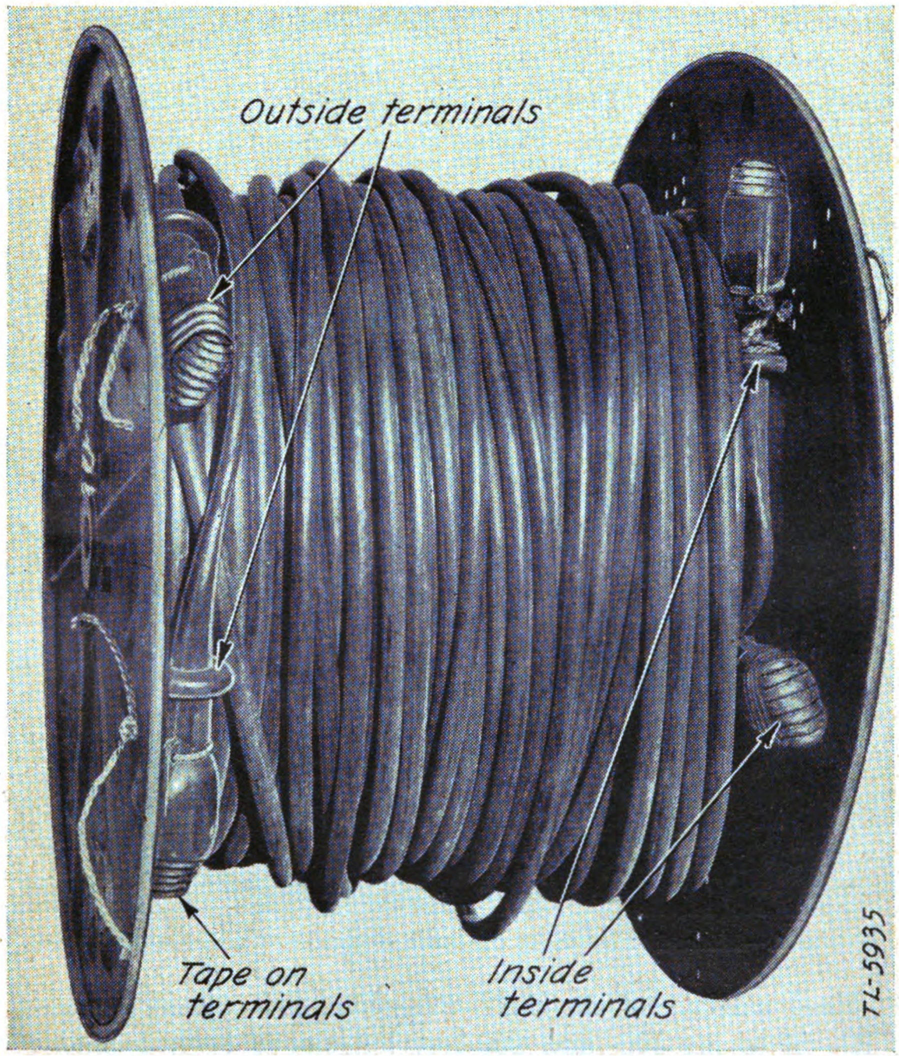

FIGURE 3.—Method of fastening rubber cable on standard metal reels (DR-7).

being damaged as the reel turns during the laying of the cable, or as it is rolled along the ground.

The cable must be wound carefully on the reel so that the outer turns do not stick out beyond the reel flange (fig. 3). Thus the flanges will protect the cable when the filled reel is rolled from one place to another. Be sure to pull the last turns of cable tight, so the outside connectors will not become loose after they have been tied. Each cable connector must be kept taped with friction tape at all times during storage, transport, and laying. Otherwise, dirt will enter the small sockets and cause trouble. Because Reels DR-4 and DR-5 were not designed for use with rubber cable, extra holes must be drilled in the reel flanges so that the connectors may be tied to the flanges without possibility of injury.

c. When Reel DR-7 is not available for cable assemblies too long for the other reels, the wooden shipping reel must be used. Tie the inner connector to nails in the flange, so that they are exposed but protected. Figure 4 illustrates the method of fastening the inner end on the wooden flange. Fasten the outer end in the same manner.

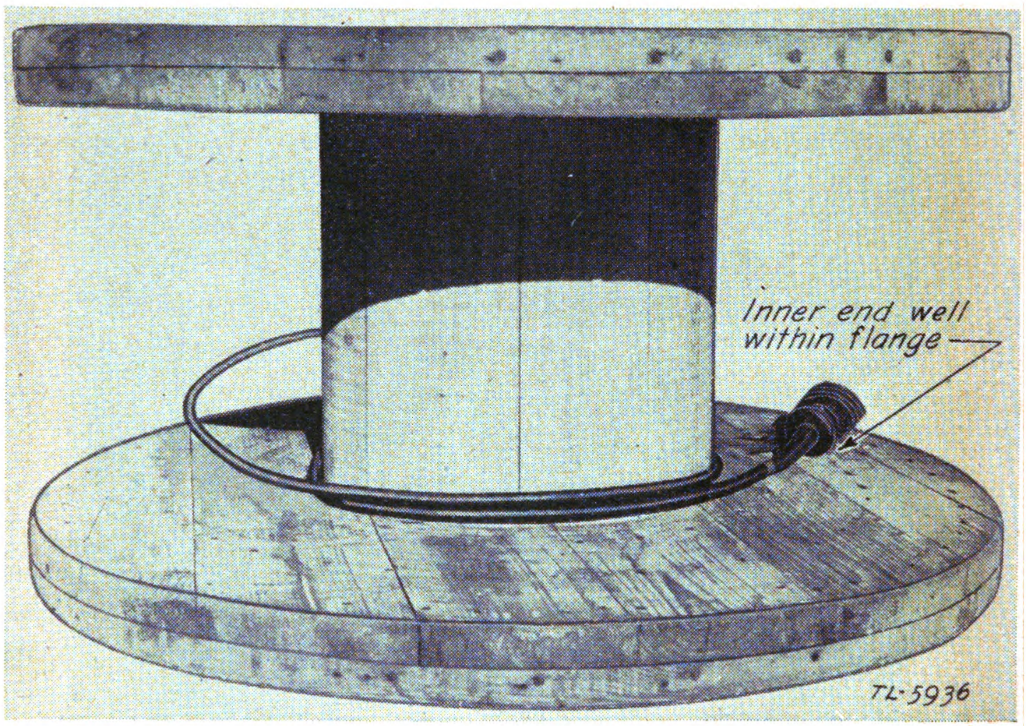

FIGURE 4.—Method of fastening the inner connector on a wooden cable reel.

12. Reel units.—*a. Axle RL-27.*—Reel DR-4 may be used with Axle RL-27 to lay 100- and 200-feet lengths of both 5- and 10-pair cable. Detailed information on the RL-27 may be found in appendix I, FM 24-5.

b. Reel Cart RL-16.—Reels DR-4 and DR-5 may be used with Reel Cart RL-16 to lay the shorter lengths of 5- and 10-pair cable. Information on the RL-16 may be found in appendix I, FM 24-5.

c. Reel Unit RL-31.—Reels DR-4 and DR-5 may be used with Reel Unit RL-31 to lay the shorter lengths of 5- and 10-pair cable. Two cable lines may be laid at the same time if Reels DR–4 are used. Reel DR–7 is designed to be used with the RL–31, which will support a filled drum of either 5- or 10-pair cable. Refer to TM 11–362 and to paragraph 1*a*, appendix I, FM 24–5 for detailed information concerning the RL–31 and its use with Reels DR–4 and DR–5. Always be sure to fasten the RL–31 securely in the toe clamps provided. Otherwise the frame will be strained and bent from the weight of the reels.

13. Improvised reel units.—*a. General.*—If Reel DR–7 is not available, the wooden shipping reels must be used with some sort of improvised reel units to lay the longer lengths of 5-pair and 10-pair cable (table II). Such reel units ordinarily will be used with a truck and then must be bolted to the bed of the vehicle. If any reel unit is not fastened down, the danger to personnel and to equipment will be great.

b. Cable Reel Jack LC–13.—A convenient reel unit may be improvised by using two Cable Reel Jacks LC–13 and an axle of 1-inch or 1¼-inch pipe at least 48 inches long. The jacks are bolted to the bed of the particular vehicle in use, 25 to 29 inches apart at their closest points. As a safety precaution, weld two slotted pieces of flat steel to the U-section of each jack, and provide a flat, tapered pin, shaped like a wedge, to fit the two slots and hold the axle in the jack (fig. 5). An additional safety measure is necessary to prevent the axle from moving laterally so far that it would fall from the jack and allow the wooden reel to drop. This is done by placing a large steel washer over each end of the axle on the outside of the jacks and holding it in place with a bolt and nut as shown in figure 5.

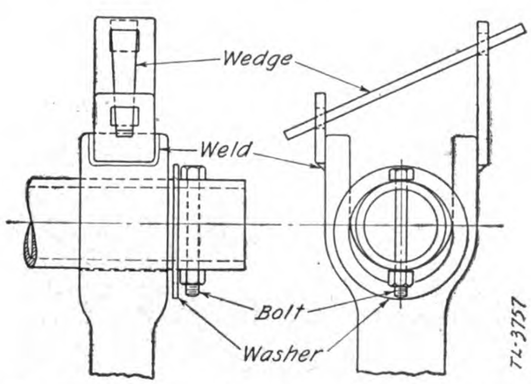

FIGURE 5.—Method of retaining axle (pipe) in Jacks LC–13.

c. Use of wooden A-frame.—Another means by which cable may be payed out from and wound on the wooden reels is by the use of a home-made wooden A-frame of 2- by 4-inch material (fig. 6). Bracing is necessary between the legs of the two A-frames, with proper clearance provided for the reels. A pipe from 1 inch to 1¼ inches in diameter and at least 48 inches long will serve as an axle. Straps must be placed over the cuts where the improvised axle is set to hold the axle in place. Lateral movement of the axle and reel can be prevented by use of a washer, bolt, and nut as described in *b* above.

14. Joining connectors.—Much of the trouble occurring on lines of these cable assemblies results from carelessness during the connection and disconnection of the connectors. The following instructions and precautions must be observed if the cable is to do the job that it is supposed to do.

a. It is strictly forbidden to remove the connectors merely to permit direct splicing of conductors.

b. First remove the protective tape placed on the connector to keep out dirt. With a connector in each hand, match the plugs and sockets

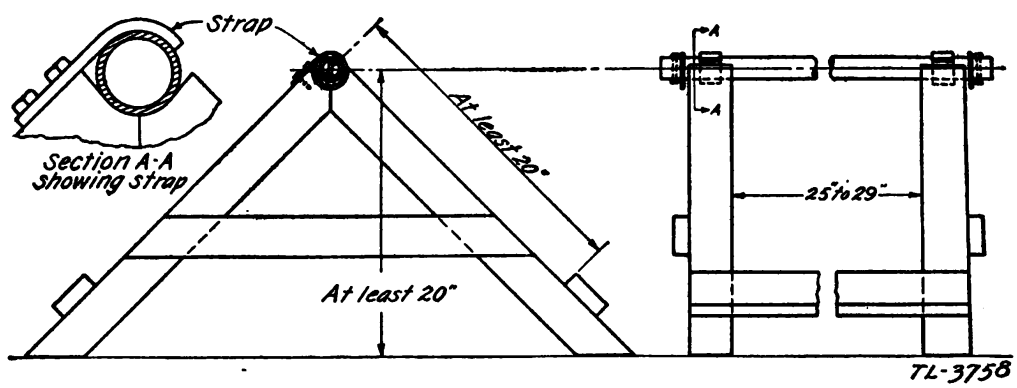

FIGURE 6.—Construction of wooden A-frame and axle for wooden cable reel.

and push the two connectors together. If the two connectors do not go together snugly, push harder or put the hands between the knees to get more leverage. Two men may be needed to do the job. Always push the connectors straight together. Do not bend them from side to side or twist them with a circular motion. That is a sure way to cause trouble, as may be seen in figure 7. Do not use grease or oil as a lubricant, for these substances will ruin the electrical connections as readily as dirt.

c. After the two connectors have been pushed together snugly, tape the crack between them first with two layers of rubber tape, and then with friction tape. Tape for a distance of 1 inch on each side of the crack (fig. 8). Although under ordinary conditions no moisture will enter through the joint between two connectors, tape must be used to make sure that extreme weather conditions and worn or loose parts do not affect electrical conductivity. Make the joint as strong as possible by fastening the two connectors together with marline. One piece of marline about 3 feet long is necessary to make the connection, as shown in figure 8.

d. Tie the joint as illustrated in figure 8, according to the following steps:

(1) Thread the two ends of the marline down through holes 1 and 2 so that the ends are of equal length.

(2) Cross the ends diagonally under the connector connection. Thread the end from hole 1 up through hole 4, and the end from hole 2 up through hole 3. Pull the marline tight.

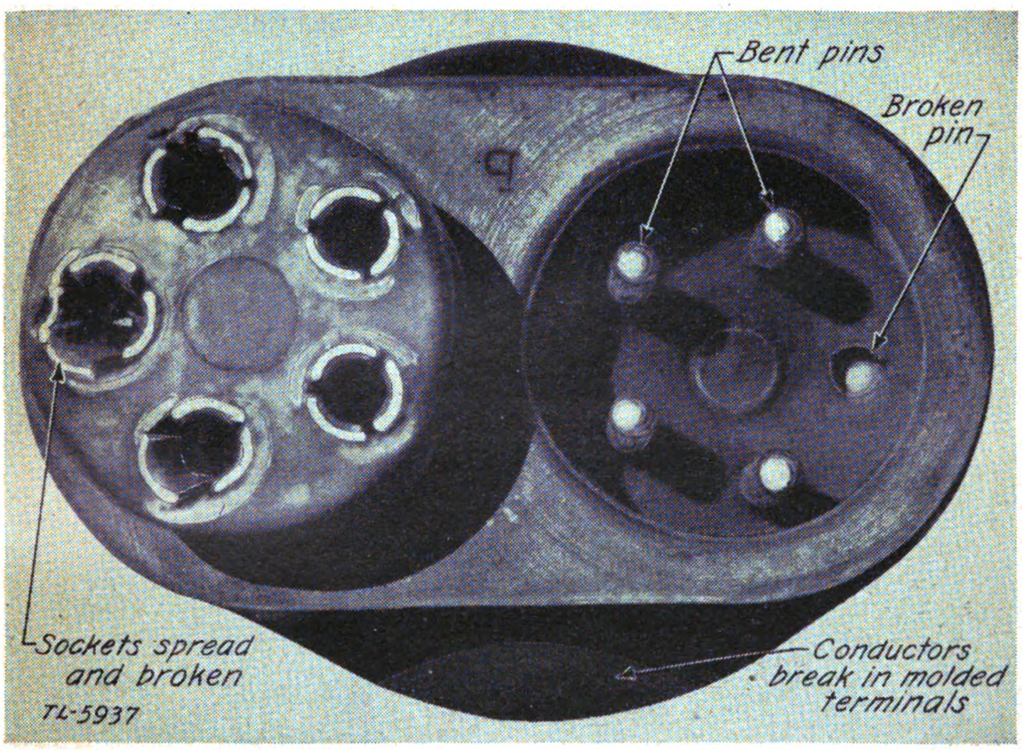

FIGURE 7.—Examples of damage resulting from mishandling of connectors.

(3) Cross the ends diagonally over the connector connection. Thread the end from hole 4 back down through hole 1, and the end from hole 3 back down through hole 2.

(4) Pull the marline as tightly as possible and tie the ends together with a square knot, as shown in the insert in figure 8.

e. If the connectors are in good condition and the connection is properly taped, it should be moisture-proof. However, to prevent moisture from collecting at the joint, each connection should be tied to a fence, tree, pole, or stake so that the connection is higher than the cable on either side of it. The placing of such connections in puddles and streams should be avoided.

f. It is just as necessary to disconnect two connectors properly as it is to connect them properly. After removing marline and tape, take one connector in each hand as close to the joint as possible and pull them straight apart. Be sure to hold the connectors, not the cable itself. Never bend or twist the connectors in an attempt to break the joint. This results in damage as shown in figure 7. If necessary, put your hands behind your knees from the outside and use your knees to help

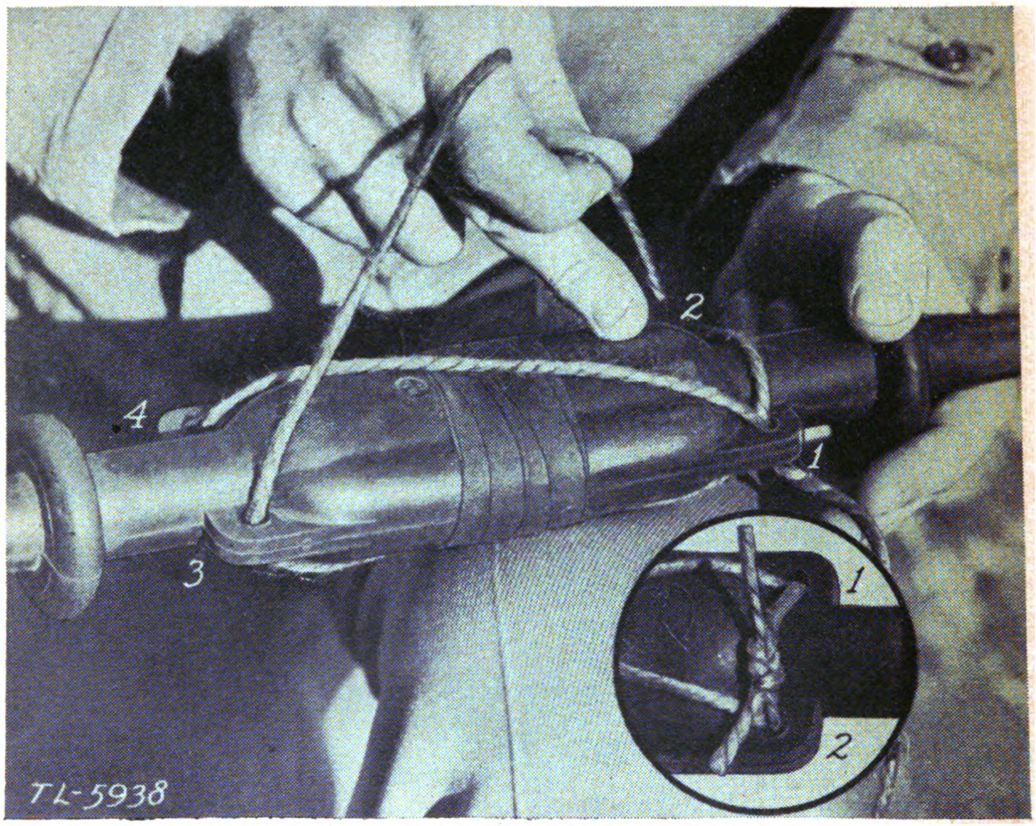

FIGURE 8.—Method of connecting connectors of cable assemblies.

pull. If this is not successful, two men probably will be needed to pull the connectors apart. Be sure to tape the end of each connector as soon as it is disconnected.

15. Terminal strip preparation.—Figure 9 shows the method of preparing units of Cable Stub CC-344, fanned out and connected to terminal strips according to the color code (par. 3*a* and *b*). Connect pair 1 (red—natural) at the top, and successive pairs in order down the terminal strip. If the terminal strip is outdoors, make provision for protecting the connection from the rain to eliminate leakage between conductors and pairs.

16. Ground construction.—*a. Tying cable.*—Even though cable is laid 100 yards from the road, it must be tied to keep it away from traffic. Use a marline tie to attach cable to trees, fence posts, poles, or stakes at any point where there may be a chance for the cable to move closer to the roadway. Also, tie cable at both sides of any length which is buried, or which passes through a culvert or under a railroad. See paragraph 188*e*, FM 24–5 for instructions on the marline

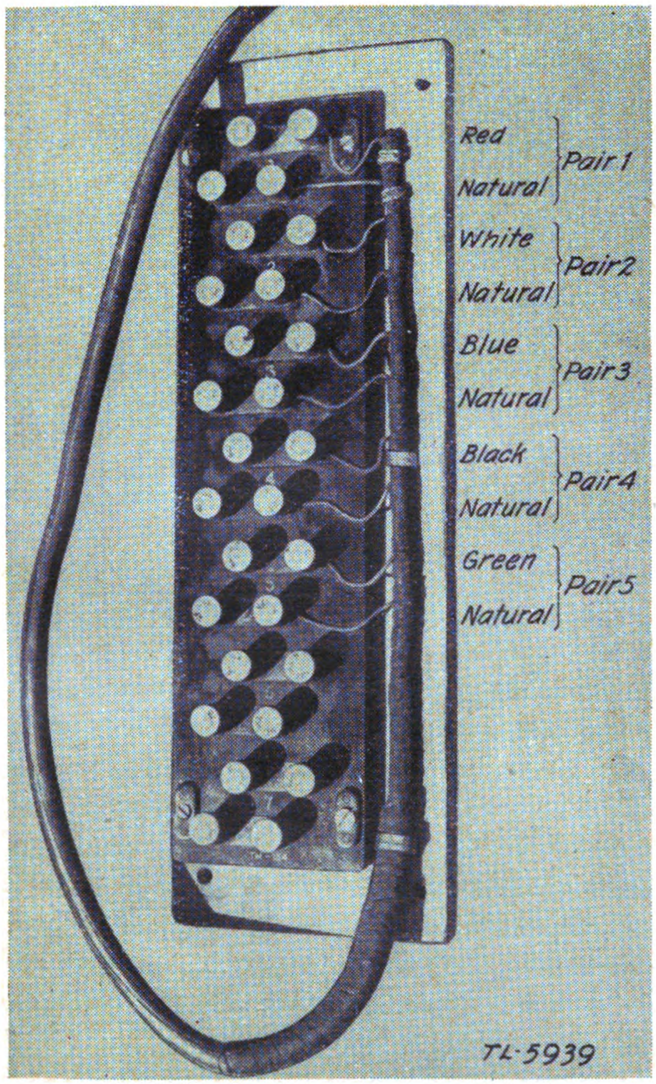

FIGURE 9.—Method of connecting cable stubs C-344 to terminal strips.

tie. At any place where there is danger that the rubber jacket of the cable may be rubbed badly, wrap friction tape around the cable as protection.

b. Burying cable.—When cable is buried at road crossings, dig the ditch at least 6 inches deep. Tie the cable to stakes at each side of the ditch with a marline tie. At any place where vehicles may pass, do not leave cable on the ground for even a short period of time. Traffic will break the copper conductors even though the rubber jacket may appear undamaged. Such a fault is extremely hard to find.

c. Tagging cable.—Tag each cable at each connector joint, at both sides of any buried length or length passing through a culvert or under a railroad, at the base of any pole or tree at which the cable goes to overhead construction, and at any entrance to a switchboard or terminal frame. Figure 10 shows an example of a 5-pair cable line tag. See paragraphs 189 and 265*n*, FM 24-5 for a complete discussion of the methods of marking tags.

17. Overhead construction.—*a.* When using overhead construction, construct the ties or patent hangers which support the cable so that neither the rubber jacket nor the conductors will be injured. Also, they must be strong enough to support the weight of the cable. The length of the supporting tie or hanger must be great enough to keep

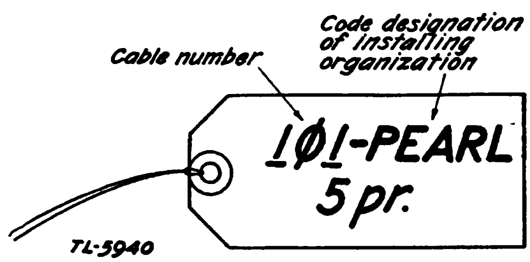

FIGURE 10.—Example of identifying tag for 5-pair cable line.

the cable from bending sharply under its own weight. Any appreciable bending will weaken and break the conductors as the cable sways in the wind. The tie or hanger used must not grip the jacket in such a way that it will injure the rubber. The types of patent hangers discussed in paragraph 18 are recommended and should be used, when available to teams installing lines of 5- and 10-pair cable. The types of ties discussed in paragraph 19 are suggested alternate methods and meet the requirements for supporting cable. Others may be used, but they must be selected carefully because the cable jacket and the conductors will not stand up under abuse.

b. Within limits of maximum length of span and minimum sag, no messenger strand or wire is necessary when lines of Cable Assemblies CC-345 and CC-355-A are placed on poles, trees, or improvised poles. Where overhead construction must be used because of possible heavy vehicular traffic, at the locations of echelons or at testing or switching stations, unsupported spans should not be longer than 100 feet. With a 100-foot span, use a 3-foot minimum sag. Under heavy weather loading (icy) conditions, make the maximum span not longer than 50 feet, with the same 3-foot minimum sag. Keep the lowest point in any span at least 14 feet in the air and the clearance at main traffic arteries at least 18 feet. Never make an overhead crossing at a railroad. Never allow a connection of molded terminals to occur in a span. Instead, tie a coil, including the connection, to the pole or tree at the near end of the span.

c. When making any kind of overhead support, patent hanger, or tie, it is necessary for a man on the ground, some distance beyond the pole in the line of lead, to help pull up the cable in the span, if that span is already supported in the air at the other end. The man on the pole or tree cannot by himself keep the cable pulled up as he installs the hanger or makes the tie which will support the span. At any pole where the cable goes from ground to overhead construction, tie the cable to a tree, close to the ground, with a marline tie.

d. At points where overhead construction begins and ground construction ends, leave sufficient slack so that there will be no tension on the cable. Tie the cable at the base of the support and halfway between the base and the aerial dead end.

18. Methods of installing hangers.—*a.* There are several types of commercially manufactured cable grips, clamps, and hangers that are designed to be used with 5- and 10-pair cable and spiral-four cable. Two types are described in *b* and *c* below. These and other types will be issued and a complete discussion of all types may be found in TM 11–369. When these are not available, the ties discussed in paragraph 19 are recommended. Moreover, these ties can always be used as an alternate method of supporting 5- and 10-pair cable in the air.

b. The Kearny cable grip (par. 24) consists of two halves which are fastened together with a small strand. There are small dogs along both sides of each half of the grip through which the strand passes. This holds the halves tightly on the cable. The lugs on the ends of the strand prevent it from pulling through the dogs on the grip halves. The strand is long enough to permit fastening each side of the grip with one of the ends and to leave a loop. To apply the grip, remove the strand from one side and spread the sections well apart. Place one section on one side of the cable and turn the other section over on the cable so that it is exactly on the opposite side. Thread the strand through the hooks on both sections and pull the strand tight.

c. The Kellems cable grip (par. 24) consists of a split, woven, leather-covered wire mesh which has eyelets on two opposite sides.

These eyelets are so arranged that, when they interlock, a cylindrical mesh sleeve is formed. The grip is then tight on the cable. A loop is provided on one end of the grip.

d. Use two grips if the cable passes the pole or tree in the air. Fasten them so there is a small amount of slack between the grips. Use one grip at an aerial dead end. The loops provided make it possible to fasten the grips to J-hooks or insulators. Otherwise field wire or marline may be used to tie the grips to the tree or pole.

19. Field wire and marline ties.—*a.* Figure 11 illustrates the method of using field wire when the cable runs in the air in both directions from the tree or pole. Make a tight loop knot on the cable with the twisted-pair field wire, 2 or 3 feet from the pole. With one end in each hand, wrap the two equal lengths of field wire in opposite directions around the cable in basket-weave effect. The basket weave should be over a foot in length. Tie the two ends securely on the cable in a square knot. Wrap each end of the field wire around the pole at least one full turn, and tie them together with a square knot. Cut off excess wire. Make the tie on the other side of the pole in the same manner. Tape the cable at the pole to prevent injury to the jacket. If the cable is to dead-end at the particular pole, only one such tie is necessary.

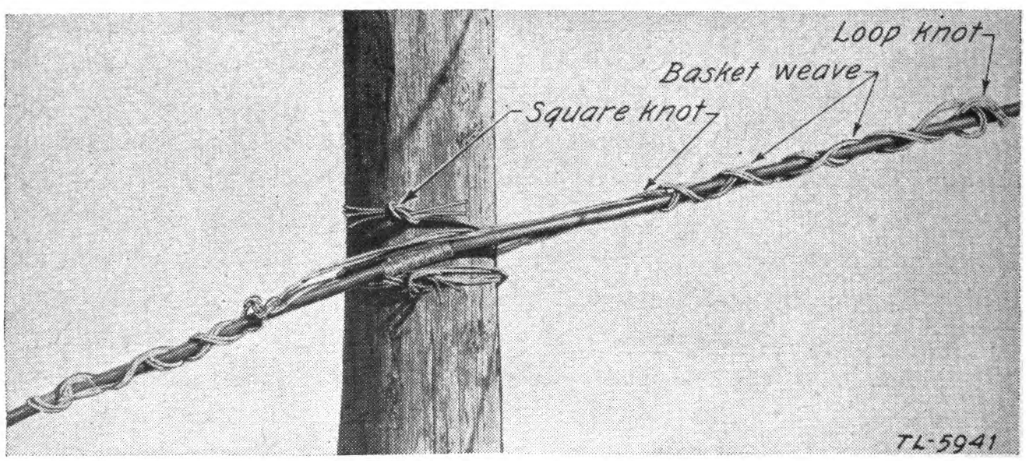

FIGURE 11.—Field wire basket-weave tie for rubber cable.

b. Marline may be used in the same manner as field wire, but is less satisfactory because it lacks wearing qualities. For short spans of about 50 feet (for 5-pair), a simplified tie may be used. Figure 12 illustrates this tie when used to support cable running in both directions from the pole or tree. Make a loop knot farther than 6 inches from the point where the cable touches the pole. Double together the two equal lengths of marline and make at least three wraps around the pole. Pass at least one wrap under the cable. Tie the end of the doubled marline to the cable with a series of at least two half hitches or with clove hitches.

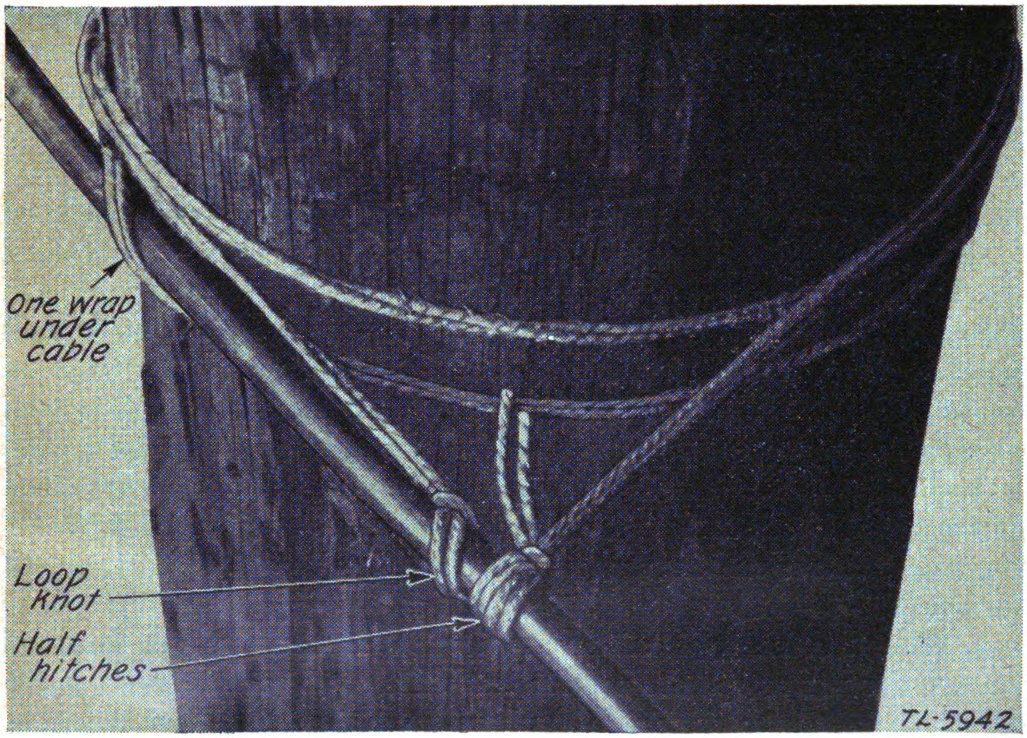

FIGURE 12.—Special marline tie for rubber cable.

c. The ties discussed above may be used in conjunction with **J**-hooks or lag screws by tying the wire or marline to them, instead of wrapping it around the pole or tree. However, the **J**-hooks or lag screws often will not be available.

20. Long-span construction.—If conditions of terrain or existing pole line construction necessitate a span of greater length than 100 feet, use Wire W-75 as a messenger and tie the cable to it at 10-foot intervals with a tie made with marline or field wire. Fasten the messenger wire by wrapping it twice around the pole or tree and twisting the loose end around the standing end in six close turns. Clearances are prescribed in paragraph 17*b*.

SECTION IV

MAINTENANCE

21. Testing.—*a.* Test sets are supplied to permit routine and trouble-shooting tests from centralized locations such as construction centers, test stations and test points, and switchboards. Thus, all local and trunk lines and all the equipment involved in furnishing wire communication are within reach of one or more test sets. Trouble may be a cross, a short circuit, a ground, an open circuit, or a combination of two or more of these. The following test sets may be used to determine the type of faults:

Test Set EE-65-( ).
Cabinet BE-70-( ) (wire chief's test set), a part of Telephone Central Office Sets TC-1 and TC-2.
Telephone EE-8-( ).

Telephone EE-8 is good only for approximations and cannot be used satisfactorily if a combination of faults exists on a circuit. Its main use is to reveal whether a circuit from some terminal strip to a telephone testing point or switchboard, or between terminal strips is good or bad. The other two test units listed can be used to show which of the types of trouble are present on a circuit. Refer to TM 11-345 for information on the use of the BE-70( ), and to TM 11-361 for the EE-65-( ).

b. When the faulty circuit or circuits and the nature of the fault are known, the next step is to use the test units at the centralized testing points, to find out approximately where the trouble is. First, it will be possible to isolate the trouble as being between two particular test points on a trunk circuit, or away from the test point on a local circuit. To isolate the trouble in this way requires cooperation between the men who are operating the test sets at the test points involved. An example of such isolation, as far as 5- and 10-pair cable is concerned, is between the switchboard and the construction center, or away from the switchboard along a local circuit.

c. Next, measure the distance to the fault, within the limits of accuracy of the test equipment. If the fault is between test points, make measurements from both points and compute their average. Unless there is conclusive evidence that it is not necessary, make routine trial and error tests to be certain that the trouble is not in the switchboard or main frame or other terminal equipment.

d. As soon as repairmen arrive at the approximate location of the fault, they should attempt to locate the fault more exactly by setting up a temporary test point along the line. This point may be at an available terminal strip, directly on an open wire circuit, or at a connection between rubber cable assemblies. An example of using the first-mentioned is setting up a test point at the terminal strip between a 5-pair assembly and the field wire of a local distribution line within a headquarters area. By testing from the terminal strip toward the switchboard and then toward the telephone, the trouble can be further isolated. This is true, also, when no construction center is installed and there is only a terminal strip available where the trunk lead-in line is connected through to the main part of the trunk line. Another example is testing at the terminal strips where there is a short section of cable line in an open wire line.

e. The procedure that has been outlined will show whether or not the fault lies in the cable. If it does and there is more than one cable assembly in the cable line, the trouble can be further isolated by testing in both directions from connections between cable assemblies. **Caution:** At such a connection, insert into the line a terminal strip, with one cable stub connected on each side of it (5-pair cable line); the purpose of this is to keep interference with communication at a minimum during testing. A Telephone EE-8 is sufficient to determine, by trial and error, in which cable assembly the fault is to be found.

f. The most efficient way of clearing the trouble is to replace the faulty cable assembly. Be sure that the longer cables of each nominal length of cable assembly are taken along when going out on a repair job, so that the replacement length will not be a few feet too short. When replacing cable assemblies, observe all the instructions for installing 5- and 10-pair cable.

g. After the faulty cable assembly has been returned to the bivouac area or other repair point, the exact location of the fault must be found. This will also be necessary if the cable is to be repaired out along the line. If the fault is other than an open circuit, and if Test Set I-51 (cableman's tone test set) or the test equipment of Test Set I-56 is available, the exact location may be found easily. Refer to section VI of TM 11-372 or Bell System Practices G72.225, G72.260, and G72.280 for information on the use of this tone test equipment.

Caution.—Because of the twist of the conductors of a circuit, a noticeable rise and fall of the signal strength will occur as the tone pick-up coil is moved along the cable line. This should not be confused with the permanent drop in signal strength as the fault is passed.

h. If the fault is an open circuit, or if the tone test equipment is not available, the fault may be much more difficult to find. Sometimes an inspection of the cable jacket may indicate the location. However, it is possible that there will be no outward indication of the fault. For example, one frequent trouble is an open circuit in the molded terminal. There is one method by which such faults may be found. Apply a voltage in series with a voltmeter (the voltmeter of the EE-65) on the bad circuit at one end of the cable assembly, and short-circuit the other end. To facilitate the test, connect a cable stub fanned out on a terminal strip to each end of the cable assembly. Make the testing unit and short-circuit connections on the terminal strips. When the connections are completed, bend and flex the cable all along its length in an attempt to correct the fault momentarily. When the cable is flexed at the location of the fault, the momentary correction of the fault will show up on the meter. Then the trouble may be repaired.

22. Expedient splice.—*a.* When another cable assembly cannot be laid immediately, the quickest method by which communication may be restored over a faulty circuit is to make a temporary field splice at the location of the fault. The faulty length of cable assembly may be replaced at some later appropriate time, and a permanent vulcanized splice will then be substituted for the temporary splice. Label every faulty cable assembly with a tag. On the tag, write the date, the nature of the fault, and the cause and location, if they are known.

b. If all circuits of a 5-pair cable assembly are faulty, cut the cable in two at the fault and square the ends, if necessary. Strip the free ends of the rubber jacket for a length of 6 to 8 inches. When cutting the cable jacket lengthwise, preparatory to stripping, the material can be slit much more readily if the knife blade is wet. Care must be taken, however, not to get water into the cable. Figure 13 illustrates the method of stripping the cable. If the precise fault which is known

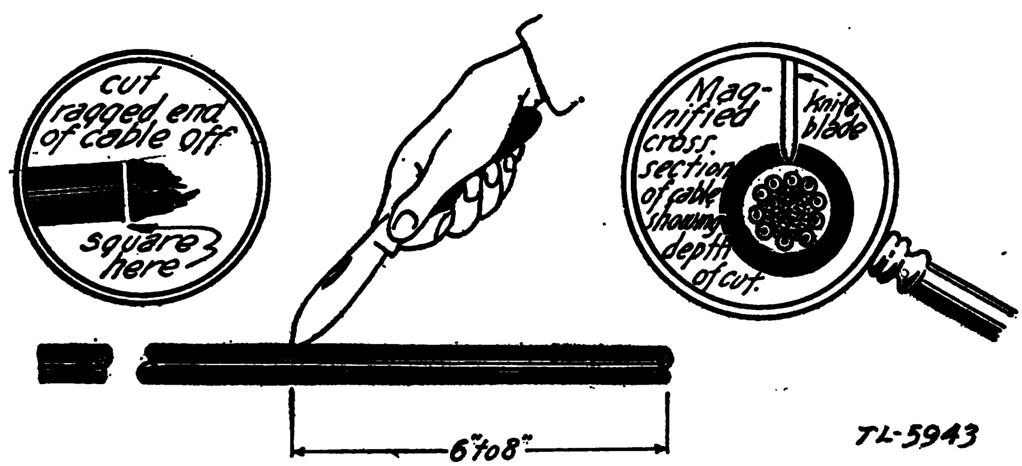

FIGURE 13.—Method of stripping rubber jacket from cable.

to exist in a circuit cannot be seen, it is necessary to strip away the jacket for a greater length. **Caution:** Before stripping the jacket further in either direction, put a Telephone EE-8-A across the faulty circuit with test clips to determine the direction of the fault from the opening in the cable. Apply the color code in selecting the faulty pair so that communication on good circuits will not be interrupted. Cable lengths produced under an early specification were not color coded; consequently faulty circuits in this old cable must be found by trial and error with the EE-8. Be sure to rub the conductor insulation with the fingers so that if there is any color coding, it will be seen. This will prevent any unnecessary circuit interruption or taping of insulation which is injured by the clips. The number of rubber-insulated conductors which must be joined depends upon the number of faulty circuits. If all circuits are not faulty, use a short length of insulated copper wire as a patching length in joining each conductor affected.

c. Separate the rubber jacket insulation from the conductors for the full 6 inches (fig. 14). Pliers may be used to facilitate this operation.

FIGURE 14.—Method of separating rubber jacket from conductors.

Cut off the heavy rubber jacket (fig. 15) and separate the pairs from the jute (the string running between the pairs). Do not cut off the jute string (fig. 16).

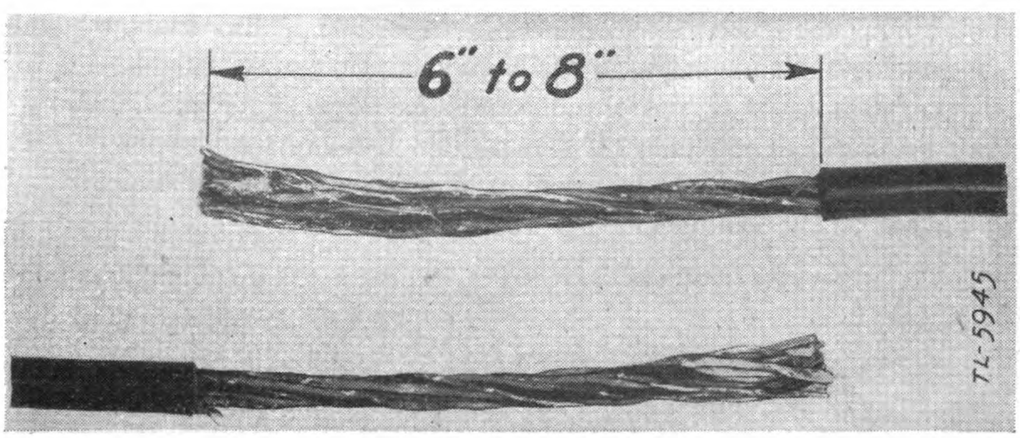

FIGURE 15.—Rubber jacket removed from cable assemblies to be connected.

d. Give both conductors of each faulty pair a single full twist with the conductors having the same color code on the other cable (fig. 16). Be sure to stagger the spliced joints on a particular pair about ½ inch apart (fig. 16), and on opposite sides of the cable from other pairs so twisted. If bronze sleeves of the proper size (for No. 19

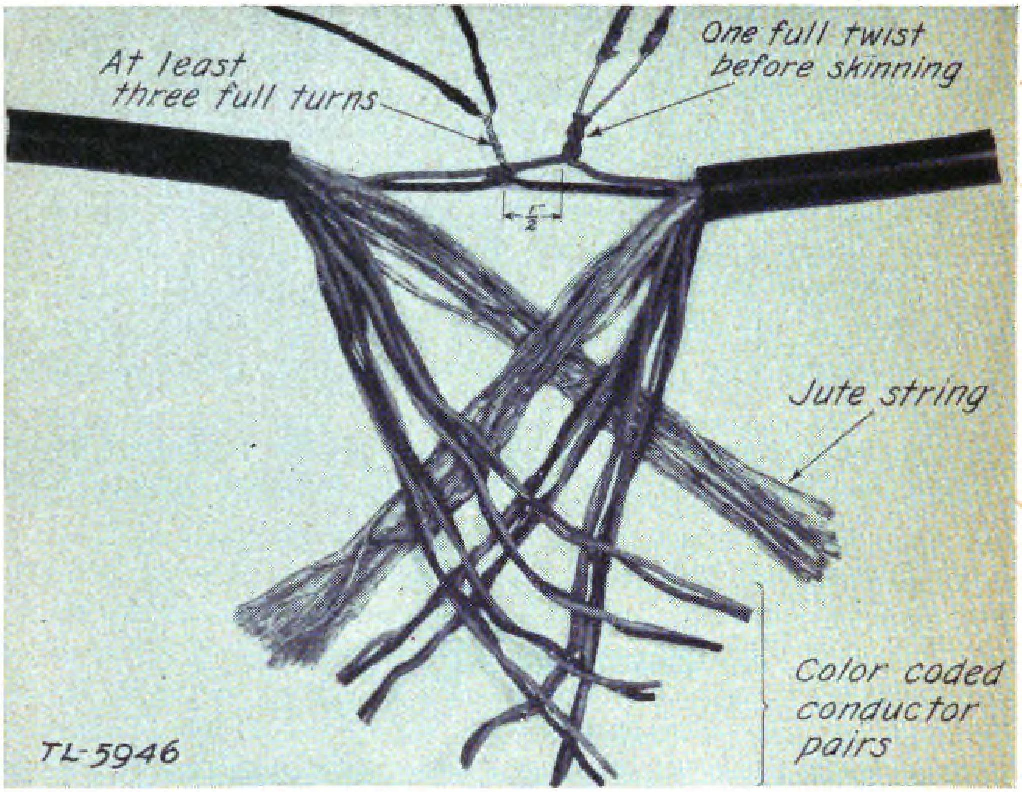

FIGURE 16.—Method of joining conductors.

(A. W. G.) wire) are available, they may be used to join the loose ends of each bad conductor. Otherwise, even up the ends so that equal strain is taken by each pair. Then strip the insulation from the copper wire down as far as the single twist, and twist together the conductors thus exposed with at least three full turns (fig. 16). A rotary motion of the thumb and forefinger ("crank-handling") may be used. Then clip off the pigtail thus formed so as to leave a total length of about ¾ inch of twisted conductors and press it down flat on the conductor (fig. 17).

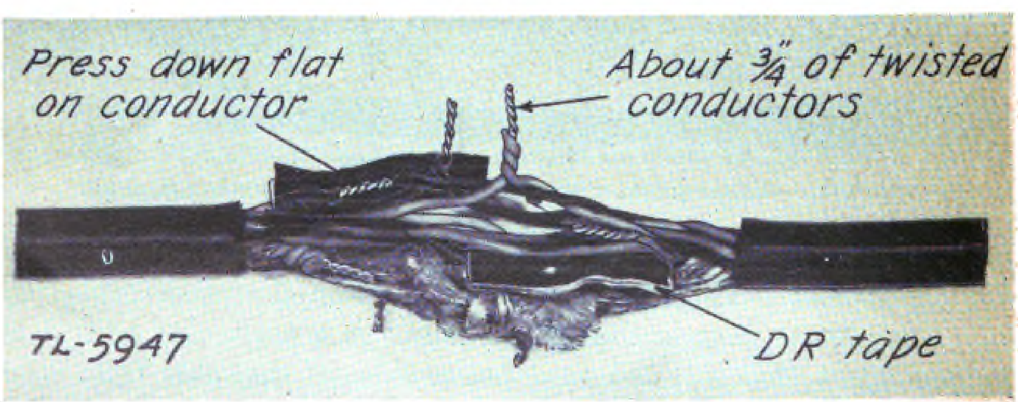

FIGURE 17.—Method of insulating conductor splices.

e. If DR tape is available (DR refers to double rubber tape, made with a dark cured rubber on one side and uncured latex on the other), fold about 1 inch of this tape in the shape of a trough and place it around the twisted pigtail (fig. 18). Be careful that the tape covers that portion of the pigtail from which no insulation was stripped. Then, after placing the tape on the joint, squeeze it together firmly. If only the more familiar type of rubber tape used with field wire is available, the pigtail should be bent flat against the insulated conductor and the joint taped with a single serving of rubber tape. If neither DR nor rubber tape is available, friction tape may be employed, but such joints may have more leakage than is desirable. Therefore, friction tape should not be used if rubber tape can be obtained.

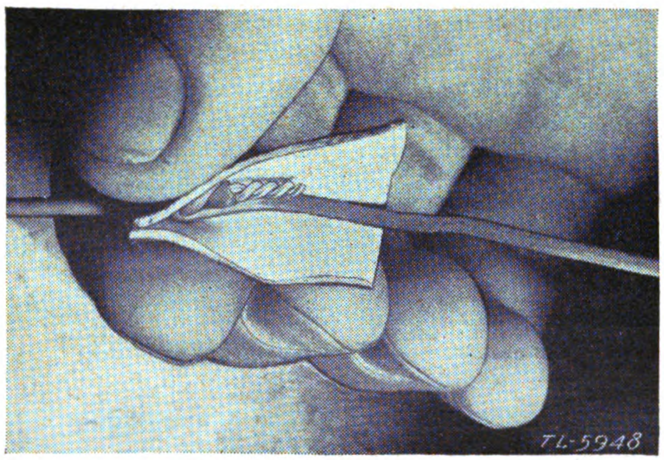

FIGURE 18.—Method of applying DR tape.

f. If the cable has been cut in two, twist together the ends of the jute core and the filling of each piece and tie the two cords thus formed in a square knot (fig. 19). The cord should be tied so that the overall length after tying is less than the length of the conductors. If this is done, the tension on the cable at the splice will be withstood by the cords instead of by the conductors. The staggered conductor splices and the knotted cords provide a smooth splice of good conductivity and sufficient strength (fig. 19).

g. Then twist the cable so as to tighten the joined conductors (fig. 19).

h. Before applying rubber tape to the spliced cable, rough the cable jacket on both sides of the splice with sandpaper and coat it with rubber cement, if these materials are available. Starting at the center of the splice, apply two layers of rubber tape half overlapped, covering the rubber jacket of the cable on both sides of the splice for about 1 inch (fig. 20). Apply one layer of friction tape half overlapped, extending about 1 inch beyond the rubber tape at each end of the splice (fig. 21).

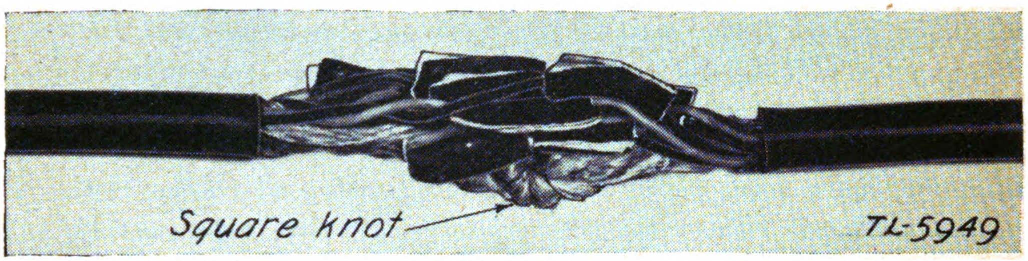

FIGURE 19.—Spliced cable prepared for taping.

i. If Cable WC-535 (10-pair) is to be spliced and if it is necessary to cut the cable in two parts, strip the rubber jacket for a length of 10 inches on each end. Join the conductors in the manner outlined

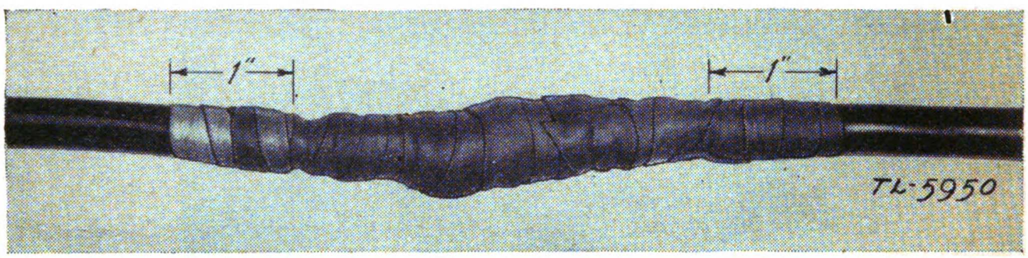

FIGURE 20.—Rubber tape applied to splice.

above, taking care that conductor joints are staggered around the circumference and over the length of the splice to prevent lumping.

j. It must be remembered that the expedient splice is only a temporary repair. The services of an expert splicer should be secured at

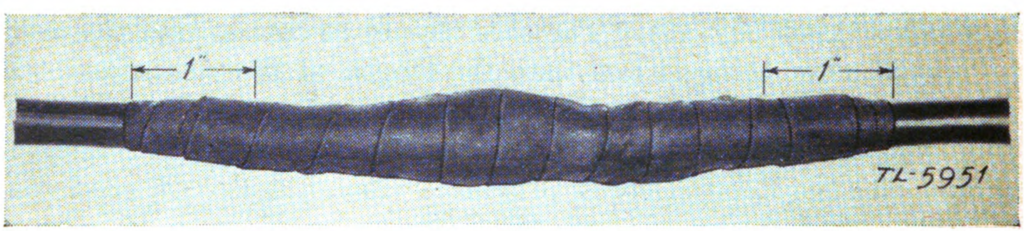

FIGURE 21.—Friction tape applied to splice.

the earliest possible moment and the damaged cable permanently repaired by means of Vulcanizing Equipment TE-54 or TE-55. Since this equipment requires approximately 500 watts of 110-volt power, it will usually be necessary to replace cables having expedient splices with equal lengths of good cable, and to return the defective cable to the bivouac area or depot shop for repair.

23. Permanent vulcanized splice.—Vulcanizing Equipments (rubber cable) TE-54 and TE-55, TE-54-A,* and TE-55-A, are made available to those organizations responsible for the construction and maintenance of cable lines and the repair of cable assemblies. Splicing of lengths of cable is accomplished by joining the conductors with individual pressed copper sleeves and vulcanizing a covering of rubber over the sleeves. Each of the vulcanizing equipments includes all the parts, tools, and materials necessary for preparing a splice and vulcanizing a patch or a complete jacket, on both sizes of cable.

a. Preparation of splices.—(1) The first steps are to cut the ends of the cables squarely and to remove the cable jackets so that about 1¼ inches of the conductors of each cable are exposed (fig. 22). This is done in the same manner as described for the expedient splice in paragraph 22. However, the jute filler of the cable must be cut back as far as possible so that the length of insulating rubber spider will fit into the cable at each end. Remove about ⅜ inch of the rubber insulation from the ends of all conductors (fig. 22). Care must be taken in skinning the insulation from the conductors to prevent nicking or bending the conductors, which might prevent the conductors from slipping into the sleeves, or prove to be a point of weakness in the spliced conductor.

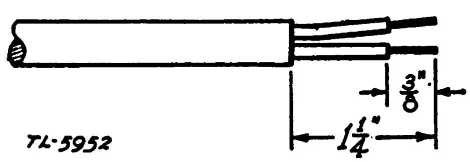

FIGURE 22.—Method of preparing conductors for splicing.

(2) To fasten the conductors together with copper sleeves, first place the sleeves on all the conductors of one cable. Place the sleeves on one conductor at a time by inserting the wire halfway into the sleeve and crimping the sleeve with the special crimping pliers. Do not crimp closer than ¹⁄₁₆ inch from the end of the sleeve (fig. 23), lest the conductor be weakened. Match the conductors of the other cable according to the color codes explained in paragraph 2*a* and *b* and then insert and crimp them in the same manner (fig. 23). If 10-pair cable is being spliced, splice the conductors in two groups of five to facilitate the insertion of the insulating rubber spiders.

(3) The conductors are insulated from one another by being placed in the grooves of a piece of insulating rubber spider (webbing). Cut a

*The letter "A" indicates the newer type of equipment. This newer type of equipment contains slightly different amounts of material than the old. Also some items of material as well as the vulcanizer itself, are different. These differences are pointed out in paragraph 23.

2¼-inch length of the spider and taper the ends so that the conductors will not bend sharply where they pass from the spider into the cable itself (fig. 24). This insulator has already been vulcanized, and will not soften and flow. Therefore, the spliced conductors are definitely insulated from one another and held in position. Place the wires in the grooves into which they fall most naturally from their positions in

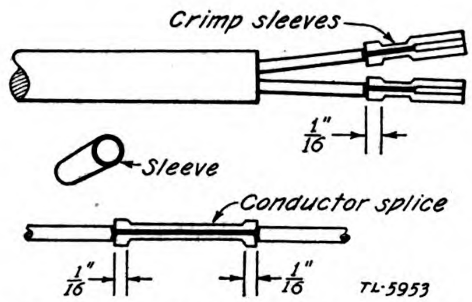

FIGURE 23.—Method of splicing conductors with sleeves.

the cable. Bind the entire assembly of conductors in place in the grooves with a thin layer of grey, inside insulating rubber tape (R–1476). If the splice is being made in 10-pair cable, use two lengths of insulating spider, properly tapered, and a double thickness of R-1476 grey, vulcanized tape between the conductors spaced around the adjacent sides of the two spiders. A strip of grey, vulcanized rubber divider is furnished with the newer TE–54–A and TE–55–A. Place the conductors of one group of five pairs in one spider, and bind

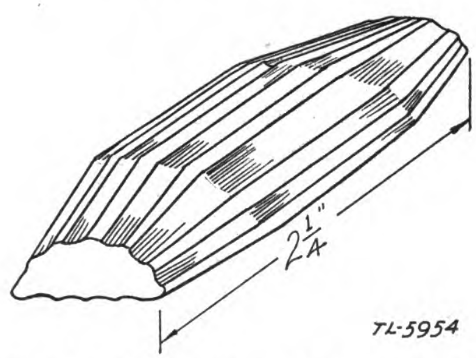

FIGURE 24.—2¼-inch length of insulating rubber spider with tapered ends.

with the grey, unvulcanized tape. Repeat for the second group, and then place the double layer of grey tape (or divider) between the two groups and bind the complete assembly. The length or lengths of spider must be centered so that the outside of the splice is concentric with the outside of the cable. Figure 25 illustrates the method of placing conductors in insulating rubber spiders.

(4) Scrape the rubber jackets of the two cables for 2½ inches on both sides of the splice with the roughing tool. Wrap two layers of grey, insulating rubber tape R-1476 tightly around the conductors and just barely overlapping the cable jacket. Apply rubber cement freely to the clean scraped portions of cable jacket and allow it to dry. Do not put this cement over the grey tape. Wrap black, outside-jacket rubber tape R-1451 around the entire splice, to a distance of about 2½ inches beyond the grey tape. Do not wrap the tape on the unscraped part of the jacket or where there is no rubber cement. The tape should be wrapped tightly, in enough layers (as many as four or five) to fill the mold completely for the particular size. *The mold must be filled*, so that enough pressure will be built up to vulcanize the rubber properly. Moreover, the length in which the tape is wrapped must be great enough to fill the mold lengthwise, as well as around the circumference. Because the mold tapers, fewer layers are needed as the distance from the center of the splice increases. Thus, only one layer is applied at the outer ends of the splice. Only

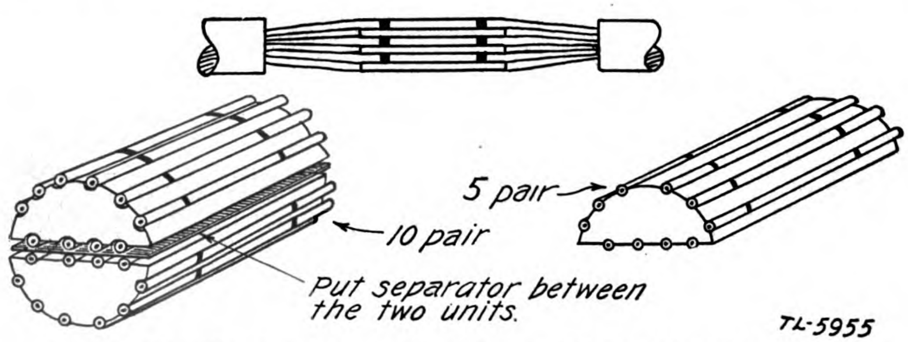

FIGURE 25.—Conductors placed in insulating rubber spiders.

experience can teach a splicer just how much rubber is necessary to make a good vulcanized joint and how it should be applied. If the pressure is great enough and evenly distributed, airholes will be prevented and the splice will be symmetrical enough to prevent conductors from being too close to the surface. Too much rubber will not make a bad splice because any fin may be cut off, but too little will cause improper or incomplete vulcanizing. Figure 26 illustrates a splice prepared for vulcanizing.

(5) If a patch on the rubber jacket is being made, scrape all surfaces clean, brush on rubber cement, and apply just enough black tape to fill the upper mold.

b. Vulcanizing.—(1) The vulcanizer made available to a particular organization may be either of two types. The operation of vulcanizing is very much the same with both units, although they vary in appearance and in the location of the heating element. Figure 27 illustrates the newer type of vulcanizer, which is built into the end of the metal case of the kit. In this newer unit, each of the two molds fits into a separate heating element. In the older type,

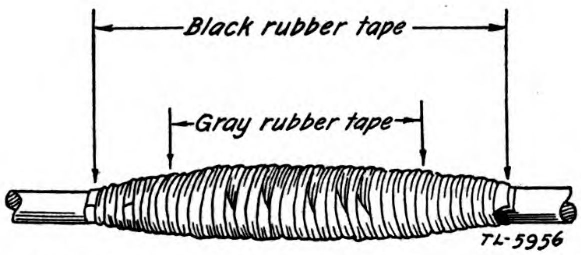

FIGURE 26.—Splice prepared for vulcanizing.

which is separated from the kit, one mold is placed in the single heating unit in the bottom of the box, and the other mold is placed

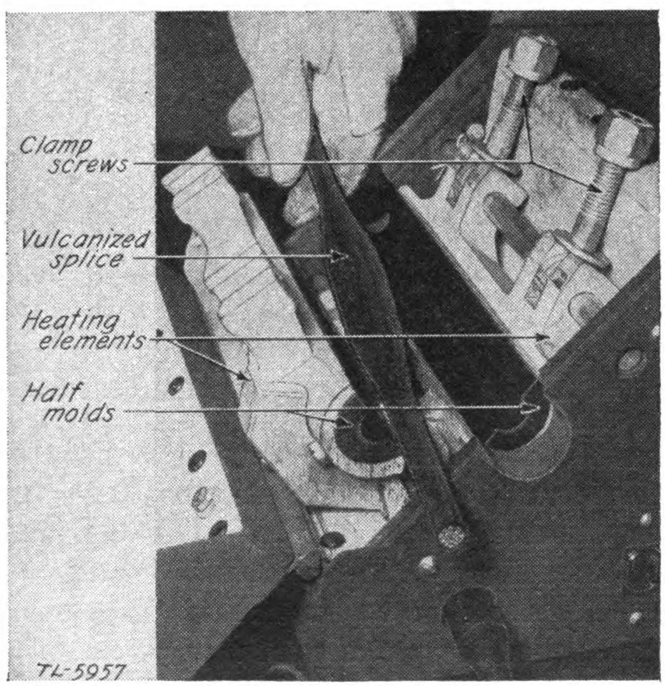

FIGURE 27.—Vulcanizer.

on top of the first one. The molds, which were aluminum in the older units, are now made of plastic. Both types of vulcanizers operate on 110 volts alternating current and draw about 500 watts.

Instruction sheets are furnished with both the new and old units. TM 11–366 describes the TE–54–A and TE–55–A.

(2) Before completing the preparation of the splice, place the proper molds in the vulcanizer and heat them fully. Just before placing the splice in the molds, apply the liquid soap compound sparingly to all surfaces of the molds. A wax mold dressing is furnished with the TE–54–A and TE–55–A. The use of mold dressing aids in the removal of the vulcanized splice.

(3) Place the splice in the molds and tighten the screws evenly until the two sides are separated by about $1/16$ inch. Allow the molds to remain partly open for about 5 minutes so that the rubber will soften completely. Close the molds until the two halves touch and let the splice vulcanize about 30 minutes. Remove the vulcanized splice and cut a slit crosswise in the fin, which should appear on the full length of both sides of the splice. If the rubber of the cut tends to stick together, the splice is undervulcanized and should be put back in the mold. Complete the vulcanized splice by trimming off the fin with scissors. Do not attempt to tear off the fin.

(4) No harm will be done if the splice is left in the vulcanizer longer than 30 minutes, so that cooking the splice longer than necessary is preferable to not curing the rubber properly.

c. Additional information.—If the insulating rubber spider is not available, it is possible to use cotton sleeves in the same manner as for splicing lead cable. Suitable desiccant must be applied to the cotton sleeves after they are in place, to make sure that there is no moisture remaining in the sleeves. If copper sleeves are not available for splicing the conductors, use the method described for joining conductors in the expedient splice.

SECTION V

SUPPLEMENTARY DATA

24. List of equipments.

Name and type No.	Stock No.
Cable Stub CC-344	1B1444
Cable Assembly CC-345	1B1445-( )*
Cable Assemby CC-355-A	1B1455A-( )*
Cable WC-534	1B1534-( )*
Cable WC-535	1B1535-( )*
Terminal Strip TM-184	4E9304
Terminal Strip TM-184-A	4E9304A
Vulcanizing Equipment TE-54	6R47254
Vulcanizing Equipment TE-54-A	6R47254A
Vulcanizing Equipment TE-55	6R47255
Vulcanizing Equipment TE-55-A	6R47255A
DR tape (rubber), A. T. & T. Co. spec. 6863, width ¾ in., length 15 ft, U. S. Rubber or equal.	
Grip, cable, Kearny, (Lay-cit) No. 6804-1 (5-pair) or No. 6403-1 (10-pair).	
Grip, cable, Kellems, type No. SC-1.	

*Always include desired length in feet.

[A. G. 300.7 (22 Mar 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

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