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DEPARTMENT OF THE ARMY FIELD MANUAL

FIELD WIRE AND FIELD CABLE TECHNIQUES

HEADQUARTERS, DEPARTMENT OF THE ARMY

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HEADQUARTERS,
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FIELD WIRE AND FIELD CABLE TECHNIQUES

***This manual supersedes FM 24-20, 17 May 1956.**

CHAPTER 1

INTRODUCTION

1. Purpose

This manual is a guide for personnel who install and maintain field wire communication systems.

2. Scope

a. This manual contains general information on field wire, field cable, splicing field wire, tying field wire, installing and recovering field wire lines, troubleshooting on field wire lines, construction records, and the general characteristics of communication equipment used with field wire communication systems.

b. This manual contains three appendixes: Appendix I, list of publications and training films covering the subjects within the scope of this manual; appendix II, information for switchboard operators; and appendix III, symbols used in wire diagrams and maps.

c. The information presented is applicable without modification to both nuclear and nonnuclear warfare.

3. Field Wire Communication Systems

Field wire communication systems are designed specifically to provide tactical units with telephone, teletypewriter, and facsimile services.

These equipments are rugged, can be installed and removed rapidly, and are comparatively easy to maintain. A typical field wire communication system consists of field telephones, teletypewriters, switchboards, and radio-wire integration stations interconnected by field wire lines. Field wire is also used in the local communication systems of rear-area elements when time or other considerations prohibit the installation of more permanent facilities.

4. Communication Responsibility

The commander is responsible for the installation, operation, and maintenance of the signal communication system within his unit. He is also responsible for installing and maintaining communication lines from his headquarters to his subordinate units, and, unless otherwise instructed, to the unit on his right. A supporting unit has the responsibility to install and maintain communication with the supported unit.

CHAPTER 2

FIELD WIRE AND FIELD CABLE

5. General

This chapter presents some of the technical characteristics of Field Wire WD–1/TT and field cables, including five-pair cable and spiral-four cable. Field cables are not discussed in detail in this manual. Detailed information on the installation and maintenance of field cables is contained in TM 11–381.

6. Field Wire WD–1/TT

Field Wire WD–1/TT (fig. 1) consists of two twisted, individually insulated, conductors having the following characteristics:

a. American Wire Gage (AWG) No. 23 (each conductor).

b. Four tinned-copper strands and three galvanized-steel strands.

c. An inner insulation of polyethylene and an outer insulation jacket of nylon.

d. Tensile strength of approximately 200 pounds (both conductors).

e. Weighs 48 pounds per mile.

f. Direct current (dc) loop resistance of from 200 to 234 ohms per mile at 70° Fahrenheit (F).

g. Loss at one kilocycle (kc) at 68° F. is 2.5 decibels (db) per mile, under wet conditions, and 1.5 db per mile under dry conditions.

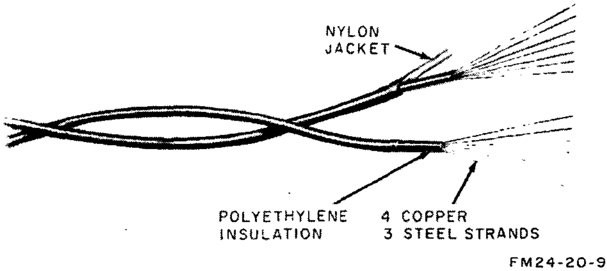

Figure 1. Wire WD-1/TT.

7. Five-Pair Cable

a. Cable Assembly CX-162/G consists of five pairs of rubber-insulated, color-coded, No. 19 AWG tinned solid-copper conductors. Cotton cord is used in the center and as a filler between pairs. A cotton yarn separator is applied over the assembled conductors, and black, vulcanized or synthetic rubber is molded around the outside to form the cable jacket. The cable is equipped with a connector on each end.

b. Five-pair cable is furnished in 500-, 300-, 200-, 100-, and 12-foot lengths. The 12-foot length of 5-pair cable, Cable Stub CX-163/G (fig. 2), has a connector at one end which connects to Cable Assembly CX-162/G; at the other end, the individual cable conductors are separated to permit connection to binding posts.

c. To facilitate installation and to eliminate large numbers of field wire circuits, five-pair cable is used in congested areas where concentration of communication circuits is required. It is particularly useful for installing circuits from a wire-head, or patching panel, to the switchboard in a command post or as a distribution cable for local circuits.

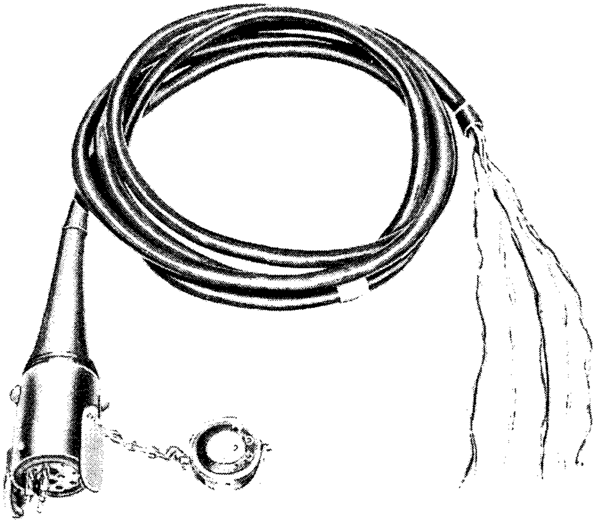

Figure 2. Cable Stub CX–163/G.

8. Spiral-Four Cable

a. General. Spiral-four cable is normally used to provide a four-wire transmission line for a carrier communication system. It also can be used for long-distance voice-frequency circuits. Detailed information on cable assemblies using spiral-four cable (Telephone Cable WF–8/G) is contained in TM 11–381.

b. Telephone Cable WF–8/G. Telephone Cable WF–8/G (fig. 3) consists of four stranded-copper conductors separately insulated with polyethylene and spiraled around a polyethylene core. One pair of the spiral-four cable is colored to permit easy identification. The spiraled conductors are covered by an inner jacket of polyethylene, a carbon-cloth stabilizing tape, a steel braid, and a thermoplastic outer jacket. The steel braid adds tensile strength to the cable, permitting the cable to be used in self-supported aerial cable lines. Telephone Cable WF–8/G is part of Cable Assembly CX–1065/G and Telephone Cable Assemblies CX–1606/G and CX–1512/U.

c. Universal Connectors. The universal connector (fig. 4) provides a high-quality, waterproof, electrical circuit connection between two spiral-four cable assemblies. The connectors are joined as shown in figure 5.

d. Electrical Connector Plug U–176/G. The electrical connector plug (fig. 6) is similar to the universal connector shown in figure 4, except that the end cap is made of nylon. An aluminum seal nut and jacket cover the cable grip, and the coupler assembly is made of rubber. The electrical connector plugs are joined as shown in figure 5.

e. Cable Assembly CX–1065/G. The cable assembly consists of approximately ¼-mile (1,280 to 1,360 feet) of spiral-four cable (Telephone Cable WF–8/G) fitted at each end with a universal connector. A pair of conductors connect the male contacts of the connector at one end to the female contacts of the connector on the other end. The steel braid is connected to the connector case at each end. Two or more of these assemblies are joined to form a transmission line of any required length. The cable assembly is supplied on Reel DR–15–B (fig. 7). The storage compartment on the reel holds both connectors plus about 12 feet of the inner end of the cable.

f. Telephone Cable Assembly CX–1606/G. This assembly consists of 100 feet of spiral-four cable (Telephone Cable WF–8/G) fitted at each end with a universal connector. It is used with ¼-mile lengths of spiral-four cable to obtain a transmission line of the required length.

g. Telephone Cable Assembly CX–1512/U (fig. 8). This assembly is a cable stub and consists of 12 feet of spiral-four cable (Telephone Cable WF–8/G) fitted at one end with a universal connector. The four conductors and steel braid are separated at the other end, allowing the spiral-four cable to be connected to terminal equipment not equipped with universal connectors. The assembly weighs 2 pounds, and contains a pair of 6-millihenry loading coils which decrease the cable attenuation on the 0 to 20 kilocycle frequency range. The end caps should be kept screwed onto the loading coil when it is not in use to protect the faces from moisture, dirt, and damage.

(1) A nylon yarn braid covers the open ends of the steel braid. The steel braid termination is made at the top of the nylon braid for ease of identification.

(2) The conductors are bared about ¾ inch and tinned. The tinned ends prevent

fraying of the conductor strands and provide a good electric connection.

h. Telephone Loading Coil Assembly CU–260/G (fig. 9). This metal cylinder (about 5 inches long and 2 inches in diameter) is inserted between two spiral-four cable assemblies to decrease transmission loss of the cable. This coil is used only when a voice frequency or four-channel carrier equipment signal is to be transmitted. It is not used when the cable is to transmit a signal of a 12-channel system.

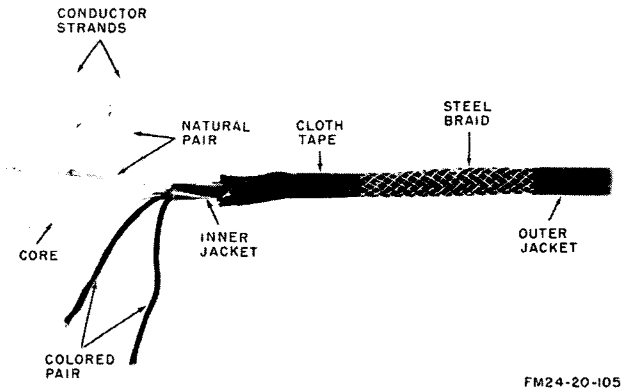

Figure 8. Telephone Cable WF–8/G, construction details.

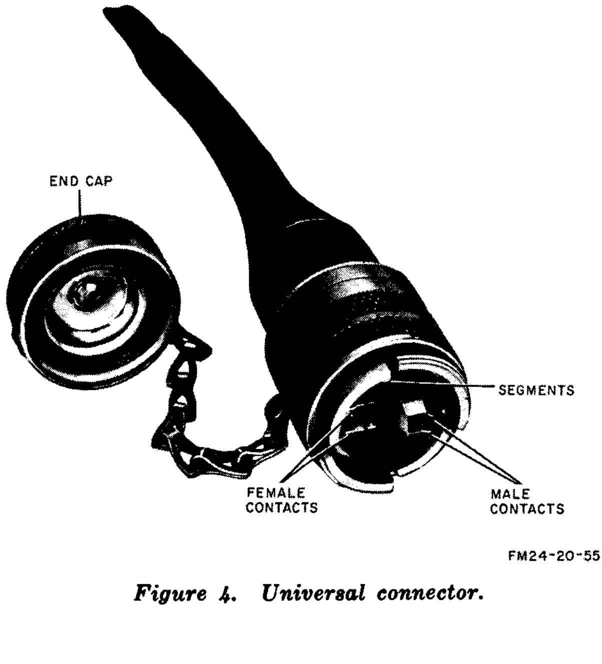

Figure 4. Universal connector.

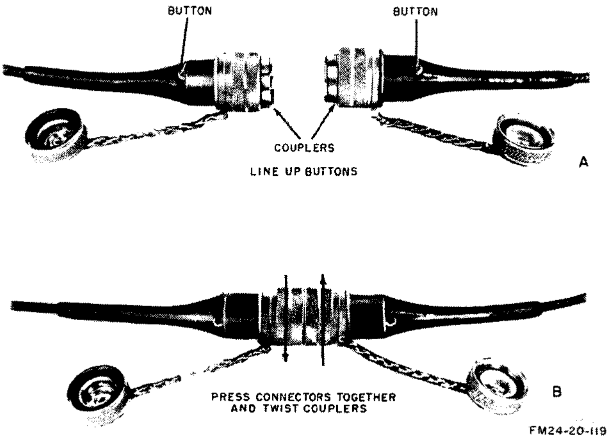

Figure 5. Joined universal connectors.

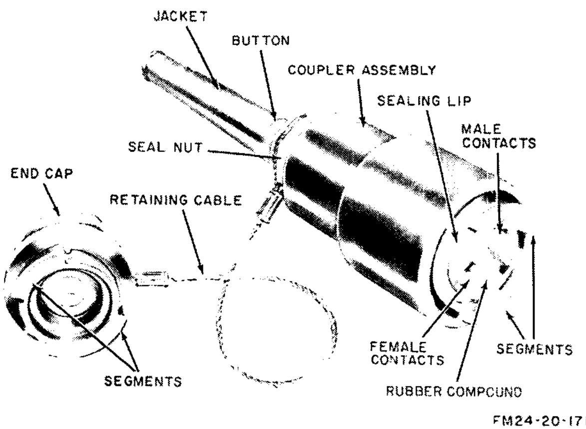

Figure 6. Electrical Connector Plug U–176/G.

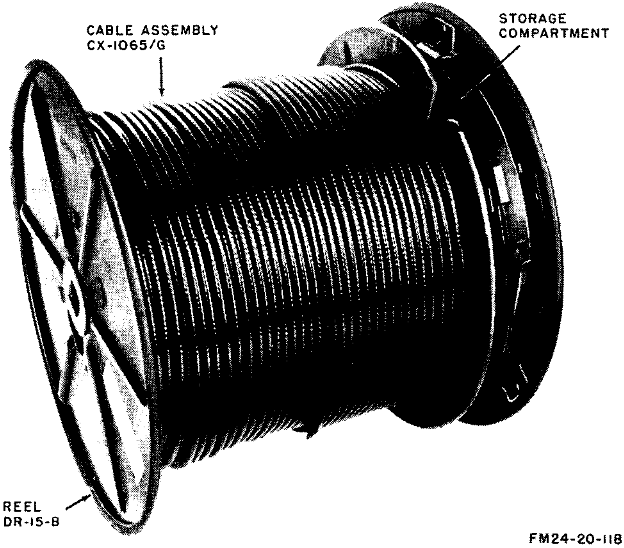

Figure 7. Cable Assembly CX–1065/G, wound on Reel DR–15–B.

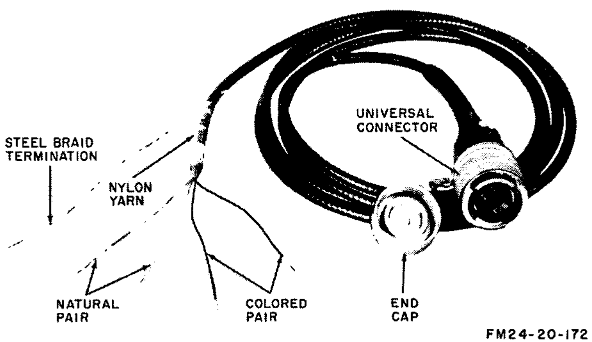

Figure 8. Telephone Cable Assembly CX–1512/U.

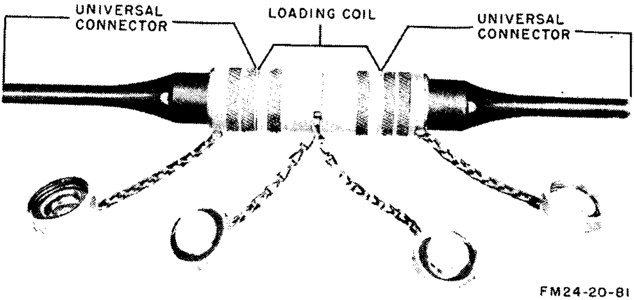

Figure 9. Telephone Loading Coil Assembly CO–260/G, joining two universal connectors.

CHAPTER 3

SPLICING FIELD WIRE

9. General

Splicing field wire is the method used to join the conductors of wire lines to maintain electrical continuity. A splice should have the same tensile strength, electrical conductivity, abrasion and weather protection, and insulation resistance as the unspliced portion of the wire. A poorly made splice introduces transmission loss, increases noise, and generally impairs the quality of the circuit.

10. Wire Splicing Equipment

Field wire splices can be made with either Wire Splicing Kit MK–356( )/G or Tool Equipment TE–33. (Nomenclature followed by ( ) refers to all models of the items of equipments.)

a. Wire Splicing Kit MK–356( )/G. Wire Splicing Kit MK–356( )/G (fig. 10) is designed to provide a means for rapidly splicing Wire WD–1/TT (standard splice). The kit consists of Wire Splicing Tool TL–582( )/U, 4 magazines, a bag, and 200 splicing connectors (sleeves). It is 12 inches long and weighs approximately 3½ pounds.

(1) Wire Splicing Tool TL–582( )/U has three basic parts: the head assembly, the cutter assembly, and the handle assembly (figs. 11 and 12).

(a) The head assembly is composed of the magazine housing, the wire guide, the wire holder, and the crimping chamber (indenter and anvil).

(b) The cutter assembly, mounted on the left handle of the tool, has a wire guide, a wire stop, and upper and lower hinged cutting blades. The cutting blades are kept closed by a coiled spring when not in use. Each blade has a groove for stripping insulation from Wire WD–1/TT.

(c) The handle assembly includes the handles and a ratchet. The ratchet prevents the tool from opening until the splice is complete. This feature insures that the operator will not make a low-tensile strength splice.

(2) The magazine holds 10 connectors or sleeves. It has a spring, follower, and a retaining slide for locking the connectors in place.

(3) The bag provides a means of carrying the splicing tool and four magazines.

(4) The splice connector assembly is made up of three concentric sleeves: copper outer sleeve, plastic intermediate insulator, and a copper insert. The copper insert insures tensile strength and conductor connection; the plastic insulator provides a waterproof seal, with the aid of pressure maintained by the outer sleeve. The plastic insulator is belled at

each end to form a funnel-like opening for the insertion of the bared wire. The spliced connector assembly provides a waterproof splice without the use of tape.

b. Tool Equipment TE–33. Tool Equipment TE–33 (fig. 13) is used for making field wire splices. It consists of Pouch CS–34, Pliers TL–13–A, and Electricians Knife TL–29. Two types of insulating tapes can be used in making field wire splices: Electrical Insulation Tape TL–636/U (black polyethylene), used in tropical and temperate zones; and Electrical Insulation Tape TL–600–U (white polyethylene), used in the Arctic and during cold weather in temperate zones. Tape TL–83 (friction) may be used for added protection of the splice. To improve the field splice

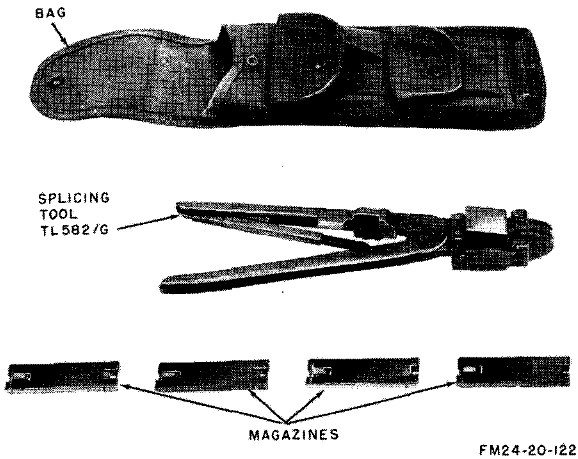

Figure 10. Wire Splicing Kit MK–356( )/G.

mechanically and electrically, a small gauge, soft-drawn copper wire (known as seizing wire) may be used. (Seizing wire may be obtained from the copper conductors in a piece of field wire.)

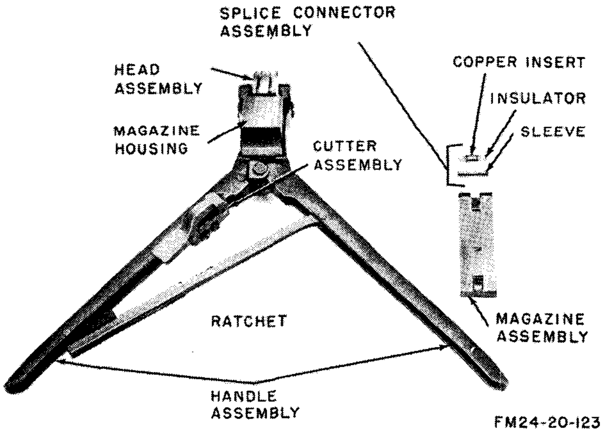

Figure 11. Wire Splicing Tool TL–582( )/U.

11. Standard Field Wire Splice

a. Steps in Making Splice.

(1) Cut the conductors.

(2) Strip the insulation from each conductor.

(3) Load the magazine.

(4) Place the sleeve in the crimping chamber.

(5) Insert the bared wires in the corresponding ends of the sleeve.

(6) Crimp the sleeve.

b. Cutting Conductors. Open the upper cutting blade of the cutter assembly and place the pair of wires toward the rear against the hinged portion

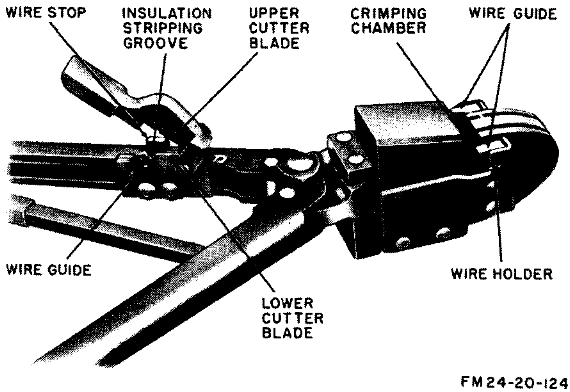

Figure 12. Wire splicing tool: Cutter assembly and head assembly.

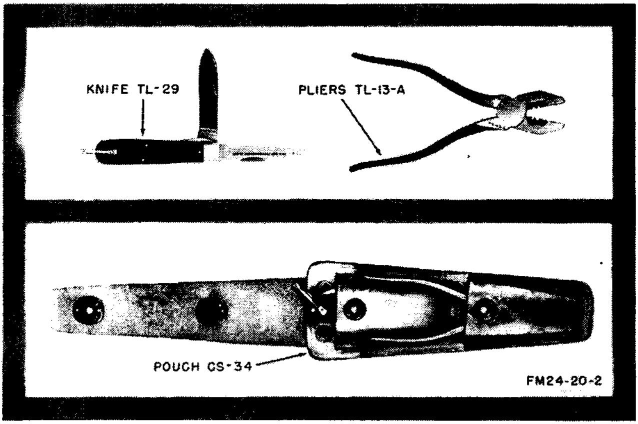

Figure 13. Tool Equipment TE-33.

of the assembly, release, and press down (fig. 14). Both conductors should be of equal length.

c. Stripping Insulation. The ends of the wires must be bared approximately $\frac{5}{16}$ inch to insure proper conductivity and tensile strength when crimped in the insert sleeve. To strip the insulation from the ends of the wires:

(1) Open the upper cutting blade of the cutter assembly, and place the end of the conductor in the wire guide and stripping groove (lower cutting blade), and forward against the wire stop (fig. 15). (The wire must be pressed against the wire stop to insure the removal of the correct amount of insulation.)

(2) Release the upper cutting blade, and give a sharp pull on the wire. If small particles of insulation remain, repeat the operation.

(3) Do not twist the bared ends of the wire. The wire strands should mesh inside the sleeves under the crimping pressure to provide a strong splice.

d. Loading Magazine. Load the magazine by either of the following methods:

(1) Open the retaining slide and insert the sleeves into the magazine. Hold each sleeve in place until the last sleeve is inserted, and then close the retaining slide to lock the sleeves in place.

(2) Open the retaining slide. With a sleeve placed in the follower slot (fig. 16), compress the spring by pressing down on the

follower until the sleeve is lined up with the follower stop hole. Lock the spring in place by pushing the sleeve in the follower hole. Fill the magazine with sleeves, close the retaining slide, and remove the holding sleeve from the follower hole.

e. Placing Sleeve Assembly in Crimping Chamber. Before inserting the magazine in the magazine housing, close the handles of the tool. This will raise the return pin so that it will open the retaining slide on the magazine as the magazine is inserted into the housing.

(1) Insert the magazine face down into the magazine housing and push forward into position (fig. 17).

(2) Extend the handles of the tool to their widest position. (The magazine will be pulled out slightly by the retaining pin.) Push the magazine into its final position; this will allow a sleeve to enter the crimping chamber (fig. 18).

(3) Close the handles of the tool until the sleeve assembly is held firmly in the crimping jaws. Do not exert excess pressure that will crimp the sleeve assembly.

f. Inserting Conductors in Sleeve Assemblies. Splice the conductor of one wire pair to the conductor of the other wire pair as follows:

(1) Insert both of the conductors to be spliced into the wire guide on each side of the head assembly of the tool; push the wires

into the sleeve assembly as far as possible (fig. 19).

(2) After the conductors are properly seated, hold them in place by wedging them into the wire holder.

g. Crimping Sleeve. Crimp the sleeve and complete the splice as follows:

(1) Close the handles of the splicing tool as far as possible (fig. 20). The tool will crimp the sleeve at its center and at both ends.

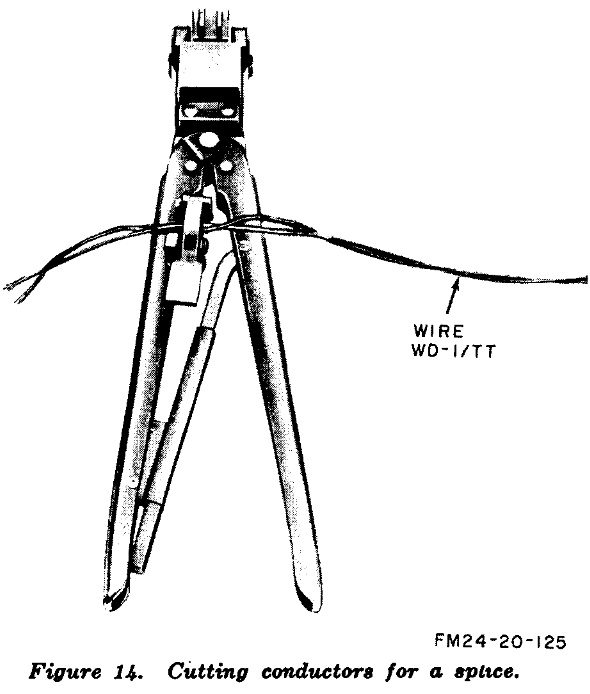

Figure 14. Cutting conductors for a splice.

Warning: Be very careful to protect the fingers while closing the handles, because the ratchet assembly prevents the tool from opening until the crimping operation is completed.

(2) Open the handles of the splicing tool to their full width and remove the splice.

(3) Test the quality of each splice by giving a sharp pull on the splice.

(4) Repeat the splicing operation on the other conductor of the field wire pair. A completed splice is shown in figure 21.

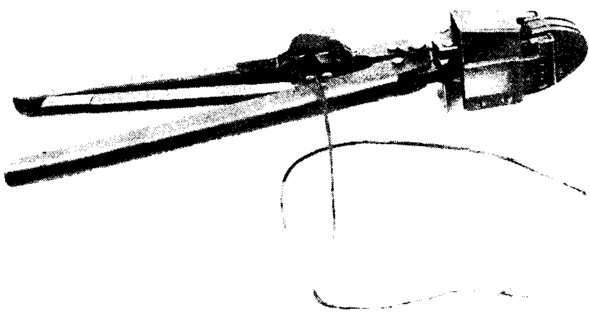

Figure 15. Stripping insulation.

12. Field Wire Splice

a. Steps in Making Splice. The field wire splice (fig. 22) consists of four essential steps:

(1) Cut the wires to stagger the lengths and remove the insulation of each conductor.

(2) Tie a square knot to retain the tensile strength of the conductors.

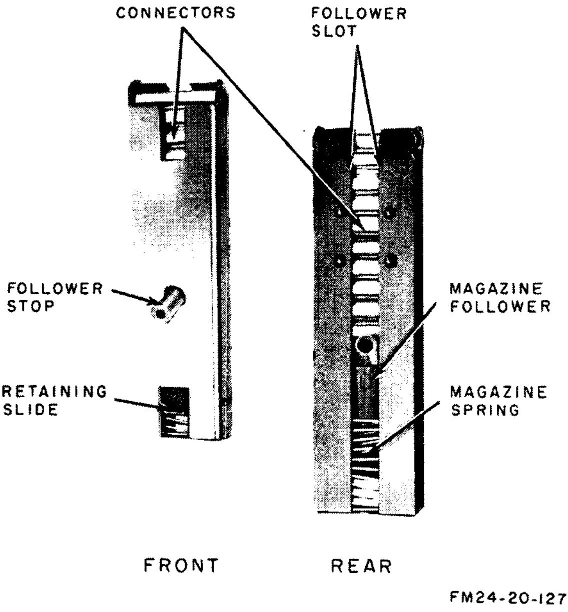

Figure 16. Loading magazine.

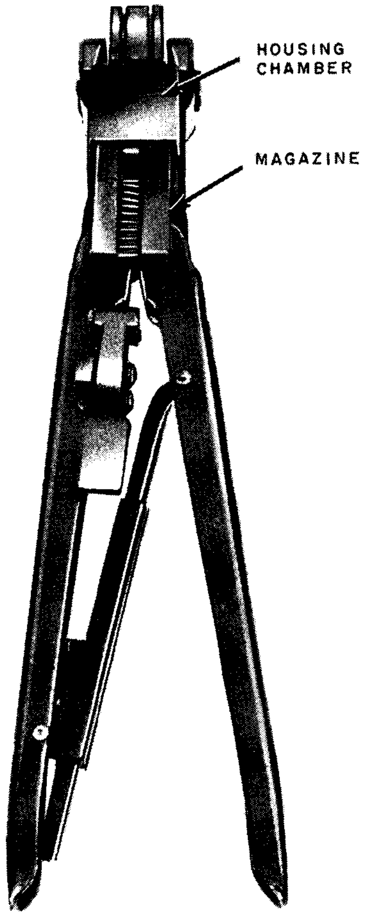

Figure 17. Inserting magazine in magazine housing.

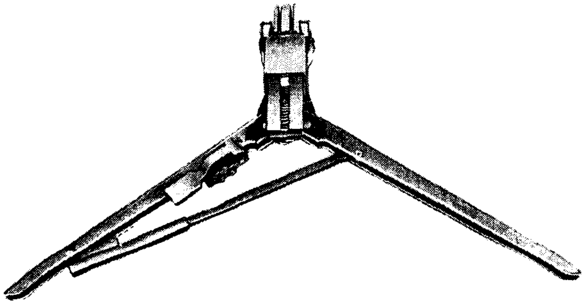

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Figure 18. Loading the crimping chamber.

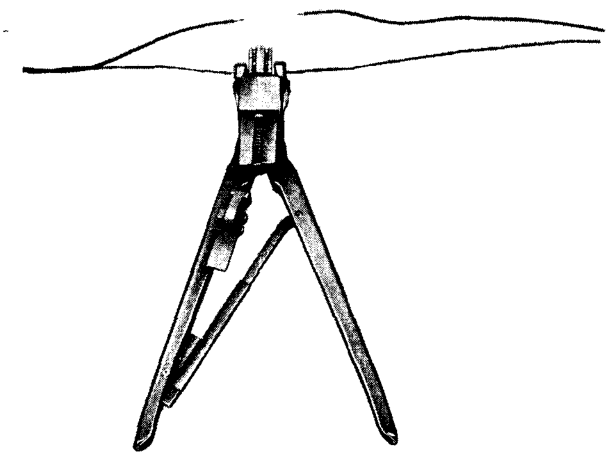

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Figure 19. Inserting wire conductor in sleeve assembly.

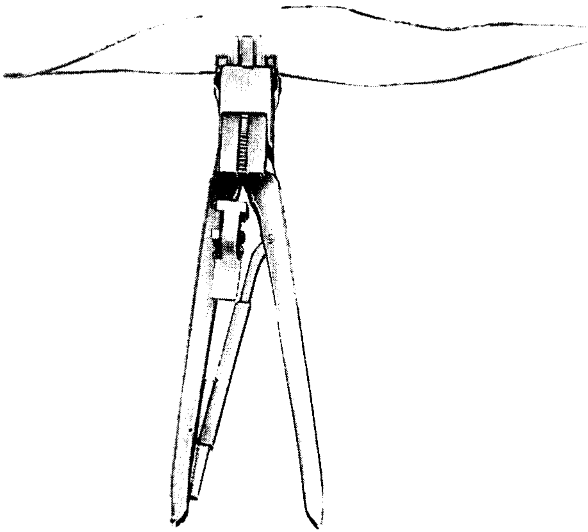

Figure 20. Crimping sleeve.

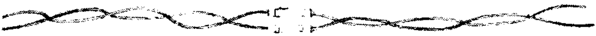

Figure 21. Completed splice.

(3) Seize the square knot to provide good electrical conductivity.

(4) Tape the splice to electrically insulate the conductors and to protect against abrasion and weather.

b. Cutting Conductors to Stagger Splice. To stagger the conductors of a field wire pair—

(1) Snip off the ends of the pair of wires to insure that both conductors are of equal length.

(2) Cut one conductor of each pair 6 inches (or one plier's length) from the end (fig. 23).

c. Removing Insulation. Remove insulation to bare the conductors for splicing (fig. 24). Remove the insulation as follows:

(1) Use the cutting edge of Pliers TL–13–A to remove 6 inches (2 inches at a time) of both nylon jacket and inner insulation. Pull the third 2-inch section of the insulation only to the end of the conductor. This will keep the wire strands together during the next step of the splice.

(2) Carefully clean the strands of the remaining insulation with Knife TL–29.

d. Tying Square Knot. Join the end of the long conductor of one pair and the end of the short conductor of the other pair after restoring the normal twist of the conductors. Twist conductor 1 over and under conductor 2 to form the first loop (A, fig. 25). Twist conductor 1 over and under conductor 2 to form the second loop of the square knot (B, fig. 25). Pull the knot tight, but leave a ¼-inch space between the knot and the insulation (B, fig. 25).

e. Seizing Splice.

(1) *With seizing wire.* When seizing wire is available, insert a 6- to 8-inch length of

seizing wire through the center of the square knot and tighten the knot (A, fig. 26). Bend the seizing wire at its center. Use half of the wire for wrapping to the right. Take several close turns with the seizing wire, both to the left and to the right, to bind the square knot (B, fig. 26). Cut the excess ends of the conductor flush with the insulation. Continue the seizing-wire wrap, to the left and to the right of the square knot, until 2 turns are taken on the insulation. Cut the ends of the seizing wire, and press them down into the insulation (C, fig. 26).

(2) *Without seizing wire.* When seizing wire is not available, use the copper strands of the conductor to seize the square knot. After the knot has been tied and pulled tight, remove the third 2-inch section of the insulation and separate the steel strands from the copper strands (A, fig. 27). (Copper strands will remain bent when flexed.) Cut the steel strands flush with the ends of the insulation (B, fig. 27). Cross the left-hand end of the copper strands over the crest of the square knot (C, fig. 27). Wrap several tight turns over the bared portion of the right-hand conductor. Continue wrapping until 2 turns have been made on the insulation. Cut the excess ends of the copper strands. Repeat the seizing operation with the right-hand end of the cop-

per strands; again cross over the crest of the square knot and wrap 2 turns on the insulation of the left-hand conductor.

f. Taping Splice. The types of insulating tapes are discussed in paragraph 10*b*.

(1) *Taping splice with electrical insulation tape.* Remove the backing and stretch the electrical insulation tape to activate its self-bonding properties. Start taping at the center of the splice (A, fig. 28). Use a steady pull and tape about 1½ inches beyond the insulation at one end. Work the tape back over the knot to about 1½ inches beyond the insulation on the opposite side. Finally, work the tape back again to the center of the splice.

(2) *Taping splice with friction tape.* Start at either end about ½ inch beyond the electrical insulation tape. Continue the taping to a point about ½ inch beyond the electrical insulation tape on the opposite end (B, fig. 28).

13. Combination Splice

The combination splice (fig. 29) is used to splice an insulated stranded-conductor to an insulated solid conductor. It is made as follows:

a. Remove 6 inches of insulation from the end of each wire and scrape the wire clean.

b. Tie an overhand knot (first half of square

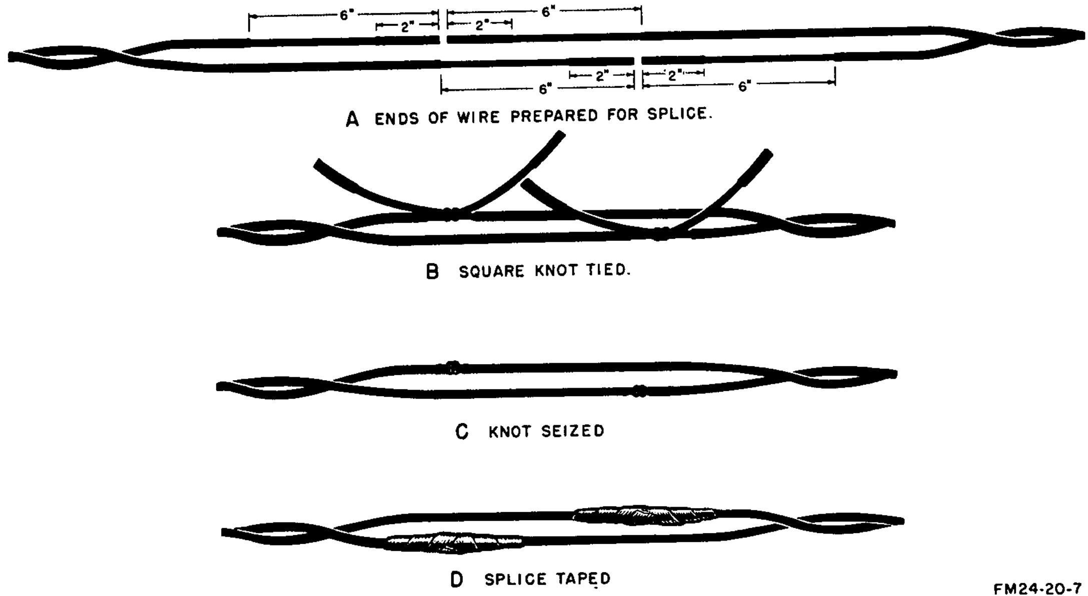

Figure 22. Four steps in making field wire splice.

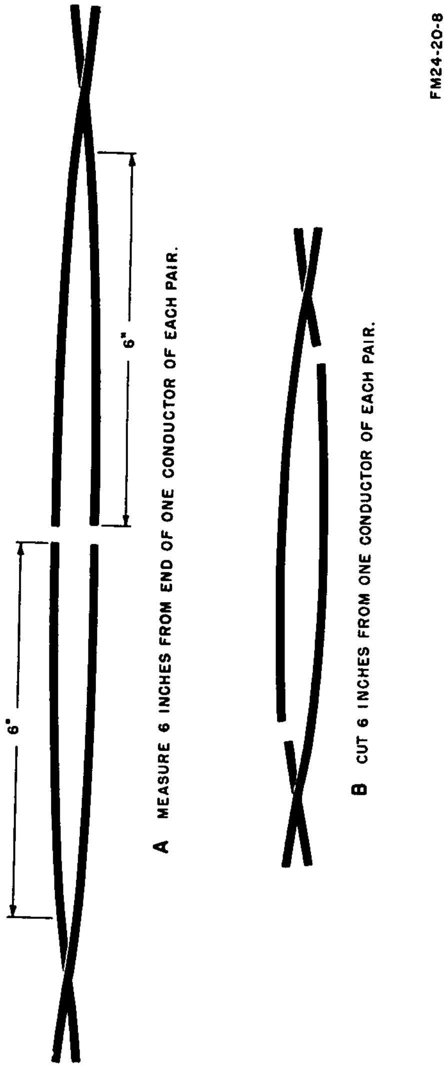

Figure 23. Conductors staggered for splicing.

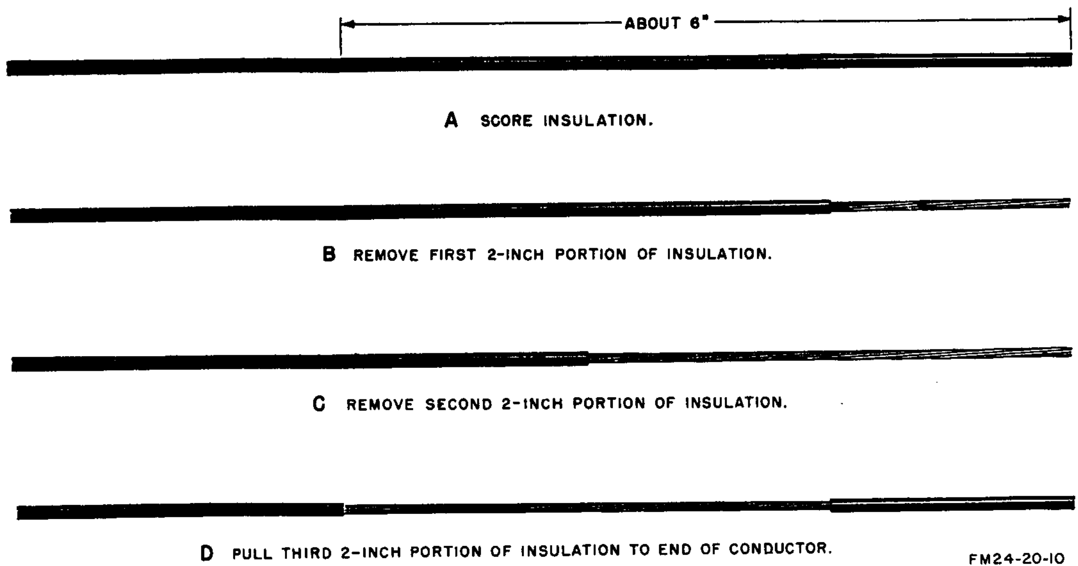

Figure 24. Removing insulation from field wire conductor.

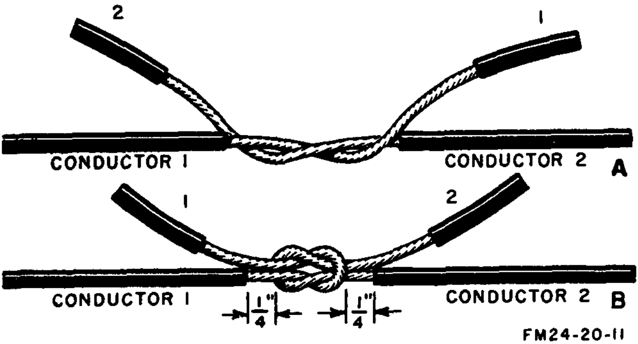

Figure 25. Tying square knot in field wire.

knot) in the stranded wire within 1/8 inch of the insulation.

c. Slip the knotted wire over the solid conductor to within 1/2 inch of the solid conductor wire insulation (A, fig. 29).

d. Wrap the stranded wire around the solid conductor up to the insulation (B, fig. 29). Cut the excess stranded wire.

e. Bend the end of the solid wire back at the knot, and wrap it around the stranded wire until 2 turns are made on the insulation (C, fig. 29).

f. Wrap the solid wire in the direction opposite to that of the wrapping of the stranded wire. Cut off the excess solid wire, and press the cut end down into the insulation.

g. Tape the splice as described in paragraph 12*f*.

14. T-Splice

The T-splice is used to splice one field wire line to another without interrupting service. This is

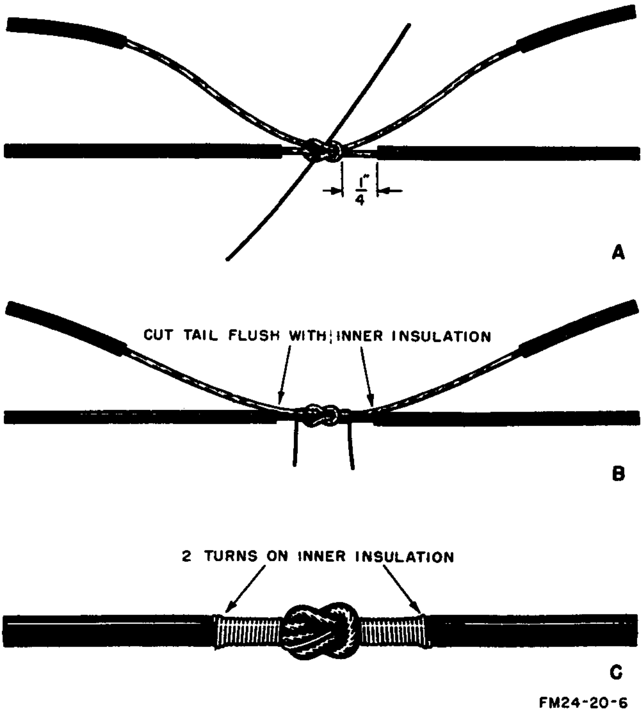

Figure 26. Square knot with seizing wire.

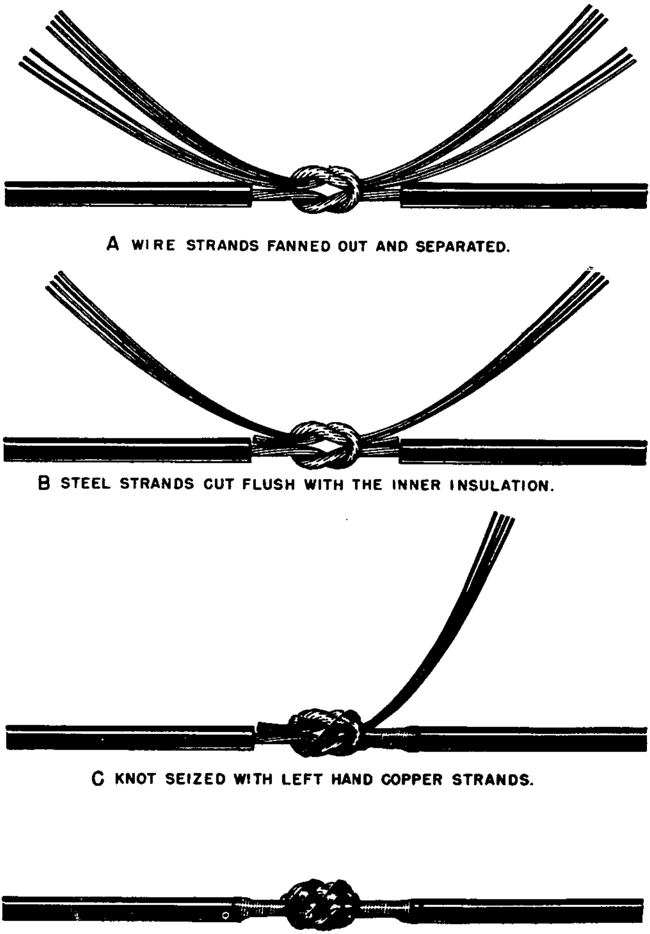

Figure 27. Square knot without seizing wire.

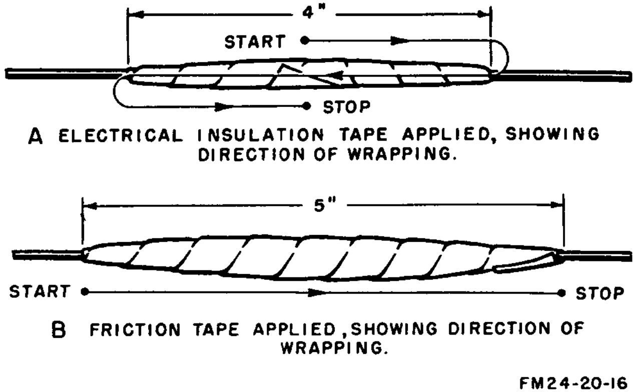

Figure 28. Applying electrical insulation tape and friction tape.

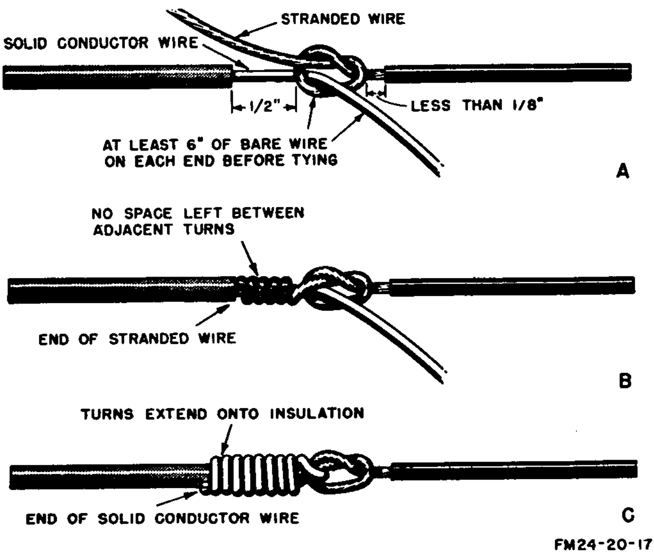

Figure 29. Combination splice, solid to stranded conductor.

used in the rerouting of existing wire lines or in the construction of a multiple party line. In figure 30, X_1 and X_2 are the conductors to be connected. Make the splice as follows:

a. Remove 1½ inches of insulation from conductors X_1 and X_2. The two bared spots should be at least 12 inches apart.

b. Place conductors Y_1 and Y_2 beside X_1 and X_2. Cut Y_1 off at the bared spot in X_1, and prepare the ends of Y_1 and Y_2 for splicing.

c. Tie Y_1 and X_1 with a square knot as follows: With the left hand, make a loop in the bared part of X_1. With the right hand, pass the end of Y_1 up through the loop, over the right side, under and around the neck of the loop, over the left side and down through the loop. Tighten the knot.

d. Twist Y_2 around X_1 and X_2. Tie Y_2 to X_2 in the same manner as described above. Assuming that the circuit going to the left of the splice will be disconnected after the splice is completed, cut off the portion of the end to be discarded and complete the splice (paragraph 12*e* and *f*).

e. When the end is not to be discarded, complete the splice with seizing wire.

15. Splicing Field Wire to Bare Copper Wire

Either a bridging connector or a combination seizing-wire splice is used to splice a stranded field wire conductor to a solid open-wire conductor.

a. Bridging Connectors. These are threaded-bolt devices used to connect two conductors. Before using the bridging connector, clean the solid

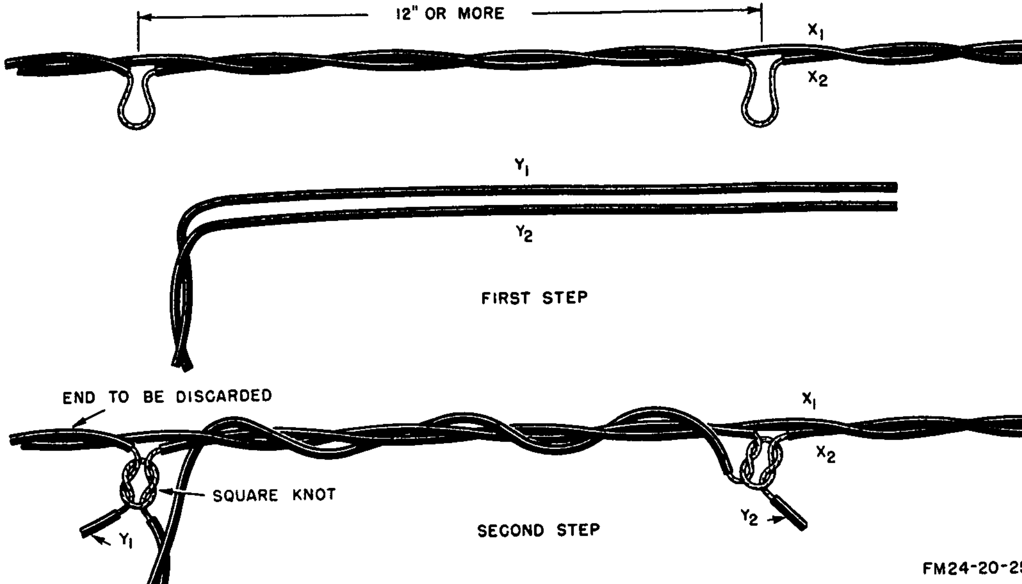

Figure 30. T-splice.

open-wire conductor at the point of connection. Place the bridging connector in position (top wire in fig. 31), and tighten the upper nut securely. Remove the insulation from the field wire, clean the strands, and wrap the bared end counter-clockwise around the threaded part of the connector between the two washers. Tighten the lower nut securely.

b. Combination Seizing-Wire Splice (fig. 32). To make this splice, remove 1 inch of insulation from the end of the stranded wire. Clean both the stranded and solid conductors. Lay the bared end of the stranded wire along the solid wire. With a 12-inch piece of seizing wire, wrap 4 turns around the solid wire in back of the stranded wire. Continue to wrap the seizing wire. Take several turns over the insulation of the stranded wire, continue over the bare end of the stranded wire, and finally finish with 4 turns over the solid wire. Wrap the seizing wire tightly, and draw the turns against each other.

c. Taping Combination Seizing-Wire Splice. A combination seizing-wire splice is wrapped with two layers of electrical insulation tape covered by two layers of friction tape. This taping helps to hold the wires firmly in place and reduces weather corrosion. The taping on the solid conductor should be extended well beyond the contact area of the two conductors (fig. 33).

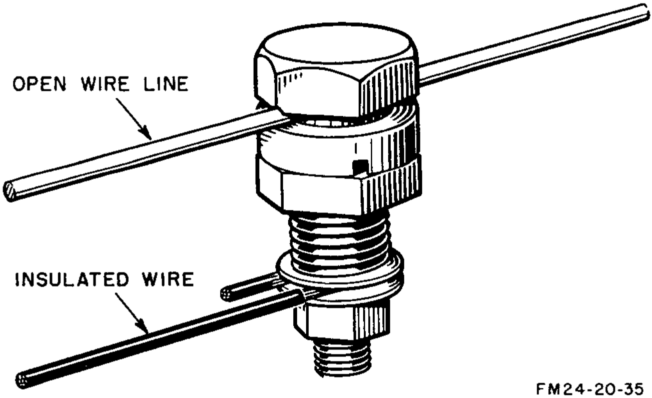

Figure 31. Field wire connected to open wire by bridging connector.

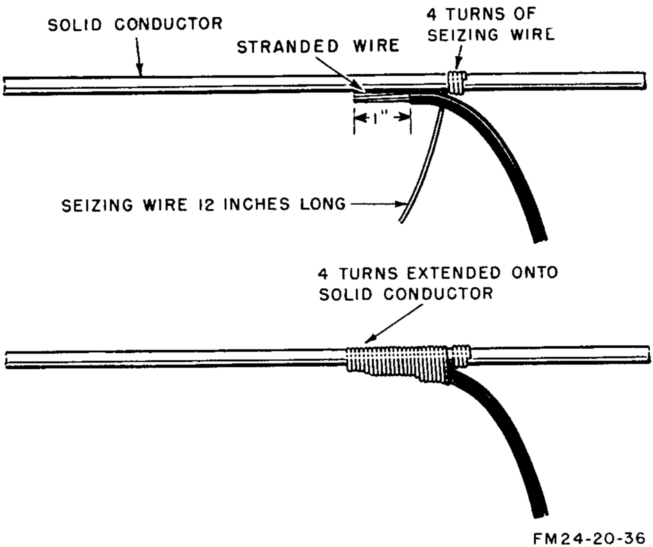

Figure 32. Combination seizing-wire splice.

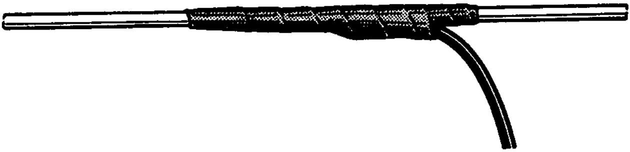

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Figure 33. Taping combination seizing-wire splice.

CHAPTER 4

TYING FIELD WIRE LINES

16. General

a. Field wire ties are used to hold wire lines in place and to relieve the strain on wire lines at their terminating points. All field wire ties are made without cutting the wire lines, thus allowing rapid installation and recovery without damage to the wire.

b. The three wire terms used in this chapter when describing these field wire ties are defined below:

(1) The *standing part* is that part of the line that has been installed.

(2) The *running end* is that part of the line that leads to the wire-laying equipment.

(3) A *wire bight* is a loop formed by the wire (A, fig. 36).

17. Drip Loop

A drip loop (fig. 34) is placed in a lead-in wire where the wire line is tied above the terminal equipment. The drip loop drains the water down the lead-in wire to the bottom of the loop, and thus prevents water from entering the equipment.

18. Clove Hitch Tie

A clove hitch tie is used to fasten a field wire line to any object having an unobstructed top,

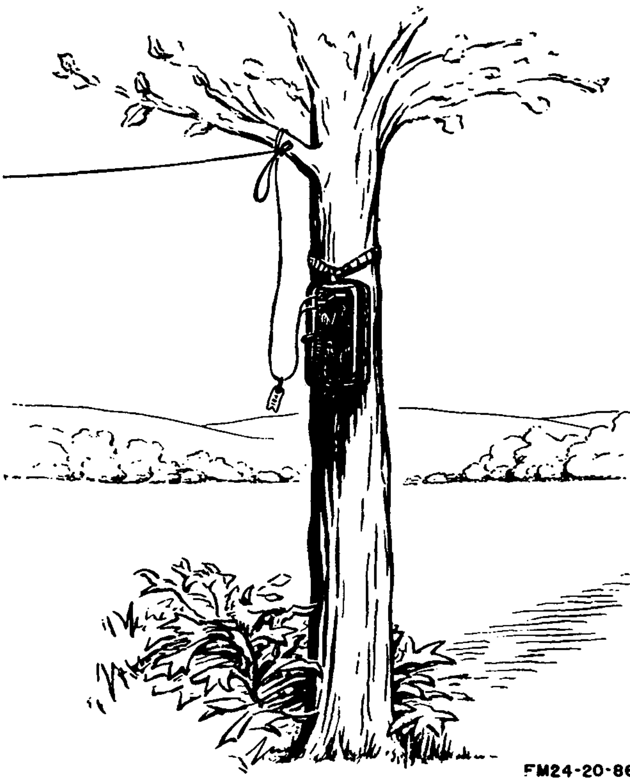

Figure 34. Drip loop.

such as a stake or a fence post. To make this tie, proceed as follows:

a. Form two loops in the wire (A, fig. 35).

b. Place the right-hand loop on top of the left-hand loop without turning either loop (B, fig. 35).

c. Place both loops over the object to which the tie is to be made and tighten the loop (C, fig. 35).

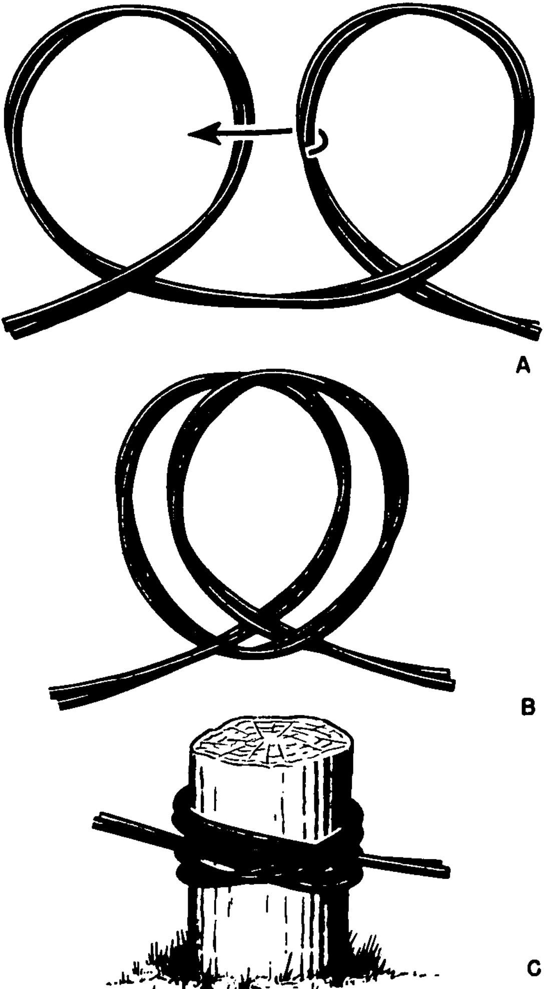

Figure 35. Clove hitch tie.

19. Loop-Knot Ties

a. Overhead Loop-Knot Tie (fig. 36). This tie is used for short, temporary overhead spans. It must not be used for long or permanent overhead spans, because the weight of the wire causes the knot to bind, thereby causing damage to the insulation. It should not be used in places where it could become untied accidentally by passing personnel, vehicles, or animals. The tie is made as follows:

(1) Place the wire between you and the object to which the tie is being made.

(2) Pull enough slack to form a bight around the object plus an additional 3 feet. (If the wire is to be later recovered, a longer bight should be formed to eliminate climbing to untie the loop.)

(3) Place the bight around the object in the direction of the running end. (If a greater strain is on the running end, place the bight around the object in the opposite direction (A, fig. 36).)

(4) Hold the running end, the standing part and the bight in one hand. With the other hand, reach over the running end with the palm down, grasp the bight and twist to form a loop. (With the palm down, the twist can only be made in one direction (B, fig. 36).)

(5) Reach down through the loop, grasp the bight, inclosing the standing end and the running end, and pull up to form a double bight (C, fig. 36).

(6) Tighten the knot securely against the object (D, fig. 36). To unfasten the tie, pull on the lower single loop.

b. Ground Loop-Knot Tie. This tie is made in the same manner as the overhead loop-knot tie, except the hand is placed under the loop. (With the palm up, the loop can be twisted in only one direction.) The double bight is pulled down through the loop and the knot is tightened. The double bight will be down, and the single loop will be up, making it easier to untie.

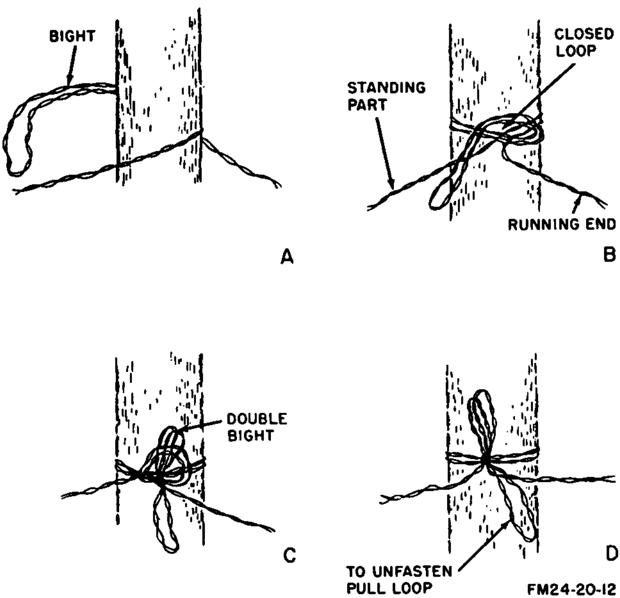

Figure 36. Overhead loop-knot tie.

20. Square Knot and Loop Tie

a. The square knot and loop tie (fig. 37) is more secure than the simple loop-knot tie, and it is used for the same purposes. To make the tie, proceed as follows:

(1) Pull in slack and pass a bight around the object, pull in an additional 3 feet (A, fig. 37).

(2) Bring the bight over the standing part and running end, and then between the object and the wire (B, fig. 37).

(3) Draw the knot tightly against the object.

(4) Bring the bight over the running end to form a closed loop opening (C, fig. 37).

(5) Reach through this opening and pull about 6 inches of wire through the opening to form a doubled bight (D, fig. 37).

(6) Tighten the tie by holding the doubled bight in one hand and pulling the running end with the other. To unfasten, pull the lower loop and untie the knot from the object.

b. The above tie can be made more secure by completing the square knot and eliminating the loop. Make a square knot tie as follows:

(1) Proceed as with the square knot and loop tie, but pull the end of the bight through the opening.

(2) Tighten the tie by holding the end of the bight in one hand and pulling the running end with the other.

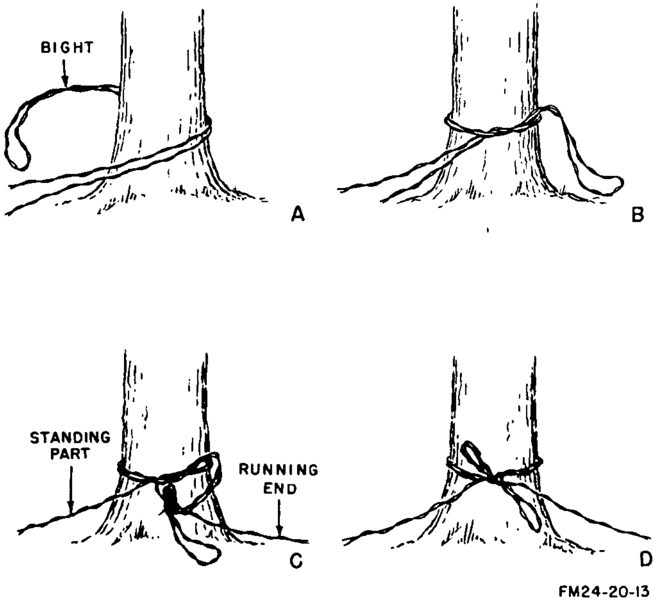

Figure 37. Square knot and loop tie.

21. Knob Tie

The knob tie (fig. 38) is used to tie field wire to small supports such as insulators and similar objects. This tie is not suitable for long spans. Make the knob tie as follows:

a. Form a loop in the wire (A, fig. 38).

b. Separate the two conductors in the loop (B, fig. 38), and bend back the loop in each conductor until the loops touch each other (C, fig. 38).

c. Place the loop over the insulator, and pull on both the standing part and the running end to secure the tie (D, fig. 38).

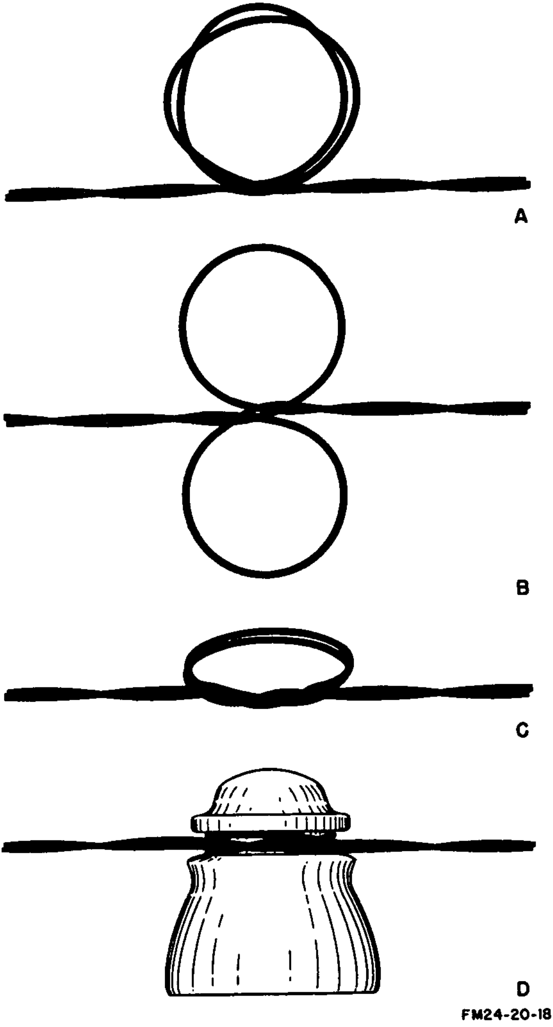

Figure 38. Knob tie.

22. Marline Tie

The marline tie is used to suspend a field wire line from a support. This tie is used when there is a possibility that the support might damage the wire insulation. Make this tie as follows:

a. Double a piece of marline that is long enough for the tie.

b. Pass the marline under the wire, and pass the ends of the marline through the loop of the doubled marline.

c. Draw the marline tightly around the wire (A, fig. 39).

d. Pass the doubled marline twice around the support and back to the wire (B, fig. 39).

e. Fasten the ends of the marline to the wire with a clove hitch knot (C, fig. 39).

f. To tie a clove hitch knot, place the marline around the wire and pass the running end over the standing part to form a loop. Pass the running end down through this loop (C, fig. 39) and tighten the knot.

23. Basket Hitch Tie

a. The basket hitch tie is used as a tie for field wire under conditions of extreme heat, long spans, heavy winds, or icing. It is used for aerial support of multiple pairs of field wire and field cables.

b. The basket hitch tie is made as follows:

(1) Cut a 10- to 12-foot length of field wire.

(2) Make a clove hitch around the wires that are to be supported (A, fig. 40). (The clove hitch in this case is formed by wrapping the tie wire *around* the wire or

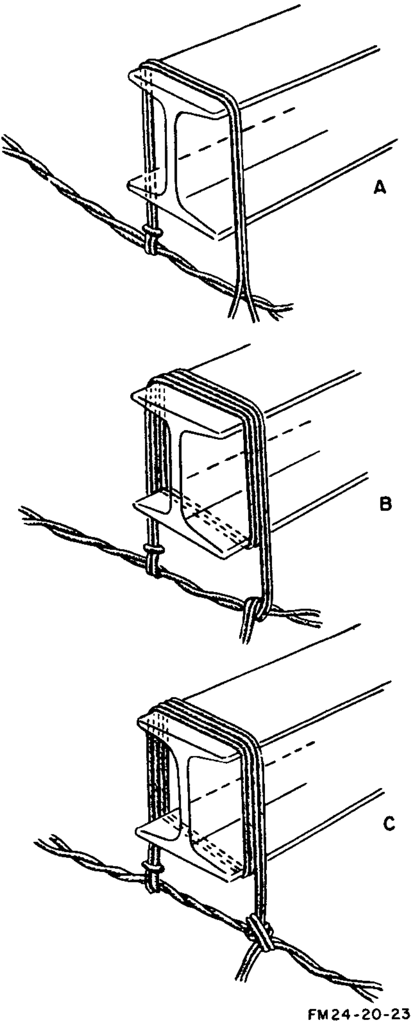

Figure 39. Marline tie.

cable to be supported. If the clove hitch slips, wrap several turns of friction tape at this point.)

(3) Weave the tie wire around the wires or cable, placing the tie wire alternately on the inside of one cross and on the outside of the next cross. When the wires are tied in this manner, the gripping action will be evenly distributed for the entire length of the tie. Usually, seven crossovers will be sufficient to hold the supported wire.

(4) Hold the two ends of the tie wire together, and make 1½ turns around the support.

(5) Separate the two ends. Bring one end over and one end under the standing part of the tie wire (B, fig. 40).

(6) Tie the two ends together with a square knot, and cut off the excess wire (C, fig. 40).

c. Two basket hitch ties are used at nonterminating support points of an overhead construction. Loop the line around the support in such a manner that the wire line or cable will not rub against the support (fig. 41). Make the ties as explained in *b* above.

d. It is possible to make the basket hitch on the ground before climbing the support for the line. After the line has been secured to one support, stand at the base of the next support and pull the line tight to the center of the next support at ground level. Measure back toward the first sup-

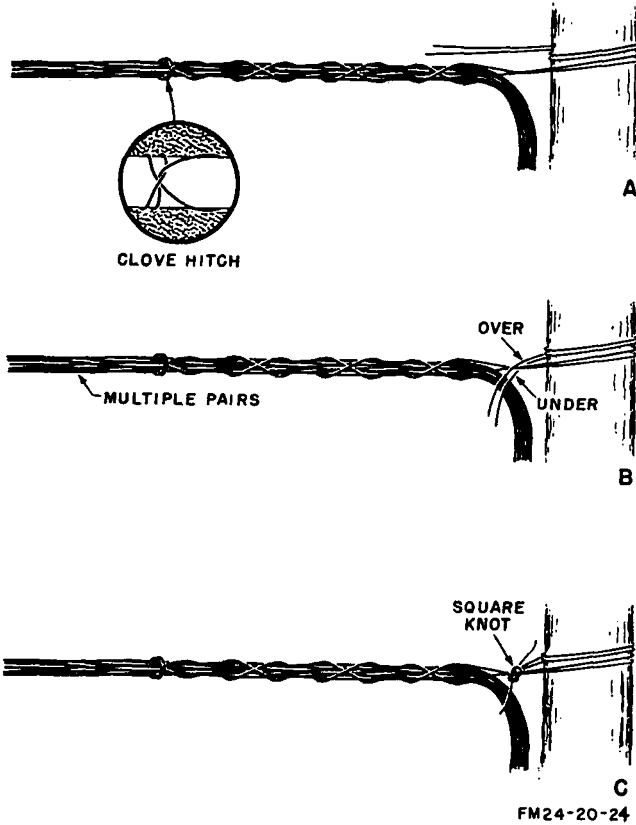

Figure 40. Basket hitch tie at termination of overhead span.

port a distance of 2 feet. Start the basket weave tie at this point. This method will allow the necessary amount of sag in the line when the span is completed. (Sag is the vertical distance between the lowest point on the line and a straight line between the two points of suspension.)

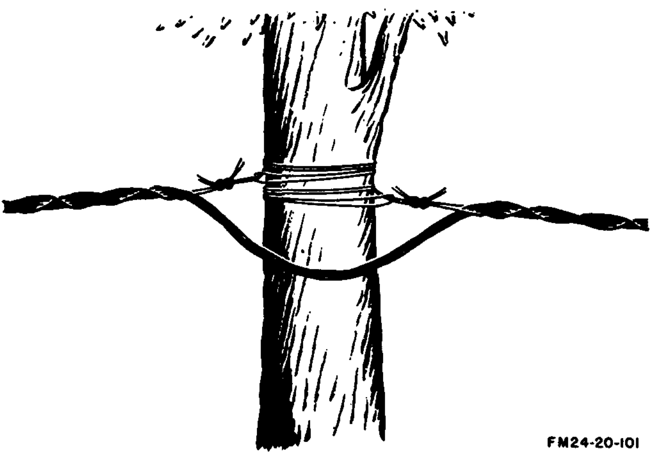

Figure 41. Basket hitch tie, supporting overhead span.

24. Variation of Basket Hitch Tie

a. A variation of the basket hitch tie (fig. 42) is well-suited for jungle areas. This tie will allow considerable swaying of the tree or other support without placing an increased strain on the wire, and it will permit suspension from a horizontal or vertical support.

b. Make this tie (fig. 42) as follows:

(1) Loop a piece of field wire twice around the tree, or other similar support, and tie a square knot. Leave about 2 or 3 feet of the wire at the free ends.

(2) Twist these tie-wire ends together to form a double twisted pair for a distance of 6 inches below the square knot.

(3) Make an overhand tie (first step in making a square knot).

(4) Insert the line to be suspended between the two tie-wire ends and tie a square knot.

(5) Untwist the opposite ends of the tie wire.

(6) Weave the untwisted tie-wire in opposite directions along the wire to be suspended.

(7) Weave both portions of each tie-wire end around the wires to be supported. Make sure that one portion of the tie wire lies on the inside of one cross and on the outside of the next cross.

(8) After four or five crossovers, tie both portions of each tie-wire end in a square knot, and cut off the excess wire.

(9) Use friction tape, where needed, to prevent the tie wire from slipping.

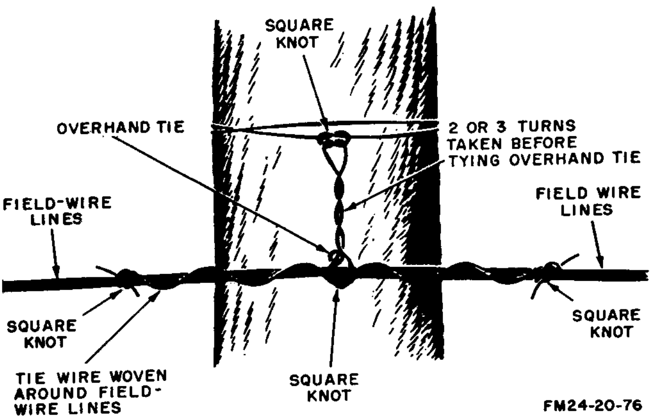

Figure 42. Variation of basket hitch tie.

25. Weave Tie

a. General. The weave tie (fig. 43), another variation of the basket hitch tie, is used to support multiple-pair cable and aerial field wire lines for semipermanent installations. It also can be used to attach field wire to ground supports, such as stakes or trees.

b. Making Tie. Select a 4- to 8-foot piece of field wire to make the weave tie.

(1) Fasten the tie wire to the support with a clove hitch. If the support is large, make only one loop, and tie with a square knot.

(2) Separate the twisted conductors of each end of the tie wires. (About 18 inches are needed to complete the tie.)

(3) Pull the wire line up against the clove hitch or square knot.

(4) Weave the tie wire along the wire line at least 8 inches in both directions. (Increase the length of the weave for long spans.)

(5) Terminate the tie-wire ends in square knots.

(6) Trim the excess wire from the square knot.

(7) Tape the wire when necessary, to prevent the tie wire from slipping.

26. Connecting Field Wire Lines to Open-Wire Lines

When a field wire line must be connected to an open-wire line, proceed as follows:

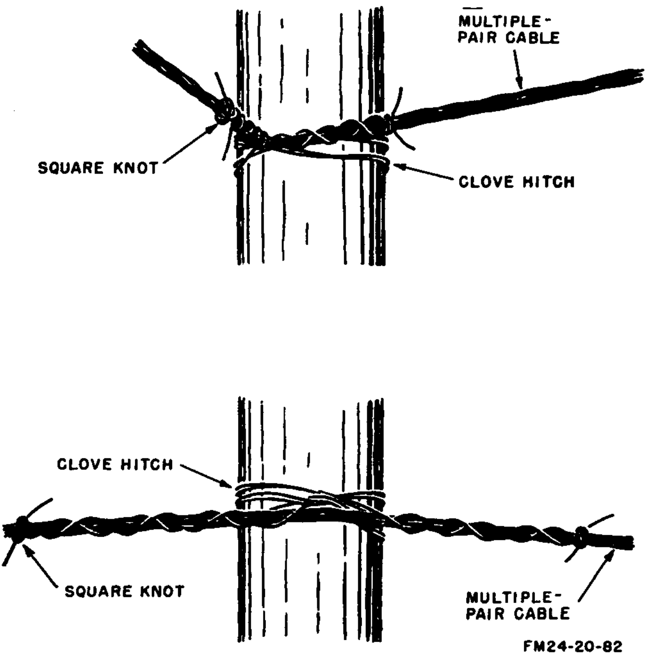

Figure 43. Weave tie used with field wire.

a. Splice the field wire conductors to the open-wire conductors as described in paragraph 15.

b. Tie the field wire lines to the cross arm or pole (never to the metal brace) near the splicing point (fig. 44).

c. Leave a little slack between the tie and the splice. The tie should take the strain, because the splice will not withstand a heavy pull.

d. Position the tie on the cross arm or pole so that each field wire conductor will touch only the open-wire conductor to which it is spliced.

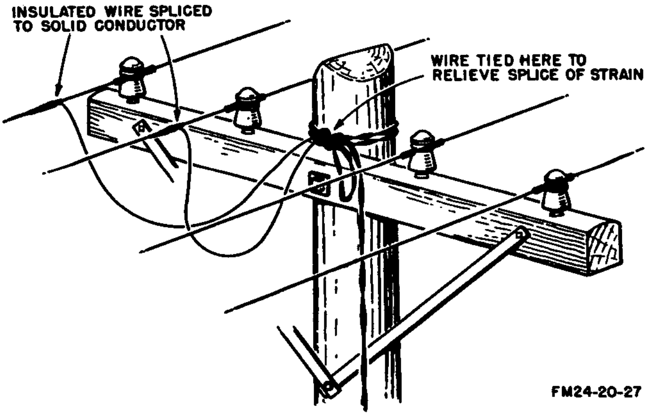

Figure 44. Tying in field wire to open wire.

CHAPTER 5

WIRE-LAYING AND WIRE-RECOVERING EQUIPMENT

27. General

Metal spool-type reels are used to store, transport, lay, and to recover Wire WD–1/TT. All reels require some type of mounting to simplify the laying and retrieving of wire. These are called *wire-laying* equipments and are made in various types and sizes for operation under varying conditions. Special canvas containers, known as *dispensers,* may also be used to lay field wire lines.

28. Field Wire Reels

The three types of reels (fig. 45) available for use with field wire are as follows:

a. Reel DR–5 is a metal spool-type container used to store, transport, lay, or recover field wire. It will hold 2½ miles of field wire and can be mounted on Reel Unit RL–26–( ), RL–31–( ), or Reeling Machine RL–118/G.

b. Wire Reel RL–159/U is a metal spool-type container used to store, transport, lay, or recover field wire. It will hold 1 mile of field wire and can be mounted on Reel Unit RL–26–( ), RL–31–( ), Reeling Machines RL–118/G and RL–172/G, or Axle RL–27–( ).

c. Spool DR–8–( ) is a metal container used to lay or recover field wire. It will hold ¼ mile of field wire and can be mounted on Reel Unit RL–39–( ) (component of Reel Equipment CE–11).

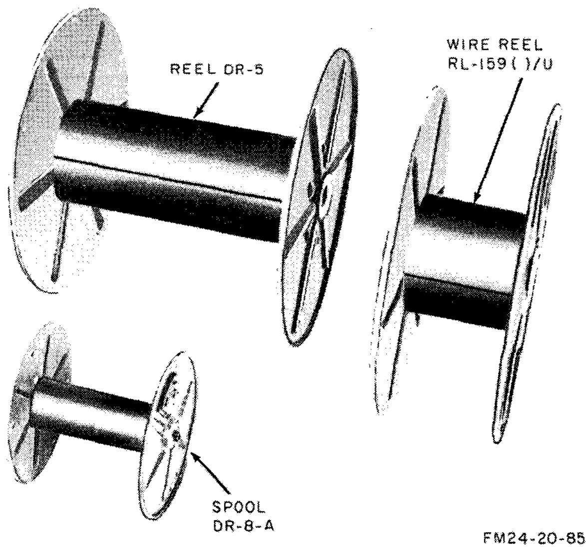

Figure 45. Reels for field wire.

29. Wire Dispenser MX–306( )/G

a. Wire Dispenser MX–306( )/G (fig. 46) is a cylindrical canvas and tape container that holds approximately ½ mile of Wire WD–1/TT. The wire of two or more dispensers may be pre-spliced in tandem when it is necessary to lay a wire line of more than ½ mile without stopping to make a splice. Figure 47 illustrates the method of splicing wires in dispensers for tandem operation.

Figure 46. Wire Dispenser MX-306A/G.

b. The dispenser has many useful features:

(1) It is portable (figs. 48 and 49).

(2) It will pay out wire at high speeds from land and amphibious vehicles, or from fixed-wing and rotary-wing aircraft.

(3) It will function at speeds up to 100 miles per hour.

(4) The wire will lie flat on the surface upon which it is laid without spirals or kinks.

c. No special mounting devices are necessary, if a single dispenser is used to lay wire. If several dispensers are connected in tandem, however, a means must be provided to support and aline the dispensers one behind the other. The wire within the dispensers, after connection in tandem, should be tested for continuity before laying the line. For more detailed information, refer to TM 11–2240.

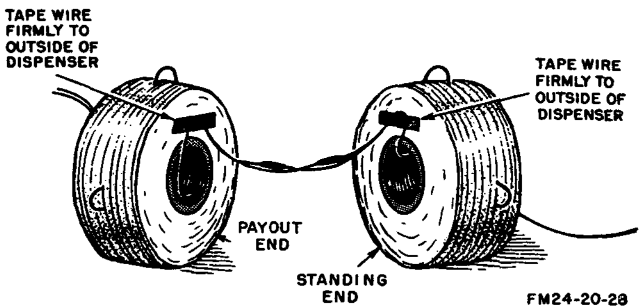

Figure 47. Wire Dispensers MX–306A/G, spliced for tandem operation.

Figure 48. Paying out field wire, using Wire Dispenser MX–306/G.

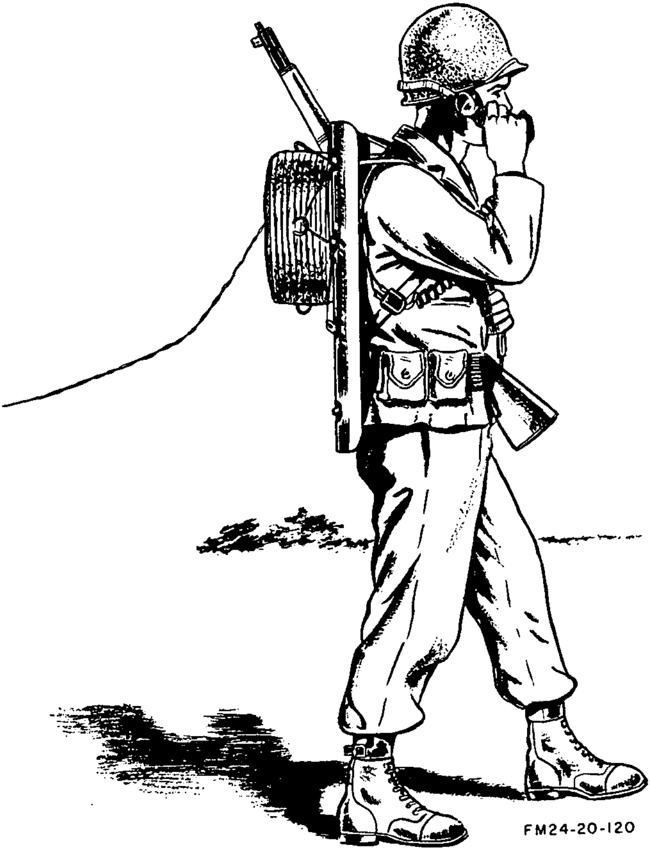

Figure 49. Paying out field wire, using Wire Dispenser MX–306A/G, on a packboard.

30. Axle RL–27–( )

Axle RL–27–( ) (fig. 50) is used to lay and recover field wire. The axle is a machine-steel bar (2½ feet long) used for mounting wire reels. The axle has two knurled handles, one of which is removable for mounting Wire Reel RL–159/U on the axle. The axle has roller bearings and is equipped with a removable crank for rewinding wire. The axle can be carried by two men (fig. 51) or placed on some improvised mounting (fig. 52).

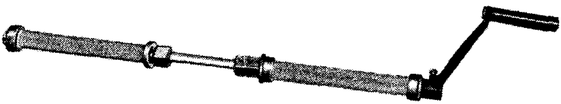

Figure 50. Axle RL–27–( ).

31. Reel Unit RL–31–( )

a. Reel Unit RL–31–( ) (fig. 53) is a lightweight, portable, folding A-frame of steel tubing used for paying-out and recovering field wire and field cable. The reel unit has the following features:

(1) A *brake unit* for controlling the speed of the reels during pay-out of the wire.
(2) A *crank* for reeling in wire on reels.
(3) A *carrying strap* for carrying the reel unit litter style.
(4) A *divided axle* for use when two reels are mounted on the reel unit. This axle allows either reel to operate independently of the other.

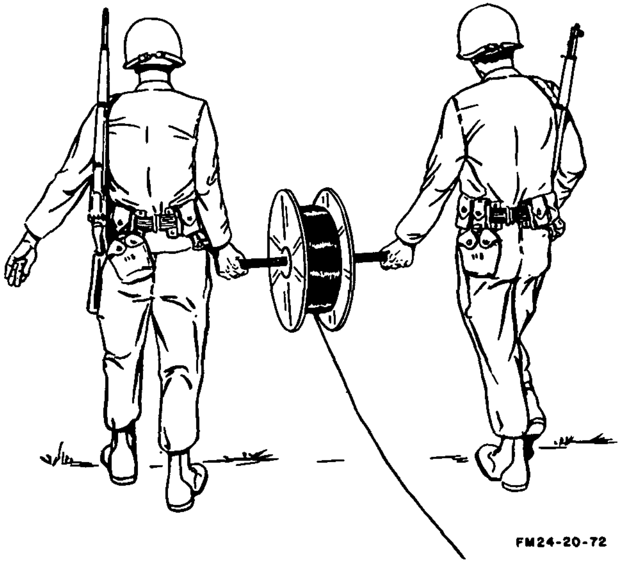

Figure 51. Method of laying field wire, using Axle RL–27–( ).

(When the divided axle is used, two cranks and two brakes are necessary for operation. They are issued with the equipment.)

b. The reel unit is capable of carrying a single Reel DR–5, DR–7, or DR–15; or two Wire Reels RL–159/U. (Reels DR–7 and DR–15 are used with field cables.)

c. Reel Unit RL–31–( ) can be set up on the ground or mounted on a vehicle (fig. 54). A special vehicular installation kit is available for mounting the reel unit in trucks.

d. For additional information, see TM 11–362.

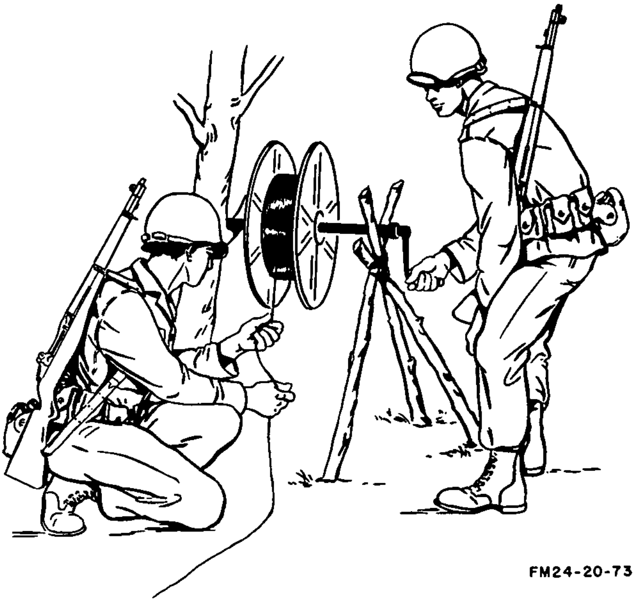

Figure 52. Method of recovering field wire, using Axle RL–27–( ).

32. Reel Equipment CE–11

a. Reel Equipment CE–11 (fig. 55) is a lightweight portable unit designed to be carried by one man. It consists of Reel Unit RL–39 and a sound-powered telephone handset. Reel Unit RL–39 mounts Spool DR–8( ) having a capacity of ¼ mile of Wire WD–1/TT (Spool DR–8 not included as a component). Figure 55 shows a Handset TS–10–( ); however, Telephone Set TA–1( )/PT can be used, if jumper wires are provided. If Telephone Set TA–1( )/PT is used, it is carried on the belt.

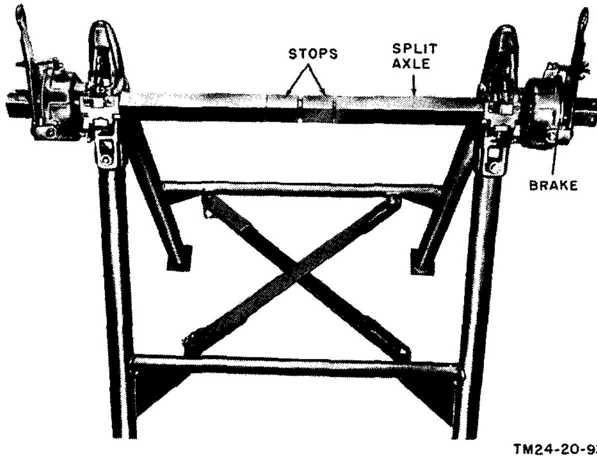

Figure 53. Reel Unit RL–31–( ).

b. The method of laying field wire is shown in figure 56. In forward areas, when it is necessary to crawl toward the objective, the spool can be pulled along the ground to unwind the wire.

c. The operator of the reel unit may, at any time, establish communication with the rear by connecting the sound-powered telephone to the terminals on the spool.

d. The handle attached to Reel Equipment CE–11 provides a means of recovering wire that has been payed out from the reel (fig. 57). Two adjustable, cotton-webbed straps support the reel unit during recovery of the wire.

e. For additional information, refer to TB SIG 314.

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Figure 54. Paying out field wire from Reel Unit RL-31-( ) mounted in truck.

Figure 55. Reel Equipment CE–11 with Spool DR–8.

33. Reeling Machine RL–172(   )/G

Reeling Machine RL–172(   )/G (fig. 58) which weighs approximately 100 pounds, is used to pay out and pick up field wire from Wire Reels RL–159(   )/U. The reeling machine is normally mounted vertically on the tailgate of a truck (fig. 59). It also may be operated horizontally from the bed of a truck.

a. The reel is driven by a 24-volt dc motor. Power for the motor is provided by the vehicle battery.

b. A handcrank is provided for manual operation.

c. The reeling machine is designed for one-man operation and is provided with controls for starting,

Figure 56. Laying wire with Reel Equipment CE–11.

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Figure 57. Recovering wire with Reel Equipment CE-11.

stopping, and reversing the direction of rotation of the reels.

d. Wire can be payed out or reeled in from either the back or the front of the reel. The speed of the reel can be controlled and varied from 0 to 300 revolutions per minute (rpm) by using the braking mechanism and varying the pressure on the control handle.

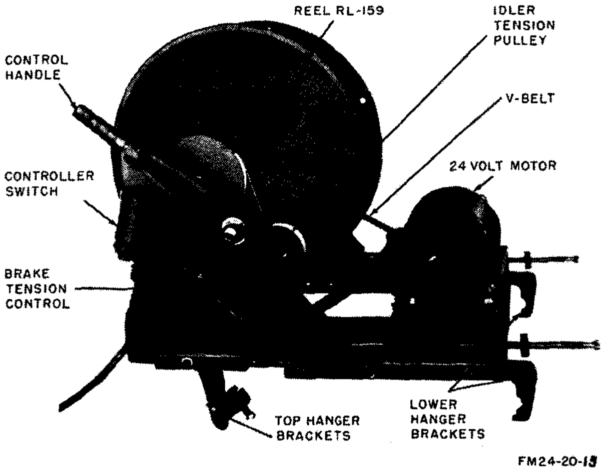

Figure 58. Reeling Machine RL–172( )/G, motor driven.

34. Reeling Machine RL–118/G

a. Reeling Machine RL–118/G (fig. 60) is a transportable wire-laying and wire-recovery gasoline-engine-driven unit. The unit is designed to be operated from a vehicle or on the ground.

b. When reeling in wire, the reeling mechanism may be operated under power or by means of a

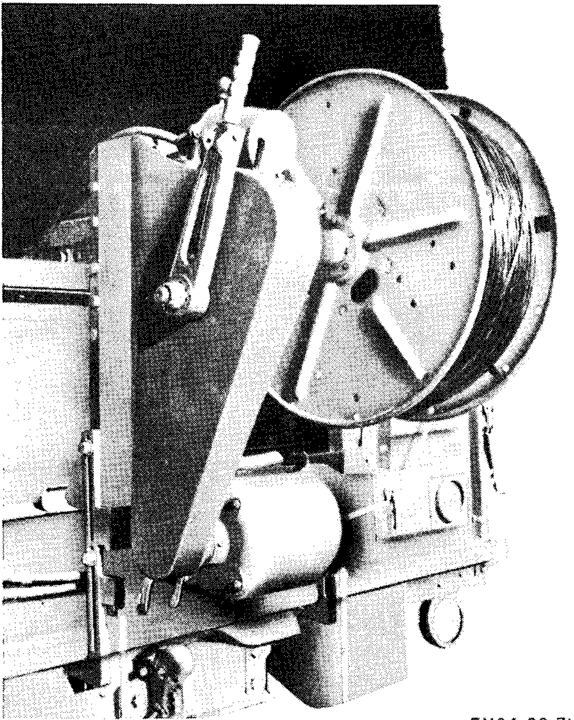

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Figure 59. Reeling Machine RL–172–( )/G, mounted on truck.

crank. When paying-out wire, the engine is not used. The speed of rotation of the wire reels is controlled by the brake mechanism.

c. Reeling Machine RL–118/G will accommodate the following reels:

2 Wire Reels RL–159/U.
1 Reel DR–5.
1 Reel DR–15–B (fig. 7).

d. For additional information, refer to SB 11–100–133.

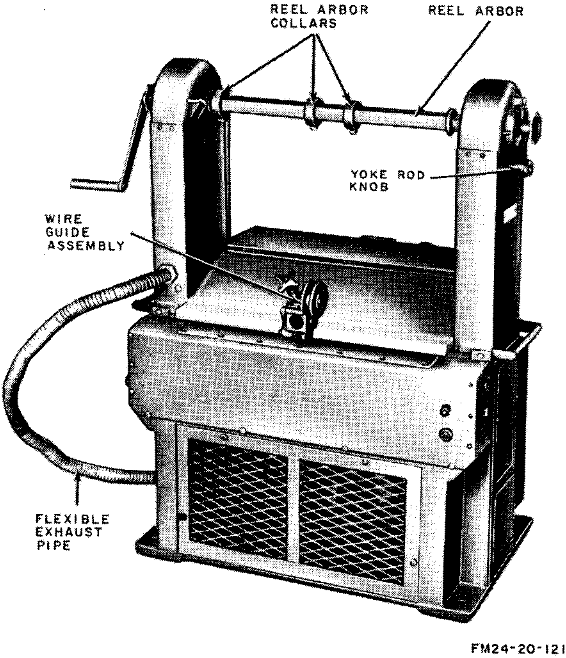

Figure 60. Reeling Machine RL–118/G.

35. Reel Unit RL–26–( )

a. Reel Unit RL–26–( ) (fig. 61) is a transportable, gasoline-engine-driven, wire-laying and wire-recovery machine. It is usually vehicular-mounted, but it can be operated on the ground.

(1) The reel unit has a capacity for two Reels

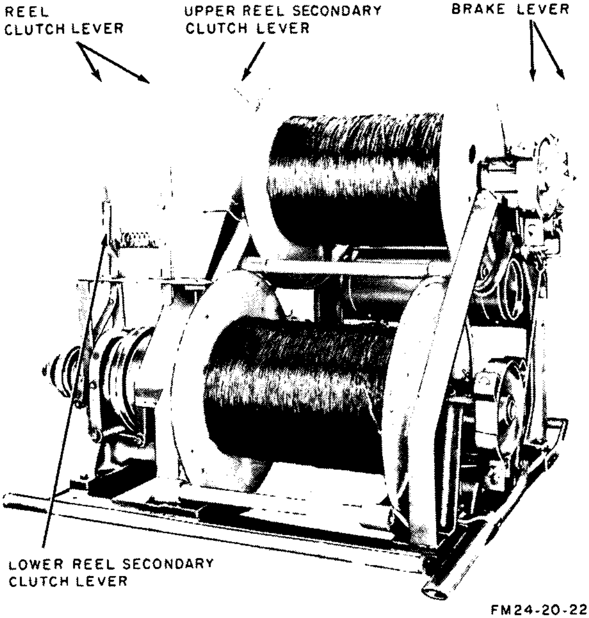

Figure 61. Reel Unit RL–26–( ).

DR–5, two Reels DR–15–( ), or four Wire Reels RL–159/U.

(2) The wire can be payed-out or recovered from any reel singly or from all reels simultaneously.

(3) Brakes are provided to prevent backlash.

(4) A gasoline engine provides power to operate the reel unit when recovering wire.

(5) The reel unit can be operated by a hand crank when necessary.

b. For complete details on the operation and maintenance of the unit, refer to TM 11–360.

36. Wire Pike MC–123

Wire Pike MC–123 (fig. 62) consists of a two-section pole, joined by metal fittings. The top section terminates in a hook, fitted with a roller. This hand tool is used by a wireman to lay or recover wire from a truck. During wire laying, it is used to place the payed-out field wire along the side of the road. For wire recovery, it is used to provide an even feed and guide the wire to the reeling machine.

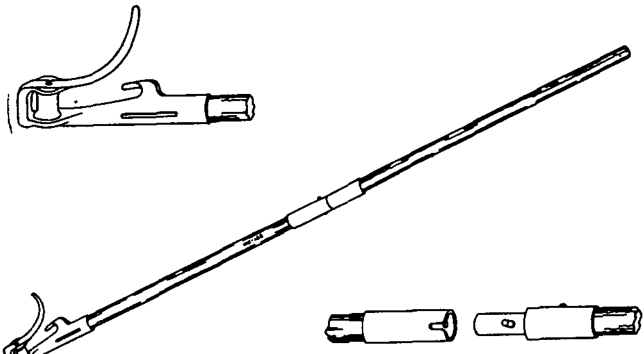

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Figure 62. Wire Pike MC–123.

CHAPTER 6

POLE AND TREE CLIMBING

Section I. CLIMBING EQUIPMENT

37. General

Climbing equipment (fig. 63) aids wiremen to climb poles or trees without pole steps or ladders, and permits the hands to be free for performing work while aloft.

38. Climbers LC–240/U

a. General. Climbers LC–240/U (fig. 64) are adjustable, lightweight, metal climbers. The

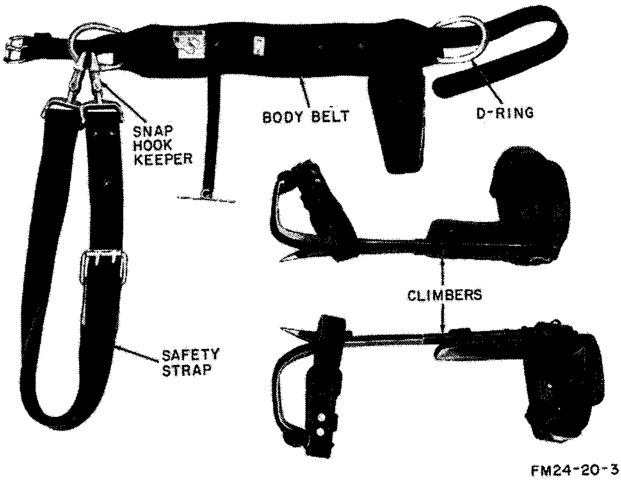

Figure 63. Climbing equipment.

length can be adjusted from 14¾ inches to 19½ inches to conform to different leg sizes. Climbers LC–240/U consist of two leg irons, 2-inch and 3-inch interchangeable gaffs, leather fastening straps, and climber pads. The 2-inch gaffs are used for climbing poles or trees with thin bark, and the 3-inch gaffs are used for climbing trees with thick bark.

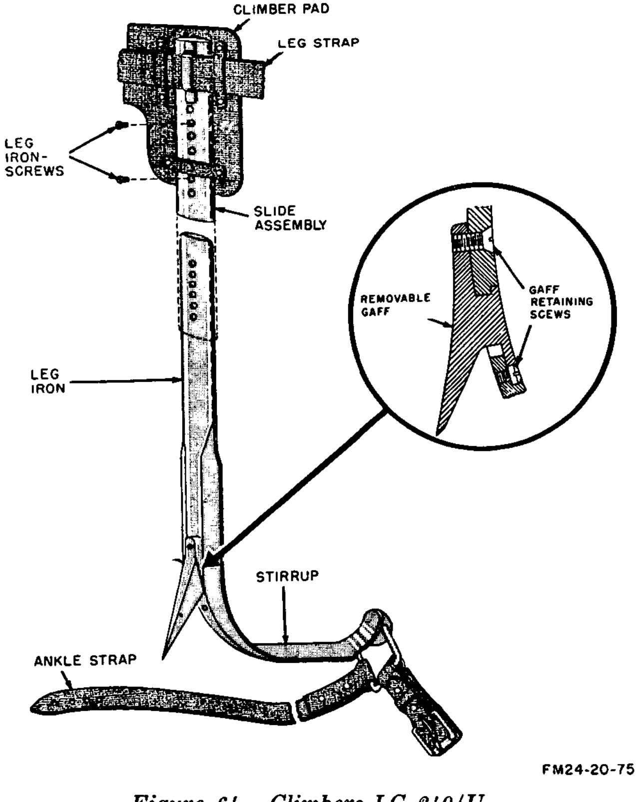

Figure 64. Climbers LC–240/U.

b. Adjustment. To adjust the leg irons, unscrew the two leg-iron screws and move the slide assembly on the leg iron to the desired length. Replace and tighten the two leg screws in the nearest screw holes.

c. Gaff Removal. Unscrew the two gaff retaining screws. Slide the gaff downward toward the stirrup and lift the gaff out of the retaining slot. Reverse these two steps to replace the gaffs.

d. Gaff Sharpening. At present, no gage is available to check the gaffs of Climbers LC–240/U. A new unused gaff, therefore, may be used as a guide when sharpening dull gaffs. (Gaffs should be sharpened only when replacement gaffs are not available.)

39. Climbers LC–241/U

Climbers LC–241/U are adjustable metal climbers designed primarily for use in arctic climates. The stirrup is made slightly wider to permit the use of arctic boots. The length of the leg irons are adjustable from 15½ to 18¾ inches.

40. Modified Climbers

a. General. Pole Climbers LC–243/G and Tree Climbers LC–244/G are adjustable from 14¾ inches to 19½ inches by changing the position of the metal sleeve.

b. Care of Climbers. The climbers should be examined for broken or loose gaffs, and for defective straps or pads. The gaffs should be sharp and have the proper dimensions. A gaff gage (fig.

65) must be used to measure gaff dimensions of modified climbers.

c. Use of Gaff Gage TL–144. The gaff climbers are checked as follows:

(1) *Thickness.* Insert the gaff, as far as possible, through the small opening marked TH with the inner surface of the gaff resting against the lined face of the gage (A, fig. 66). If the point of the gaff does not extend beyond the reference line, the thickness of this section of the gaff is satisfactory. Insert the gaff, as far as possible, through the large opening marked TH with the inner surface of the gaff resting against the lined face of the gage (B, fig. 66). If the point of the gaff does not extend beyond the far edge of the gage, the thickness of this section of the gaff is satisfactory. Gage TL–144 may be used to check either pole or tree climber gaffs. However, the length of tree climber gaffs must extend full length of gage, or beyond, to be satisfactory.

(2) *Width.* Insert the gaff, as far as possible, through the small slot marked W with the inner surface of the gaff resting against the lined face of the gage (C, fig. 66). If the point of the gaff does not extend beyond the long reference line, the width of this section of the gaff is satisfactory. Insert the gaff, as far as possible, through the large slot marked W with the inner surface of the gaff

toward the lined face of the gage (D, fig. 66). If the point of the gaff does not extend beyond the far edge of the gage, the width of this section of the gaff is satisfactory.

(3) *Length.* Place the lined face of the gaff gage against the inner surface of the gaff, with the nearest edge of the gage tight against the leg iron (E, fig. 66). If the point of the gaff extends to or beyond the short reference line, the length of the gaff is satisfactory.

(4) *Sharpening.* When sharpening a gaff, be sure to maintain the original shape as nearly as possible. Only the flat undersurface of the gaff should be filed when sharpening.

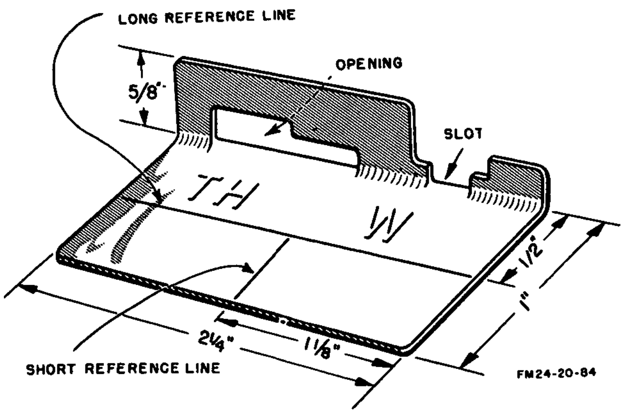

Figure 65. Gaff gage.

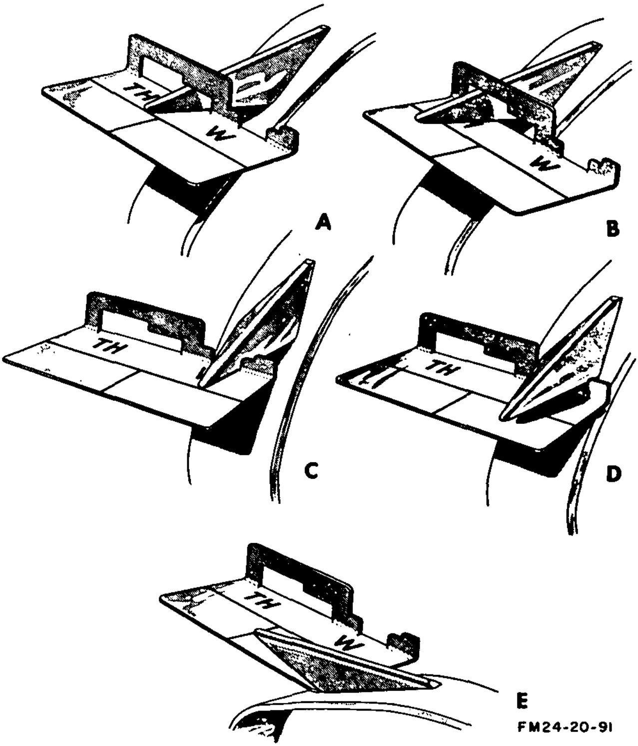

Figure 66. Checking gaff with gaff gage.

41. Lineman's Belt LC–23–(   )

a. General. Lineman's Belt LC–23–(   ) consists of a leather belt and an adjustable leather safety strap (fig. 63). The body belt is supplied in various sizes, according to the distance in inches between the D-rings. Safety straps are furnished in 61-, 68-, and 70-inch lengths.

b. Care of Leather. Keep the leather clean, soft, and pliable by using either saddle soap or lather from a neutral soap (such as castile). This removes embedded dirt and perspiration that rots the leather. Wipe the leather dry. Do not use mineral oil or grease, and do not stand near an open flame while wearing leather equipment. Clean and dress the leather parts frequently if they become wet or if they come in contact with paint. Always remove paint as soon as possible. Examine the leather for cracks and pliability as follows:

(1) *Safety straps.* With the smooth side (grain side) out, bend the straps over a round object not less than three-fourths of an inch in diameter. Make the test in at least three places (near both ends and in the middle of the strap). Slight cracks will normally appear on the surface.

(2) *Body belts.* Bend the belts at any points that can be bent without great effort (such as under the leather tool loop and tongue strap). Do not bend belts over too small an object, because this can cause damaging cracks. Always keep the grain side of the belt on top when bending the leather.

***Caution:* If large cracks appear in the leather, the straps should be discarded as unsafe.**

42. Wearing Climbing Equipment

a. Climbers. The climbers should be adjusted to a length that is generally ½ inch less than the distance from the underside of the shoe at the arch of the foot to the small bone projecting from the lower inner side of the kneecap. Straps should be fastened snugly around the calf and ankle.

b. Body Belt and Safety Strap. On a correctly fitted body belt, the D-rings are just behind the projecting portions of the wearer's hipbones. The body belt is worn over the hips; it should be loose, but it should be tight enough to prevent slipping (figs. 67 and 68). If the wearer is right-handed, both ends of the safety strap are snapped to the left-hand D-rings; if left-handed, the ends are snapped to the right-hand rings. The double end of the strap is snapped to the D-ring with the keeper toward the rear, and is kept hooked at all times. The other end of the strap is snapped on the D-ring, with the keeper toward the front and above the snap hook of the double end. Before climbing a pole, always adjust the length of the safety strap. To do this, engage the gaffs of the climbers near the base of the pole. Pass the safety strap around the pole, and fasten the strap to the D-ring. Carefully lean back until the body is supported by the safety strap. When the safety strap is adjusted properly, the palms of the hands should rest on the far side of the pole without any overlapping of the fingers.

c. Precautions.

(1) *On ground.* Be careful at all times when wearing climbers; gaffs can cause serious

Figure 67. Wearing climbing equipment, front view.

wounds. When wearing climbers, be careful not to step on your feet or the feet of others. *Wear climbers only while climbing and working on poles or trees.* The habit of wearing climbers while working on the ground or riding in a vehicle frequently results in serious injury.

(2) *Aloft.* While aloft on a pole or tree, always use the safety strap to minimize the danger of falling and to allow you to work with minimum fatigue. Be careful not to drop tools or other equipment.

(3) *Before climbing.* Beginners should practice fastening and unfastening the safety strap close to the ground until they perform this step speedily, safely, and with precision.

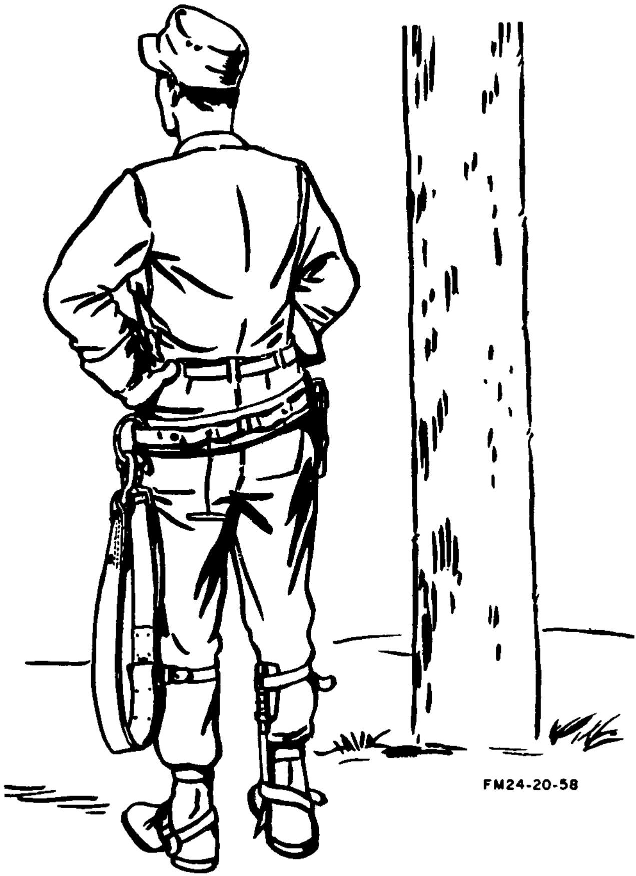

Figure 68. Wearing climbing equipment, rear view.

Section II. POLE CLIMBING

43. Safeguards

a. Poles that have been in service for long periods of time might be defective, and could break under the weight of a lineman climbing or working aloft. Always inspect or test the pole before climbing. Rig temporary supports if you suspect that a pole is defective. Generally, a well-guyed pole may be climbed without testing. However, take no chances—test it before climbing.

b. The soundness of a pole can be tested by gently rocking the pole back and forth in a direction at right angles to the lines. Do not rock the pole if there is a chance that the pole will cause damage if it should fall. Rocking can be done with pike poles. A defective pole will crack or break.

c. The pole can also be tested for soundness by jabbing the butt at a point several inches below the ground line with a screw driver or pick. This test will reveal rotten wood, if the pole has begun to decay at that point.

d. When working in the vicinity of powerlines, follow all rules relating to powerline clearances (par. 64*c*). Always assume that any metallic portion of the powerline is alive with dangerous voltage. Do not rock a telephone pole to make a soundness test if there is a possibility that the swaying telephone wires will contact the powerline.

44. Preliminary Instructions

In the following instructions, it is assumed that the wireman is right-handed. A left-handed person would perform the operations with the opposite hand and leg.

a. When climbing a pole, keep the arms slightly bent, with the hips away from the pole.

b. To engage the gaffs, whether ascending or descending, thrust the legs sharply inward and downward. To disengage the gaffs, move the legs sharply upward and outward.

c. Place the hands on the far side of the pole, but do not have the hands overlap. Placing the hands on the sides of the pole will cause unnecessary strain on the arms. Remember that the weight of the body is carried entirely on the gaffs —the arms merely help to balance the climber.

d. Keep the body away from the pole. If the hips are too close to the pole, the legs will not angle inward. This could cause gaffs to cut out (loss of footing). If the hips are too far out, the arms are placed under the strain of supporting a large portion of the climber's weight. If the knees touch the pole, the gaffs will probably cut out. Keep the toes pointing upward.

45. Ascending

a. Before climbing, circle the pole and inspect it for soundness; also note the location of wide weather cracks and soft or hard spots in the wood. Look for any cables, crossarms, or other obstruction that may interfere with climbing. If the pole leans, face the direction in which the pole is leaning and climb on the high side.

b. Grasp the pole and raise the left foot about 10 inches from the pole. With a downward thrust,

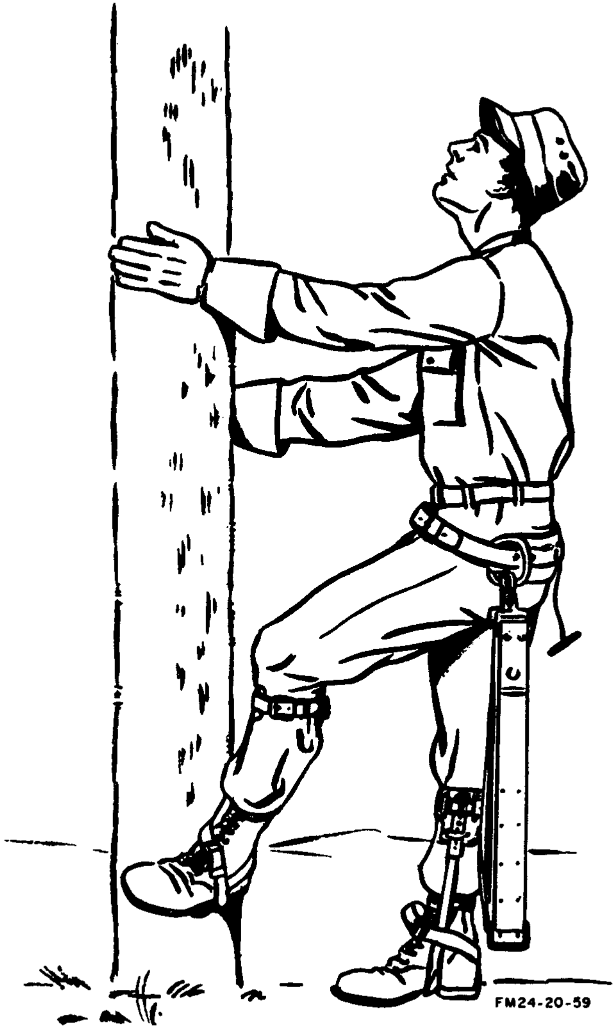

Figure 69. Beginning the climb.

jab the gaff of the climber into the face of the pole at a point about 8 inches from the ground (fig. 69).

c. Lift the weight of the body on the gaff by straightening the leg. While the weight of the body is on one leg, keep the knee straight and away from the pole. Raise the other leg and corresponding arm and drive the gaff downward and inward to seat it firmly (fig. 70).

d. The gaff is disengaged by a sharp upward and outward motion of the leg. When taking the next step, raise the left leg and left arm (or right leg and right arm) together. The body should not sway excessively.

e. Reengage the free gaff firmly and continue climbing to the desired height. While ascending, always look up and avoid any possible obstructions.

f. Whether ascending or descending, the gaffs should travel in a path on the face of the pole (approximately 4½ inches apart). This may vary slightly, depending on the size of the climber.

46. Fastening Safety Strap

To fasten the safety strap when the desired height on the pole has been reached, proceed as follows:

a. Shift the weight to the left foot and engage the right gaff at a slightly higher level than the left gaff.

b. Place the right hand around the pole (fig. 71). With the thumb of the left hand, open the keeper on the snap hook and shift the end of the safety strap around the pole to the right hand.

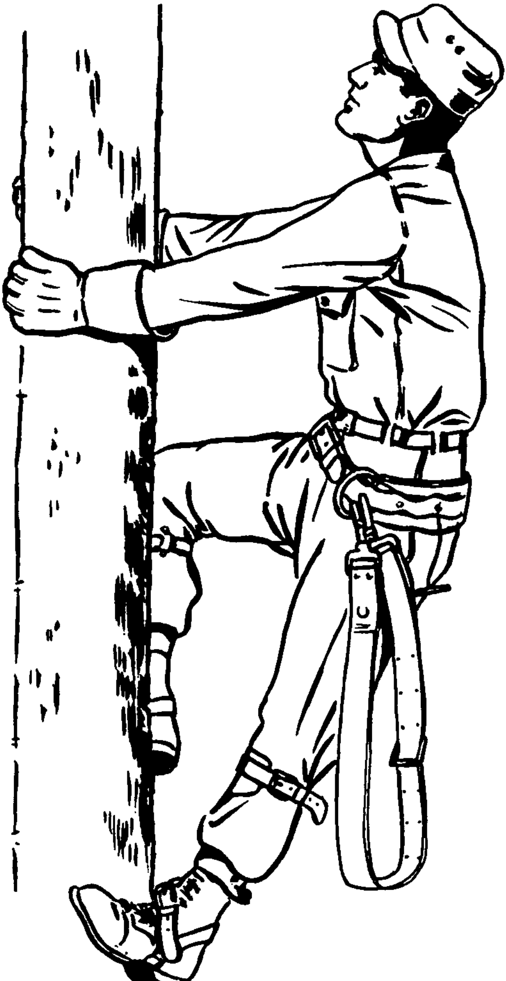

Figure 70. Climbing.

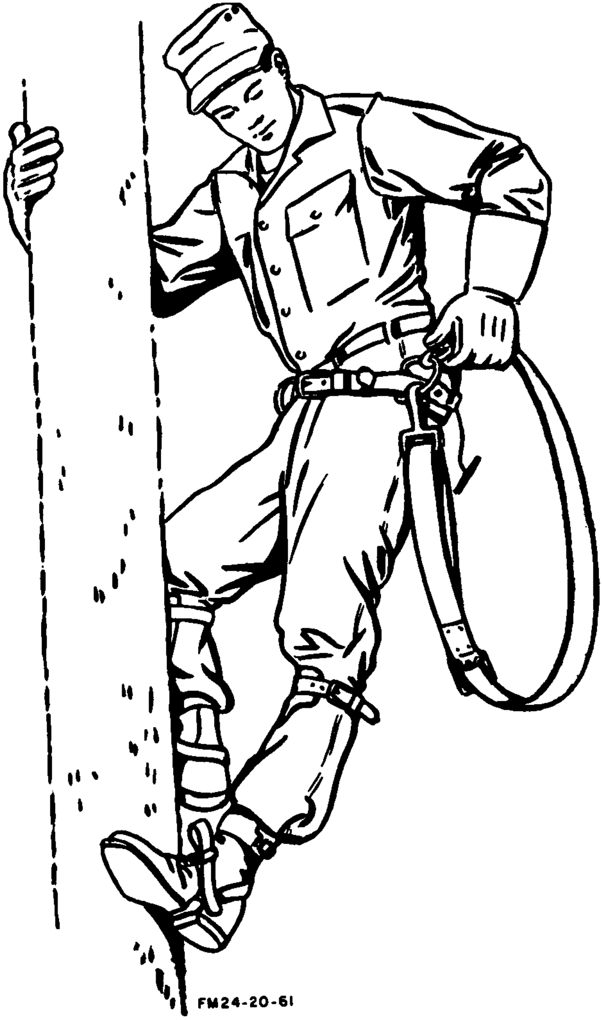

Figure 71. Unhooking safety strap.

Figure 72. Transferring safety strap.

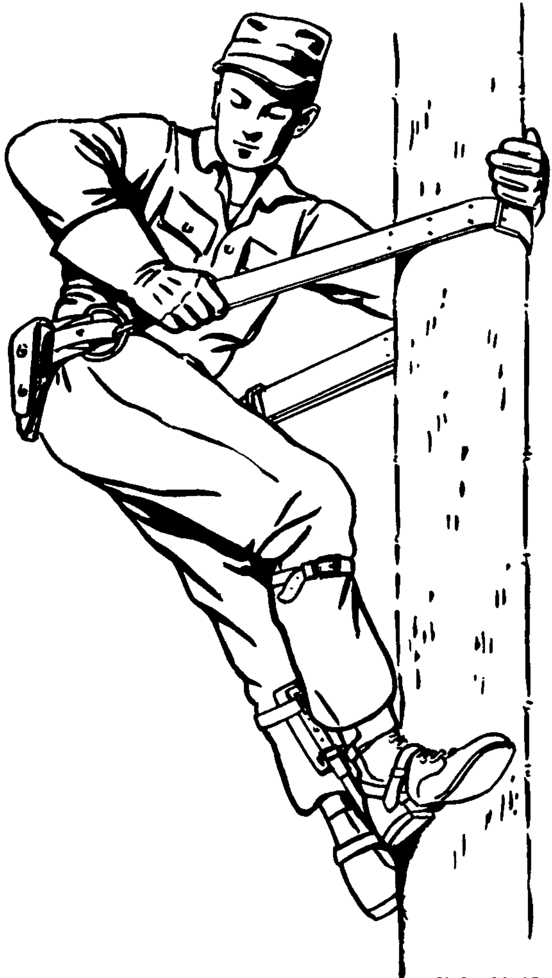

Figure 73. Snapping hook on D-ring.

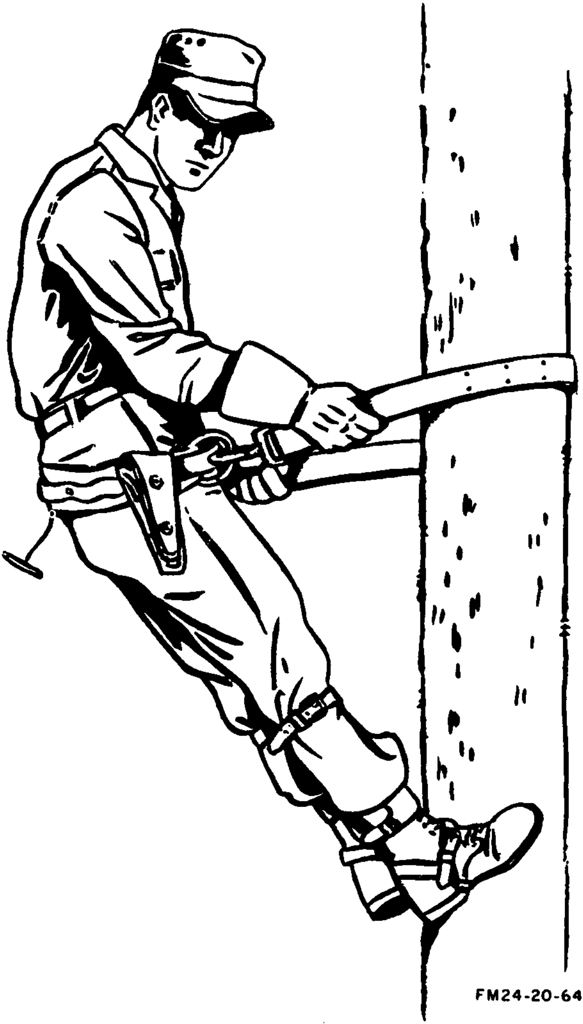

Figure 74. Setting into working position.

c. Transfer the snaphook and strap to the right hand (fig. 72), while balancing the body with the left hand.

d. Loosely support the strap on the pole, and with the right hand pull the strap around the right-hand D-ring. Snap the hook on the D-ring with the heel of the right hand (fig. 73).

Warning: **It is essential to *see* that the snaphook is properly engaged. *Do not assume,* merely from the snapping noise of the keeper, that the D-ring has been engaged by the snaphook.**

e. Lean back, carefully placing the full weight of the body on the safety strap, adjust body position and feet to take up a comfortable working position (fig. 74).

47. Working Aloft

a. When working aloft on a pole, the safety strap is never placed within 12 inches of the top of the pole or above the top crossarm. To reach the outer right insulator (fig. 75), hook the safety strap below the crossarm. Place the right foot slightly lower and to the side of the pole. Straighten the right knee. Lean out and slip your head and shoulders between the conductors. To reach the outer left insulator, reverse the procedure. (Frequently, the length of the safety strap must be adjusted to allow the climber to reach the end of a long crossarm. If this is the case, adjust the safety strap before ascending.)

b. When circling a pole to the right, thrust the right gaff slightly lower and to the right side of the pole. (Take small steps.) Stiffen the knee, and shift the body to the right, disengage the left gaff, and thrust close to and slightly higher than the right foot. A slight twist of the hips will equalize the length of the safety strap. Continue in this manner until the desired position is reached. To circle left, reverse the above procedure. (Practice circling the pole close to the ground until confidence and efficiency are gained.)

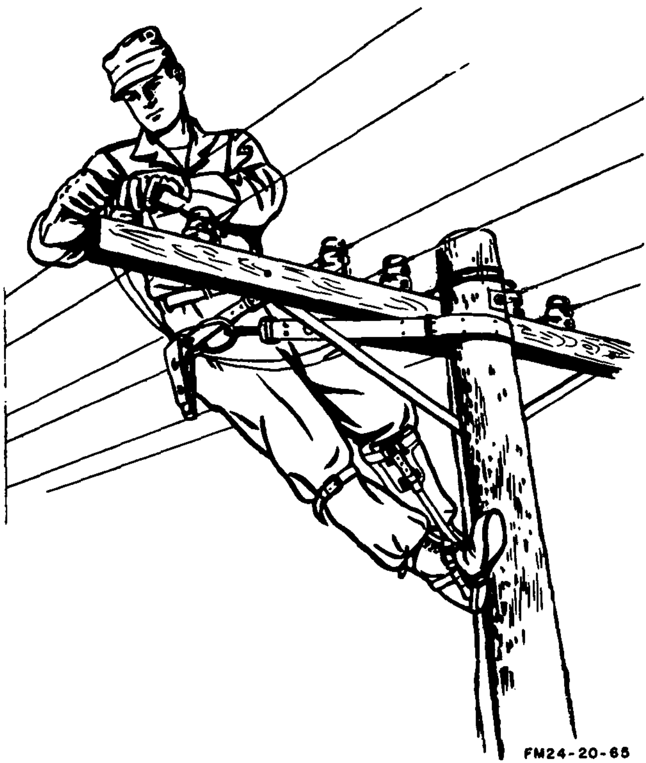

Figure 75. Lineman working on outer insulator of cross arm.

48. Unfastening Safety Strap

To unfasten the strap, reverse the procedure described in paragraph 47.

a. Move the right gaff up, and reengage it at a slightly higher level than the left gaff. Grasp the pole with the left hand. With the right elbow up, the hand twisted, and the thumb held downward, press the keeper and disengage the snaphook from the right-hand D-ring.

b. Pass the strap around the pole to the left hand, balancing the body with the right hand. Snap the hook to the left-hand D-ring with a single downward movement.

49. Descending

Descend the pole as follows: Take a small step up with the right foot, unsnap the safety strap, and reconnect it to the left D-ring. Disengage the right gaff. Stiffen the right leg, keep the toes pointing upward, take a long downward and inward step, and drive the gaff into the pole. The right knee should now be approximately opposite the left heel. Disengage the left gaff and, in the same manner, take a downward step with the left leg. The right arm is moved with the right leg, and the left arm is moved with the left leg whether ascending or descending. Continue to descend, looking down to avoid any obstructions or defects on the pole.

Section III. TREE CLIMBING

50. Safeguards

Before climbing trees, remove all dead wood, branches, or any other material at the base of the tree that may hinder or cause injury to the climber. Inspect the firmness and thickness of the bark. Remove all twigs and small branches in the way of the climber. Guard the eyes and face when working in trees. Do not stand on limbs that are not strong. Avoid touching any poisonous plants.

51. Methods

a. To climb trees, use climbers fitted with tree gaffs, and proceed as described in paragraphs 43 through 49.

b. Trees that have large diameters generally are more difficult to climb than smaller trees, and usually require some variation in the method of climbing. The safety strap is normally long enough for trees with diameters up to 24 inches. When climbing larger trees, it may be necessary to substitute a rope for the safety strap. Two safety straps may be linked together, if the combined length is sufficient to pass around the tree trunk.

Section IV. FIRST AID

52. General

First aid is the immediate and temporary care given to the victim of an accident or illness, before treatment can be administered by trained medical personnel. Since the field wireman is subject to many hazards, and his work is performed in areas where medical personnel are not available, it is important for him to be well trained in first aid procedures.

53. General First Aid Procedures

When a field wireman has been injured, the person applying first aid must properly diagnose the injury and apply proper first aid procedures. The application of improper first aid procedures may do more damage to the victim than the injury. Some of the general first aid procedures are listed below:

a. Place the victim in a prone position, head level with the body, until treatment requires movement.

b. Check for hemorrhage, stoppage of breathing, wounds, burns, fractures, dislocations, and other injuries. If clothing must be removed, cut it away; do not remove the injured person.

c. Provide immediate treatment for serious bleeding, stoppage of breathing, and poisoning, in that order.

d. Determine which victims have injuries that require immediate attention and treat them first.

e. Keep the victim warm, and treat for shock.

f. Call a medical officer or an ambulance. Give the medical officer the following information: the location of the victim; the nature, cause, and probable extent of injury; available supplies, and the type of first aid being given.

g. Keep calm. Unless it is absolutely necessary, do not hurry while moving the injured person.

h. Provide only necessary first aid, and be sure that nothing is done to cause further injury.

i. Never give liquids to an unconscious person.

j. Keep onlookers away from the injured person.

k. Make the victim comfortable, and keep him cheerful.

l. Do not let the victim see his injury.

54. First Aid for Electrical Shock

In an electrical shock accident, quick rescue and application of artificial respiration are extremely important. If an unconscious person is in contact with a wire, and it is not definitely known that the wire has been deenergized, assume that the wire is live. This is a dangerous situation, since a live wire can send electric current through the body of the victim to the rescuer. Exercise extreme caution to insure that the live wire does not come in contact with the rescuer. Consider quickly but carefully the steps to be carried out in the rescue.

a. Wear rubber gloves, and, if possible, rubber footwear in all rescue work involving electric shock.

b. Pull the wire clear of the victim with a dry rope, or push it clear with a dry tree pruner handle, board, or ladder.

c. Use a tree pruner handle equipped with a wire cutter head or a pair of pliers to cut the wire on both sides of the victim.

d. Treat for shock, and, if the victim is not breathing, apply artificial respiration.

55. First Aid for Shock

Every injured person is potentially in shock, since shock usually occurs whenever there is severe injury of any part of the body. Start treatment for shock immediately; do not wait for symptoms to develop. Shock is easier to prevent than to cure.

a. Shock is caused primarily by the reduction of blood circulation and a resultant decrease in blood pressure. The symptoms of shock are—

(1) A fast but weak pulse.
(2) A cold and clammy body surface.
(3) Rapid and shallow breathing.
(4) Weakness, faintness, dizziness, or nausea.
(5) Wide and dilated eye pupils.

b. In treating a victim in a state of shock, proceed as follows:

(1) Conserve the victim's body heat. Place blankets or clothing underneath as well as on top of the victim.
(2) Remove cold or wet clothing. However, do not expose the victim unnecessarily.
(3) Keep the victim comfortably warm, but do not apply excessive heat.
(4) Keep the victim's head lower than his feet, unless he has a chest injury.
(5) Give small amounts of hot coffee, tea, or broth to conscious victims who are not nauseated or vomiting.

(6) Do not disturb the victim by handling him unnecessarily.

56. First Aid for Wounds

A wound is a break in the skin or in the mucous membrane; it is subject to two primary dangers: serious bleeding and infection. Treatment of a wound depends primarily upon whether or not the bleeding is serious. When bleeding is severe, stop it as rapidly as possible. Proceed as follows:

a. Place a thick layer of gauze or a clean folded handkerchief against the bleeding point, and apply firm pressure with your hand.

b. After 15 minutes, release the pressure. If the bleeding stops, apply a bandage over the gauze. If the bleeding continues, apply hand pressure for 15 minutes and then test again for bleeding.

c. Elevate the injured part, if possible.

d. If the bleeding is not controlled in this manner, apply hand pressure at a pressure point or use a tourniquet.

e. After the bleeding is controlled, treat the victim for shock.

57. Use of Artificial Respiration

Apply artificial respiration to victims of electric shock, carbon monoxide poisoning, drowning, and other accidents where breathing has stopped. Begin artificial respiration immediately, and *continue* until the victim starts breathing, or the medical officer pronounces him dead. In many cases, persons presumed dead have started breathing after 3 hours of continuous artificial respiration. The most effective method of artificial respiration, at the present time, is the *back-pressure arm-lift method of artificial respiration.*

a. Place the victim in a prone position, face down (fig. 76). Bend his elbows and place his hands one upon the other. Turn his face to one side, placing his cheek upon his hands.

b. For the *compression phase,* kneel on either the right or left knee at the side of the victim's head, close to his forearm. Place the opposite foot near his elbow. If it is more comfortable, kneel on both knees, one on either side of the victim's head. Place your hands upon the flat of the victim's back, so that the heels of the palms lie just below a line running between the victim's armpits. With the tips of the thumbs just touching, spread your fingers downward and outward (A and B, fig. 76).

c. Rock forward until your arms are approximately vertical, and allow the weight of the upper part of your body to exert a slow, steady, even pressure downward upon the victim's back (C, fig. 76). This forces the air out of the victim's lungs. Keep your elbows straight and the pressure exerted almost directly downward on the victim's back.

d. Release the pressure, avoiding a final downward thrust, and start to rock slowly backward. Place your hands on the victim's arm just above his elbows (D, fig. 76).

e. Begin the *expansion phase* by drawing the victim's arms upward and toward you. Apply

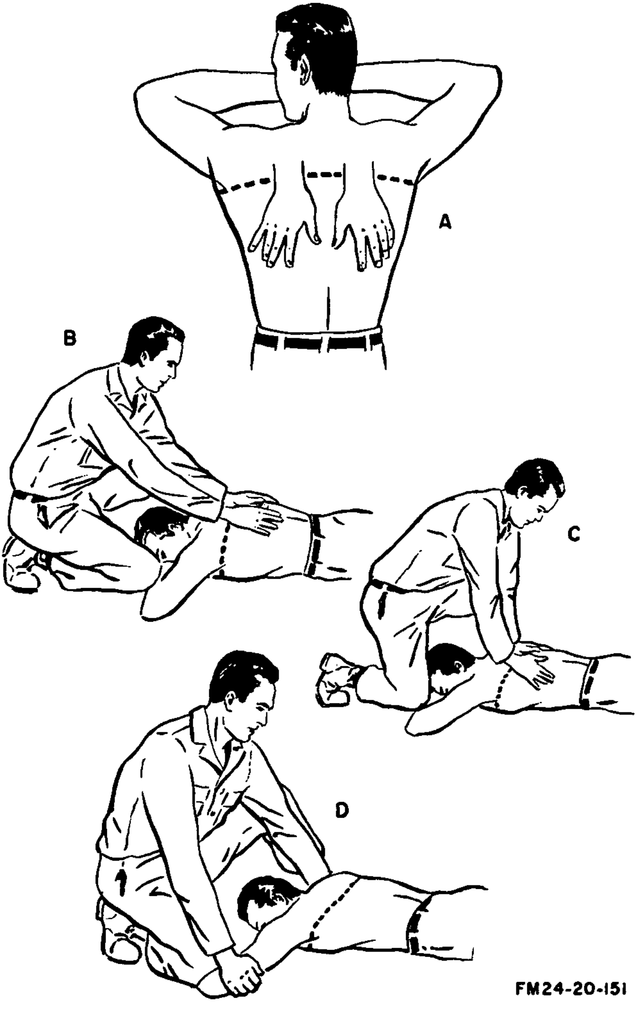

Figure 76. Artificial respiration

just enough lift to feel resistance and tension in his shoulders (do not bend your elbows as you rock backward). Then, lower his arms to the ground.

f. The procedures in *a* through *e* above represent 1 full cycle. Repeat this cycle 12 times per minute at a steady, uniform rate. The compression and expansion phases should occupy about equal time, with the release periods of minimum duration.

g. If the victim regains consciousness before a doctor arrives, give him a stimulant, such as hot coffee or tea. Do not give the victim liquids if he is nauseous or unconscious.

h. Treat the victim for shock.

58. First Aid for Simple and Compound Fractures

a. *Simple Fractures*. In a simple fracture, the bone is broken but does not protrude through the skin. Improper handling of simple fractures may cause them to become compound fractures. Give first aid for the simple fracture in the following manner:

(1) Consult a medical officer immediately.

(2) Do not move the injured person until some sort of splint is applied to immobilize the fractured bone ends and the adjacent joints.

(3) Control shock by keeping the victim in a comfortable prone position. Keep the patient warm.

b. Compound Fractures. Compound fractures are accompanied by the same symptoms as simple fractures. In addition, the bone may protrude through the skin. They are usually much more serious than simple fractures, because of the danger of infection and the damage done to tissue around the bone. Care for a compound fracture in the following manner:

(1) Consult a medical officer immediately.

(2) Check arterial bleeding by applying hand pressure at a pressure point, and apply tourniquet.

(3) Apply a sterile dressing to the wound, and bind it in place.

(4) Treat as for simple fracture. Do not try to restore the bones to normal position.

CHAPTER 7

FIELD WIRE LINE CONSTRUCTION

Section I. INTRODUCTION

59. General

The construction of field wire lines requires planning prior to the actual installation. When planning, consideration should be given the following:

a. The availability of material.

b. The number and type of circuits required.

c. The length of the line.

d. Time permitted for the installation.

60. Types of Construction

When the circuit requirements have been determined, consideration must be given to the type of construction required. This can be aerial, surface, or underground construction, or a combination of all of these.

a. Aerial Construction. An overhead line generally provides the most satisfactory type of service. Aerial construction is easiest to maintain, and provides better quality circuits than surface construction. However, aerial construction has some disadvantages; it requires more time for installation, is vulnerable to enemy action, and is subject to the effects of storms and weather.

b. Surface Construction. Wire lines laid on the ground require a minimum of time and material for installation. However, they are extremely vulnerable to foot troops and vehicles. Surface lines laid rapidly, and not properly installed, usually require immediate and continuous maintenance. Carefully installed surface wire lines provide reliable circuits that are suitable for most combat operations.

c. Underground Construction. Underground construction is rarely used in forward areas. However, it may be necessary at times to bury wire lines to protect the lines from troops and vehicles. In addition, buried wire lines are more stable electrically than aerial or surface lines, and are rarely affected by weather and temperature. They are less affected by nuclear detonations and on the preferred type of construction when the situation permits. Buried wire lines have the following disadvantages:

(1) More time is required for installation.

(2) They are more difficult to maintain and recover.

(3) The wire is generally damaged during recovery and is not reusable.

61. Selection of Routes for Wire Lines

The route for wire lines is selected on the basis of a map study supplemented by ground reconnaissance.

a. Topographical maps and aerial photographs can be used to select several possible routes. In addition, they will show routes to be avoided because of difficult terrain, such as forests, rivers, swamps, towns, sudden changes in elevation, and very rocky areas.

b. Several routes should be planned from a map survey, and the final selection should be made after ground reconnaissance. During this ground reconnaissance:

(1) Determine the type of construction needed.

(2) Select cross-country routes or secondary roads, when possible.

(3) Select a line route that provides concealment and cover from observation and hostile fire.

Section II. TECHNIQUES OF INSTALLING FIELD WIRE LINES

62. General

a. During reconnaissance (par. 61) of the available routes, the following should be noted:

(1) Number of overhead crossings.

(2) Number of underground crossings.

(3) Number of railroad crossings.

(4) Number of streams or river crossings.

(5) Type of terrain.

(6) Type of construction best adapted to available wire-laying equipment.

(7) Distances in miles.

(8) Concealment for wire parties during construction and maintenance.

(9) Obstacles to maintenance, such as small arms fire.

b. The next procedure is to select and clearly mark on a map the exact route along which the wire is to be laid. Select a route that meets the requirements of the tactical situation and is the least difficult for construction and maintenance of a wire line.

c. The next step is to test and service field wire before placing it in use. Electrically check for opens and shorts; visually check for faulty insulation and poor splices.

63. Construction Ground Surface Lines

a. While units are on the move in combat, field wire lines are usually laid on the ground. Surface lines must be protected against damage from both foot and vehicular traffic. This is particularly true where the wire lines cross traffic lanes at command posts, road and railroad crossings, etc.

(1) Lay surface lines loosely, leaving slack, where necessary, along the line. Sufficient slack allows the line to lie on the ground, and facilitates maintenance and construction changes.

(2) At suitable intervals, tie the surface lines to trees, posts, or stakes at ground level (fig. 77). This procedure reduces the possibility of damage from passing troops and vehicles.

(3) When surface lines are laid along a road, keep the wires well off the traffic lanes.

(4) Often, due to urgency, wire lines are hastily laid. However, installation is not

complete until a thorough policing of each circuit has been accomplished.

(5) When laying wire, always take precautions against mines and booby traps.

b. Tie the wire lines to some fixed object at the beginning and at terminating points of the line. Leave sufficient slack at these points to provide lead-in wire to reach the switchboard at the command post or terminal strips in the construction center.

c. Test wire lines before and after a new reel is spliced onto the line. Perform an operational test after the line is connected to the terminal equipment.

d. Tag all wire lines as described in paragraph 71.

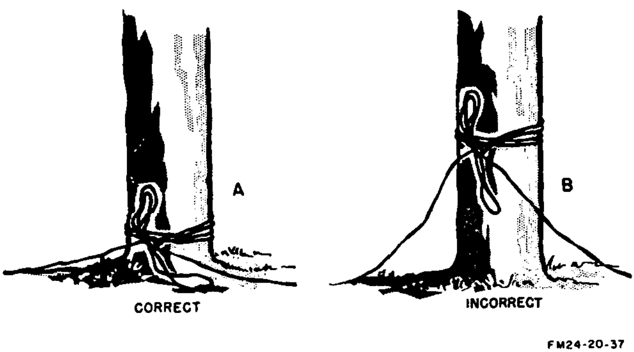

Figure 77. Tying surface lines on trees or posts.

64. Overhead Construction

a. General. Field wire lines should be placed overhead at command posts, at congested troop areas, along roadways at points where traffic is likely to be diverted from the road, and at main and secondary road crossings. Overhead crossings constructed across rivers, streams, and valleys that are in the flight pattern or air routes for rotary-wing aircraft will be marked by white streamers spaced across the span. Overhead spans near heliports will be similarly marked.

b. Ties. In overhead construction, wire lines must be tied securely at both ends of the overhead span. The type of tie used depends on the span length and local climatic conditions. Ties are made at the top and bottom of the support, as shown in figure 78. Wire lines should be tagged above the tie at the bottom of the support.

c. Sag in Line. Sag in the line is an important factor in the construction of overhead lines. The wireman can meet the minimum sag requirements for overhead spans by pulling the wire as tight as he can, using his arm strength alone. A good rule of thumb is 6 inches of sag for every 25 feet of span length. When placing sag in the lines, it is necessary to maintain a minimum road clearance of 18 feet across all roads.

d. Power and Light Distribution Poles. When power distribution poles are used for supports in overhead construction, the field wire lines must be tied *4 to 6 feet below* the power lines, depending on the voltage of the lines. These clearances are required to prevent inductive hum on the line and as a safety precaution for the construction crew.

Caution: **All electric light and power wires must be considered to be carrying dangerous**

voltage. Do not tie field wire lines to transformer cases, electric light brackets, or power cross arms. Be extremely careful when working near power lines. Observe all safety precautions, and follow safe construction practices.

e. Open-Wire Pole Line. When field wire lines are tied to the poles of open-wire lines, they should be tied at least 2 feet below the open-wire conductors. This clearance minimizes the possibility of inductive interference or contact between the field wire and open-wire circuits.

65. Lance Pole Construction for Overhead Spans

a. General. When poles, trees, or other supports are not available, Lance Poles PO–2 provide a convenient method of supporting overhead lines. These wooden poles, which are 14 feet long and 2 inches in diameter, are tapered at the bottom. An insulator pin, threaded for Insulator IN–12 or IN–15, is attached to the top of the pole.

b. Lance Pole Construction at Roads. A wire line crossing a road must have an 18-foot clearance (fig. 79). Since the lance pole is only 14 feet, the additional length is obtained by lashing two poles together. When additional strength is required, two lance poles are lashed together at the base (fig. 80). Lash the poles with field wire, overlapping the poles at least 5 feet. This type of construction can support up to 10 field wire lines for short spans such as road crossings.

c. Erecting and Guying Overhead Span. An overhead span supported by lance poles must be

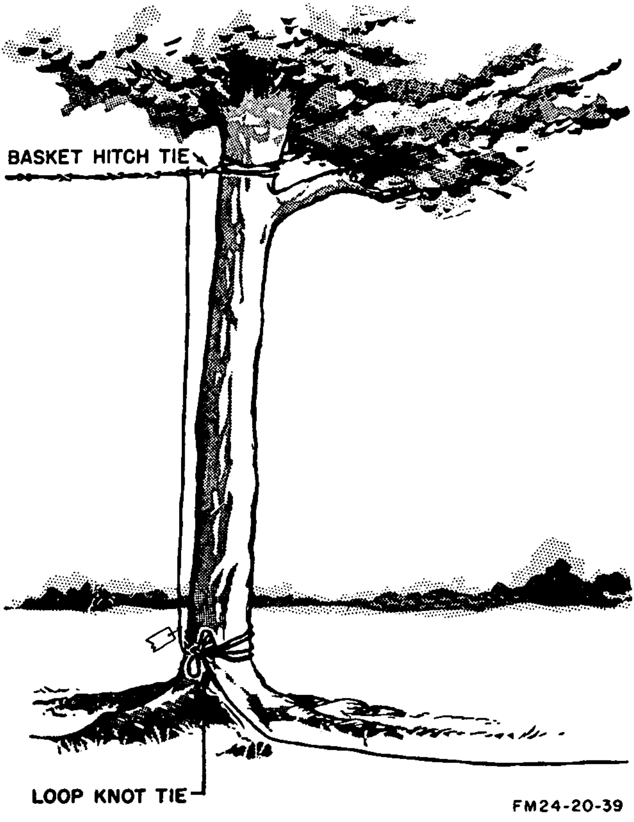

Figure 78. Method of tying wire lines at bottom and top support.

securely guyed. To correct and guy an overhead span, proceed as follows:

(1) Lash the lance poles together (*b* above) and lay the poles on the ground parallel to the road.

(2) Tie the line wire to the insulator on the lance pole (use clove hitch tie).

(3) Tie one end of each guy wire near the top of the lance pole. (Field wire is suitable for guy wires.)

(4) Raise the lance poles, and line into position.

(5) Tie the guy wires at a 45-degree angle from the line to a secure object such as a post, tree, or stake.

(6) Tie the wire line to a stake at the bottom of the lance pole.

(7) Tag the line just above the tie at the bottom of the lance poles.

(8) Figure 79 illustrates a properly constructed overhead span.

d. Guying Lance Poles Supporting Aerial Lines. Lance poles used to support aerial field wire lines must be guyed at each pole. Each pole has two guys at right angles to the direction of the line. Each 10th pole is four-wire guyed, with two guys on each side of the line at a 45-degree angle from the line. The length of each span will vary according to the storm loading in that particular area. The normal span length is 100 feet.

66. Wire Construction Across Roads

a. General. During the construction of field wire lines, it will be necessary to have the wire lines cross roads. This can be done by placing the lines through a culvert, placing the lines overhead, or burying the lines underground. For hard surfaced roads that are subject to

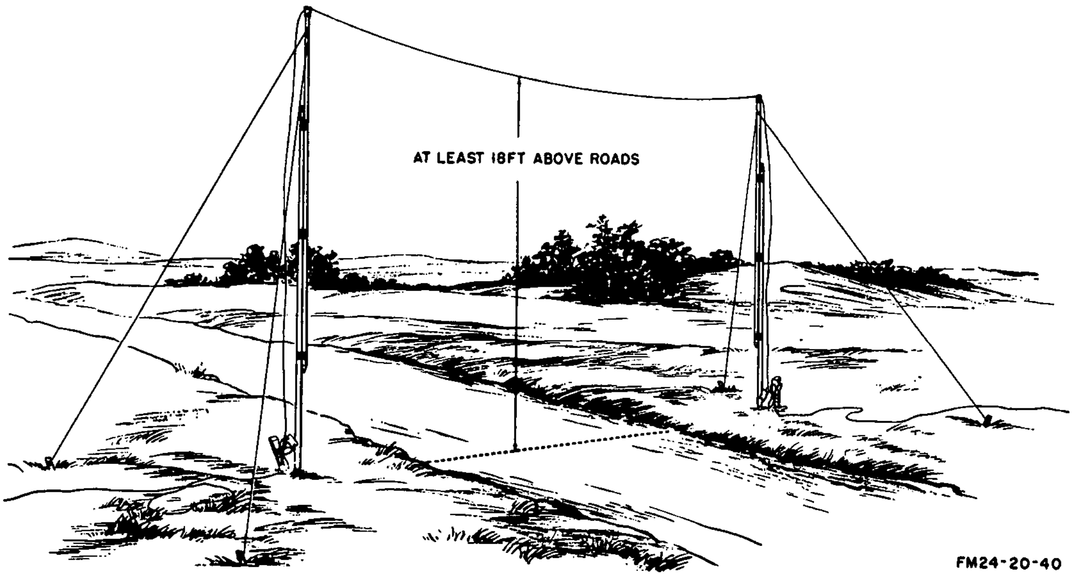

Figure 79. Wire construction across roads, using lance poles.

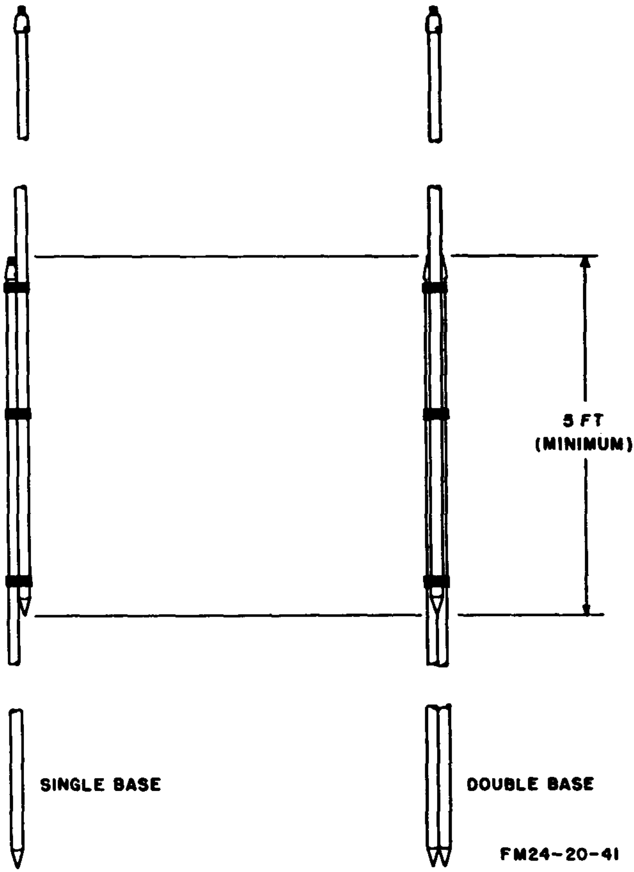

Figure 80. Lashing lance poles.

wheel-vehicle traffic and do not permit burial, the wire may be *laddered.* This is done by cutting the field wire and by splicing one or more lengths of twisted pair to each conductor. These lines are then laid across the road in parallel paths at distances greater than the longest vehicle expected to use the road. The ends of the laddered arrangement are spliced to the original conductor on the other side of the road in the identical manner. When properly staked, these laddered lines (each *rung* serving as a single conductor) will provide initial communication but should be replaced by an overhead crossing when the line is policed.

b. Culverts. Placing wire lines through culverts is the fastest method of getting wire lines from one side of the road to the other. The wires are passed through the culvert, and are tied and tagged at each end of the culvert (fig. 81). Where the wire lines contact the culvert, the wires should be wrapped with friction tape to prevent damage to the insulation.

c. Overhead Lines. Overhead lines across roads may be suspended from trees, poles, or other supports. They must be tied at ground level, as well as overhead. These lines are tagged at the base of the support on both sides of the crossing. A lance pole crossing is shown in figure 79 and discussed in paragraph 65.

d. Underground Lines. Field wire lines can be laid across a road by burying them underground (fig. 82). Proceed as follows:

(1) Dig a trench 6 to 12 inches deep across

the road. The trench should extend at least 2 feet beyond each side of the road. In loose, sandy soil, a trench at least 3 feet deep is necessary to afford protection from tracked vehicles.

(2) Lay the wire loosely in the trench.

(3) Tag and tie the wires to a stake at each end of the trench.

(4) Backfill the trench. Do not place stones or sharp objects on the wire when backfilling the trench. These objects could crush the wire insulation when passing vehicles cross over the trench.

(5) Leave enough slack on one side of the road to permit replacement of the wire in the trench, if it becomes damaged. Another useful technique for wire replacement is to place a spare wire in the

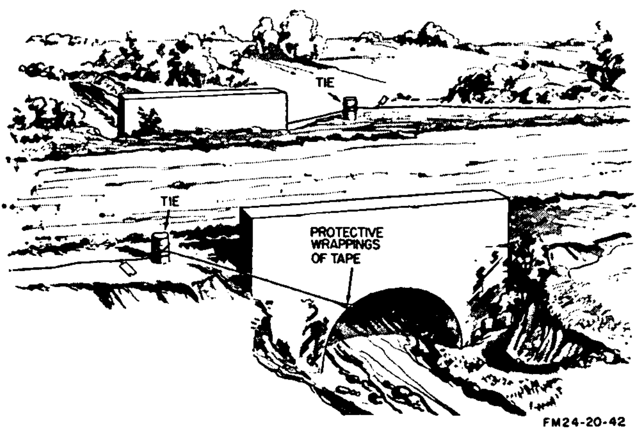

Figure 81. Wire crossing through culvert.

trench with the working wire. This spare line should also be tagged and tied to stakes with sufficient slack for splicing.

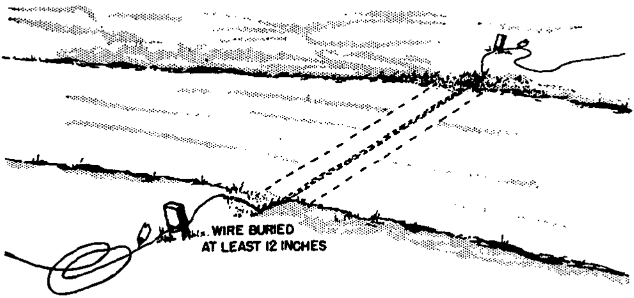

Figure 82. Wire buried in trench to cross roads.

67. Construction Across Railroads

When a field wire line must cross railroad tracks, great care must be exercised in selecting the crossing site. If possible, the lines should cross underneath, through culverts, or overhead on bridges or viaducts. If none of these are available, lay the wire under the rails as shown in figure 83. To accomplish this—

a. Pull sufficient slack from the wire reel to reach across the railroad track.

b. Cut the wire at the reel and pull the end of the line under the rails of the track.

c. Tie the line at the far end to a stake. Pull the line taut and tie it to another stake.

d. Bury the wire lines from the rails to a point outside the shoulders of the track.

e. Splice the free end to the end of the wire on the reel, and continue to lay the line.

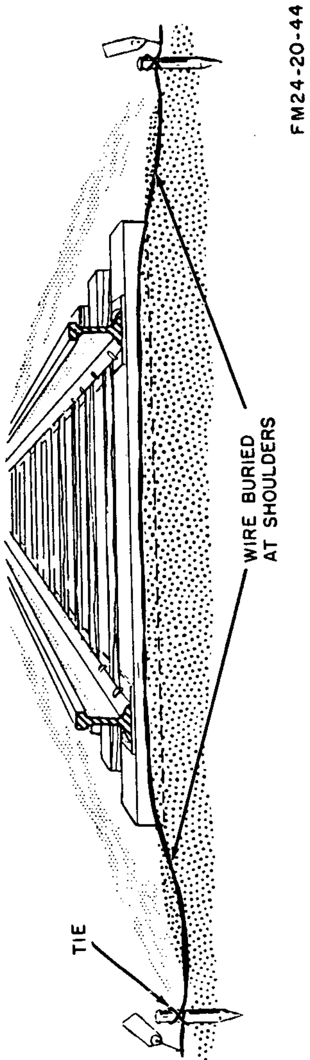

Figure 83. Wire crossing under railroad tracks.

68. Construction Across Rivers

When a field wire line is to be laid across a river, lay it on a bridge, construct an overhead span, or submerge it under water.

a. Use of Bridge. Where a bridge is used, attach the field wire lines to the bridge, so that the lines will not be damaged by traffic. When possible, make a multipair field wire cable by combining all field wire lines crossing the river. Attach the cable to the bridge supports below the road surface.

b. Use of Overhead Construction To Cross Streams. A narrow stream crossing can be made in the same manner as the overhead construction to cross roads (par. 66*c*). The wire lines will vary in height, but must be high enough to clear waterborne traffic. For long-span construction across streams, field wire lines must be supported by a steel suspension strand. This will require the special construction technique described in TM 11–2262.

c. Submerging Wire Lines To Cross Streams Field wire lines can be submerged to cross streams (fig. 84). The longer the wire remains in the water, the more rapid the circuit quality deteriorates and talking range of the submerged field wire decreases. Selecting the proper crossing site is the most important factor when crossing a stream. The crossing should be made at a point where there is little vehicular traffic and where the stream flow is relatively slow. After the site has been selected, proceed as follows:

(1) Lay the wire line to the stream bank and

tie it securely to some object such as a tree or stake.

(2) Tag the wire line at the tie.

(3) Bury the wire line to the water's edge. (Be sure that there is enough unspliced wire left on the reel to cross the stream. If there is not enough, cut the line and splice on a new reel.)

(4) Lay the wire across the stream and anchor it in several places. It should be anchored at both sides of the stream and several times in the middle, depending on the width of the stream. There are many ways to lay wire across streams (rafts, trucks, rotary-wing aircraft, rifle grenades, or boats).

(5) On the far shore, bury the line from the water's edge to a tree or stake on the bank of the stream.

(6) Tie the wire to the tree or stake.

(7) Tag the wire line at the tie, and continue to lay the line.

69. Long-Span Construction

a. When constructing long spans of Wire WD–1/TT, the length of the span, number of pairs, sag, and weather conditions of the area must be considered. Normally the field wire for long spans must be supported by a steel suspension strand. (See TM 11–2262.)

b. When a single wire, not supported by a suspension strand, is used for a long span, the method used for dead-ending the wire becomes much more

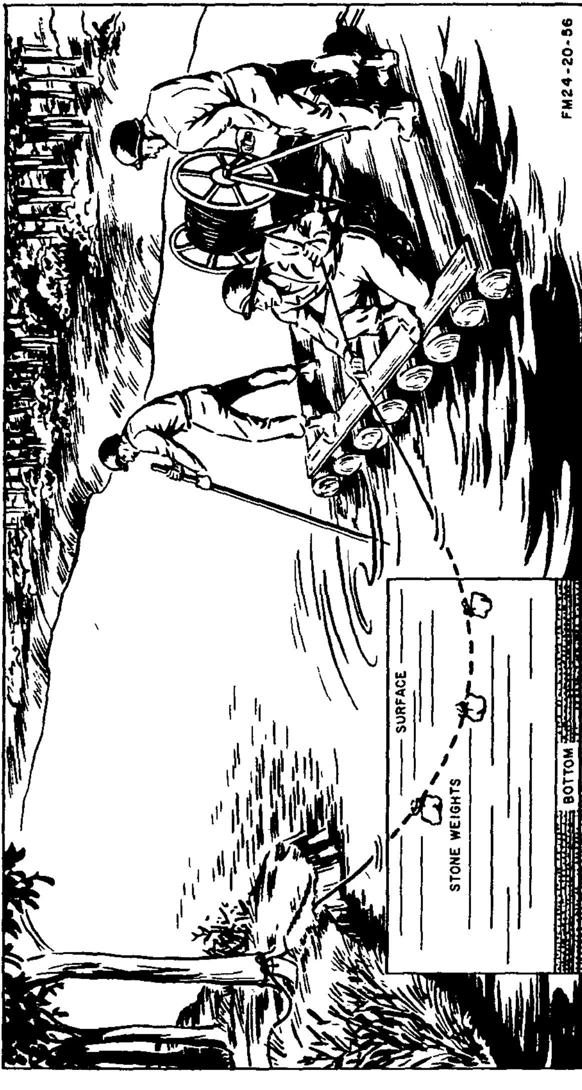

Figure 84. Submerged construction.

important. A correct dead end will prevent the weight of the wire from cutting the insulation at the point of the tie. Figure 85 illustrates the correct method of dead-ending a long span of Wire WD–1/TT. Note that the running end of the wire is given 3 turns around the pole, and is then taped to the standing part of the wire.

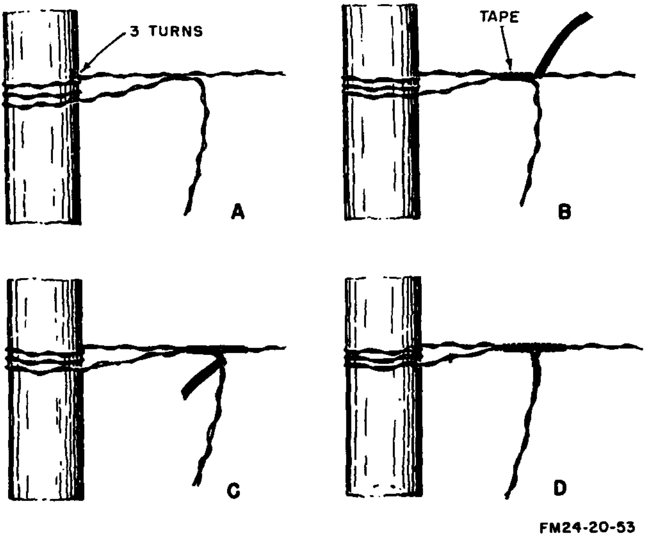

Figure 85. Dead-ending Wire WD–1/TT in long-span construction.

70. Construction and Use of Field Wire Cables

During the construction of field wire systems, wire lines will converge at such points as command posts and switching centers. In this case, it is desirable to construct a field wire cable to be used in lieu of multiple field wire lines. Use of field wire cables will facilitate construction and maintenance.

a. Construction of Field Wire Cables Without Suspension Strand. This type field wire cable is used when the weight of the cable can be supported by its own tensile strength. Normally, this cable is used to connect the terminal strips in the construction center to the switchboard in the command post or switching central. It may also be used for short span construction to cross obstructions such as gullies, streams, roads, and railroads. Construct it in the following manner:

(1) Use one Wire Dispenser MX-306A/G for each circuit of the cable.

(2) Place the wire dispensers, one behind the other, with the pay-out end of each dispenser facing the same direction.

(3) Pass the wire of each dispenser through the center of all subsequent dispensers (fig. 86).

(4) Pull the wires through the dispensers so that the wire lines will spiral-wrap around each other.

(5) Tie the resultant cable, formed by the wrapped wire lines, with marline or unserviceable field wire. As an alternate method, use friction tape at frequent intervals to tape the cable wire pairs together.

b. Construction of Field Wire Cable With Suspension Strand. Field wire cables for long-span construction must be supported by suspension

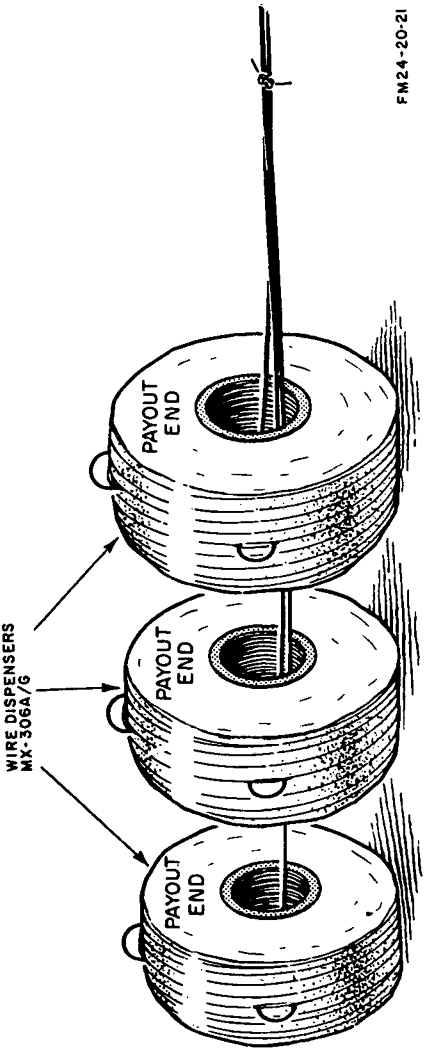

Figure 86. Forming field wire cable without suspension strand.

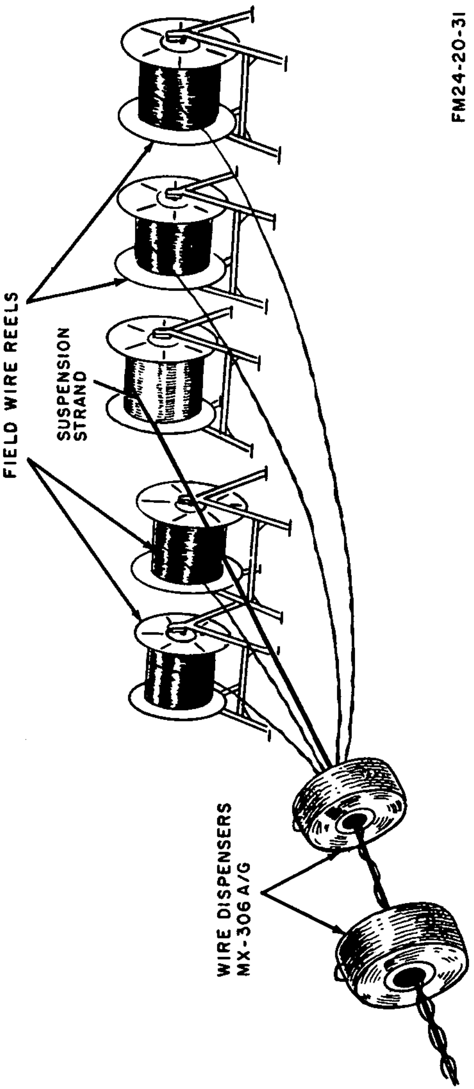

Figure 87. Forming field wire cable with suspension strand.

strand. Construct this cable in the following manner:

(1) Pull the suspension strand through Wire Dispensers MX–306A/G with the field wire pairs (fig. 87). The wire of the Wire Dispensers MX–306A/G will spiral-wrap the wire pairs and the suspension strand, and thus form the cable.

(2) As the cable is formed, tie it with marline or unserviceable field wire, or tape it at frequent intervals to hold the field wire pairs and suspension strand together.

71. Tagging Field Wire Lines

a. General. The method to be used in marking and identifying wire lines and circuits is given in the signal operation instructions (SOI) and the standing signal instructions (SSI) of an organization.

b. Identification of Lines. Circuits are designated by individual circuit numbers, by name, or by a combination of the two. For example: 101–36 is a combination of numbers identifying a circuit (fig. 88). The circuit number is 101, and the code designation of the installing organization is 36. (The circuit designation remains the same from the point of origin to the termination of the circuit.) Field wire lines are numbered consecutively, and no two lines are given the same number.

c. Importance of Tagging. Tagging of field wire lines is necessary, because tags often provide the only method of distinguishing one line from another. Tagging simplifies the turning over of wire systems to relieving units; makes line tracing easier, especially in darkness; and simplifies maintenance. If tags normally issued as a field item are not available, a unit is expected to improvise substitute tags. Every unit is responsible for insuring that its lines are adequately labeled.

d. Points To Be Tagged. During wire laying, lines are tagged at the following points:

(1) Crossings at roads, trails, trolley and railroad tracks, railroad junctions, and bridges.

(2) Communications centers (inside and outside).

(3) Telephones, repeaters, switchboards, and test terminal points.

(4) Both sides of buried or overhead crossings.

(5) Where the wire-laying or construction techniques change from—

(*a*) Surface to underground.

(*b*) Surface to overhead.

(6) A point at which a wire line branches off the main route.

(7) Frequent intervals where several lines are laid along the same route.

(8) Possible future trouble spots along a route.

e. Shape, Material, and Marking of Tags. The oblong-shaped tag must be made of moistureproof and waterproof material. Tags are cut, notched, colored, or marked in accordance with the SOI or

SSI issued by the organization or unit headquarters. The markings must not disclose the identity of the unit or organization. Examples of some of the cuts, and notches, and markings that can be employed are given in figure 88.

f. Attachment of Tags. Tags must be securely attached to the line. At points where many lines are tagged (such as test terminal points), tags should be arranged in oblique or staggered rows. This prevents one tag from covering another.

72. Establishing Construction Centers

A construction center is an installation, consisting of field wire lines, terminal strips, and test switchboards, erected at the point where trunk and long-local wire lines converge to enter a command post or switching central. (In some units, these centers are called *wire heads* or *zero boards*. However, wire heads and zero boards are only part of a complete construction center. A wire head is the part of a construction center where the wire lines enter or leave the construction center. The zero board is a switchboard used to test wire lines.) Construction centers are located near command post areas, and are used to facilitate wire installation and maintenance.

a. The construction center is located at a point where the wire lines can be easily terminated.

b. The wire lines are tied to a terminal strip or test switchboard as the construction teams install them.

c. From the terminal strip or test switchboard, the wire lines are connected to the switchboard in

EXAMPLES OF CUTS, NOTCHES, AND MARKINGS ON TAGS

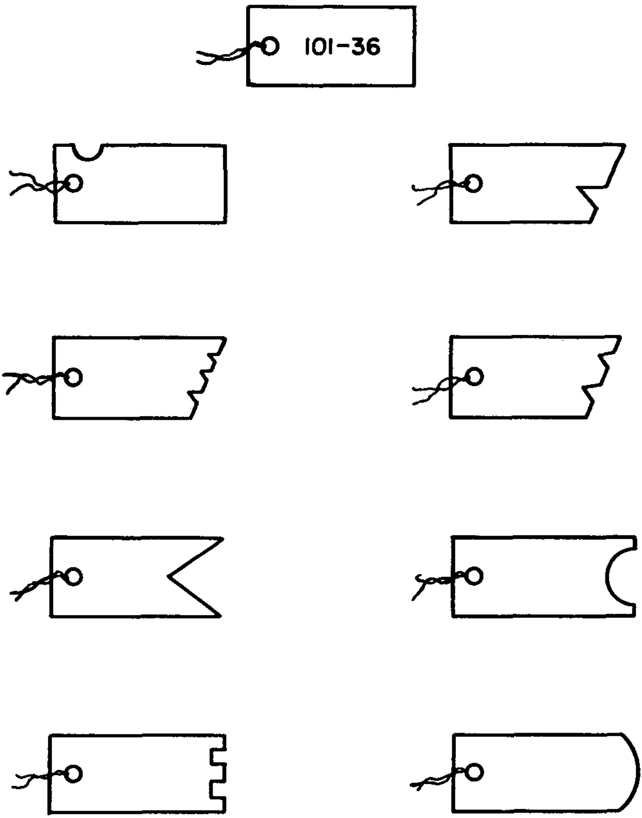

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Figure 88. Examples of cuts, notches, and markings on tags.

the command post or switching central by field cable or field wire cable. The cable can be buried underground or constructed overhead to protect it from vehicular traffic that enters and leaves the command post.

73. Establishing Test Stations

a. Test stations are normally installed at important wire line junctions to simplify locating and clearing trouble on field wire lines. In field wire installations, these test stations usually consist of one or more terminal strips.

b. Test stations may or may not be manned. A manned test station can coordinate with the repairman on the line for rapid troubleshooting. Signals or instructions to the test personnel to monitor a particular circuit should be previously arranged by the wireman. If needed, a simplex or phantom circuit can be set up temporarily to assist in this operation (par. 154*c*).

Section III. CONSTRUCTING FIELD WIRE LINES UNDER UNUSUAL CONDITIONS

74. General

Terrain and climatic conditions will affect the speed and type of construction used in installing field wire lines. Speed of installation, however, should not restrict good construction practices. Wire lines installed under unusual conditions of terrain and climate should be installed with greater care than those installed under normal conditions. Some of the construction practices that should be emphasized are as follows:

a. Wire lines should be tagged more often for identification during maintenance.

b. Test stations should be installed to facilitate maintenance.

c. Wire ties should be suitable to the climatic conditions and to the type of construction. Wire ties should be made carefully to hold the wire lines in place.

d. The construction techniques discussed in section II also apply to construction under unusual conditions of terrain and climate. Certain factors that are peculiar to each condition of terrain or climate will be discussed in the succeeding paragraphs.

75. Field Wire Construction in Mountains

The construction and maintenance of field wire lines in mountainous terrain is usually more difficult than in other areas. The lack of roads may make it necessary to lay wire lines by aircraft or by man-pack wire-laying equipment. In addition, the laid wire lines will require constant maintenance because of ice, rock falls, and snow slides. When air-laying field wire in mountains, it is advantageous to lay the wire on top of trees and shrubs where possible and away from roads and trails to protect the lines from damage caused by traffic or by rock slides.

a. In selecting the routes for wire lines, it may be necessary to make an aerial reconnaissance of the area. Roads and trails are more clearly identified from the air.

b. If the lines are to be laid by aircraft, an aerial reconnaissance of the area should be made to determine areas to be avoided.

c. When it is determined that the lines are to be laid on the ground, it will be necessary to establish supply points along the route. Supplies may be delivered by air-drop, by rotary-wing aircraft, or by man- or animal-pack trains.

d. If the lines are to be constructed above the snow line or during the winter, they should be constructed overhead on trees or lance poles to facilitate locating of the wires for maintenance.

76. Field Wire Construction in Arctic Areas

The construction techniques for field wire lines described in section II must be modified for use in arctic areas. Wire lines in arctic areas should be constructed overhead to protect them from the deep snow and from vehicle and foot traffic. Because of the lack of trees and telephone poles, lance poles must be used for overhead construction. Other construction techniques peculiar to arctic areas are noted below.

a. A heated shelter should be provided for the wire-laying crews. The arctic personnel shelter mounted on a 2½-ton truck or tracked vehicle provides a good facility for wire laying. The field wire can be kept warm and pliable as it is spliced and payed out at the rear door of the shelter.

b. In deep snow, the shelter should be mounted on a tracked vehicle of high flotation to facilitate movement over the snow.

c. To place the wire lines overhead, proceed as follows:

(1) Tie three lance poles together at the top to form a tripod.

(2) Use a basket hitch or weave tie to tie wire lines to the top of this tripod. Never tie wire lines in the normal manner in arctic areas. Bending the lines will crack and break the insulation, causing a short circuit.

d. When wire lines must be taped for any reason, use Electrical Insulation Tape TL–600/U (polyethylene). This tape retains its adhesiveness in cold climates.

77. Field Wire Construction in Desert Areas

Desert areas provide the most suitable climatic conditions for the installation and maintenance of field wire lines. Thus, field wire lines properly installed and maintained will give good service for a long time. There are, however, certain factors peculiar to desert areas that must be considered in the construction of the field wire lines.

a. Since there are no trees or poles in the desert, lance poles or other erected supports must be used for overhead construction. However, overhead wires are easily identified from the air and difficult to camouflage.

b. Buried field wire lines will give good service in the desert. To facilitate identification and maintenance, buried lines should be tied and tagged whenever a new reel of wire is spliced to the line. The location and direction of buried wire must be carefully plotted on a map in order to facilitate maintenance.

c. Field wire lines laid on the ground must be tied and tagged at frequent intervals, because shifting sand will cover the lines and make location of the lines difficult.

78. Field Wire Construction in Tropical Areas

The continual dampness and fungus growth in jungle areas will reduce materially the effective range of field wire lines. Therefore, the construction techniques listed below must be used to maintain the effective range and extend the life of field wire lines.

a. Selection of the best route for a wire line is extremely important to construction and maintenance. Ground reconnaissance is more effective than aerial reconnaissance, because dense jungle growth hides trails and roads from aerial observation.

b. Repeaters and amplifying telephones can be used to increase the range of field wire circuits. The laying of two field wire lines, using two wires for each side of the circuit, will also increase the range of field wire circuits. When using two field wire lines for one circuit, one wire of each pair is connected together for one side of the circuit, and the other wire of each pair form the other side of the circuit to prevent crosstalk and extraneous noise (unless the lines are spaced and transposed on insulators as open wire).

c. If possible, field wire lines should be constructed overhead on forestry-type insulators (Insulator IL–3/G). This type of construction will give better service and require less maintenance than field wire lines laid on the ground.

d. When maintenance becomes difficult, wire maintenance teams can be placed at close intervals along the lines. Maintenance can be facilitated if test stations are installed at frequent intervals. The lines should be tagged often so that they can be readily identified.

Section IV. RECOVERING FIELD WIRE

79. General

a. Field wire is recovered for reuse whenever possible. This is important as an economy measure, because recovered field wire constitutes a source of wire supply. Field wire lines should be recovered as soon as they are no longer required. The wire should be repaired, tested, and placed in condition for future use.

b. In the recovery of wire, the recovering equipment (chapter 5) should be preceded by a wireman who removes all tags, unties the wire lines, and places the wire along the side of the road in the path of the recovering equipment. To recover the wire, wiremen proceed along the wire line and wind up the wire enroute. Under some conditions, it may be necessary to have the recovery equipment stationary, dragging in the wire by hand. This method should be avoided if possible, because it abrades the insulation and may cause the wire to break.

c. Ordinarily, wiremen should wear leather gloves or pads to protect their hands during field wire recovery.

80. Servicing Field Wire

After field wire has been recovered, it should be reconditioned (serviced) for reuse as follows:

a. Mount an empty reel on one reel unit, and mount the reel containing the wire to be reconditioned on another reel unit. Position the reel units so that the wire may be wound on the empty reel from the full reel (fig. 89).

b. Pass the end of the wire through the holes provided on the drum of the empty reel. Secure the wires, and allow the ends to protrude from the side of the reel. These ends are left free for future testing.

c. Station one man at each reel and another man between the reels to examine the wire as it is wound slowly on the empty reel.

(1) Tape each abrasion or break in the insulation as described in paragraph 12*f*.

(2) Carefully splice every break in the conductors.

(3) Examine each old splice, cut out each poorly made splice, and resplice the wire properly.

(4) If the insulation has been damaged over a long section of the wire, or if there are several splices located very close together, cut out the entire section and resplice the two ends of the wire.

d. After each splice and at the finish of the reel, test the wire on the wound reel for open circuits, short circuits, or high loop resistance. A high resistance measurement usually indicates poorly made splices. These are made in accordance with test procedures described in chapter 10.

e. Wire Dispensers MX–306A/G are not refilled in lower-echelon units. However, the wire from the dispensers can be recovered and reconditioned and wound on metal reels.

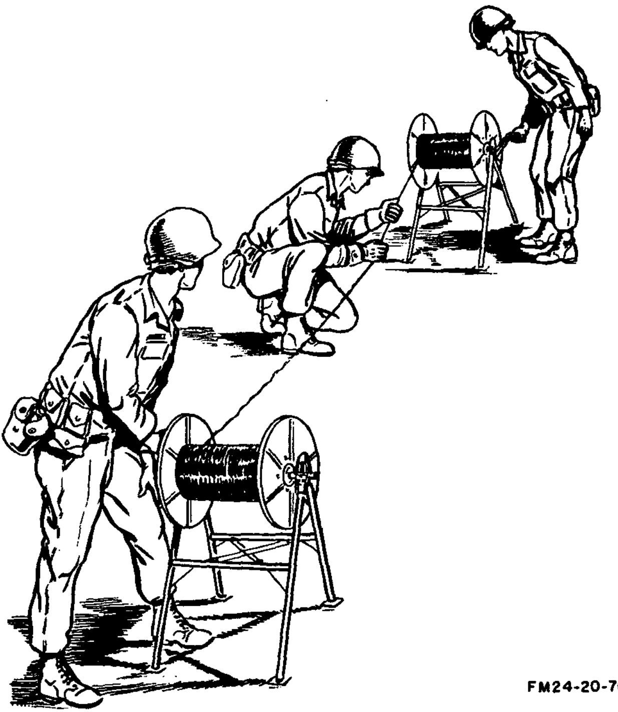

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Figure 89. Servicing field wire.

Section V. FIELD WIRE RECORDS

81. Construction Orders

The construction orders given to constructioi teams, organized and equipped on the basis of information obtained from reconnaissance, should prescribe the number of circuits to be installed, the priority of each installation, the time when each of the various circuits must be completed, and the action to be taken upon the completion of the installation. Much of this information is included in line route maps and tactical circuit diagrams.

82. Line Route Map

a. A line route map (fig. 90) is a map, a map substitute, or an overlay on which are shown the actual or proposed routes of wire lines. It is used to show the actual physical location of wire circuits to wire personnel and to higher headquarters.

b. The line route map contains a few lines, symbols, and notations as are necessary for clarity. It shows the routes of wire lines, switchboards, switching centrals, and test stations, the number of circuits along a route, and the type of wire construction. Line route maps do not show the actual connection or type of equipment at switching centrals or test points.

c. An organizational line route map is normally prepared from information obtained from the various construction teams performing the actual construction. This compilation of wire construction information is maintained and kept up-to-date for reference data in future organizational movements and in maintenance.

d. For an explanation of symbols used in line route maps, refer to appendix III.

83. Circuit Diagram

The circuit diagram (fig. 91) is an illustration (in symbol form) of the technical arrangement and connections of a wire system. It indicates the following:

(1) Switching centrals at command posts and at establishments served by the wire system; commercial switching centrals; test stations; and long local telephone circuits. These are shown by lines, special symbols, and notations as are necessary for clarity. Locations may be indicated by map coordinates or terrain features. (The tactical commander may prohibit the use of map locations, unit designations, or symbols when security is jeopardized.)

(2) Number of circuits between the command posts or installations are shown.

(3) Number assigned to each circuit.

(4) Manner of connecting each circuit into or through switching centrals and test stations, including the connections for separate or simultaneous telephone and teletypewriter service.

(5) Type of line construction used for each

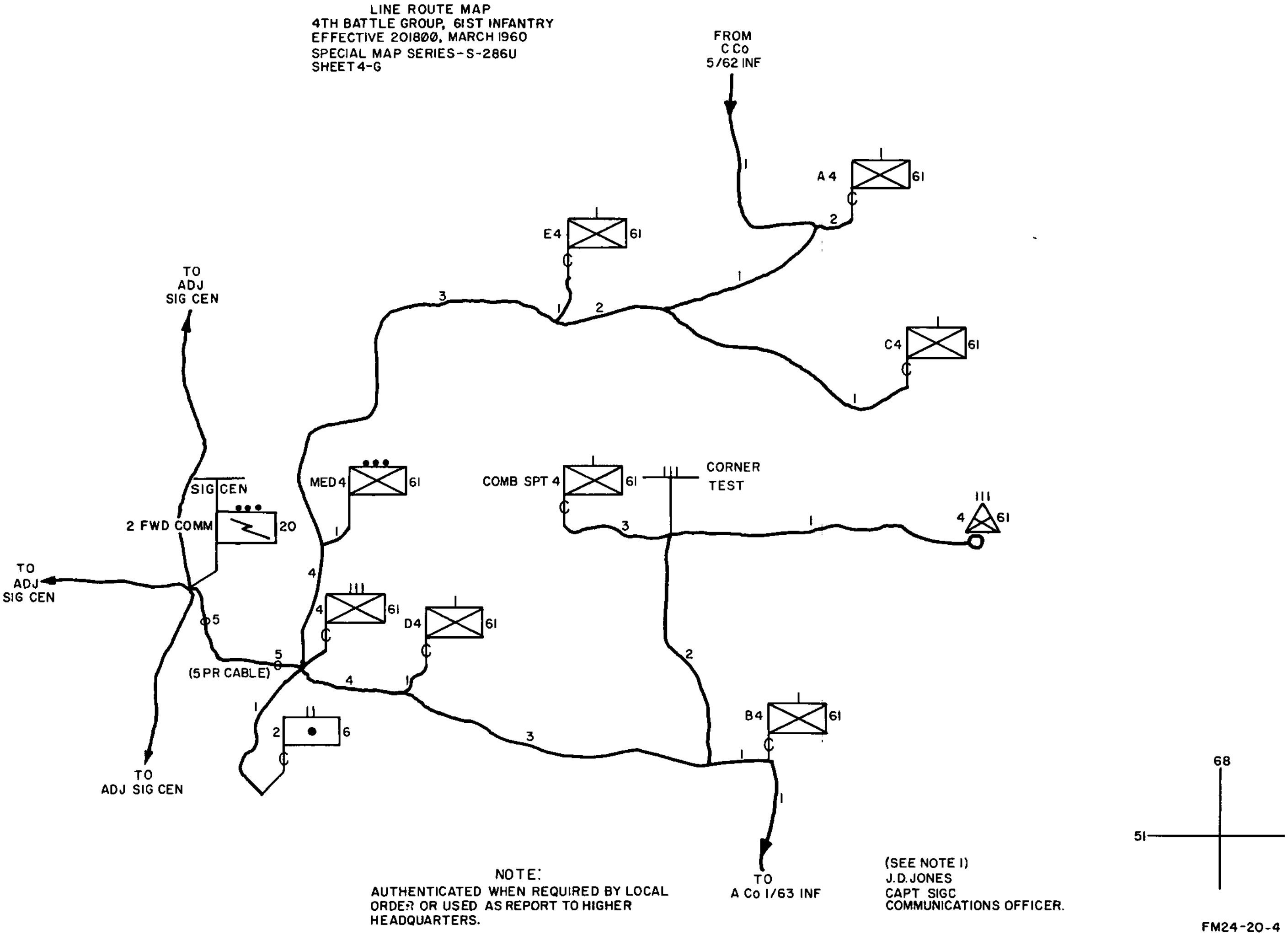

Figure 90. Example of line route map.

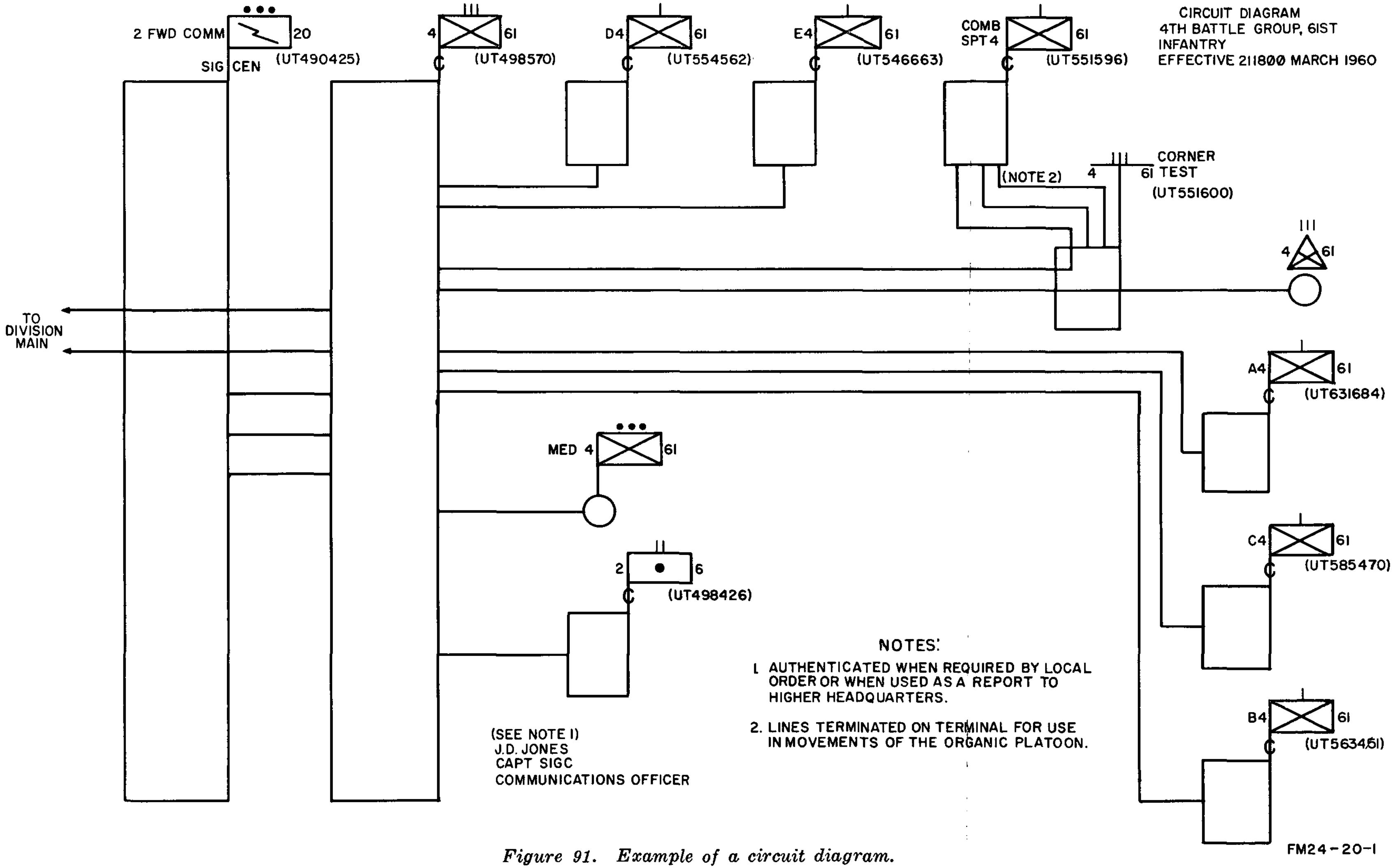

Figure 91. Example of a circuit diagram.

line, such as field wire, open wire, cable, and commercial circuits.

b. A circuit diagram is normally made up at the communication (or signal) office from data on the line route map and information obtained from the wire construction crews. It is used as an organization wire system engineering and maintenance reference.

c. For an explanation of symbols used in circuit diagrams, refer to appendix III.

84. Security

Complete line route maps and circuit diagrams must not be carried into forward areas. Individual construction and maintenance teams are issued only such extracts of maps or diagrams that permit the proper performance of their specific mission. Such extracts will not show unit designations.

CHAPTER 8

AIR-LAYING OF FIELD WIRE AND FIELD CABLE

85. General

Air-laying of wire and cable becomes necessary when time, terrain obstacles, tactical conditions, and area contamination make extremely difficult, and sometimes impossible, the laying of wire and cable by normal ground surface methods.

a. Air-laying of wire and cable is of particular importance in forward areas, where tactical units are highly mobile and widely dispersed. In these areas, aircraft can be used to lay wire and/or cable lines between—

(1) Observation posts.
(2) Forward observers.
(3) Division artillery units.
(4) Division headquarters and battle groups.
(5) Battle groups and their companies.
(6) Battle groups.

b. Aerial wire laying is also important in support of airborne operations. In the initial assault, for example, wire lines must be installed rapidly to connect the independent units in the airhead. These wire lines can be laid much more rapidly by aircraft than by surface vehicles.

c. Air-laying of field wire and cables is not required as much in rear areas as in forward areas. However, this type of wire-laying can be of great value in providing wire lines in support of rear area damage control and security operations.

86. Aircraft for Air-Laying Operations

Field wire lines can be laid from either fixed-wing or rotary-wing aircraft. However, experience has shown that rotary-wing aircraft are more suitable, since they have the following advantages over fixed-wing aircraft:

a. Rotary-wing aircraft have greater maneuverability and versatility.

b. The *wash down* action of the rotor on rotary-wing aircraft keeps the wire at a safe distance below the aircraft.

c. Rotary-wing aircraft can land on, and take off from, small areas. This facilitates policing of the lines.

d. The slow-speed, low-flying, and hovering capability of the rotary-wing aircraft makes it adaptable to low level dispensing.

87. Dispensing Techniques

The following are flying precautions and techniques that must be observed by the aviator during the process of laying field wire from rotary-wing aircraft. They should—

a. Lift the rotary-wing aircraft gradually and at a slow speed.

b. Maintain air speeds of from 45 to 60 knots (51 to 69 miles per hour) during dispensing of the field wire.

c. Maintain an elevation of from 50 to 100 feet.

d. Slow down the speed of the aircraft to pay out slack. Slack is necessary to make crossings over rivers, roads, railroads, etc.

e. Dispense field wire with extreme care in rough and mountainous terrain. For example, wire lines suspended between two high points will sway and rub against rocks and trees, thereby causing abrasion to the insulation. To avoid this, high peaks must be by-passed and enough slack must be payed out to insure that the wire lines will lay flat on the surface of the ground, even in defilade areas.

88. Requests for Air-Laying Operations

a. Requests for air-laying operations in the division area are sent to the division signal officer. He, in turn, requests the division aviation officer to provide aircraft from the division aviation company to fly the mission. This is the normal procedure, but there are times when air-laying requests will be of such volume that aircraft will be assigned to the division signal officer for accomplishment of the air-laying missions.

b. Requests for air-laying missions at corps and field army level are forwarded to the corps and field army signal officers, respectively. Aircraft for such missions are provided by the army aviation units of each command.

89. Preflight Considerations

After a decision has been made to fly an air-laying mission, the aviator and the wire chief must coordinate in considering the various aspects of the operation.

a. A check must be made to insure that dispensing equipment is securely attached to the aircraft.

b. Equipment must be flight tested prior to flying the mission.

c. The actual route of the wire line must be determined to insure—

(1) Flying safety during dispensing operations.
(2) Circuit effectiveness.
(3) Circuit protection.
(4) Wire economy.
(5) Accessibility of the lines for maintenance.

d. Information must be given to the aviator on the following:

(1) Number and length of lines.
(2) Starting and ending point of each line.
(3) Type and weight of each load.
(4) Obstacles along the route, such as bridges, power lines, railroads, mine fields, CBR areas, and artillery danger areas.
(5) Wire policing methods to be used.
(6) Routes used by friendly tracked vehicles.

90. Route Reconnaissance

Unless it is firmly established that the projected route for the wire lines is free of obstacles, there is a definite need for an aerial reconnaissance of the route. In some cases, the aerial reconnaissance can be made in one flight over the area, and the wire lines can be laid on the return flight. If the wire lines must be laid at night, the aerial reconnaissance of the projected route should be conducted during daylight hours.

91. Air-Laying Operations

Since the dispensing of wire and cable lines from aircraft is a dangerous operation, trained signal personnel must be made available to load the dispensers, splice and test the lines, and dispense the lines. One or more lines may be laid with each flight of the aircraft.

a. Initial Step. Initial pay-out begins after the lines are tied to some object at the take-off point, or after the lines are weighted and dropped over the initial point while the aircraft is in flight.

b. Electrical Continuity of the Line. The air-laying wire team must insure that electrical continuity of the line is maintained. This can be accomplished by connecting telephones to each end of the line: one at the initial point, and one at the standing end of the last dispenser. This circuit will provide continuous telephone communication between the wire team on the ground at the initial point and the wire team in the aircraft. Telephone TA–312/PT, with Headset HS–91, is preferred for use by the air-laying wire team, since it permits the man with the headset to listen in on the circuit and still use his hands to help in the wire dispensing operation. It is also desirable to use alligator clips to connect the telephone to the standing end of the line; this will permit the telephone to remain connected to the line until the entire line is laid.

c. Policing the Line. The lines must be policed during the wire-laying operation. This can be done by the air-laying wire team, or by supporting wire teams on the ground. If done by the air-laying wire team, directions must be given to the aviator to insure that he will land the aircraft at points where the policing operation can be accomplished. Equipment required for the policing operation must be loaded aboard the aircraft prior to take-off. Normally, it will be necessary to load splicing tools to splice breaks and cuts in the line, lance poles to construct overhead crossings, stakes to secure lines in place, and digging tools to bury the lines.

(1) If the line should break during the air-laying operation, the aviator must try to land his aircraft near the break. This will facilitate the work of the wire team in splicing the break. If it is impossible to land the rotary-wing aircraft in this particular area, the aviator should hover over the location of the break until the wire team can recover the wire.

(2) When it is necessary to install wire lines over or under such obstacles as roads, railroads, or power lines, the aviator lands the rotary-wing aircraft just short of the obstacle. The wire team dismounts, pulls out enough slack to make the crossing, and cuts the wires. The aviator then moves the aircraft to the far side of the obstacle and lands. The wire team installs the crossing (over or under the obstacle), and ties the lines

securely at both sides of the crossing. After the break in the line is spliced, air-laying operations continue. On some occasions, power lines will be sufficiently high above the ground to permit rotary-wing aircraft to fly under them. However, the aviator must land the aircraft to permit the wire team to tie the lines to a stake or tree. This will hold the lines close to the ground, thereby preventing them from coming in contact with the power lines as the aircraft gains altitude.

d. Terminal Step. At the terminus of the wire lines, ground wire teams extend the ends of the lines to the proper patch panel or switchboard. For additional information on air-laying operations, refer to TM 11–2240.

92. Air-Laying Field Cable

Field cables, such as Cable Assembly CX–1065/G (spiral-four), may be laid by rotary-wing aircraft to connect line-of-sight radio terminals with accessory equipments in a command post; to provide cable lines across contaminated areas or minefields; and to span rivers. Rotary-wing aircraft may also be used to reestablish cable lines destroyed by nuclear weapons. There is no device for dispensing field cable from aircraft; however, some device could be improvised in an emergency. Field tests have indicated there are five important factors to be considered in improvising a dispenser for the air-laying of field cable.

a. The dispenser must be sling-loaded, rather than being carried within the aircraft.

b. The cable cannot be payed out from cable reels; it must be arranged in gentle folds on the dispensing frame.

c. The dispenser must be as light as possible to increase the amount of cable that can be carried by the aircraft. This fact indicates that the dispenser should be made of aluminum.

d. Some means must be provided to quickly jettison the dispenser in case the cable snarls during the dispensing operation.

e. Any improvised cable dispenser should be ground-tested before it is attached to the aircraft. To do this, mount the cable dispenser on the back of a truck, and then run the truck at high speeds to insure that the dispenser will pay out the cable at these speeds.

CHAPTER 9

RAPID CONSTRUCTION OF SPIRAL-FOUR CABLE ON AERIAL SUPPORTS

Section I. LAYING THE CABLE

93. General

This chapter discusses the procedure for installing spiral-four cable on aerial supports. It covers the laying of the cable, construction and installation of the aerial supports, and mounting of the cable on the aerial supports.

94. Dispensing the Cable

Spiral-four cable can be laid from the rear of a truck, using Reel Unit RL–26–( ) (fig. 92). If three or four cables are to be laid simultaneously, two Reel Units RL–26–( ) must be used. Lay the cable as follows:

a. Tie the cable ends to a post or tree, leaving enough cable slack to reach the terminal or repeater equipment.

b. Lay the cables straight back from the cable reels, across the tail gate of the truck; start the truck, moving forward slowly.

c. As the truck moves forward, rotate the cable reels by hand to reduce the pull on the cables.

d. When the truck gains full dispensing speed, use the reel brake on Reel Unit RL–26–( ) to prevent the cable from unreeling to fast. If the reels begin to unwind at excessive speed, the slack caused by the excessive speed may kink the cable as it unwinds.

e. When the last layer of cable begins to unwind from the reel, signal the truck driver to reduce the speed of the truck.

f. When there are but a few turns of cable left on the reel, signal the truck driver to stop the truck. Unreel the last few turns of cable, and leave them as slack.

g. Lay all other cable sections in the same manner.

h. The construction crew laying the cable should install the repeaters and construct overhead spans over roads, railroads, etc.

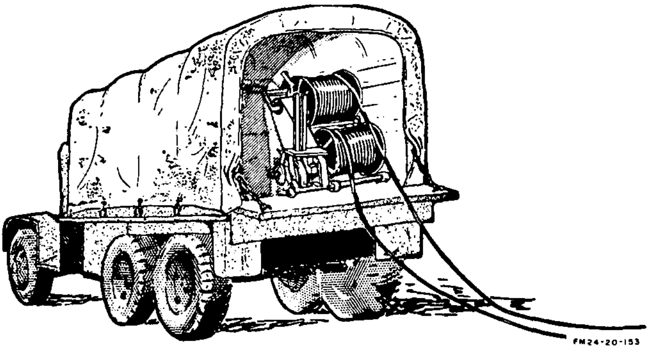

Figure 92. Laying cable using Reel Unit RL–26–( ).

95. Installing Unattended Repeaters

When required, an unattended repeater is installed at the end of every twenty-third cable section ($5\frac{3}{4}$ miles). The repeaters should be placed on supports, or on high dry ground, so that water will drain away from them in wet weather.

96. Construction of Overhead Spans

When it is necessary for the cable lines to cross over roads, the cable must be placed overhead on suspension strand. Telephone poles are used to support the cables above the minimum road clearance (18 feet). There are two types of spans used to cross roads: one type will support up to five cables, and the other type will support more than five cables.

97. Constructing a Span to Support up to Five Cables

To construct this type span as follows:

a. Dig two post holes, 4½ feet deep, on each side of the road, approximately 6 feet beyond the drainage ditch.

b. Set the poles in the holes, and rake each pole 1 foot (fig. 93). Backfill the hole and tamp.

c. Cut a piece of Wire W–145 about 6 to 8 feet longer than the span between the poles. This piece of wire is used as the suspension strand to support the cables.

d. Wrap one end of this wire around the first pole, about 18½ feet above the road surface (2, fig. 93). Allow about 2 feet of wire on the running end to make a wrap around the standing end.

e. Wrap the running end of the wire around the standing end, using four open wraps and five closed wraps (3, fig. 93).

f. On the second pole, attach a wire puller to the pole and to the other end of the suspension strand. Pull the suspension strand tight.

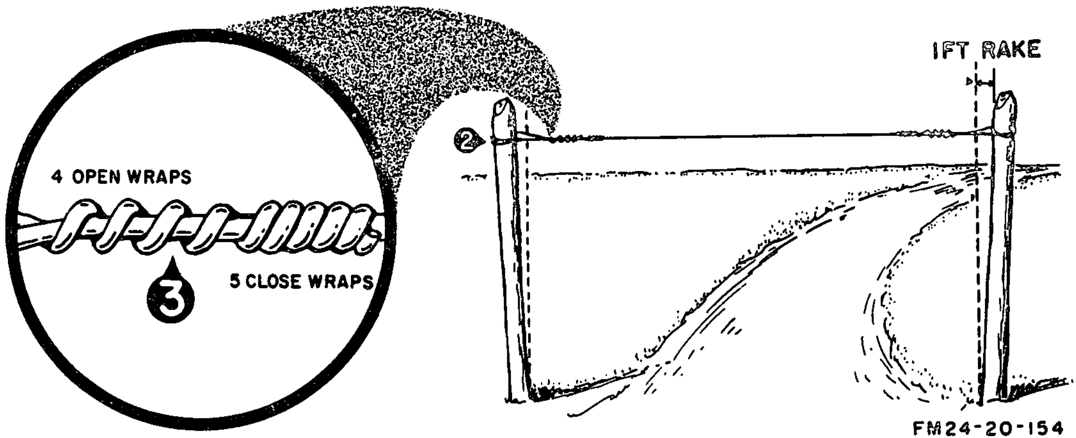

Figure 93. Constructing a span for five cables.

g. Tie the wire to the second pole in the same manner as in *d* and *e* above.

98. Constructing Span to Support More than Five Cables

The overhead span to support more than five cables is made in the same way as the span described in paragraph 97. However, the span to support more than five cables will require guy wires (fig. 94). To make the guys:

a. Cut four pieces of wire. Each piece should be three times the length of the pole to be guyed.

b. Secure four logs, from 3 to 4 feet long, to be used as deadmen. Discarded telephone poles can be cut up to be used as deadmen.

c. Dig a hole for each deadman. These holes should be about 8 feet from the pole to be guyed, and at a 45-degree angle from a straight line between the two poles (fig. 94).

d. Wrap a wire (*a* above) twice around the middle of a deadman. Leave enough slack on the tied end, so that 3 feet will remain above ground after the deadman is buried.

e. Bury the deadman and backfill the hole.

f. Take the guy wire to the top of the pole, pull it tight, and wrap it around the pole three times. As each wrap is made, drive a nail under the wrapped wire, and clinch the nail over the wire to keep it from slipping.

g. Bring the remaining wire down to the anchor wire (*d* above), and splice the ends; use a sleeve splice or Western Union Splice (5, fig. 94).

h. Construct the other three guys in the same manner.

99. Placing the Cables on the Overhead Span

After the overhead span has been completed, install the cables on the span. Place the cable on overhead spans as follows:

a. Drive a J-hook in each pole, just under the support wire (1, A, fig. 95).

b. Lay the cable up to the bottom of the first pole, and secure it to the pole with a cable clamp or basket hitch tie (2, A, fig. 95).

c. Unreel enough cable to hang on the span, and add 10 feet as slack. For example, a span of 60 feet on poles 20 feet high, would require 110 feet of cable: 60 feet for the span, 40 feet to reach up and down the poles, and 10 feet for slack.

d. Move the cable reel across the road (4, A, fig. 95).

e. Use a basket hitch tie to secure a handline to the cable.

f. Throw the handline over the support wire, pull the cable up the support pole, and place the cable in the J-hook (5, A, fig. 95).

g. Attach the cable to the support wire, using a cable hanger or patent ring (6, A, fig. 95).

h. Place the hand line in the J-hook on the second pole (7, A, fig. 95).

i. Pull the cable approximately 10 feet; there, use a cable hanger to attach the cable to the support wire (8, B, fig. 95).

j. Continue the procedure in *i* above until the span is completed.

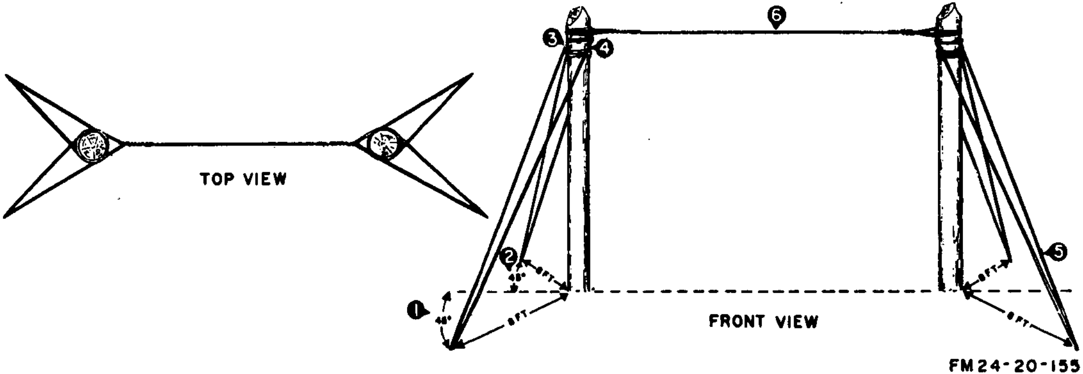

Figure 94. Constructing a span for more than five cables.

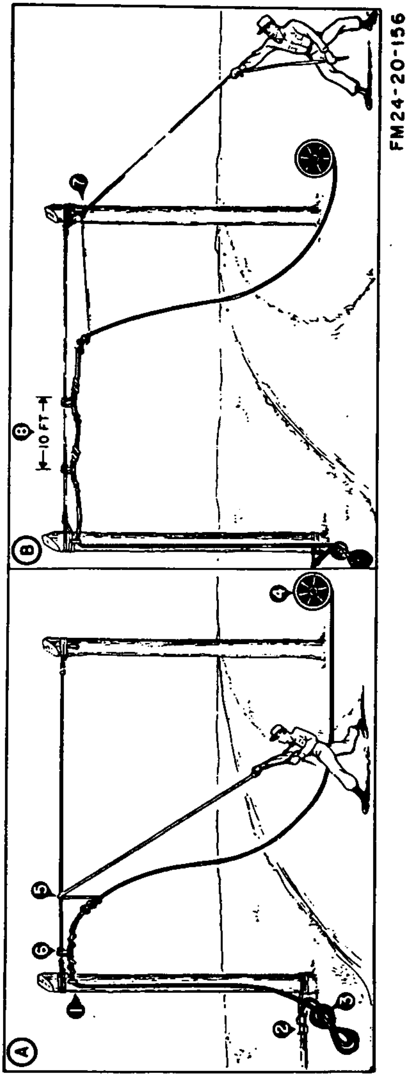

Figure 95. Placing the cable on the span.

k. Pull in all slack, and use a cable clamp or basket hitch tie to secure the cables to the bottom of the second support pole.

100. Railroad Crossings

At a railroad crossing, the cable should be laid between two ties under the rails. Proceed as follows:

a. Lay the cable line up to the roadbed of the railroad.

b. Unreel enough cable to reach across the railroad.

c. Remove the ballast stones from between two railroad ties.

d. Pull the cable between the two ties, under the rails.

e. Cover the cable with the ballast stones removed in *c* above.

f. Bury the cable on both sides of the tracks to the edge of the roadbed. This will protect the cable from the hot coals dropped by passing engines.

g. If the cable cannot be laid under the rails, construct a span to support the cables overhead. Overhead spans were explained in paragraphs 98 and 99. However, the clearance over railroads is 27 feet, instead of 18 feet.

101. Testing and Connecting Cable Sections

As soon as the cable dispensing teams begin to lay the cable, the mobile test team moves along the cable line to test and connect the cable sections. The cable sections are tested and connected as follows:

a. The mobile test team moves to the end of the first section of cable, and tests it for opens, shorts, and grounds. If the test is negative, the team connects the first section of cable to the second section.

b. The mobile test team then moves to the end of the second section to test the connected cable sections for opens, shorts, and grounds. If the test is negative, the team connects the first two sections to the third section and moves to the end of the third section.

c. The above method is continued until all sections are tested and connected to form the cable line.

d. If one section tests positive for opens, shorts, or grounds, this cable section is repaired or a new section is substituted.

e. After all cable sections have been tested and connected, the cable is connected to the terminal equipment. The wire chief then makes a system test. When the cable system is in operation, the cable is placed on aerial supports.

Section II. A-FRAME CONSTRUCTION

102. General

a. There are two types of aerial supports that can be constructed to support spiral-four cable lines: A-frame construction and "hasty pole" construction. The type used will depend on the materials available to make the supports, the tools and equipment available, and the type of terrain on which the supports are to be installed.

b. The A-frame construction is more flexible than the "hasty pole" construction, because A-frames can be used on all types of terrain. The method for construction and installation of the A-frames will vary according to the number of personnel and amount of equipment available. In an ideal situation, construction work is conducted in one continuous operation; one team makes the supports, another team installs the supports, and the third team hangs the cable line on the supports. When personnel or equipments are limited, the construction can be done in stages. The frames are constructed during the first stage and installed during the second stage; the cable line is hung on the supports in the third stage.

103. Materials Required

The amount of supplies required to install the A-frames will depend on the length of the cable line. Each mile of A-frame construction will require the following supplies:

a. 55 A-frames.

b. 2 miles of copper wire W–145.

c. 3,000 feet of marline twine, copper wire, or field wire.

d. 100 stakes, 3-feet long.

e. 50 cable clamps.

f. In addition, construction of a cable line of any length will require one 2½-ton truck, one ¾-ton truck, and one Reel Unit RL–26–( ).

104. Building the A-FRAMES

An A-frame will require two supports (2 x 4's or poles) 20 feet long, a bolt (½ to ⅝ inches) 5 to 6 inches long, and one J-hook. Construct the frame as follows:

a. Cut the supports in 20-foot lengths.

b. Drill a hole two feet from one end of each support (1, fig. 96).

c. Lay one support on top of the other so that the holes match.

d. Insert the bolt through the holes and tighten the nut on the bolt (2, fig. 96).

e. Drive the J-hook 6 inches from the top of one of the supports (3, fig. 96). If more than five cables are to be supported, drive another J-hook in the other support, so that one-half of the cables can be hung on each side of the frame.

105. Laying the Support Wires

Lay the support wires from Reel Unit RL–26–( ), as follows:

a. Mount the reel unit on the rear of the ¾-ton or 2½-ton truck.

b. Load the reel unit with Wire W–145.

c. Pay out some wire from the reel unit at the starting point, and tie the wire to a stake, post, or tree.

d. Pay out the wire as the truck moves along the cable route.

e. If more than 5 cables are to be supported, two support wires must be laid.

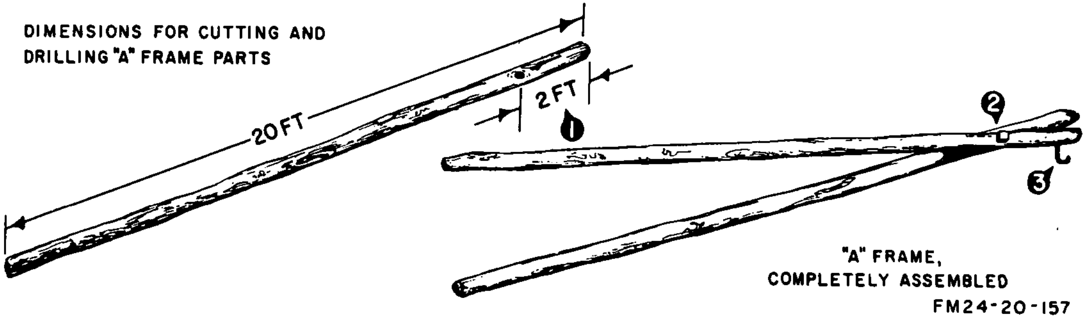

Figure 96. How to make the frames.

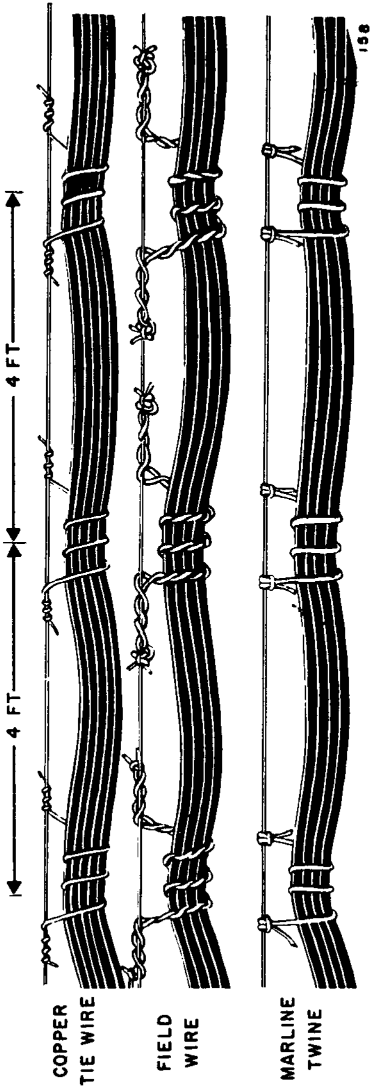

Figure 97. Tying the cables to the support wire.

106. Tying the Cables to the Support Wires

a. As the wire-laying team lays the support wires, another team ties the cables to the support wires. Figure 97 shows the proper method for tying cables to the support wire. Copper wire, field wire, or marlin twine can be used to make the ties.

b. The teams tying the cables to the support wire should also install tension bridges at points of interconnection of the cable sections. Tension bridges will relieve the strain on the connectors; provide slack for replacing a damaged cable section; permit the insertion and removal of loading coils; and permit access to the cable sections for testing purposes. Construct a tension bridge as follows: (fig. 98)

(1) Cut a 6-foot piece of marlin twine or field wire.

(2) Loop the cable at the connectors, as shown in figure 98.

(3) Begin a basket hitch tie with the twine or field wire, one foot from the center of the loop (3, fig. 98).

(4) Complete the basket hitch tie in the center of the loop, as shown in 4, figure 98.

(5) Install a basket hitch tie on the other cable in the same manner, and tie the two ends in a square knot (5, fig. 98).

(6) Use the remainder of the twine or wire to support the loop, as shown in 6, figure 98.

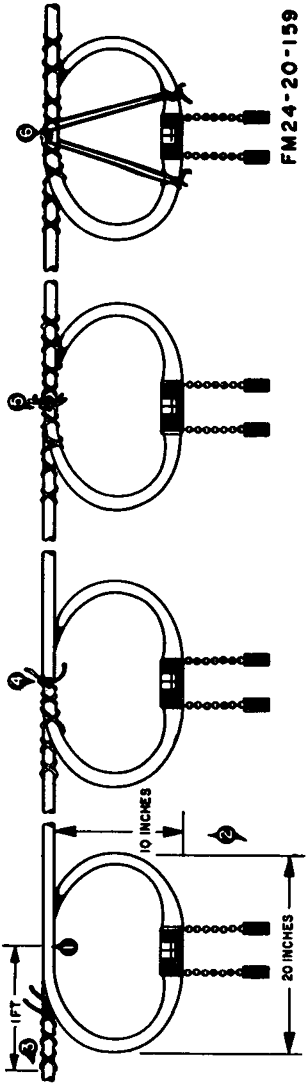

Figure 98. Steps in making a tension bridge.

107. Surveying the Line

The A-frames are built; the support wires are laid; the cables are tied to the support wires; and then, the line is surveyed. The construction team that performs the survey must be provided with marker stakes, hammers to drive the stakes, three range rods, and a 150-foot measuring tape. Survey the line as follows:

a. Drive the first marker stake at the exact location of the first A-frame.

b. Measure the distance for the first span (125 feet or less than 10 cables; 100 feet for more than 10 cables). At this point, drive the second marker stake.

c. Measure the distance for the third span, and line the stakes as shown in figure 99. (Lining the stakes must be done with care, since an A-frame out of line will collapse under the weight of the cable.)

d. Continue the lining procedure, as explained above, until the line is completely surveyed and all marker stakes are placed and driven.

108. Installing Terminal A-Frames

As soon as the survey team has driven several marker stakes, a construction team can begin installation of the A-frames. The A-frames installed at the terminals of the cable line are constructed as double frames (fig. 100). Double A-frames are required to support the weight and strain of the dead-end cables. Double A-frames are installed as follows:

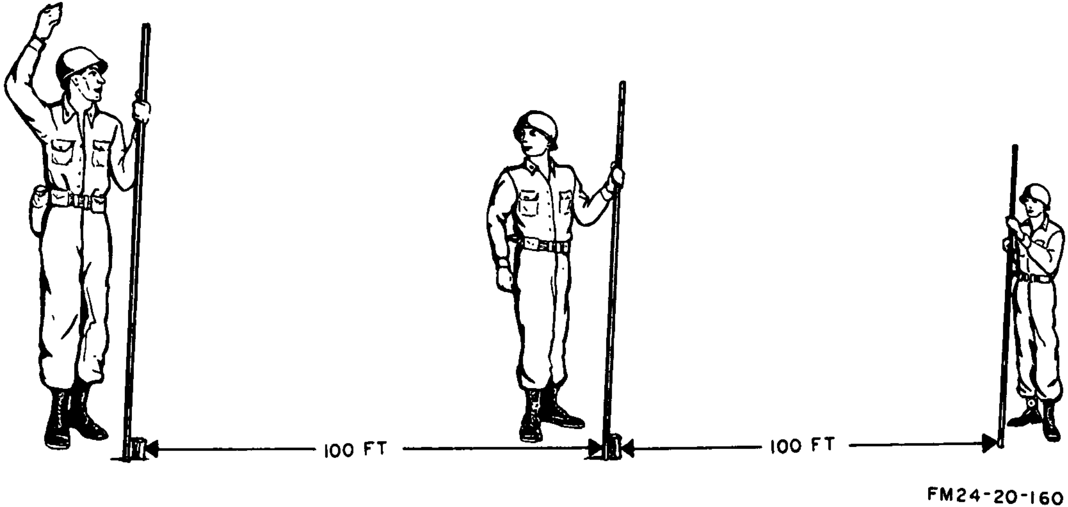

Figure 99. Lining up the marker stake.

a. Place the first A-frame directly above the first marker stake and perpendicular to the line of marker stakes (1, fig. 100).

b. Place the second A-frame under the first A-frame and in line with the marker stakes (2).

c. Drive an anchor stake behind each leg of the double A-frame to prevent the legs from slipping (3).

d. Drive a nail in each leg of both A-frames approximately 3 feet above the ground.

e. Wrap a piece of wire around each leg, under the nail; pull the wire tight, and splice (4).

109. Installing the Intervening A-Frames

All of the intervening A-frames are installed as single A-frames (fig. 101). Single A-frames are installed as follows:

a. Extend the legs of the A-frame as far as possible, and place the frame against the marker stake and perpendicular to the line of marker stakes (1).

b. Cut a piece of wire (W–45) about 50 feet long.

c. Loop the wire around the A-frame, so that approximately 25 feet of the wire extends on each side of the A-frame.

d. Drive an anchor stake 17 feet from, and on each side of, the marker stake (3).

e. Tie the ends of the anchor wire to each anchor stake (3).

f. Push the legs of the A-frame together until the anchor wires (4) become tight. The legs of

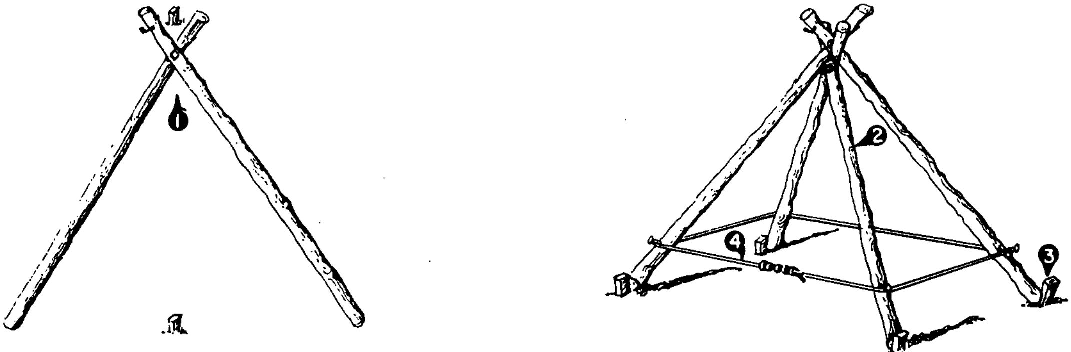

Figure 100. Installing the terminal A-frames.

the A-frame should be about 20 feet apart at ground level.

g. Drive an anchor stake (5) behind each leg of the A-frame to keep it from sliding.

h. Remove the marker stake. (This stake can be used as an anchor stake in later installations.)

i. Erect all intervening A-frames in the same manner.

110. Hanging the Cable

After a few A-frames are installed, another construction team can begin to hang the cables on the A-frames. The cable-hanging crew will require two wire pikes and two handlines (approximately 50 feet long). The cable-hanging operation can be expedited by using a Line Construction Truck V–17/MTQ, since the cables can be hung by hand from the top of the platform mounted on the truck box. The procedure below is a method of hanging cables when the construction truck is *not* used.

a. Tie the cables and support wire to the base of the first (terminal) A-frame.

b. At the first and second A-frames, loop the hand-lines under the support wire to form a double line.

c. Loop the double line over the J-hooks on both the first and second A-frames.

d. Pull the cables to the top of the first A-frame, but only half-way up on the second A-frame (2 and 3 fig. 102).

e. Using the wire pikes (4), place the support wire in the J-hook on the first A-frame.

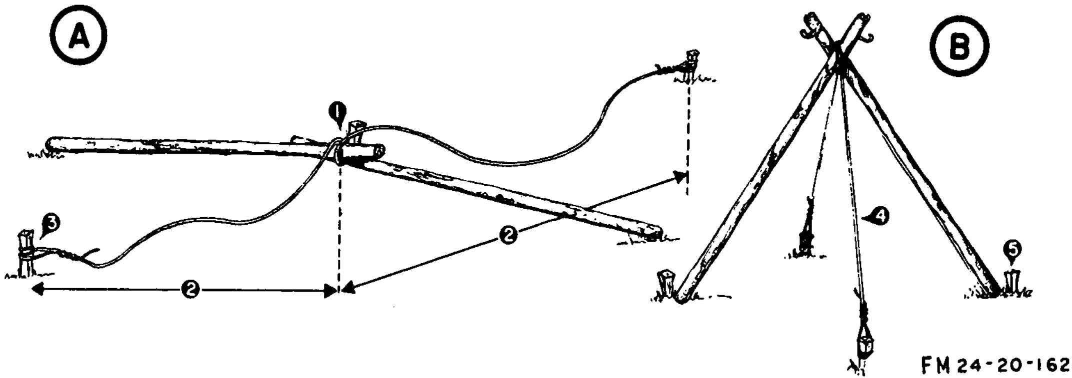

Figure 101. Installing the intervening A-frames.

f. Release one end of the double handline, and pull the other end until the handline falls free from the cable support wire.

g. Adjust the cables on the second A-frame to leave 2 feet of sag between the first and second A-frames. When the spans between A-frames are 125 feet long, leave 3 feet of sag. Tie the cable support wire in place by using a cable clamp or basket hitch tie.

h. Hang the cables on all other A-frames, and tie the cable support wires in place in the same manner as outlined above.

i. While the cable-hanging crew is hanging the cables on the A-frame, other personnel can dig a trench and bury the cables from the first A-frame to the terminal equipment.

111. Mounting the Unattended Repeaters

When required on cable lines, unattended repeaters are mounted on supports by the cable-hanging crew. To provide these supports, use a specially constructed frame made with two regular size A-frames. Construct the mountings as explained below, and as illustrated in figure 103.

a. Extend the legs of the two A-frames, and place them flat on the ground (A, fig. 103).

b. Cut two pieces of 2 x 4 lumber two feet longer than the repeater.

c. Nail the first 2 x 4 to one leg of each frame, 2½ feet below the bolted joint of the frame (1, A, fig. 103).

d. Nail the second 2 x 4 parallel to the first

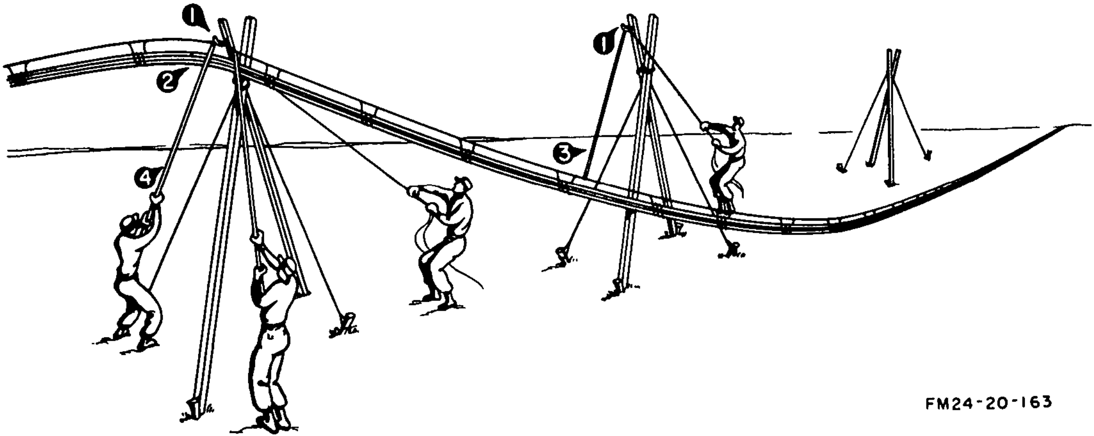

Figure 102. Hanging the cables.

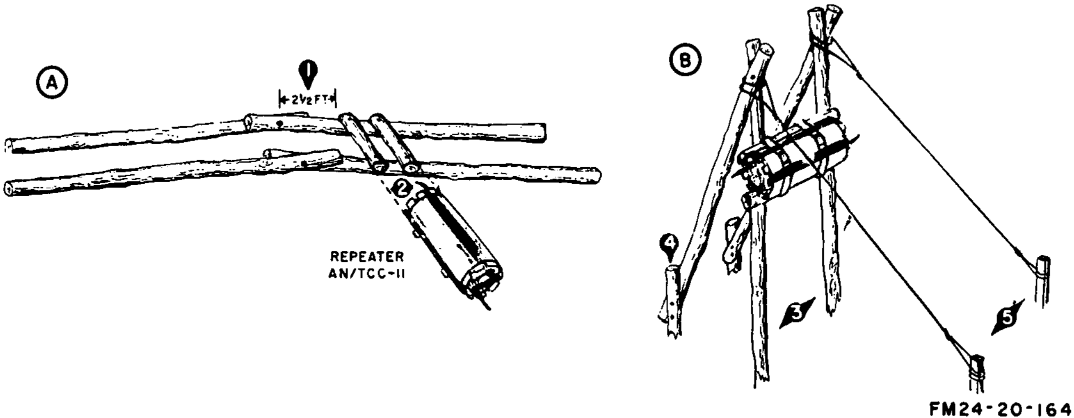

Figure 103. Mounting the unattended repeaters.

2 x 4, separating them by the distance equal to the width of the repeater (2, A, fig. 103).

e. Cut two pieces of guy wire (W–145) 22 feet long, and tie one piece to each frame at the joint.

f. Lift up the frames (B, fig. 103) so that the legs on which the cross pieces are nailed are vertical.

g. Drive two anchor stakes as shown in B, figure 103, and nail the free legs of each frame to the anchor stakes (4, B, fig. 103).

h. Drive two other anchor stakes into the ground, 12 feet from the base of the upright legs of the frames; tie the guy wires as shown in 5, B, figure 103.

i. Mount the repeaters on the crosspieces, using a web strap to secure the repeaters to the crosspieces (B, fig. 103).

j. Ground the repeaters (par. 123).

Section III. "HASTY POLE" CONSTRUCTION

112. General

The "hasty pole" type of construction is practical for erecting supports for spiral-four cable lines; however, it is not suitable for use in rocky or swampy terrain. Since the poles used in the "hasty pole" method are much smaller than those used for normal pole line construction, "hasty pole" construction progresses at a faster rate. The procedures used in this type of construction will vary according to the situation, but the information given in paragraphs 113 through 124 will aid in setting up procedures for "hasty pole" construction.

113. Materials Required

The following supplies and equipment are needed to erect supports in the "hasty pole" type of construction.

a. Supplies required to construct one mile of "hasty pole" line are—

(1) 55 poles, class 9 or smaller, 20 feet long.

(2) Two miles of wire W–145.

(3) 1,325 cable rings or cable hangers.

(4) 50 cable clamps.

(5) 3,000 feet of copper tie wire, marline twine, or field wire.

(6) 110 (30d) nails.

(7) 10 drive hooks.

b. The following equipments are required for a line of any length:

(1) One line construction truck V–17/MTQ.

(2) One earth auger truck V–18/MTQ.

(3) One 2½-ton truck.

(4) One ¾-ton truck.

114. Organizing the Construction Teams

There are six main jobs in the construction of a "hasty pole" spiral-four cable line, and there are enough personnel in a construction platoon to organize six teams to perform each job concurrently. Each team is organized to accomplish one of the following functions:

a. Provide the poles.

b. Survey the line.

c. Deliver the poles along the cable route.

d. Dig the holes, set the poles, and lay the support wires.

e. Tie the cables to the support wires.

f. Hang the cable.

115. Providing the Support Poles

The best source of poles is any wooded area that may be near the cable route. The trees selected should be tall enough to provide a pole 20 feet long and at least 4 inches in diameter at the top. There should be at least six to eight men on this team, and they should be briefed thoroughly on safety precautions before they cut down any trees. The following points should be stressed in this briefing:

a. Always work in pairs.

b. Work in a straight line, and stay far enough from the pairs on each side to insure that trees will not fall on you.

c. When notching a tree, swing the axe away from your body and not in the direction of any other member of the team.

d. Notch the tree on the side toward the direction of fall.

e. Use axes to cut the notch about half way through the tree; then use the cross-cut saw to complete the cut from the opposite side of the tree.

f. As the tree begins to fall, drop the saw, move about 20 feet in the opposite direction from the tree fall, and shout, "Timber." This will warn other personnel to get out of the way of the falling tree. (DO NOT TRY TO REMOVE THE SAW FROM THE CUT WHILE THE TREE IS FALLING. The saw can be recovered after the tree falls.)

g. Trim all branches from the first 20 feet of the tree; cut the tree at this point to provide a 20-foot pole.

116. Surveying the Line

While one team is cutting the poles, another team should begin a survey of the line. The line is surveyed, and the marker stakes are set in the same manner as was done for A-frame construction (par. 107).

117. Distributing the Poles

If the 2½-ton truck can be driven through the forest, the pole distributing team can pick up the poles where they were felled; otherwise, the poles must be dragged or carried to an assembly area at the edge of the forest.

a. Load the poles on the truck, and deliver one pole to each marker stake. Lay the pole 10 feet from the marker stake to provide room for the earth auger truck to dig the hole.

b. After each pole is unloaded, it must be prepared for use as a support.

(1) Drive a J-hook, 6 inches from the top, into each of the dead-end poles.

(2) Drive two 30d nails into each of the other poles; one nail should be 8½ feet from the bottom of the pole, and the other 6 inches from the top of the pole.

(Both nails should be on the same side of the pole, driven in at a 45-degree angle from the top of the pole.)

118. Erecting the Support Poles and Laying the Support Wire

As soon as a few poles have been placed at marker stakes, the team erecting the poles and stringing the support wire can begin work. To erect the poles and lay the support wire, proceed as follows:

a. Mount a reel of wire (W–145) on the side of the Earth Auger Truck V–18/MTQ, as shown in figure 104.

b. Dig a pole hole, 4½ feet deep, 8 feet to the rear of the first marker stake. Place a short pole in the hole, backfill the hole, and tamp (1, fig. 104).

c. Dig a hole, 4½ feet deep, at the first marker stake, and set the first support pole in the hole (2 and 3, fig. 104).

d. Rake the pole one foot toward the anchor stake or terminal equipment, backfill the hole, and tamp (fig. 104).

e. Tie the support wire (W–145) to the first support pole at a point about 4 feet above the ground. Leave from 6 to 8 feet of extra wire on the running end (1, fig. 105).

f. Move the truck to the next marker stake. Note that the truck pays out the support wire as it moves from pole to pole (fig. 105).

g. Dig the second pole hole (2, fig. 105), set the pole (do not rake), backfill the hole, and tamp.

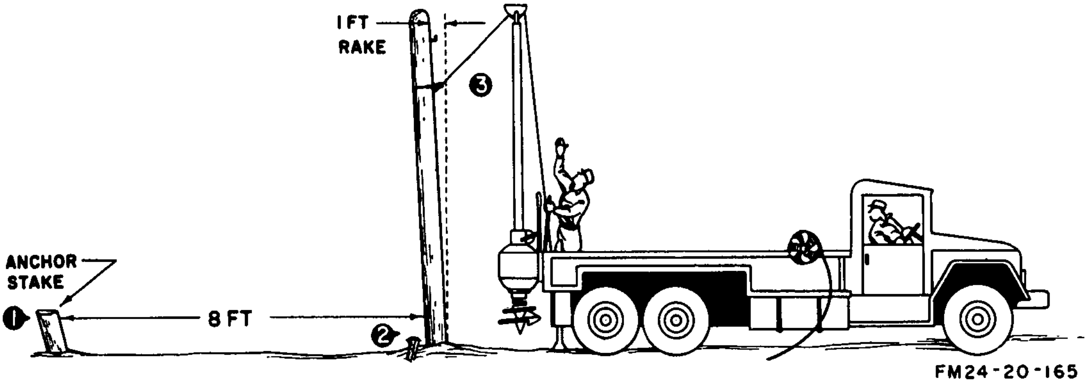

Figure 104. Digging the holes and setting terminal poles.

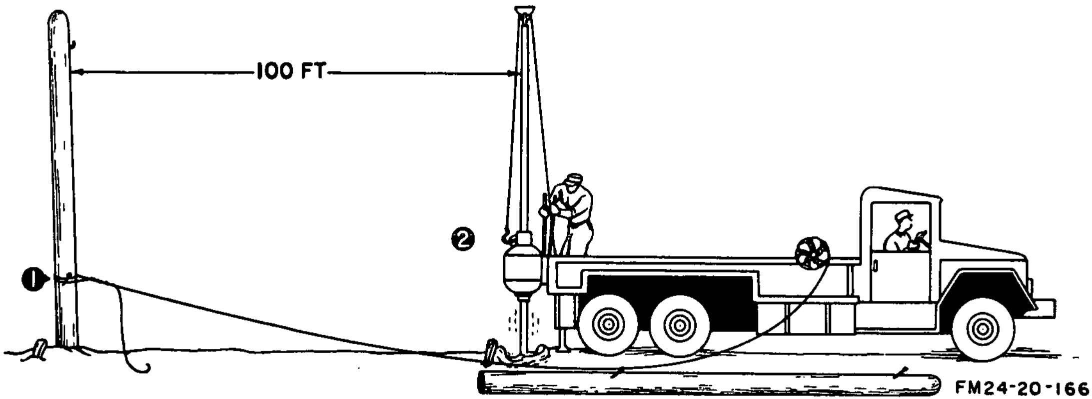

Figure 105. Digging holes and setting intervening poles.

All intervening poles (between the dead-end poles) are set in this same manner.

h. At the far end of the cable line, rake the last (terminal) pole one foot toward the terminal equipment, and place an anchor stake 8 feet from the base of the pole (*b* above).

119. Guying the Terminal Poles

The guys for the terminal poles are installed by the team that ties the cables to the support wire. The guy for the first pole can be installed as soon as the anchor stake and pole have been set and tamped. Install the guy as follows:

a. Cut a piece of wire (W–145) 40 feet long.

b. Loop one end of this wire twice around the anchor pole, and tie; leave about 3 feet of this wire on the running end.

c. Take the anchor wire to the top of the first support pole, and pull it tight; loop it twice around the support pole, 4 inches above the J-hook (1, fig. 106).

d. Bring the remaining wire down to the anchor stake, pull it tight and splice it to the 3 feet of wire on the running end (*b* above).

e. Place a stake or turnbuckle between the anchor wires at a point midway between the anchor and the top of the pole; turn the stake or turnbuckle until the anchor wire is tight (2, fig. 106).

120. Tying the Cables to the Support Wire

After the first pole has been guyed, tie the cables to the support wire. Proceed as follows:

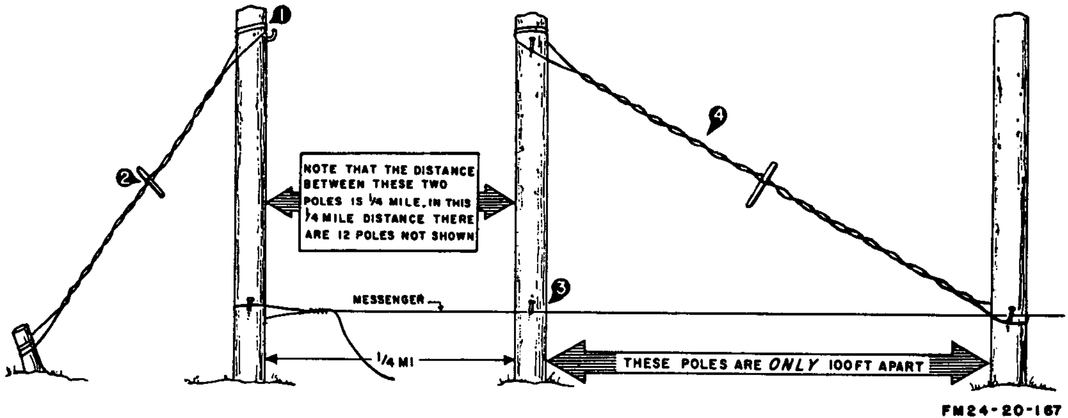

Figure 106. Installing head guys.

a. On the first six poles, lay the support wire on the 30d nails that are four feet above the ground (3, fig. 106).

b. At the sixth pole, use a wire-pulling block to tighten the support wire.

c. If there are more than three cables, tie the cables into a bundle.

d. Provide 30 feet of cable slack between the terminal equipment and the first support pole.

e. Tie the cables to the support wire (par. 106).

f. After the six-pole section is completed, use a second wire-pulling block, attached to the 12th pole, to pull the support wire tight. Disconnect the first wire-pulling block from the sixth pole. Tie the cables to the support wire between the sixth and 12th poles.

g. Continue to pull the support wire and tie the cables, as explained above, until the first 1/4 mile of cable section has been completed. At the end of each cable section (1/4 mile), install a tension bridge in the cable lines (par. 106).

h. Construct a temporary head guy between the two poles at the end of each 1/4-mile cable section (4, fig. 106).

i. Continue to pull the support wire and tie the cables until the cable line is completed.

121. Hanging the Cables

After the cable-tying team has completed its work on the first cable section (1/4 mile), the cable-hanging team can begin to hang the cables. Proceed as follows:

a. Untie the support wire from the bottom of the first pole, and take the support wire and the cables to the top of the first pole.

b. Attach a wire-pulling block to the top of the first support pole, and pull the support wire tight.

c. Wrap the support wire three times around the pole, just above the J-hook.

d. Tie the running end of the support wire to the standing end, using four open wraps and five closed wraps (1, fig. 107).

e. Tie the cables to the pole, just under the J-hook. Use a basket hitch tie or cable clamp (2, fig. 107).

f. Lash the cables to the pole, at four-foot intervals, with field wire or marlin twine.

g. Hang the cables on the 30d nails of the support poles, using the method outlined in paragraph 112.

h. At the end of each cable section (1/4 mile), attach a wire-pulling block to the pole with the temporary head guy.

i. Pull the cable support wire, and adjust the cable until there is a cable sag of one and one-half to two feet between each support pole.

j. Leave the wire-pulling block attached to the support wire, and hang the next cable section (1/4 mile); attach a second wire-pulling block to the support wire, and pull and adjust the cable sag on the second section of cable line. Remove the first wire-pulling block. Continue the adjustment for sag for each section of cable until the line is completed.

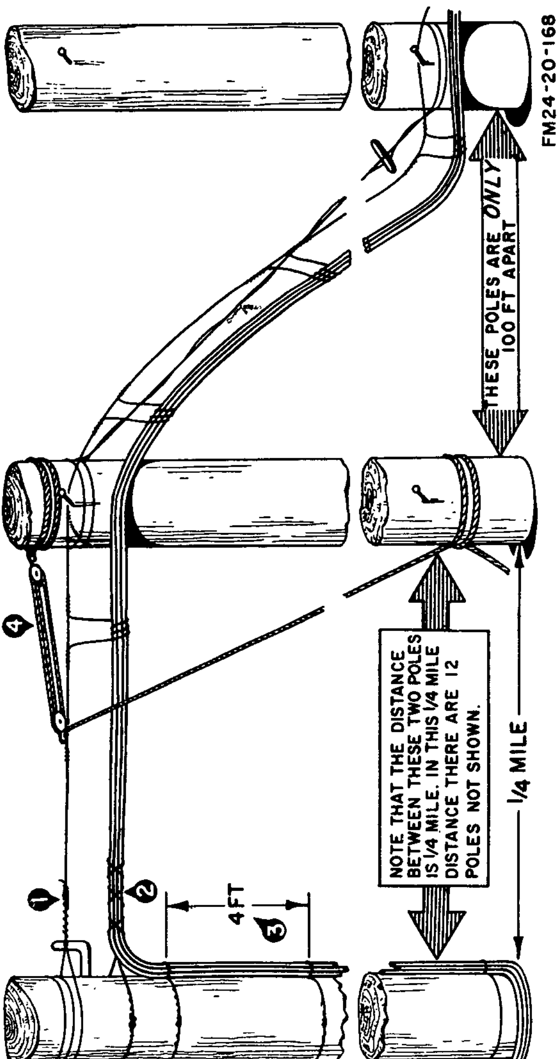

Figure 107. Hanging the cable.

122. Mounting the Unattended Repeaters

To mount unattended repeaters, on support poles, proceed as follows:

a. Drive two J-hooks into the support pole on which the repeater is to be mounted. One J-hook should be placed about three feet below the cable support wire, and the other about five feet below the cable support wire (1 and 2, fig. 108). Both J-hooks should be on the same side of the pole.

b. Pass a web strap through each of the two brackets on the one side of the repeater case (3, fig. 108).

c. Using a block and tackle, pull the repeater up the pole on the opposite side from the J-hooks. (Be sure that the "J1" end of the repeater faces up.)

d. Pull the web straps, attached to the repeater in *b* above, around the pole and through the J-hooks; then, pull the straps tight (5, fig. 108).

123. Grounding the Repeater

The repeater must be grounded to protect it, and the personnel who maintain it, from surges of electrical current caused by lightning or other sources (6, fig. 108). Ground the repeater as follows:

a. Dig a hole, six inches deep, near the base of the pole.

b. Drive a ground rod into the ground at the bottom of the hole. Only three inches of the rod should extend above the ground at the bottom of the hole.

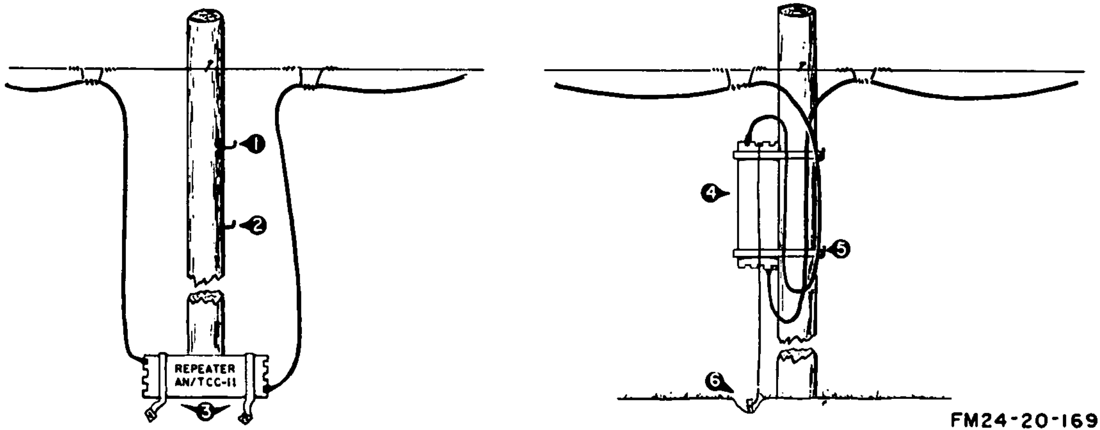

Figure 108. Mounting the unattended repeaters.

c. Cut a piece of wire (14-gauge or larger) long enough to reach from the "J1" end of the repeater to the ground rod.

d. Connect one end of the ground wire to the binding post on the repeater, and connect the other end to the ground rod.

e. Saturate the ground around the ground rod with water.

124. Cable Line Maintenance

a. Maintenance begins immediately after the cable lines are installed. Maintenance teams inspect the cable lines daily and repair defects. These teams check—

(1) Posts, anchor stakes, and A-frames for signs of rotting.

(2) Guys and support wires for weakness and sag.

(3) Cable under cable clamps and basket hitch ties for cuts.

(4) Tension bridges to insure that the cable has not slipped, thereby causing sharp bends in the cable.

b. When maintenance patrols find that cable lines are damaged, they must make repairs immediately. These patrols carry the necessary equipment to—

(1) Remove damaged poles. A new pole is installed beside the damaged one, and the damaged pole is removed.

(2) Support weak A-frames. A new A-frame is installed under the weak one (par. 108 and fig. 100).

(3) Reinforce or replace weak guys.

(4) Tape all cuts in the cable. If the cuts are under ties or cable clamps, the tie or clamp is removed, the cable is taped, and the tie is retied or the cable clamp is re-installed.

(5) Retie all slipped tension bridges. A wire-pulling block is attached to the cable to provide slack, and the tension bridge is unfastened and remade (par. 106*b*).

CHAPTER 10

MAINTAINING FIELD WIRE LINES

125. General

Maintenance of field wire lines includes both the prevention and the correction of circuit failures. Prevention of troubles on wire lines and equipment begins with the careful planning and selection of wire routes, and continues with the installation of a system that uses approved methods of construction. Troubles will occur, however, regardless of the care with which the circuits are installed. To efficiently diagnose and correct circuit failures, maintenance personnel should know the various troubles common to field wire lines and their effect on circuit quality and speech transmission.

126. Common Troubles of Field Wire Lines

Trouble can occur either in the wire line or in the terminal equipment connected to the line. Wire circuit failures include open circuits, short circuits, grounded circuits, crossed circuits, or combinations of these defects at one or more points in the circuit. These common troubles are shown in figure 109 and are defined as follows:

a. A short circuit, or *short,* occurs when the two conductors of a pair come in electrical contact with each other. Shorts are usually the result of bruised or stripped insulation.

b. An open circuit, or *open,* is a break or cut in one or both conductors of a pair. It occurs most frequently on long-span overhead construction or at other points subject to strain.

c. A grounded circuit, or *ground,* occurs when one or both conductors of a circuit come in electrical contact with the ground or a grounded object. Grounds are the result of bruised insulation or poorly made splices. They occur most frequently during rainy weather or when the line is installed in wet or damp areas.

d. A crossed circuit, or *cross,* exists when two conductors, each of a different circuit, are in electrical contact with each other. It occurs most frequently in field wire cables supported on overhead spans or at points where multipair wire lines converge or are installed along the same route.

127. Symptoms of Troubles on Field Wire Lines

Field wire troubles can exist in various degrees of severity. For example, opens and shorts can cause intermittent troubles that are often very difficult to locate. In this case, the wireman must utilize knowledge in the employment of test instruments and logical troubleshooting procedures to determine the nature and location of the trouble.

a. An open disrupts communication completely. An intermittent open, caused by a poorly made splice or loose contact introduces a high resistance in the circuit. It may be possible to communicate

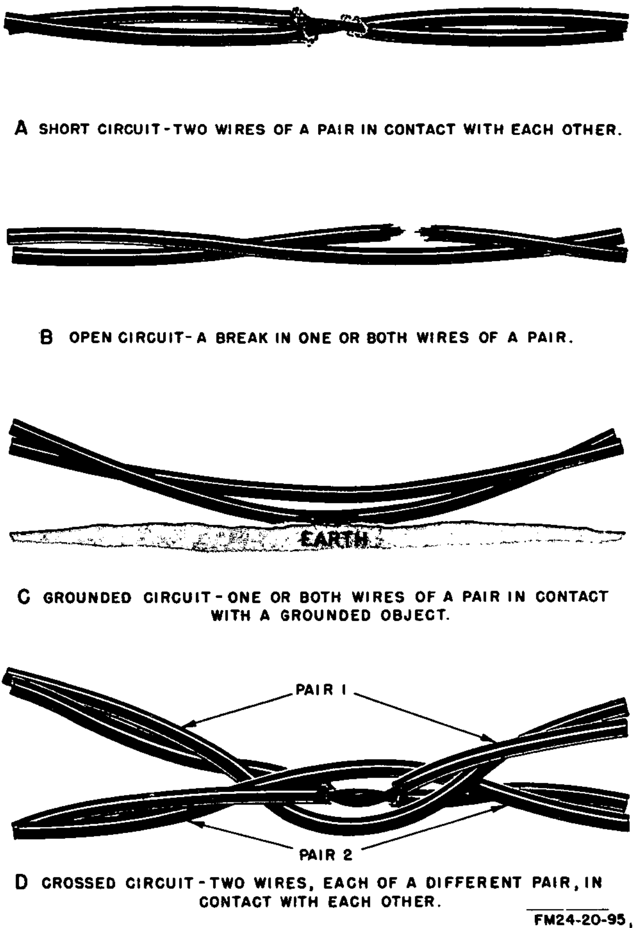

Figure 109. Common troubles in field wire lines.

over a highly resistive circuit, but the transmission is usually weak and noisy.

b. A complete (low resistance) short will disrupt communication completely. A partial (high resistance) short, however, usually causes weak transmission and signaling.

c. A ground on both sides of a circuit will produce the same effect as a short. Usually, a ground occurring on one side of a circuit will not interrupt communication; however, it will introduce hum or noise in the circuit.

d. A cross usually causes cross talk or interference between the two crossed circuits. This cross talk or interference could make the separate conversations unintelligible.

128. Methods of Testing Field Wire Lines

a. Test During Construction. Field wire should be tested before installation to determine its condition and serviceability. While constructing a line, tests are made after every underground installation, after every overhead span, at the end of each reel length, and before connecting the line to the terminal equipment. Testing during construction will disclose troubles that might have developed during the wire-laying operation.

b. Routine Testing. Proper maintenance requires routine tests to be conducted at regular intervals on all working circuits and equipment. The frequency of these routine tests will vary according to the nature and importance of the circuits, the equipment, the type of installation, the amount of traffic handled, and the amount of trouble experienced. Communication is never interrupted to make a routine test. Routine tests should be made by maintenance personnel during the slack traffic periods. These tests must include all operating functions normally required of the circuit and equipment.

c. Troubleshooting. Tests are conducted when trouble is reported or detected on a circuit. The wireman must quickly analyze the fault, determine its location, and clear the trouble with the least possible interruption of service. High-priority circuits are rerouted, or spare lines, along the same route, are put into service at patch panels or test points.

d. Testing Wire Lines. Tests are usually made from the construction center, test station, or switching central. The test equipment used with field wire installations is described in chapter 11. If no test equipment is available, a field telephone can be used to determine several types of trouble in field wire circuits and equipment.

(1) *Test for open.* Connect the ends of the circuit to be tested to the line terminals of the test telephone. Turn the generator crank of the telephone rapidly. If the crank turns freely without drag, the circuit is open.

(2) *Test for short.* Connect the ends of the circuit to the line terminals of the test telephone. Turn the generator crank of the telephone rapidly. If the crank turns hard with a heavy drag, a short or ground exists on both sides of the circuit.

(3) *Test for ground.* Connect one conductor of the circuit to one line terminal of the test telephone. Connect the other line terminal on the telephone to a ground stake. If there is a ground on that side of the circuit, the generator will turn hard as in the case of the short. Test the other side of the circuit in the same manner.

(4) *Test for cross.* Connect *both* conductors of the first circuit to one line terminal of the telephone and *both* conductors of the second circuit to the other line terminal of the telephone. Turn the generator crank. The generator should turn as freely as on an open circuit. If it does not, the circuits are crossed.

129. Locating and Clearing Trouble

a. Localizing Trouble. After it is verified that there is trouble on the line, it is necessary to test and localize the defect to an equipment or particular section of a circuit. Further tests are made within the section until the trouble source is located. Before testing a line, always check the circuit to determine whether or not it is in use. Never open a circuit that is in operation.

b. Wire-Line Troubles.

(1) *General.* If tests indicate that the trouble is in the wire line, the wireman should determine accurately the nature and approximate location of the fault. Often, information such as the type of

terrain over which the wire is laid, unusual troop activities, or shellfire in an area, will aid the repairman in locating the trouble.

(2) *Preliminary checks.*

(*a*) Normally, a wire team physically inspects a line route with the required maintenance equipment. The wire line should be carefully examined with particular attention to—

1. Condition of the insulation and splices.

2. Underground and overhead crossings.

3. Ties on swaying trees.

4. Places where the wire has been run over or pulled out of place by vehicular traffic.

(*b*) Bruised insulation, poorly made splices, and other possible trouble spots are repaired and tested along the route. If no obvious troubles are found, tests are made at frequent intervals along the line to the terminal testing point.

(3) *Tests.* When possible, always open a circuit at a splice or at a test point nearest a terminal end. Tape all points where the insulation of the line was pierced or removed during a test. If each test proves that the line is serviceable toward the terminal testing point, the trouble exists farther out along the line. If the repairman can not communicate with the terminal test point, he has passed the

trouble and, therefore, should work back along the line, dividing in half the distance between successive tests. Since a defective circuit could have trouble at more than one point, it is essential that the repairman make a complete circuit test after removing each trouble.

(*a*) When checking for an open circuit, the test equipment can be connected across the circuit without cutting the wire line.

(*b*) When checking for a ground or short, it will be necessary to cut the line.

(4) *Visual inspection.* Testing at too frequent intervals at the start of the troubleshooting procedure can delay detection of the line trouble. Considerable time is spent in splicing the circuit after tests are made for shorts and grounds. A visual inspection of the wire lines often will disclose the trouble sooner. However, if any long section of the line cannot be inspected visually, tests should be made at each end of that particular section.

c. Equipment Trouble. If it is determined that the trouble is in the terminal equipment, prescribed tests are given in accordance with procedures listed in the technical manuals on the specific equipment. Equipment repairs will be performed only by qualified personnel at the proper repair echelon.

d. Patrolling Wire Lines. In certain critical areas, the routine maintenance testing of a wire line is commonly supplemented by the use of patrols that inspect these sections of the line that are most subject to damage. When possible, the wiremen who constructed a given section of a line should also be assigned the mission of patrolling that section. Wire patrols repair trouble where needed, replace poor splices or sections of the line, tape any insulation abrasions, and generally improve the line construction.

130. Use of Test Stations in Testing Field Wire Lines

a. General. Test stations are installed on a wire line to simplify the testing and rearranging of circuits. A test station is usually given a geographic designation. The equipment used at these points is Terminal Strip TM–184 (fig. 124). Test stations are usually located:

(1) At points where circuits diverge.

(2) At the end of a wire line that does not terminate in a switchboard.

(3) Near points where circuits are most exposed to damage.

(4) At probable future locations of command posts.

(5) At other convenient points along the line.

b. Construction of Test Stations. The site selected for a test station should afford concealment and cover from hostile observation and fire. In addition, it should be readily accessible for testing purposes. A test station consists of one or more terminal strips fastened to a tree, fence post, or other support. The wire circuits at a test station are tagged and tied before being connected to the binding posts of the terminal strip. The circuits are connected in numerical order, beginning at the top with the lowest numbered circuit. A test station can be installed after initial installation of the wire lines, but this should be done without any interruption to communication service.

c. Removal of Test Stations. When a test station is to be abandoned, the usual practice is to leave the terminal strip connected. If the test station is removed, the circuits must be spliced. The removal of test stations should be accomplished without interrupting communications.

d. Conversion of Test Stations to Telephone Centrals. Command posts are often established at a former test station location. When converting a test station into a telephone central, it is important that the wire lines be placed overhead or buried, and that the switchboard be set up as near the test station as possible to simplify the cutover. The terminal strips which were used at the test station can be utilized as a main distributing frame for the switchboard or serve as part of a construction center for a switching central. When the transfer is completed, the operator should check the circuits and notify the units concerned that the conversion has been completed.

e. Cross-Patching Circuits. The cross-patching of circuits at test stations or switching centrals frequently allows communications to be maintained during the troubleshooting period.

For example, assume that two telephone centrals are connected by two circuits passed through a common test station; one circuit has trouble on the near side of the test station, and the other circuit has trouble on the far side. To re-establish one serviceable circuit, take the good section at each side of the test station and connect (cross patch) the sections together. Restore the original connections after the repairs have been made.

131. Records Used for Troubleshooting

It is essential that various installation and maintenance records be maintained. These records, which include line route maps, circuit diagrams, and traffic diagrams, must show all changes in a wire line throughout its operation. In addition, trouble reports, test records, and work schedule rosters are maintained when necessary.

CHAPTER 11

COMMUNICATION EQUIPMENT USED IN FIELD WIRE SYSTEMS

Section I. INTRODUCTION

132. General

This chapter is a review of the communication equipment used in field wire systems. The information is limited to a brief description of individual items of equipment. For more detailed information on any specific equipment, refer to the technical manual or other publication on that item.

133. Power Supplies

a. General. Most of the portable communication equipments described in this chapter require a power source. In some instances, this power source might be a battery pack—in others, a gasoline engine-generator, or a centralized power source.

b. Battery. When the communication equipment requires battery power, be sure to check the equipment manual for the proper battery nomenclature. When the specific battery or batteries are not available, consider the following factors before selecting a substitute:

(1) Voltages required.

(2) Minimum power requirements. (Battery life is affected by the equipment current drain.)

(3) Physical size of battery in relation to the space available in the equipment battery compartment.

(4) Type of battery connections on the equipment.

c. Other Power Sources. Equipments requiring a steady power supply over a long period of time usually use a centralized power source or a gasoline-engine generator. The equipment load must not exceed the capabilities of the power source. Before attempting to connect any equipment, check the power output of the power source against the required power input of the equipment.

Section II. FIELD TELEPHONES

134. General

a. Field telephone sets are portable, self-contained equipments designed for field use. These sets combine durable construction with portability. The selection of a specific field telephone depends on length and type of circuit and the type of switchboard used.

b. There are two principal types of field telephones; sound-powered and battery-powered.

(1) In a sound-powered telephone, the transmitter unit is the generator of the electrical energy. The sound waves created by the voice of the speaker strike the transmitter unit and are converted di-

rectly into electrical energy. The receiver unit of the distant telephone reconverts this electrical energy back again to the original sound waves. Sound-powered telephones, which have a shorter voice range than battery-powered telephones, can be used with or in place of local-battery telephones. However, sound-powered telephones cannot be used in common-battery systems.

(2) In a battery-powered telephone, small dry-cell batteries contained inside the telephone are used as a source of transmission power. When a battery-powered telephone is used in a common-battery system, dry-cell batteries inside the telephone may not (depending on the equipment) be necessary. Field telephones contain hand-operated magnetos or ringing generators for signaling. The incoming ringing signals are indicated audibly by a bell or buzzer, or visually by a light or noiseless signal device.

c. The talking ranges of the principal field telephones are summarized in the table below:

Field telephones	Talking distances, using Wire WD-1/TT (nonloaded)*	
	Wet conditions (miles)	Dry conditions (miles)
TA-1( )/PT	4	10
TA-312/PT	14	22
TA-264/PT:		
With amplifiers	33	60
Without amplifiers	12	18

* The above distances are approximate, since talking range is also affected by the following factors: number and quality of splices, weather conditions, number of switching centrals and test stations, noise cross talk, and other interference in a circuit.

135. Telephone Set TA-1( )/PT

a. Telephone Set TA-1( )/PT (fig. 110) is a sound-powered equipment, providing facilities for talking and signaling without batteries. The approximate talking and signaling range of the TA-1( )/PT is from 4 to 10 miles over Wire WD-1/TT. This telephone set can be used to advantage in forward areas, in switched networks having magneto signaling switchboards, in closed nets, and in point-to-point circuits.

b. The telephone handset contains sound-powered transmitter and receiver units, a hand generator that is operated by a lever-type switch, and a push-to-talk switch. The user can receive either visual or audible-visual signaling indications during operation.

c. To install the telephone, connect the field wire conductors to the binding posts on the terminal block at the end of the cord.

d. To signal the distant telephone, depress and release the generator lever. To silence the audible signal, turn the switch at the back of the set to OFF. The volume of the audible signal can be controlled by turning the switch to various settings between OFF and LOUD.

e. To talk to the distant station, press the push-to-talk switch. It is possible to hear the distant party faintly if he tries to interrupt while the push-to-talk switch is depressed, but it is necessary to release the switch to hear him clearly.

f. For further information, refer to TM 11–5805–243–12.

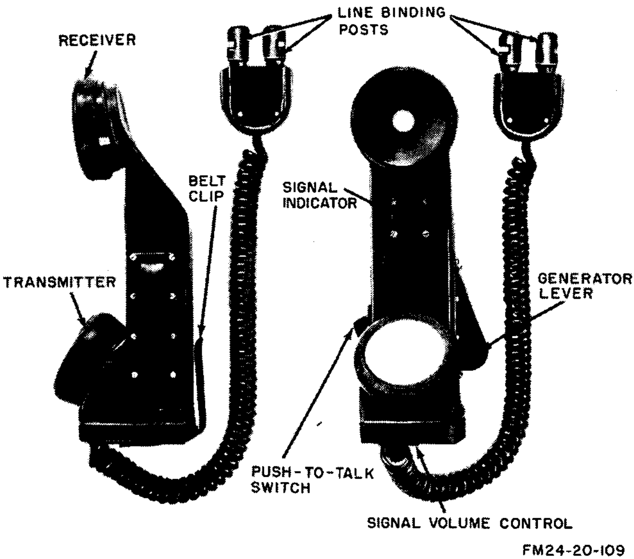

Figure 110. Telephone Set TA–1( )/PT.

136. Telephone Set TA–312/PT

a. Telephone Set TA–312/PT (fig. 111) is used as a local battery (LB) or common battery (CB) manual telephone. It may also be arranged for operation as a local battery telephone using common battery signaling (CBS).

b. It can be used under all outdoor conditions or as a desk or wall-mounted telephone. A receptacle is provided for connecting a handset-headset, which may be used in place of the handset provided. In addition, the telephone set can be used to control remotely operated radio equipment.

c. For more detailed information, refer to TM 11–2155.

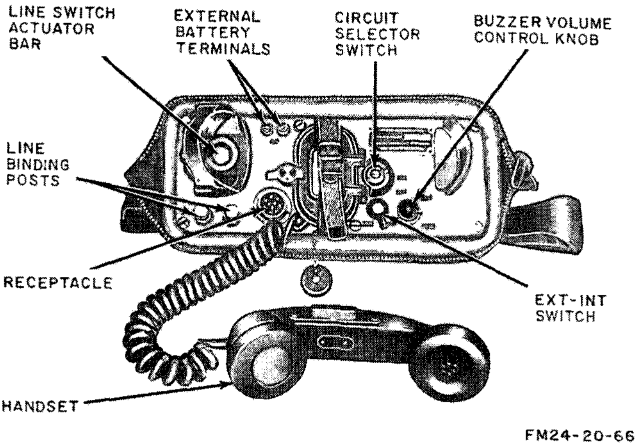

Figure 111. Telephone Set TA–312/PT.

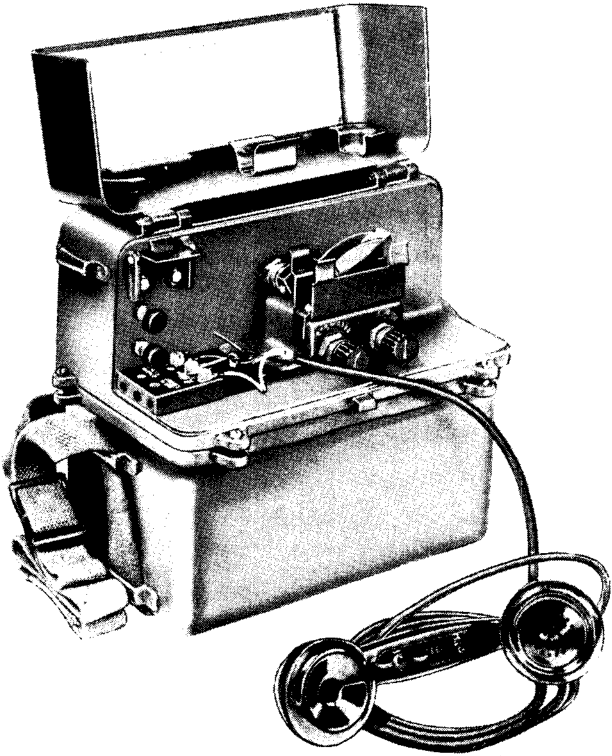

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Figure 112. Telephone Set TA–264/PT.

137. Telephone Set TA–264/PT

a. Telephone Set TA–264/PT (fig. 112) is a portable battery-powered field equipment designed for use on long field wire lines. Vacuum-tube amplifiers in both the transmitting and receiving circuits of the telephone make communication possible over a greater distance than that obtainable with other field telephone sets. Forward observers in combat areas, for example, would find excellent use for this set. When the amplifiers are in use, communication is on a one-way reversible basis. The incoming ringing signal can be indicated audibly or visually.

b. Telephone Set TA–264/PT cannot be used in common-battery systems, connected to switchboards or used over telephone carrier derived circuits.

c. For further information, refer to TM 11–2059.

Section III. MANUAL TELEPHONE SWITCHBOARDS

138. General

Manual telephone switchboards are designed for use in several types of operation, such as common battery, local battery, and common battery signaling—local battery operation. Some field switchboards are designed specifically for one type of operation. Others are designed for all three types of operation.

a. Field telephone switchboards are manually operated equipments, constructed to withstand rough handling and designed for quick, simple installation.

b. In a common battery system, the course of electrical energy for speech and ringing signals is located at the switchboard telephone central. In a local battery system, this source of electrical energy is a component part of the telephone set. In the other system (CB signaling—LB operation), the source of power for speech is part of the telephone set; the power for signaling the switchboard is located at the switchboard.

139. Emergency Switchboard SB–993( )/GT

a. Emergency Switchboard SB–993( )/GT (fig. 113) is a light, portable local battery switching center normally used in company-size units. It consists of a plug holder and seven two-pronged Adapter Plugs U–184( )/GT in a case. A field telephone is required for the operator's use. The SB–993( )/GT may be used as an emergency field replacement for any local battery switchboard.

b. Each Adapter Plug U–184( )/GT (fig. 114) consists of a neon glow lamp, two binding posts, two plugs, and two jacks, all molded together in a translucent plastic housing. The plugs serve as the thumbscrew ends of binding posts to which incoming lines are connected. The plugs may be inserted into the jacks of another Adapter Plug U–184( )/GT to establish a connection between two lines.

c. Several Adapter Plugs U–184( )/GT can be connected in tandem for conference connections (several separate parties conversing at the same time).

d. An incoming ringing signal lights the neon lamp in the switchboard plug connected to the line, for the duration of the signal. An audible signal is not heard when the neon lamp lights, unless the switchboard operator's telephone is connected to that line. Thus, the operator must be constantly watching for an incoming signal.

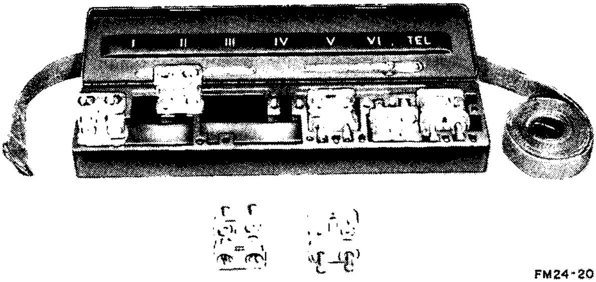

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Figure 113. Emergency Switchboard SB-993( )/GT.

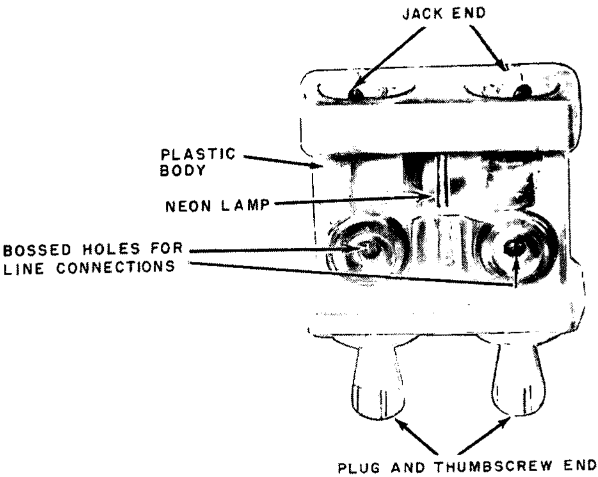

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Figure 114. Adapter Plug U-184( )/GT.

140. Manual Telephone Switchboard SB–22/PT

a. Manual Telephone Switchboard SB–22/PT (fig. 115) is a single-position field equipment, used primarily in field wire systems. It is small, lightweight, portable, and immersionproof, and it requires no special mounting equipment for operation.

b. The switchboard is equipped for interconnecting local-battery telephone lines, voice-frequency teletypewriter circuits, and remote-control circuits for radio communication. Each switchboard has a maximum capacity for switching either 12 field telephones, 12 voice-frequency teletypewriter circuits, 12 remote-control circuits, or a combination of these facilities. A capacity of 29 circuits can be obtained by stacking 2 switchboards and replacing the operator's pack of 1 switchboard with 5 additional line packs. The SB–22/PT obtains operating power from four Batteries BA–30.

c. For detailed information, refer to TM 11–2202.

141. Manual Telephone Switchboard SB–86/P

a. Manual Telephone Switchboard SB–86/P (fig. 116) is a portable, single-position field equipment used primarily in field wire systems. The switchboard is composed of component parts that can be rapidly assembled or dismantled during tactical employment. It can be used to interconnect voice-frequency teletypewriter circuits.

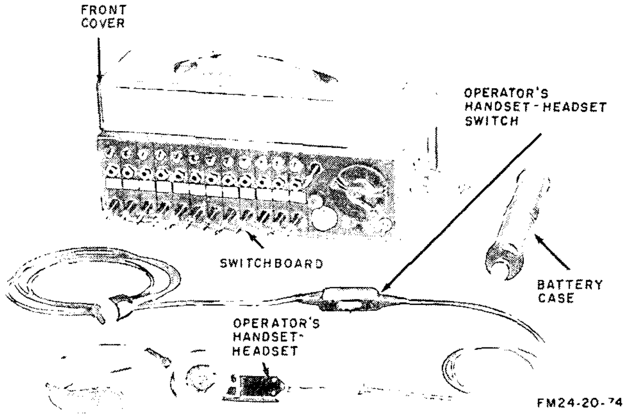

Figure 115. Manual Telephone Switchboard SB–22/PT.

b. Manual Telephone Switchboard SB–86/P consists of a portable jack field section, Switchboard Signal Assembly TA–207/P, Manual Telephone Switchboard Section SB–248/P, and Power Supply PP–990/G.

(1) The jack field section has a capacity of 30 complete line circuits. In addition, it contains the line signals, designation strips, panel lamps, and switches necessary for operation of the switchboard. A second jack field can be stacked on top of the first to increase the capacity of the switchboard to 60 line circuits.

(2) The switchboard section consists of 8 replaceable groups: 16 answering cords and 16 calling cords.

c. Local battery or common battery signaling can be selected by using a switch associated with

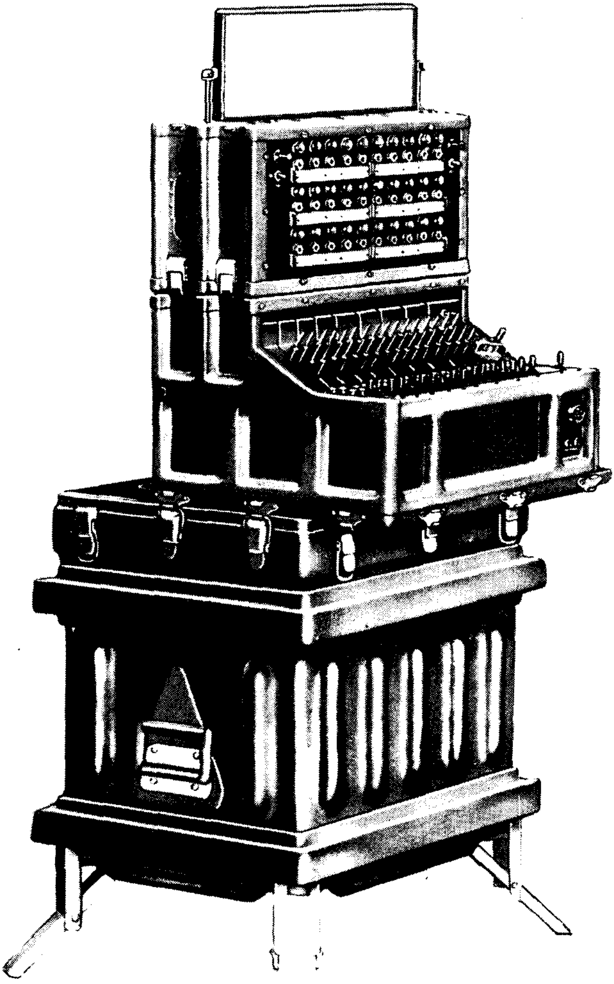

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Figure 116. Manual Telephone Switchboard SB–86/P.

each line circuit. There are also two common battery line circuits for use with common battery switchboards.

d. The cord circuits of the switchboard do not supply battery power to the distant telephone for speech transmission; therefore, only local battery telephones or telephones designed for common battery signaling can be used with this switchboard.

e. For further information, refer to TM 11–2134.

Section IV. FIELD TELETYPEWRITER EQUIPMENT

142. General

a. A teletypewriter is an electromechanical machine for the transmission and reception of coded electrical impulses that are converted into a recorded message. Messages are recorded by either of two methods—typed page copy (page-printing teletypewriters) or code perforations on tape (reperforators). Some teletypewriters that record messages by code perforations on tape also record the typewritten characters on the same tape (typing reperforators). Teletypewriter messages are transmitted manually by typing the message on a keyboard or by transmitting automatically from perforated tape in a transmitter-distributor.

b. A teletypewriter uses both alternating-current (ac) and direct-current (dc) power for its operation. Dc power must be used for the line current.

c. When a centralized power source is not available, a small engine-generator unit is used for furnishing power for the teletypewriter.

d. Tactical teletypewriter sets are provided with carrying cases, power supplies, and necessary accessories such as paper, perforating tape, printing ribbons, and a supply of spare parts.

143. Teletypewriter Set AN/PGC–1

a. Teletypewriter Set AN/PGC–1 (fig. 117) is a lightweight, portable, page-printing, sending and receiving set that is designed for field use. It consists of a standard communication teletypewriter (Teletypewriter TT–4( )/TG) and Case CY–694A/PGC–1.

b. Teletypewriter TT–4( )/TG is capable of sending and receiving standard teletypewriter start-stop, five-unit code impulses at the speeds of 60, 66, 75, or 100 words per minute, depending on the motor-drive gear set used. It is designed for dc neutral or voice frequency operation over wire lines or as dc or voice frequency over telephone carrier systems. The carrier systems may operate over spiral-four cable or radio relay carrier systems. Operation with either 60- or 20-milliampere dc line current is made possible by using a changeover switch.

c. Teletypewriter TT–4( )/TG is not equipped to supply dc power for the line current. This must be supplied by some external source. To operate the teletypewriter universal motor, a power source of 105- to 125-volts ac or dc is required.

d. For more detailed information, refer to TM 11–5815–206–12.

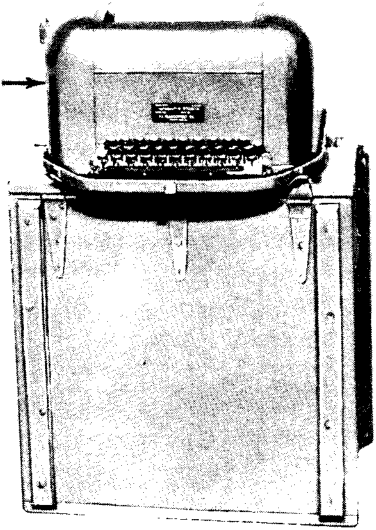


Figure 117. Teletypewriter Set AN/PGC–1.

144. Teletypewriter Set AN/GGC–3

a. Teletypewriter Set AN/GGC–3 (fig. 118) is a lightweight, portable sending and receiving equipment used in either tactical or fixed-station military communication systems. The transmitted message is sent from either a keyboard or a tape transmitter. The received signals are recorded both in code perforations and in typewriter characters on the same tape. Teletypewriter Reperforator-Transmitter TT–76/GGC, the major component of the set, is equipped with a standard communication keyboard and type wheel.

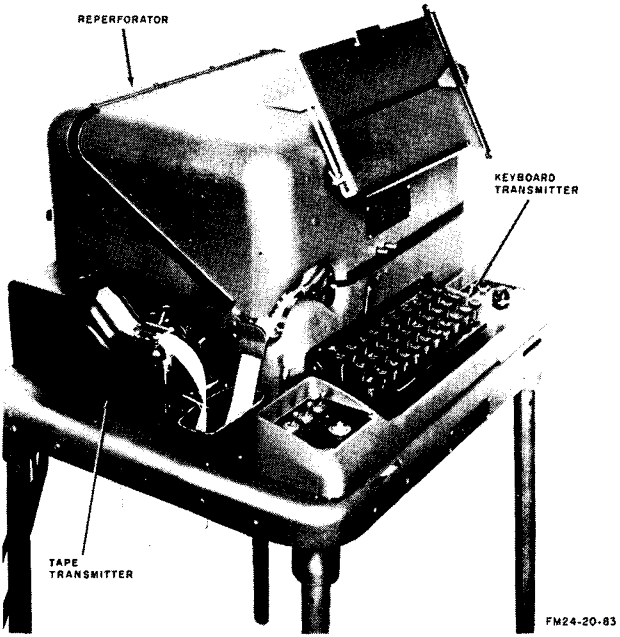


Figure 118. Teletypewriter Set AN/GGC–3.

b. Teletypewriter Reperforator-Transmitter TT–76/GGC can be arranged to operate with either neutral and, if modified, polar signals on a half- or full-duplex basis. The selector magnet of this unit can be adapted for 20- or 60-milliampere dc line current. The unit can send and receive standard teletypewriter five-unit, stop-start code impulses at 60 or 100 words per minute, depending on the motor-drive gear that is used.

c. Teletypewriter Set AN/GGC–3 is not equipped to supply the dc power for the line current. This must be supplied by a telegraph switchboard, a line unit, or another external source. A 115- or 230-volt ac power supply that can provide 150 watts of power is required for the operation of the teletypewriter motor and rectifier. If a line unit or other line-terminating device is used, the power requirements are increased.

d. Although Teletypewriter Set AN/GGC–3 is designed for fixed-station and field purposes, do not expose it to rain, snow, excessive heat, or dampness. When possible, install the set in a shelter.

e. For detailed information, refer to TM 11–2225.

Section V. TELEGRAPH-TELEPHONE TERMINAL AN/TCC–14

145. General

a. Telegraph-Telephone Terminal AN/TCC–14 (fig. 119) is a transportable, voice-frequency terminal equipment that provides simultaneous telephone and teletypewriter service over a normal telephone circuit. It consists of three separate components—Telegraph Terminal TH–5/TG, Electrical Filter Assembly F–98/U, and Telegraph-Telephone Signal Converter TA–182/U. Telegraph-Telephone Terminal AN/TCC–14 can be used in point-to-point networks, switched telephone systems, and in remote-control radio systems.

b. For detailed information, refer to TM 11–2239.

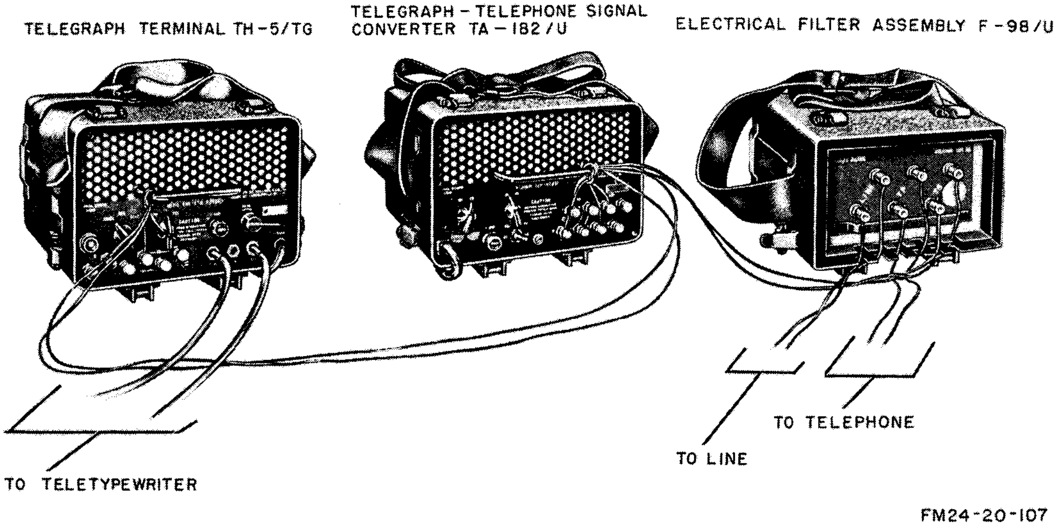


Figure 119. Telegraph-Telephone Terminal AN/TCC-14.

146. Telegraph Terminal TH–5/TG

a. Telegraph Terminal TH–5/TG is a lightweight, portable frequency-shift telegraph terminal. It is used to convert dc teletypewriter pulses to 1,225-cps and 1,325-cps signals, and to convert these signals back again to dc teletypewriter pulses. The ac signal is a voice-frequency (VF) signal, because it lies within the voice-frequency range.

b. The VF telegraph sytsem can be used over existing facilities of a telephone system. This is an advantage over the dc telegraph system, since the VF telegraph circuits can be switched through telephone switchboards. Dc telegraph circuits require a separate dc teletypewriter switchboard.

c. Telegraph Terminal TH–5/TG is designed for half, or full duplex operation, and may be used with Telegraph-Telephone Signal Converter TA–182/U and Electrical Filter Assembly F–98/U. It supplies 20-milliampere line current for the local teletypewriter set. This terminal can be used in two-wire, four-wire, and radioteletype applications. The telegraph terminal requires a 115-volt, 50- to 60-cycle as power supply for operation.

147. Telegraph-Telephone Signal Converter TA–182/U

a. Telegraph-Telephone Signal Converter TA–182/U is a portable frequency-shift signal converter commonly called a voice-frequency finger. This converter makes it possible to pass ringing signals over circuits that do not pass 20 cycles. In telegraph circuits, Telegraph-Telephone Signal Converter TA–182/U converts 20-cps ringing signals to 1,225-cps ringing signals, and converts 1,225-cps ringing signals to 20-cps ringing signals. In telephone circuits, Telegraph-Telephone Signal Converter TA–182/U converts 20-cps ringing signals to 1,600-cps ringing signals, and converts 1,600-cps ringing signals to 20-cps ringing signals.

b. The TA–182/U requires a 115-volt, 50- to 60-cycle ac power source for operation.

c. The signal converter is used in certain circuit applications with Telegraph Terminal TH–5/TG and Electrical Filter Assembly F–98/U. For additional information, refer to TM 11–2137.

148. Electrical Filter Assembly F–98/U

a. Electrical Filter Assembly F–98/U is a portable, two-section filter. The filter permits simultaneous teletypewriter and telephone service over existing telephone facilities. The band-pass section is used for teletypewriter transmission; the band-stop section is used for telephone transmission.

b. The electrical filter assembly is used with Telegraph Terminal TH–5/TG and Telegraph-Telephone Signal Converter TA–182/U. For additional information, refer to TM 11–2239.

149. System Application

Telegraph-Telephone Terminal AN/TCC–14 has many applications. Some of the applications given below do not require the use of all the components of the equipment.

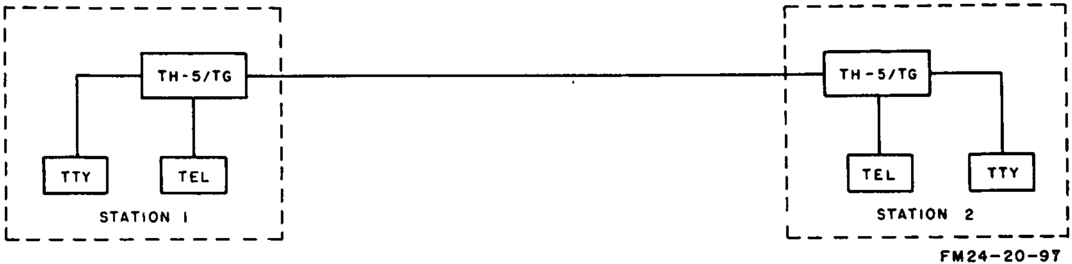


Figure 120. Alternate telegraph-telephone service on point-to-point circuit, using Telegraph Terminal TH–5/TG.

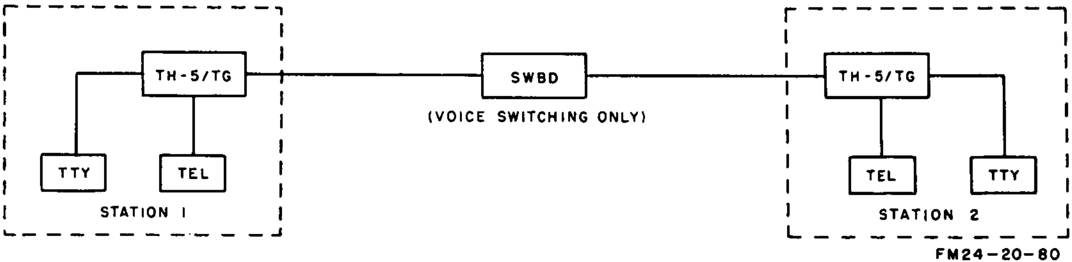


Figure 121. Alternate telegraph-telephone service on switchboard loop circuit, using Telegraph Terminal TH–5/TG.

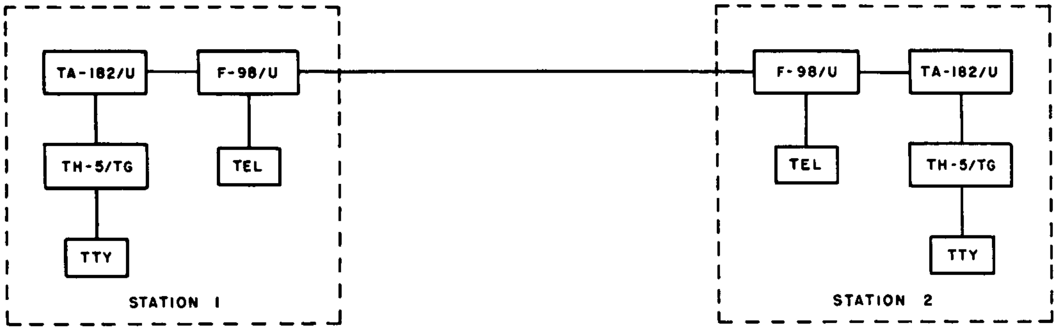


Figure 122. Simultaneous service on point-to-point circuit, using Telegraph-Telephone Terminal AN/TCC–14.

a. Telegraph-Only Service. This application is designed solely for teletypewriter communication. Speech transmission is not involved.

b. Alternate Telegraph-Telephone Service (figs. 120 and 121). This application is designed for either telegraph or telephone use. Telegraph and telephone service, however, cannot be used at the same time.

c. Simultaneous Telegraph-Telephone Service. This application is designed to provide a two-wire, voice-frequency channel that can pass teletypewriter and telephone signals simultaneously (fig. 122). However, teletypewriter and telephone circuits cannot be switched (or signaled) separately. Electrical Filter Assembly F–98/U is used to separate teletypewriter and telephone transmission at the terminal.

d. Speech Plus Half-Duplex Service. This application is designed to provide a two-wire, voice-frequency channel that can pass teletypewriter and telephone signals simultaneously. Both teletypewriter and telephone circuits on the same wire line are completely independent of each other and are switched (or signaled) separately. Electrical Filter Assembly F–98/U is used to separate teletypewriter and telephone transmission. Refer to TM 11–2239 for detailed installation instructions and illustrations.

Section VI. TELEPHONE REPEATERS

150. General

a. A telephone repeater is a device used to increase the strength of a signal that has been decreased by line losses. Repeaters consist essentially of vacuum-tube amplifiers and such associated components as repeating coils equalizer networks, and hybrid coils. Amplifiers increase the signal in one direction only, and, since a telephone system must provide for two-way communication, most repeaters use separate amplifier circuits for transmitting and receiving.

b. Repeaters used at the ends of a transmission line are called *terminal repeaters;* those used between the ends of a transmission line are called *intermediate repeaters.*

c. The proper spacing of repeaters depends on the characteristics of the transmission line and the amplification capabilities of the repeater.

151. Telephone Repeater TP–14

a. Telephone Repeater TP–14 (fig. 123) is a portable unit used to extend the telephone communication range over a wide variety of two-wire line facilities. It may be used at terminal and intermediate points, at junctions of different types of line facilities, and at points where entrance cables are used.

b. If desired, Telephone Repeater TP–14 can be used for interconnecting two-wire and four-wire facilities or as a special form of four-wire repeater. The repeater has simplex terminal connections for dc telegraph operation (par. 154*c*). Twenty-cps ringing signals can pass through the repeater.

c. The repeater uses an ac power supply, storage batteries, or dry-cell batteries as a power source.

d. For detailed information, refer to TM 11–2007.

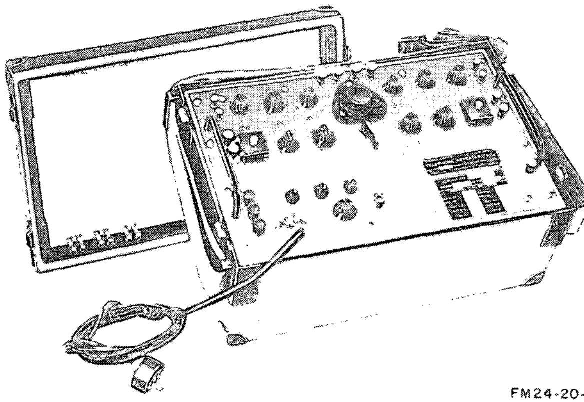


Figure 123. Telephone Repeater TP–14.

Section VII. TERMINAL STRIPS AND REPEATING COILS

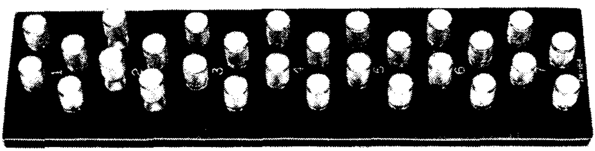
152. Terminal Strip TM–184

a. Terminal Strip TM–184 (fig. 124) is a block of insulating material, on which are mounted 28 insulation-piercing binding posts and 4 mounting holes. This terminal strip can terminate seven pairs of wires.

b. To connect a wire to the terminal strip, remove about ½ inch of insulation from the end of the wire to be connected. Unscrew the knob on the binding post to its fullest extent. Insert the end of the wire into the slot, so that the wire projects through the binding post.

c. As an alternate method, remove about 1 inch of insulation from the wire (leaving about 1 inch of insulation on the end), double the bared portion, and insert it into the slot of the binding post. Tighten the knob firmly with the fingers, clamping the wires securely in the slot. Do not use pliers to tighten or unscrew the knob; this may strip the threads on the binding post.

d. Terminal strips mounted in the open and subject to the effects of weather must be protected. Since no prescribed cover is provided, suitable wooden boxes or salvaged canvas must be improvised by personnel installing the terminal strips.



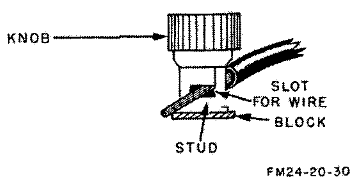


Figure 124. Terminal Strip TM–184.

153. Terminal Box TA–125/GT

a. Terminal Box TA–125/GT (fig. 125) is a small lightweight equipment. It is used at wire heads and test points where weatherproof terminations are essential for uninterrupted service.

The terminal box is used wherever rapid installation of field wire or cable circuits is required. It also may be used as a main distributing frame for Manual Telephone Switchboards SB–22/PT and SB–86/P.

b. Terminal Box TA–125/GT contains 48 binding post assemblies and 48 pin jacks. To insert the bare end of field wire, the binding post must be pushed in. A row of 12 slots located on each side of the box provides an entrance for the wire pairs. A row of 24 screwdriver slotted switches are located at the center of the box. These lugs are turned to open or close the electrical contact between the corresponding binding posts. The pin jacks are used for insertion of the test prods of Maintenance Kit MX–842/GT.

c. For futher information, refer to TM 11–2138.

154. Repeating Coils

a. A repeating coil is an audio-frequency transformer (usually with a 1 to 1 winding ratio) used to transfer energy from one electrical circuit to another, and to permit the formation of simplexed and phantomed circuits for additional teletypewriter or telephone channels. The coils consist of two balanced windings. One winding—the line side—is connected to line terminals. The other winding—the switchboard side—is connected to switchboard terminals. When a telephone is used in place of a switchboard, these windings are connected to the telephone. The line side of the coil is tapped at the midpoint. This tap, called

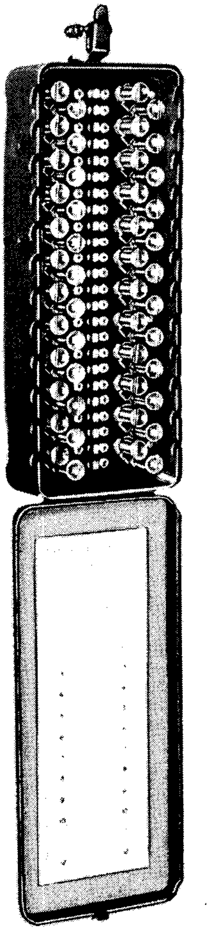


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Figure 125. Terminal Box TA–125/GT.

the leg, provides a means of forming simplex and phantom circuits (fig. 126).

b. Coil C–161 (fig. 126) is a ring-through transformer with a 1 to 1 winding ratio. The line-side winding of this transformer is tapped at the center for simplex- or phantom-circuit operation. The LINE binding posts are connected directly to the line; the SWITCHBOARD binding posts are connected to the line terminals on a switchboard or telephone; and the TELEG. binding post is connected to one line terminal of a teletypewriter (except in a phantom circuit, where it is connected to the switchboard binding posts of the phantom line). Figures 127 through 129 illustrate different circuit arrangements using Coil C–161.

c. Additional circuits can be obtained from existing metallic circuits by the use of repeating coils (fig. 126). These circuits are as follows:

(1) *A simplex circuit* (fig. 127) is one in which a ground-return telephone or telegraph circuit is superimposed on (added to) a single, full-metallic circuit to obtain an additional circuit.

(2) *A phantom circuit* (fig. 128) is obtained from two full-metallic circuits to provide an additional telephone or telegraph circuit.

(3) *A simplexed-phantom circuit* (fig. 129) combines the principles of both simplex and phantom circuits to obtain a fourth circuit.

d. Mutual interference will result on all circuits of a simplexed or phantomed group if the side circuits are unbalanced (do not have the same impedance). The amount of interference will depend on the degree of unbalance between the two metallic circuits. The primary causes of unbalance are poor splices that introduce a high resistance into either side of the circuit, and improperly taped splices or damaged portions of insulation which, when wet, cause excessive leakage from one side of the circuit to ground. Although it is extremely difficult to obtain perfect balance in field wire circuits, mutual interference can be reduced considerably by using overhead construction, by making each wire pair of a simplexed or phantomed group the same length, and by making splices properly.

e. Usually, more mutual interference results from a phantomed group than from a simplexed circuit, because more circuits are involved in the phantomed group. A phantomed circuit should be used in field wire systems only when an additional speech channel is required. (Simplexed circuits are most commonly used to provide teletypewriter channels.)

f. Repeating coils are field-tested by connecting the coils with a short length of field wire in the same circuit arrangement as that in which the coils will be used. This circuit arrangement should also include the terminal equipment. After the equipment is installed and connected, make an operational test.

g. Dc signals employing metallic, simplex or phantom circuits are used for shorter distances and unless properly repeated, are restricted in their use.

h. For further information in repeating coils, see TM 11–678.

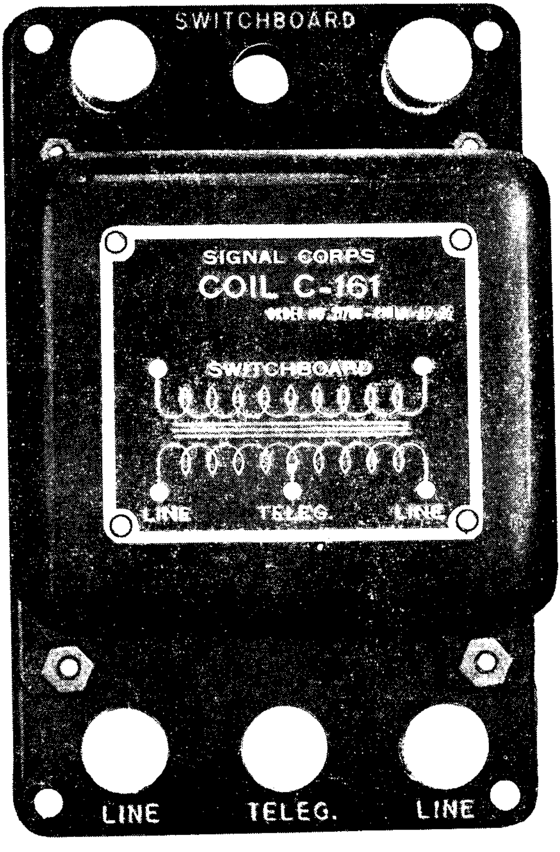

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Figure 126. Coil C–161 (repeating).

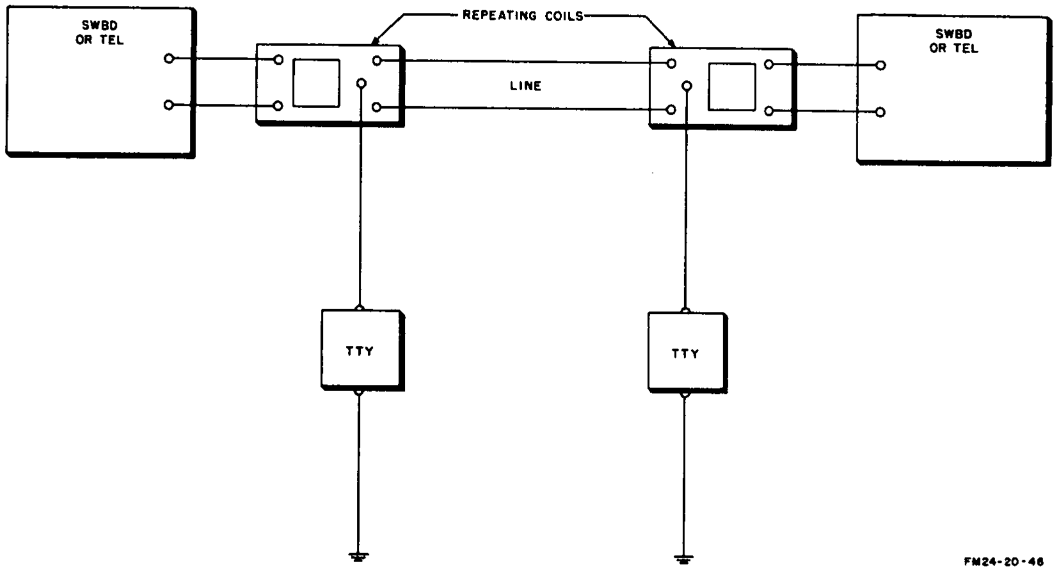

Figure 127. Simplex circuit, using Coil C–161.

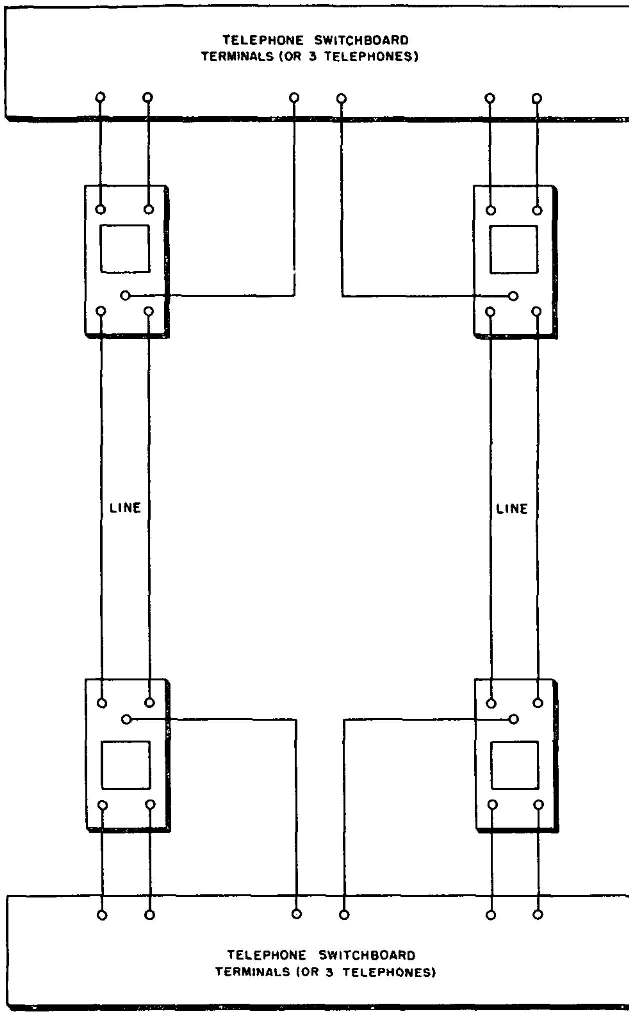

Figure 128. Phantom circuit, using Coil C–161.

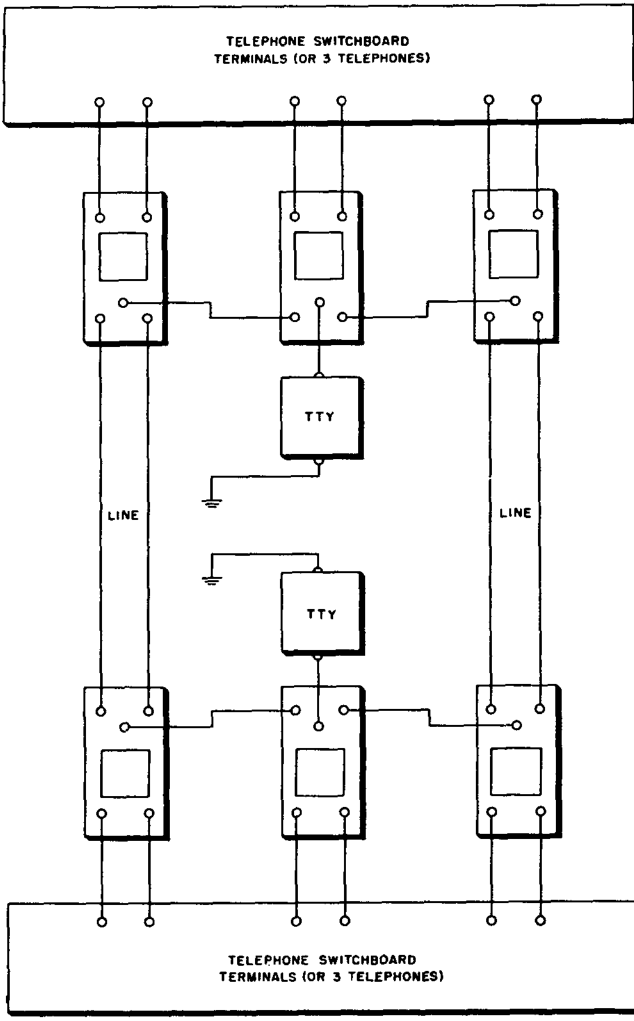

Figure 129. Simplex-phantom circuit, using Coil C–161.

Section VIII. TEST EQUIPMENT

155. General

a. Various types of specialized test equipment are used to test different types of lines in a communication system. This equipment enables the tester to conduct, with speed and accuracy, those tests necessary during installation and maintenance of field wire lines.

b. Test instruments are delicate, precision devices that require careful handling while being transported or operated. The tester should be familiar with each test set, and should observe all required safety measures during the performance of any test.

c. Precautionary safety measures must be taken when making tests on field wire lines, because the lines under test might be crossed with high-tension power lines. Carelessness could prove fatal to the tester. *Always wear rubber gloves and be extremely careful when handling lines suspected of carrying high voltages.* If rubber gloves are not available, cover hands, before handling the wires, with material that has high insulating quality. Wire lines can be tested for high voltage before connecting the wires to a test set by briefly touching the bare ends of one conductor against the end of the other, and also by touching the ends of each wire to a ground. There should be an arc or spark if high voltages are present.

156. Multimeter TS–297/U

Multimeter TS–297/U (fig. 130) is a pocket-size multirange test instrument for measuring ac and dc voltages, low values of dc current and dc resistance. It is used for general purpose testing of electrical and electronic equipment. Complete operating instructions are contained in TM 11–5500.

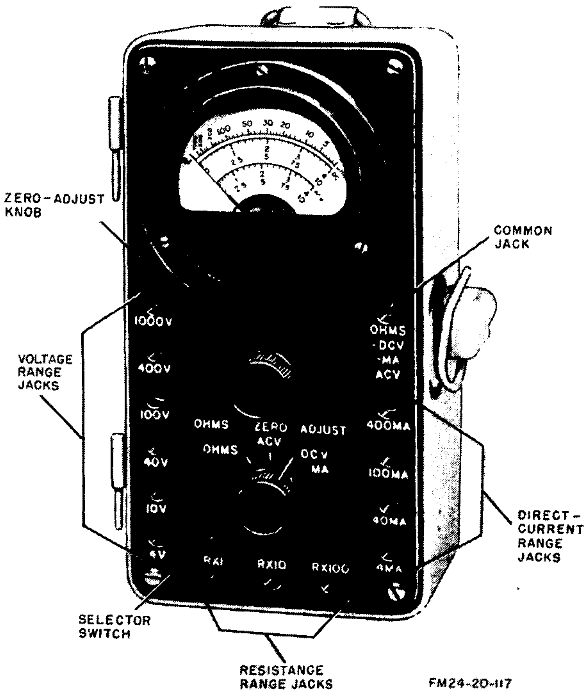

Figure 130. Multimeter TS–297/U.

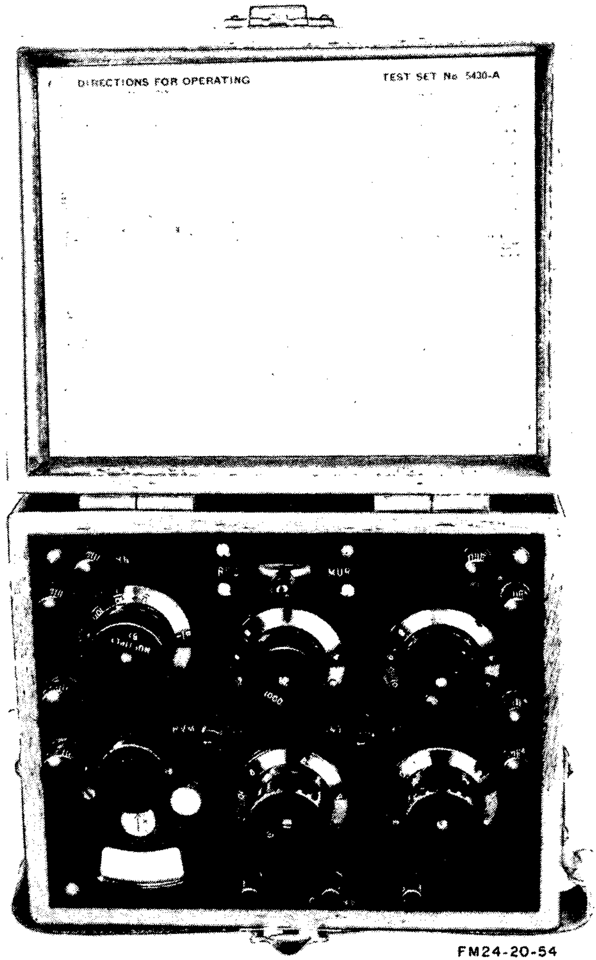

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Figure 131. **Resistance Bridge ZM–4( )/U.**

157. Resistance Bridge ZM–4( )/U

Resistance Bridge ZM–4( )/U (fig. 131) is a portable direct-reading Wheatstone bridge used to troubleshoot and locate defects in a circuit. It can be used to determine the value of unknown resistances and to serve as an auxiliary resistance box. Complete operating instructions are contained in TM 11–2019.

158. Test Set TS–26( )/TSM

Test Set TS–26( )/TSM (fig. 132) is a portable voltohmmeter used for identifying crosses, shorts, and opens in tactical wire communication systems. It can be used to measure insulation and conductor resistances and dc voltages. The unit can also be used for determining the approximate location of grounds, shorts, and crosses by resistance measurements, and for locating opens by the capacity-kick method. The test set consists of a meter panel assembly and a switch panel assembly, both of which are mounted in a carrying case. A storage compartment is provided for the two test leads. Complete operating instructions are contained in TM 11–2017.

159. Test Set TS–27( )/TSM

Test Set TS–27( )/TSM (fig. 133) is a form of Wheatstone bridge, powered by dry-cell batteries. It is used to measure capacitance, conductor and insulation resistances, and to accurately locate grounds, opens, crosses, and shorts. When the test set is used to measure capacitance and to locate opens, a 20-cps signal is supplied by a vacuum-tube oscillator circuit. This unit is contained in a portable, watertight carrying case complete with accessories. Complete operating instructions are contained in TM 11–2057A.

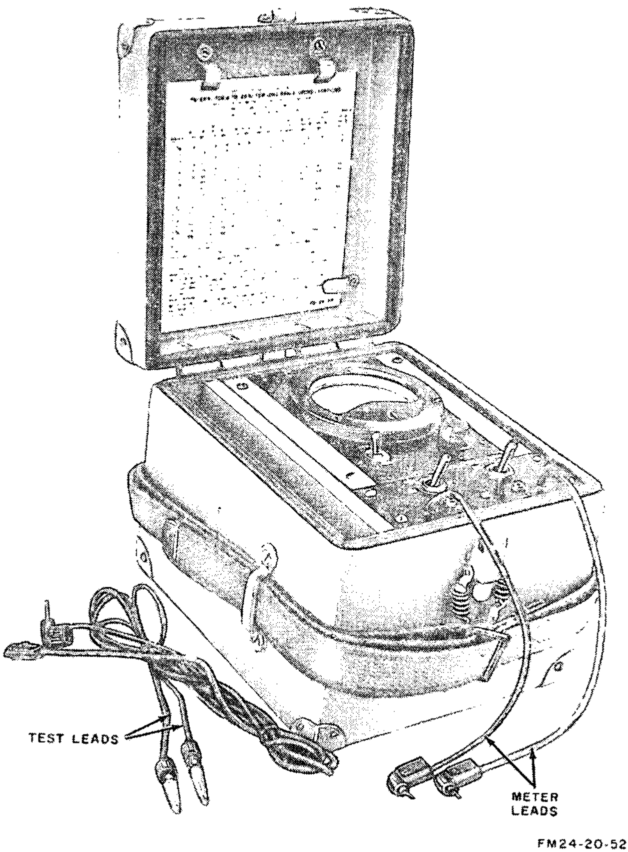


Figure 132. Test Set TS–26( )/TSM.

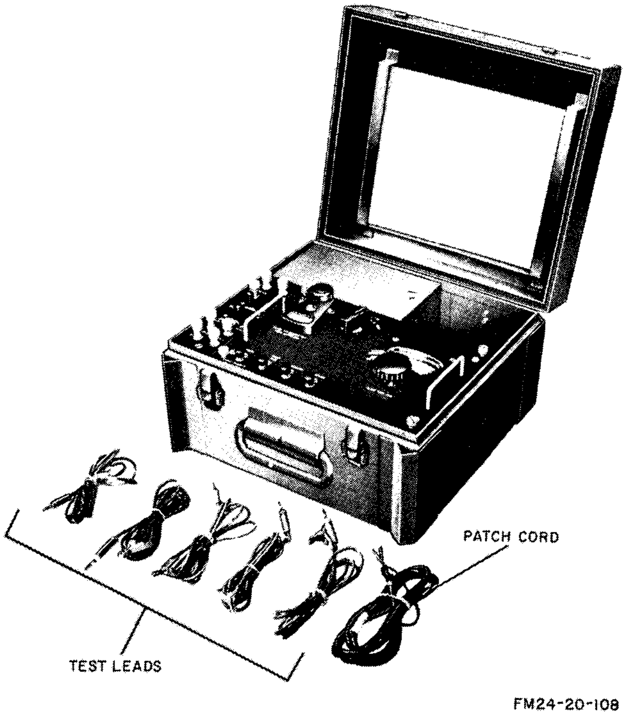


Figure 133. Test Set TS–27( )/TSM.

APPENDIX I

REFERENCES

1. General

This appendix is a selected list of publications, training films, and film strips pertinent to field wire installations. For availability of items and publications on additional subjects, refer to DA Pamphlets 108–1, 310–1, 310–3, and 310–4.

2. Army Regulations

AR 105–15 ..... Army Field Commands.
AR 320–5 ...... Dictionary of United States Army Terms.
AR 320–50 ..... Authorized Abbreviations and Brevity Codes.
AR 380–5 ...... Safeguarding Defense Information.
AR 750–5 ...... Maintenance Responsibilities and Shop Operations.

3. Department of the Army Pamphlets

DA Pamphlet 310–1	Index of Administrative Publications.
DA Pamphlet 310–3	Index of Training Publications.
DA Pamphlet 310–4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.

DA Pamphlet 108–1 — Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings.

4. Field Manuals

FM 21–5 .... Military Training.
FM 21–6 .... Techniques of Military Instruction.
FM 21–30 .... Military Symbols.

5. Film Strip

FS 11–64 .... Use of Repeating Coil C–161.

6. Technical Bulletins

TB SIG 69 ...... Lubrication of Ground Signal Equipment.
TB SIG 252 ..... Use of Electrical Insulation Tapes TL–600/U and TL–636/U.
TB SIG 314 ..... Reel Equipment CE–11.

7. Technical Manuals

TM 11–360 ...... Reel Units RL–26–A, RL–26–B, and RL–26–C.
TM 11–381 ...... Cable Assembly CX–1065/G, Telephone Cable Assemblies CX–1606/G and CX–1512/U, Telephone Loading Coil Assembly CU–260/G, and Electrical Connector Plug U–176/G.
TM 11–655 ...... Fundamentals of Telegraphy (Teletypewriter).

TM 11-661.....Electrical Fundamentals (Direct Current).

TM 11-678.....Fundamentals of Telephony.

TM 11-680.....Teletypewriter Circuits and Equipment (Fundamentals).

TM 11-681.....Electrical Fundamentals (Alternating Current).

TM 11-2007....Telephone Repeater TP-14.

TM 11-2017....Test Sets TS-26/TSM and TS-26A/TSM and TS-26B/TSM.

TM 11-2019....Test Sets I-49, I-49A and I-49B and Resistance Bridges ZM-4A/U and ZM-4B/U.

TM 11-2057....Test Set TS-27/TSM.

TM 11-2057A ..Test Set TS-27B/TSM.

TM 11-2059....Telephone TP-9 and Telephone Set TA-264/PT.

TM 11-2134....Manual Telephone Switchboard SB-86/P, Installation and Operation.

TM 11-2137....Telegraph-Telephone Signal Converter TA-182/U.

TM 11-2155....Telephone Set TA-312/PT.

TM 11-2202....Manual Telephone Switchboard SB-22/PT.

TM 11-2225....Teletypewriter Sets AN/GGC-3 and AN/GGC-3A and Teletypewriter Reperforator-Transmitters TT-76/GGC, TT-76A/GGC and TT-76B/GGC.

TM 11-2239____Telegraph-Telephone Terminal AN/TCC-14.

TM 11-2240____Wire Dispenser MX-306A/G.

TM 11-2262____Outside Plant Wire Construction and Maintenance.

TM 11-5500____Multimeter TS-297/U.

TM 11-5815-206-12 Operation and Organizational Maintenance: Teletypewriter Set AN/PGC-1, and Teletypewriters TT-4A/TG and TT-4B/TG.

8. Training Films

TF 11-2062____Theory of Simplex and Phantom Circuits. Part I: Balanced Conditions.

TF 11-2063____Theory of Simplex and Phantom Circuits. Part II: Unbalanced Conditions.

TF 11-2755____Installation and Operation of Switchboard-22/PT.

TF 11-2827____Climbing and Working on Poles.

9. Other Publications

ACP-126 ______Communication Instructions Teletypewriter (Teleprinter) Procedures.

ACP 134(A) ____Telephone Switchboard Operating Procedure.

SB 11-100-133__Serviceability Standards for Reeling Machine, Cable, RL-118/G.

APPENDIX II

INFORMATION FOR SWITCHBOARD OPERATORS

Section I. INTRODUCTION

1. General

Telephone switchboard operators must, at all times, furnish service with the least possible delay, confusion, or annoyance to the telephone users. This requires that operators be skilled and thoroughly trained to follow the approved operating procedures.

2. Operating Procedures

a. Voice procedures (expressions and phrases) used in the operation of switchboards are discussed in detail in *Telephone Switchboard Operation Procedure ACP 134 (A)*.

b. The switchboard operational instructions are contained in the associated technical manual for each specific equipment.

c. A field telephone switchboard can be used to switch voice-frequency (vf) teletypewriter circuits. In this case, the operator must know the correct teletypewriter procedures. (Refer to ACP–126.)

3. Operating Records

a. The records, publications, printed forms, and other information maintained at any particular switchboard installation will depend on the type of telephone or teletypewriter switching central, and on the local communication and security requirements.

b. The following is a typical list of publications that are normally made available to operators at switching centrals:

(1) Directory
(2) Equipment manuals
(3) Procedure directives (ACP's)
(4) Phonetic alphabet
(5) Station log
(6) Test and trouble reports
(7) Traffic diagrams

Section II. TELEPHONE DIRECTORY

4. General

a. The purpose of a telephone directory is to simplify and expedite telephone switching service. To fulfill this purpose, a telephone directory must be compiled accurately and must contain both the users' names and their assigned numbers. A telephone directory should be used consistently and correctly by all telephone operators and telephone users.

b. There are two main parts to a military telephone directory: directory names and directory numbers. In field operations, both the names and numbers are issued as items of the SOI or SSI.

5. Directory Names

Telephone directory names are assigned to all units equipped with a switchboard. Directory names are not meant to provide security, but are used to speed up telephone service. These names are permanent; they are changed only when there is a chance of confusion with directory names of other units. Telephone directory names must not be used in messages or in conversations to refer to units. Typical directory names are as follows:

Telephone central	*Directory name*
1st Infantry Division	Dexter
1st Battle Group, 61st Infantry	Deadeye
3d Battle Group, 8th Infantry	Dolly
4th Battle Group, 12th Infantry	Dandy
12th Battalion, 44th Artillery	Donkey

6. Directory Numbers

Directory numbers are assigned to the local telephones installed within a headquarters or installation. Directory numbers, once assigned, remain fixed. These numbers, which may be issued separate from the directory name, are distributed to all telephone users. The following are typical examples of directory numbers:

Number	*Title*
1	G1 or S1
2	G2 or S2
3	G3 or S3
4	G4 or S4
5	Chief of Staff or Executive Officer
6	Assistant Commander
6	Commanding Officer
7	Adjutant (Division or higher units)
8	Ordnance Officer
9	Inspector
10	Signal or Communication Officer
11	Message Center (incoming)
12	Message Center (outgoing)

Number	*Title*
13	Aide-de-camp
14	Air Officer
15	Engineer Officer
16	Surgeon or Medical Officer
17	Judge Advocate
18	Finance Officer
19	Chaplain
20	Postal Officer
21	Quartermaster (not Supply Officer)
22	Chief of Artillery or Artillery Officer
23	Chemical or Gas Officer
24	Liaison Officer
25	Division Ammunition Officer
26	Pigeon Loft (if applicable)
27	Provost Marshal
28	Radio Station
29	Reconnaissance Officer
30	Telegraph or Teletypewriter Office
31	Telephone Wire Chief or Trouble Chief
32	Veterinarian
33	Public Telephone
34	Headquarters Commandant
35	Motor Officer
36	Antitank Officer
37	Special Service Officer
38	G5 or S5

Section III. TRAFFIC DIAGRAMS

7. General

a. A traffic diagram is a chart showing the number of telephone or teletypewriter channels existing between switching centrals in a military wire system. A single line indicates direct communication. A numeral placed on the line indicates the number of channels available, including simplex, phantom, and carrier circuits.

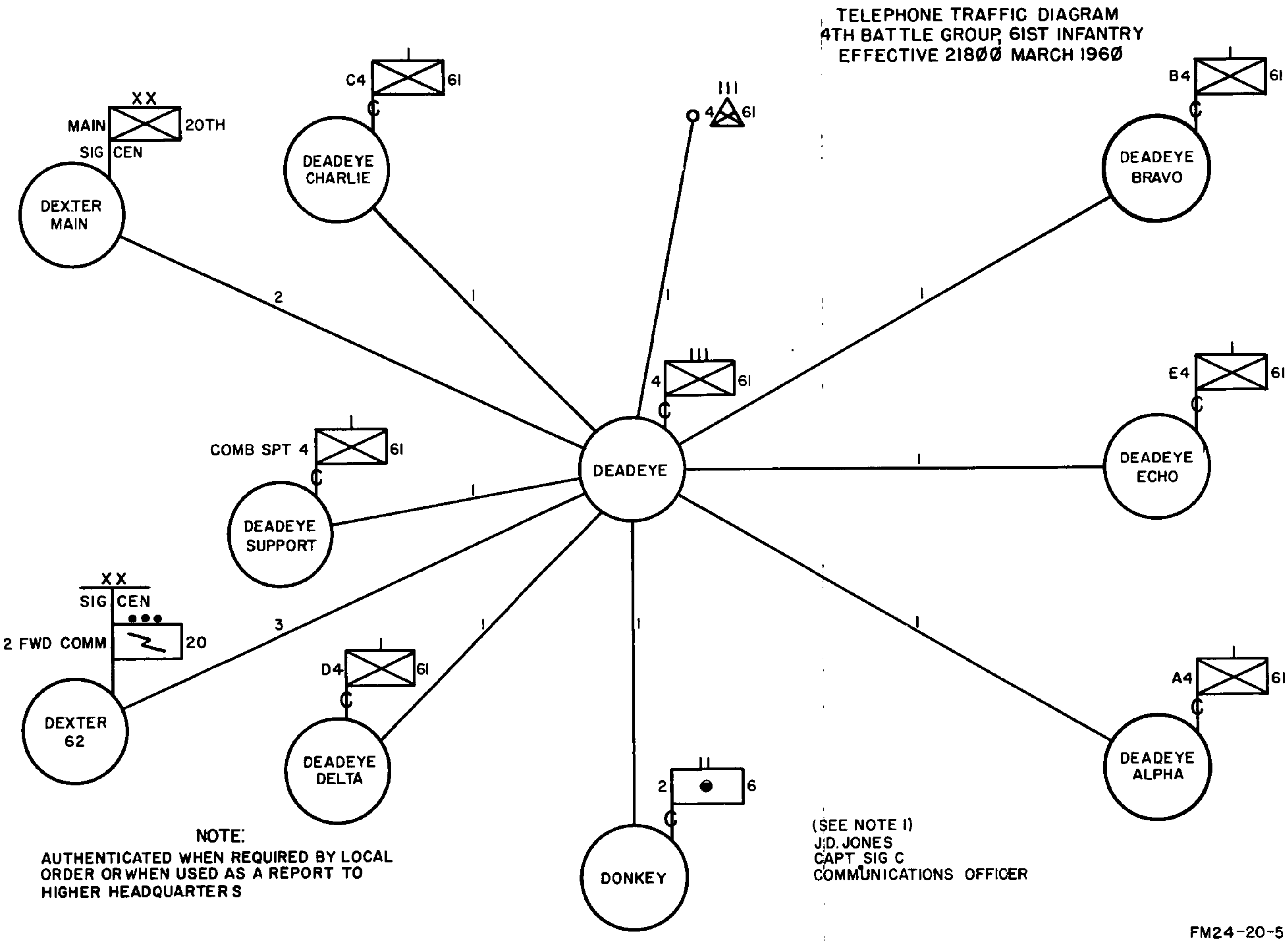


Figure 134. Example of telephone traffic diagram.

b. A traffic diagram is prepared at each switching central by the wire chief or chief operator, assisted by the operator on duty. In the case of extensive or elaborate systems, traffic diagrams may be prepared for all centrals by the officer in charge of the entire system.

c. The purpose of the traffic diagram is to indicate to the operator the most direct routing for a call to any other switching central in the system, and to show alternate routing in case the direct routing is busy or out of service. For this reason, the diagram often includes connecting systems of higher, lower, and adjacent units. It must be corrected continuously as changes occur, and expanded as new information is obtained.

d. Local security measures will determine the extent of information that will be placed on traffic diagrams.

8. Telephone Traffic Diagram

A telephone traffic diagram (fig. 134) indicates the number of telephone circuits in the communication system. It is used by the switchboard operator to route telephone calls between switching centrals.

9. Teletypewriter Traffic Diagram

A teletypewriter traffic diagram shows the number of teletypewriter trunk circuits in a communication system. It is used by the teletypewriter switchboard operator when routing teletypewriter calls between switching centrals.

Section IV PHONETIC ALPHABET AND NUMERALS

10. General

Certain letters and certain numerals have similar sounds. Thus, they can cause confusion in telephone conversations.

11. Phonetic Alphabet

Words of a phonetic alphabet are spoken in place of the letters they represent. If a word might be misunderstood, spell it out phonetically. For example: "DANDY—I SPELL: DELTA, ALFA, NOVEMBER, DELTA, YANKEE—DANDY." The encrypted group SPWXT is spoken as "SIERRA, PAPA, WHISKEY, X-RAY, TANGO." The complete phonetic alphabet is listed below:

Phonetic alphabet

Letter	Word	Pronunciation	Letter	Word	Pronunciation
A	ALFA	*AL* FAH	N	NOVEMBER	NO *VEM* BER
B	BRAVO	*BRAH* VOH	O	OSCAR	*OSS* CAR
C	CHARLIE	*CHAR* LEE	P	PAPA	PAH *PAH*
D	DELTA	*DELL* TAH	Q	QUEBEC	KEH *BECK*
E	ECHO	*ECK* OH	R	ROMEO	*ROW* ME OH
F	FOXTROT	*FOKS* TROT	S	SIERRA	SEE *AIR* RAH
G	GOLF	GOLF	T	TANGO	*TANG* GO
H	HOTEL	HOH *TELL*	U	UNIFORM	*YOU* NEE FORM
I	INDIA	*IN* DEE AH	V	VICTOR	*VIK* TAR
J	JULIETT	*JEW* LEE *ETT*	W	WHISKEY	*WISS* KEY
K	KILO	*KEY* LOH	X	XRAY	*ECKS RAY*
L	LIMA	*LEE* MAH	Y	YANKEE	*YANG* KEY
M	MIKE	MIKE	Z	ZULU	*ZOO* LOO

12. Phonetic Numerals

Each digit of a large number is pronounced separately, except in the case of even hundreds and even thousands when the word hundred or thousand is used. For example: DOBO 19 is spoken as DO-BO WUN NINER: DEXTER 6100 is spoken as DEX-TER SIX WUN HUN-DRED: and DOLLY 36000 is spoken as DOL-LY THU-REE SIX THOW-ZAND. The phonetic numbers are listed below:

Phonetic numbers

Number	Pronunciation	Number	Pronunciation
1	Wun	8	Ate
2	Too	9	Niner
3	Thu-ree	0	Zero
4	Fo-wer	10~~0~~	Wun Hun-dred
5	Fi-yiv	1000	Wun Thow-zand
6	Six		
7	Seven		

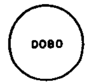
APPENDIX III

SYMBOLS USED IN WIRE DIAGRAMS AND MAPS

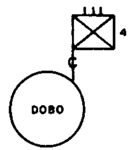
Special symbols are used in signal communication on tactical circuit diagrams, line route maps, and traffic diagrams. To clarify certain symbols, it might often be necessary to include the equipment type number with the symbols. The application of these symbols is shown in figures 90, 91, and 134. For additional information on symbols, refer to FM 21–30, Military Symbols.

1. Basic Symbols Used in Traffic Diagrams

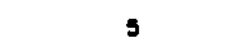
TELEPHONE
(MILITARY SYMBOLS OF THE USING UNITS OR INSTALLATIONS ARE PLACED ABOVE THE SYMBOL)



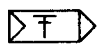
TELEPHONE SWITCHING CENTRAL
(SWITCHBOARD CODE NAMES ARE PLACED WITHIN THE CIRCLE. MILITARY SYMBOLS OF UNIT OR INSTALLATIONS MAY ALSO BE SHOWN WHEN SECURITY MEASURES PERMIT.)



CHANNELS LINKING TELEPHONE TERMINALS
(THE NUMERAL ABOVE THE LINE INDICATES THE NUMBER OF AVAILABLE CHANNELS.)



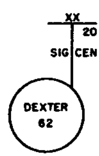
TELETYPEWRITER SET
(PAGE PRINTING, MANUAL, OPERATING HALF-DUPLEX)



TELETYPEWRITER SWITCHING CENTRAL

TELETYPEWRITER SWITCHING CENTRAL INCLUDING TAPE RELAY FACILITIES
(IDENTIFYING NAMES OR CALL SIGNS ARE PLACED WITHIN THE CIRCLE.)

AREA SIGNAL CENTER
(THE NUMERAL ON THE RIGHT SIDE OF THE STAFF INDICATES THE UNIT)
(UNITS CODE NAME AND NUMBER ARE PLACED WITHIN THE CIRCLE)



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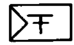
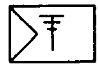
2. Basic Symbols Used in Tactical Circuit Diagrams

TELEPHONE (SMALL CIRCLE)

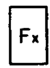
TELETYPEWRITER, PAGE PRINTING, (RECEIVING ONLY)



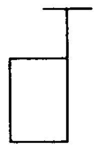
TELETYPEWRITER, TAPE PRINTING, (RECEIVING ONLY)



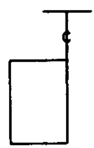
FACSIMILE



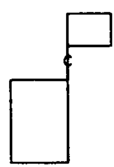
TEST STATION OR PATCHING PANEL



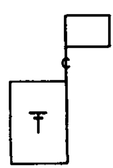
TELEPHONE SWITCHING CENTRAL
(ALSO USED WHEN SWITCHBOARD PROVIDES ALTERNATE OR SIMULTANEOUS TELEPHONE AND TELETYPEWRITER SERVICE.)



TELEPHONE SWITCHING CENTRAL AT A COMMAND POST OR HEADQUARTERS
(ALSO USED WHEN SWITCHBOARD PROVIDES ALTERNATE OR SIMULTANEOUS TELEPHONE AND TELETYPEWRITER SERVICE.)



TELEPHONE SWITCHING CENTRAL AT COMMAND POST OR HEADQUARTERS WITH SEPARATE SWITCHBOARD FOR TELETYPEWRITER



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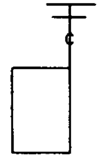
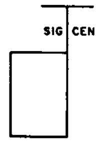
TELETYPEWRITER SWITCHING CENTRAL



AREA SIGNAL CENTER



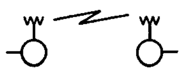
REPEATING COIL IN A SIMPLEX CIRCUIT

FIELD-WIRE PAIR OR CABLE
(TYPE CIRCUIT IS INDICATED ABOVE LINE WITHIN PARENTHESIS)

RADIO CHANNEL

CIRCUIT NOT TERMINATED

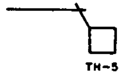
RADIO LINK IN A WIRE LINE



WIRE LINES CONNECTED ELECTRICALLY

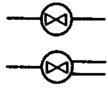
WIRE LINES NOT CONNECTED ELECTRICALLY

EQUIPMENT FOR DERIVING ADDITIONAL CHANNELS FROM CIRCUITS
(EQUIPMENT TYPE NUMBER IS INDICATED NEAR SYMBOL)



UNATTENDED REPEATER
(THE NUMBER OF LINES TO EACH SIDE OF THE SYMBOL WILL VARY DEPENDING ON THE REPEATER TYPE AND ITS USE.)

ATTENDED REPEATER
(THE NUMBER OF LINES TO EACH SIDE OF THE SYMBOL WILL VARY DEPENDING ON THE REPEATER TYPE AND ITS USE.)



TM24-20-103B

3. Basic Symbols Used in Line Route Maps

TELEPHONE (SMALL CIRCLE)

TELETYPEWRITER, PAGE PRINTING, MANUAL, HALF-DUPLEX.

TEST STATION

FACSIMILE

RADIO TERMINAL

RADIO RELAY STATION

FIELD-WIRE LINE OR FIELD CABLE ON GROUND.
THE NUMERAL INDICATES THE NUMBER OF FIELD WIRE PAIRS OR FIELD CABLES.
(CABLE TYPES ARE ADDED IN PARENTHESIS.)

INDIVIDUAL FIELD-WIRE PAIRS OR CABLES TIED TOGETHER TO FORM A SINGLE CABLE
(THE NUMERAL INDICATES THE NUMBER OF FIELD-WIRE PAIRS OR CABLES. CABLE TYPES ARE ADDED IN PARENTHESIS.)

FIELD-WIRE LINE, UNDERGROUND

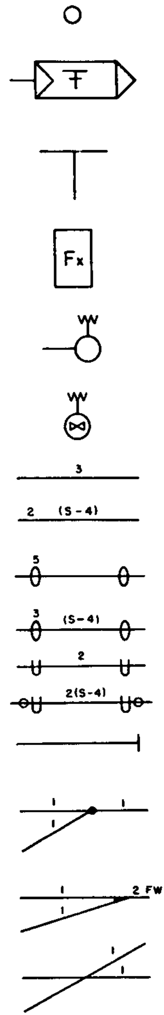
FIELD CABLE, UNDERGROUND

FIELD-WIRE LINE OR CABLE, NOT TERMINATED

FIELD-WIRE LINE SPLICED INTO ANOTHER FIELD-WIRE LINE

TWO FIELD-WIRE LINES JOINING TOGETHER AND FOLLOWING SAME ROUTE (NOT SPLICED)

FIELD-WIRE LINES CROSSING



FM24-20-104A

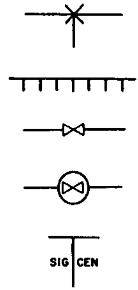
REPEATING COIL, SIMPLEXED IN A LINE

FIELD-WIRE LINE OR CABLE ON OVERHEAD SUPPORTS

UNATTENDED REPEATER

ATTENDED REPEATER

AREA SIGNAL CENTER



FM24-20-1048

GLOSSARY

Alternating current (ac)—An electric current that reverses its direction of flow at regular intervals.

Amplifier—A device used to increase the signal voltage, current, or power; used to increase the talking range of wire lines in repeater and carrier equipment.

Audio frequency (af)—A frequency that can be detected as sound by the human ear. The AF range is approximately 30 to 20,000 cycles per second.

Bridged circuit—A circuit connected in parallel with an existing circuit.

Channel—Electrical path over which transmissions can be made from one station to another. A circuit may be composed of one or more channels.

Circuit—Comunication link between two or more points capable of providing one or more communication channels.

Circuit marking tag—A tag which identifies a field wire line or a field cable.

Command post—The tactical headquarters of a unit at which the commander and his staff are stationed. In combat, the headquarters of a unit is often divided into a forward echelon and a rear echelon. The forward echelon is called a command post.

Common battery system—A telephone system in which the switchboard battery provides the power for operating the line and supervisory signals. The supervisory signals are controlled by the subscriber's telephone. The power for speech transmission is provided by a central source.

Common battery telephone (set)—A telephone which is supplied with both signaling and speech transmission power from a central source.

Communication means—A medium through which a message is conveyed from one person or place to another.

Conductor—Any wire, cable, or other material that provides an electrical path for the flow of current.

Construction center—An installation located in or near a command post area where trunk lines and long-local circuits converge for entrance to the telephone central. Test equipment and construction personnel are usually located at this point.

Cross—An electrical contact between conductors of two independent circuits.

Direct current (dc)—An electric current that flows in one direction.

Duplex circuit—A circuit which permits communication between stations in both directions simultaneously.

Echelon—Subdivisions of a headquarters, such as forward echelon, rear echelon; or separate levels of command. For example, to a battle group division is a higher echelon and company is a lower echelon.

Fault—A defect in a wire circuit caused by a ground, a break, a cross, or a short.

Field telephone—A portable telephone designed for field use.

Field telephone switchboard—A portable telephone switchboard designed for field use.

Field-type—Term used to describe equipment, troops, or units used primarily to carry out a combat mission.

Full duplex—An operation of a telegraph system having simultaneous communication in opposite directions.

Ground—The contact of a conductor with the earth; also refers to the physical earth when it is used as a conductor.

Half duplex—An operation of a telegraph system arranged to permit communication in either direction but not in both directions simultaneously.

Lateral communication—Communication between units that are located side-by-side along a front; or communication between units at the same level of command.

Line route map—Map or overlay for signal communication operations that shows the actual route and type of constructions for tactical wire circuits.

Loaded line—A wire line in which loading coils have been inserted at regular intervals to reduce losses caused by the line capacitance.

Local-battery system—A telephone system in which the speech transmission power is supplied at each telephone.

Local circuit—A wire circuit connecting a telephone to a switchboard or to another telephone; sometimes called a loop.

Main distributing frame (MDF)—A framework containing terminals which are used for interconnecting incoming wire lines to the terminal equipment.

Manual telephone system—Telephone system in which interconnections are manually established by operators.

Map substitute—A reproduction of wide-coverage aerial photographs, photo-maps, or mosaics, or of provisional maps, or any document used in place of a map. A map substitute does not necessarily meet the precise requirements of a map.

Marline—A small, loosely twisted twine used for tying field wire to a support.

Messenger strand—A steel cable used to support aerial communication cable.

Monocord switchboard—Field telephone switchboard in which each line terminates in a single jack and plug.

Open—A break in the continuity of a wire circuit.

Open-wire line—Parallel bare conductors strung on insulators mounted on cross arms of telephone poles.

Overlay—Transparent sheet giving special military information not ordinarily shown on maps. When the overlay is placed over the map from which it was drawn, its details will supplement the map; a tracing of a photograph, mosaic, or map which is used to present the interpreted features and the pertinent details, or to facilitate plotting of a certain area.

Phantom circuit—Telephone or telegraph circuit obtained by superimposing an additional circuit on two existing physical circuits by means of a repeating coil.

Rear area—General term designating the area in the rear of the combat and forward areas.

Rear echelon—The part of a headquarters engaged in administrative and supply duties. It is usually located a considerable distance behind the front lines.

Repeater—A combination of apparatus for the reception and transmission of either 1-way or 2-way communication signals and delivering corresponding signals which are either amplified or reshaped or both.

Repeating coil—An audio-frequency transformer, with a one-to-one winding ratio, used for transferring energy from one electrical circuit to another, and for forming simplex and phantom circuits.

Routes and signal centers of area communication system—This indicates the major routes of signal communication and locates the principal signal centers of an area communication system.

Sag—Slack placed in aerial wire or cable construction to compensate for contraction caused by weather conditions; the vertical distance between the lowest point on a line and the point of suspension.

Section of wire line—That portion of a wire line which begins and ends at successive centrals, testing points or, in the case of long-local circuit, at telephones.

Seizing wire—Soft-drawn copper wire which is wound over a field wire splice to improve the splice mechanically and electrically.

Short—An electrical contact between two conductors of the same circuit.

Simplex circuit—An additional ground-return telephone or telegraph circuit obtained from a single full-metallic circuit by means of a repeating coil.

Skinning—The process of removing insulation from wire.

Sound-powered telephone—A self-contained communication set which provides two-way signaling and voice communication over limited distances without the use of batteries. The sound-powered telephone may be switched through a telephone central.

Spliced joint—A junction in which conductors of a circuit are joined for electrical continuity.

Staggering—The spacing of splices in the two conductors of a field wire so that the individual splices will not be opposite each other.

Switching central—A wire-system installation in which switching equipment is used to interconnect teletypewriters or telephones.

Tactical—Pertains to the employment of units in combat.

Tactical circuit diagram—A line drawing of circuits of a communication wire net, showing the number and kind of circuits, and all headquarters and subordinate units by code names and map coordinates. The extent of this information is determined by local security requirements.

Telegraphy—A means of communication whereby a message is transmitted by using a code of electrical impulses of various lengths and combinations to designate the individual characters. Teletypewriter transmissions are a form of telegraphy.

Terminal—One end of an electrical circuit. A terminal might also include the equipment at the end of the circuit.

Terminal strip—A block of insulating material with a series of binding posts.

Test set—An electrical device used to determine and locate troubles in a circuit or equipment.

Test station—An installation where circuits can be tested and rearranged.

Traffic diagram—An illustration showing the number of long-local circuits and channels actually existing between switchboards of a signal communication network.

Transmission—The flowing of electrical energy through a circuit.

Trunk—A circuit between two switchboards.

Twisted-wire pair—Two conductors of a wire line which are individually insulated and spirally wound around each other.

Voice frequency (vf)—The band of frequencies generated by the human voice.

Way station—A teletypewriter connected to a line between, and in series with, other teletypewriter stations.

Wire communication—Communication by telephone, telegraph, teletypewriter, or any other means of communication employing a metallic circuit between the transmitting and receiving equipments.

Wire gage—System of numerical designations of wire sizes. (Low numbers designate the larger size.) Usually expressed AWG (American Wire Gage).

Wire head—This is similar to a construction center. Construction personnel and test equipment, however, are not located at this point.

Wire net—Telephone communication system.

Wire pike—A 9-foot pole with hook and roller attached to one end, used to simplify the laying and recovering of field wire.

Zero board—A switchboard installed at a construction center and used as a test board.

INDEX

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NG: State AG (3); units same as active army except allowance is one copy.

USAR: None.

For explanations of abbreviations used, see AR 320–50.

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