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TM 11-474

SUBSTATION INSTALLATION

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IC 44: Hq & Hq Btry, AAA Comd (HAW).

For explanation of symbols see FM 21-6.

CONTENTS

DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW—1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools, etc.
2. Cut—Use axes, handaxes, machetes, etc.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades, etc.
4. Explosives—Use firearms, grenades, TNT, etc.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Terminal blocks, telephones, bell boxes, keys, protectors, connecting blocks, and insulators.
2. Cut—Cable, wire, and cords.
3. Burn—Cable, wire, and cords.
4. Bury or scatter—Any or all of the above pieces after destroying them.

DESTROY EVERYTHING

SECTION I

GENERAL

1. Purpose

The purpose of this publication is to provide a reference manual of methods and practices used in the installation and maintenance of telephone substations.

2. Scope

It is impractical to include in this manual information covering all the conditions that are encountered by a substation installer; therefore, only those methods and practices in common use are covered. The material is presented under seven section headings: General, Outside Installation, Station Protection, Inside Installation, Station Wiring Plans, Special Equipment, and Supplementary Data. Appropriate Bell System Practices have been used in the preparation of this manual.

3. Terminology

Common terms and their definitions follow:

a. AERIAL. Cable or wire construction suspended above the ground surface.

b. ARMOR. Additional outer wire and jute wrappings on some types of cable, affording mechanical strength and protection from the effects of abrasion.

c. BARE. Not insulated.

d. BRIDGE. Connect across.

e. B.S.P. Bell System Practices.

f. BLOCK WIRE RUN. Parallel distribution consisting of two or more pairs, usually drop or bridle wire, suspended from a suspension strand in bridle rings, or cable rings. Used mostly in warehouse areas and similar installations at army posts.

g. BRAID. The woven outer covering of drop wire, inside house wire, bridle wire, cross-connecting wire, and instrument wire, which affords protection to insulation.

h. BURIED CABLE. Construction where the earth is in direct contact with the outer surface of the cable.

i. CABLE. Wires separately insulated which are paired in a common covering or sheath. The insulation and covering vary according to the type of cable. Cable pairs that are exposed to dampness of the atmosphere are usually covered with impregnated silk and cotton insulation. Cable used in aerial and underground construction requires only paper insulation for each individual conductor. A lead sheath overall provides waterproof covering. Buried and submarine cables have additional armor and jute wrappings to protect the lead sheath from physical injury. Rubber-covered cables of 5 and 10 pairs have been developed for temporary and semipermanent installation in wire communication systems.

j. CABLE PAIR. Two insulated wires, twisted together, which form the two sides of an intended electrical circuit, and are often included with other pairs within a cable sheath.

k. Cable Terminal. Equipment used to terminate cable pairs, permitting access for cross-connecting, testing, and making service connections.

l. Cross-connection. Physical and electrical connection of two circuits which have been terminated to provide flexibility in the plant. The circuit may be fused or not where cross-connected. Cross-connection also provides a test point at which the cable may be sectionalized to determine the location of trouble.

m. Drop Wire. The pair of wires used to complete the circuit between the cable terminal and the subscriber's premises, when this section of the circuit is subjected to the effects of weather.

n. Exposed. A circuit that is vulnerable to high voltage or lightning.

o. FX. Fused cross-connection.

p. Ground Wire. A special, low-resistance copper wire which forms the metallic link between the ground post of the protector and ground clamp or ground rod.

q. House (Inside) Wire. Two or three conductors twisted together and used to connect the subscriber's telephone to the protector. House (inside) wire is not intended for wet runs and should not be subjected to tensile strain. The insulation will not stand severe abrasion.

r. Insulation. A nonconducting material used to cover or separate electrical conductors. Rubber, glass, bakelite, paper, silk, cotton, and air are the nonconductors most commonly used.

s. Jumper. A piece of wire used to cross-connect.

t. Key. A switch used to close an electrical circuit.

u. Loading Area. A section of the country; designated light, medium or heavy, according to weather severity. Wind, rain, sleet, ice, and snow are the principal factors involved in determining the classification of an area.

v. Protector. A device used to protect inside and outside telephone plant facilities from excessive voltage or current.

w. Subset (Bell Box). A telephone ringer and induction coil inclosed in a box.

x. Substation (Subscriber's Station). A complete telephone installation on a subscriber's station.

y. Telephone Instrument. Subscriber's handset, desk set, or combination set.

4. Types and Uses of Wire

a. Drop Wire. (1) Wire W–38 is a twisted-pair drop wire, with solid No. 17 B.&S. gauge, copper-clad, steel conductors which are separately insulated with a tough rubber compound and covered by an asphalt-impregnated, weather-proof, cotton braid. The tracer wire is designated by a raised thread which is woven into the braid of one conductor.

(2) Wire W–50 is similar to Wire W–38, but the conductors are No. 14 B.&S. gauge, solid, hard-drawn copper. Designation of tracer wire is the same as for Wire W–38.

(3) Wire W–108 is a two-conductor, parallel drop wire, having solid bronze or copper-clad steel conductors of 0.045 inch diameter or No. 17 B.&S. gauge wire, separately insulated with a rubber compound.

Both conductors are encased in an asphalt-impregnated, weatherproof, cotton braid. The tracer is identified by a straight moulded ridge in the rubber insulation on one conductor. Wire W–108 will not withstand excessive abrasive action.

(4) Wire W–108–A is a modification of Wire W–108. The conductors are slightly smaller than conductors of Wire W–108, being No. 18 B.&S. gauge, of solid bronze or copper-clad steel.

(5) Commercial parallel drop wires are designated BR, TR, BP, or TP. Use BP or TP type for normal runs. BR and TR types have a heavier braid and slightly heavier rubber insulation on the individual conductors. They are intended for use where drops are subjected to light abrasive action due to rubbing against foliage and branches ½ inch or less in diameter.

(6) Drop wire should be used in the following places:

(*a*) Span between poles.

(*b*) Pole to building.

(*c*) Open wire to protector.

(*d*) Terminal to protector.

b. Ground Wire. (1) Wire W–119 has a single No. 12 B.&S. gauge, solid, tinned-copper conductor, and is insulated with a rubber compound and flameproof, weatherproof braid. Wire W–119 will accommodate four or five protectors.

(2) No. 14 B.&S. gauge ground wire is similar to Wire W–119, but has no Signal Corps type number. No. 14 B.&S. gauge ground wire will accommodate one to three protectors.

c. Inside House Wire. (1) Wire W–33 is a two-conductor, twisted-pair inside house wire. Each conductor is separately insulated with a rubber compound and green cotton braid. The conductors are solid, No. 19 B.&S. gauge, tinned copper. The tracer wire is designated by a red thread in the braid. Wire W–33 is used inside buildings where moisture will not be encountered.

(2) Wire W–117 is a two-conductor, twisted-pair, inside house wire. Each conductor is No. 22 B.&S. gauge, solid, soft, tinned copper wire, separately insulated with a rubber compound, and covered with a green cotton braid. Wire W–117 may be used as a substitute for Wire W–33.

(3) Wire W–118 is a three-conductor twisted wire; each conductor is a solid, soft, tinned copper wire, No. 22 B.&S. gauge. Each conductor is insulated with a rubber compound and protected with a green cotton braid. The tracer for identification is a red or yellow thread in the braid of two conductors; the third conductor is covered with a green braid.

(4) War Production Board (WPB) special wire is, at present, the only commercially manufactured wire procurable (as authorized by the War Production Board) for commercial telephone company use. WPB special wire is a twisted-pair, two-conductor wire; each conductor is a solid, soft, tinned copper wire, No. 22 B.&S. gauge. Each conductor of WPB special wire is separately insulated with a rubber compound, and both conductors are covered with a brown cotton braid, giving the appearance of a single conductor unless examined closely. The tracer is a raised ridge on the rubber insulation of one conductor. WPB special wire is a permissible substitute for inside house Wire W–33.

d. Duct Wire. Duct wire is a commercial product having no Signal

Corps equivalent. Duct wire is a twisted-pair, two-conductor wire; each conductor is a solid No. 22 B.&S. gauge, soft, tinned copper wire. Each conductor is separately insulated with a rubber compound, and over the rubber insulation is a tightly wrapped jacket of paper which is impregnated with a sealing and waterproofing compound. The ring tracer is a red thread, and the tip tracer is a green thread. Duct wire is designed especially for use where dampness is evident or probable, as in conduits, ducts, or damp cellars. Being weatherproof, duct wire may be used for cross-connecting open wire pairs, connecting outdoor connecting blocks to cable terminals, or connecting outdoor protector mountings to line or cable terminals. Duct wire should never be subjected to abrasion because of its paper covering.

e. Bridle Wire. Wire W–69–A is a twisted, two-conductor wire; each conductor is a solid, soft, No. 22 B.&S. gauge, tinned copper wire. Each conductor is separately insulated with a rubber compound and wrapped in a black cotton, weatherproof braid. The tracer designation is either a raised ridge on the rubber insulation of one conductor or a raised thread in the cotton braid of one conductor. Wire W–69–A is used extensively in damp, inside runs such as cellars or under buildings. Wire W–69–A may be used for cross-connecting at outdoor terminals, between outdoor protectors and terminals or open wire, and will withstand considerable abrasive action. Wire W–69–A is also suitable for use in duct or conduit runs.

f. General Purpose. Bell System GN station wire, a commercial type of wire having no Signal Corps equivalent, is a twisted pair of two conductors; each conductor is a solid, soft, No. 22 B.&S. gauge, tinned copper wire. Each conductor is separately insulated with a rubber compound and is covered with a cotton braid. The tracer consists of a red thread woven in the braid of one conductor. Bell System GN station wire is obtainable in either brown or ivory color, and offers an inconspicuous installation against colored backgrounds. Bell System GN station wire may be used in damp locations, but will not withstand wet conditions. Under most conditions, Bell System GN station wire may be substituted for either inside wire or bridle wire.

5. Handling Drop Wire

a. Care. When transporting drop wire in vehicles do not allow the wire to be damaged by tools and equipment. Do not trample the drop wire, or allow vehicles to run over it. When uncoiling drop wire do not allow kinks to develop. When not using a drop wire reel, kinks in the wire can usually be avoided by reversing the coil every five or six turns. If a kink does develop, and is pulled tight, cut the kink out of the wire.

b. Drop Wire Reels. Drop wire reels are provided to facilitate the installation and recovery of drop wire. A drop wire reel will accommodate coils of wire having an inside diameter of about 15 inches. A coil of wire is placed on a drop wire reel by removing the side of the reel, and placing the coil on the hub and against the other side of the reel. The removed side is then replaced. If coils of wire having an inside diameter of more than 15 inches are to be used, the wire must first be rewound on the drop wire reel. The weight of wire coiled on one reel should never exceed 50 pounds.

6. Splicing Drop Wire

a. GENERAL. When splicing drop wire in the field, the following rules must be observed:

(1) Do not nick the conductor when removing the insulation.

(2) Clean the wire thoroughly before making the splice.

(3) Splice tracer wire to tracer wire, and plain wire to plain wire.

(4) Make the splice mechanically secure, and make a good electrical connection.

(5) Check to see that the tension on the completed splice is equal on both conductors.

(6) Make the splice as neat as possible.

b. DOUBLE-SLEEVE SPLICE. A double sleeve consists of two parallel, soft metal tubes soldered together. The size of sleeve to be used and the method of splicing appears below.

(1) Remove 12 inches of braid from each pair of wires to be spliced.

(2) Cut one wire of each pair 6 inches shorter than the other wire of that pair. (Cut the plain wire of one pair, and the tracer wire of the other pair.)

(3) Remove about 4 inches of the rubber insulation from all the conductors, and clean the conductors thoroughly.

(4) Place the double sleeve over the end of one wire of one pair and insert the corresponding wire of the other pair. Bend the projecting ends of the wires slightly to keep the sleeve and the wires in place.

(5) Grip opposite ends of one sleeve of the pair with sleeve twisters (Clamp LC–24), or pliers which have grooves to fit the sleeve.

(6) Give the sleeve five half-turns, twisting from both ends.

(7) Wrap each projecting end of the bare wire around the insulated portion of the wire in the direction in which it tended to wrap when the sleeve was twisted.

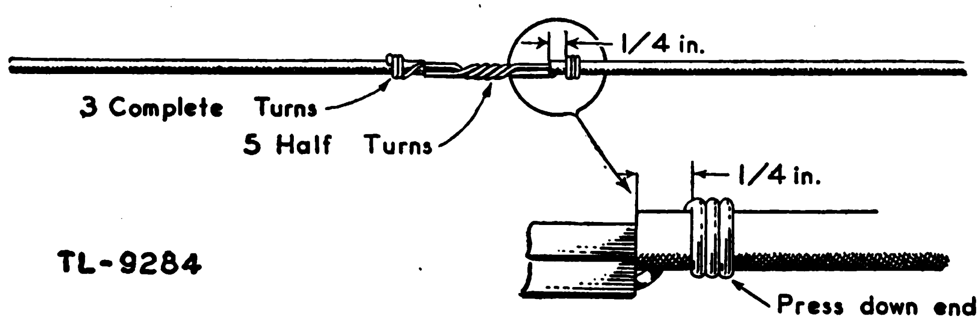

Figure 1. Twisted double-sleeve splice.

(8) Cover the joint with two wrappings of ¾-inch rubber tape. Start at the center; wrap 1 inch beyond the last turn of wire on one end; reverse direction and wrap 1 inch beyond last turn of wire on the opposite end; reverse direction once more, and complete the wrapping at the center of the splice. Roll the completed joint between the fingers to bind the tape more firmly together.

(9) Repeat the operations described in (4) to (8) above with the remaining two wires.

(10) Wrap the entire splice with two layers of ¾-inch black friction tape to a point ½ inch beyond the edge of the rubber tape. (Apply black friction tape in the same manner that the rubber tape was applied, as described in (8) above.)

Table I. Double-sleeve Splice

Wire to be spliced	Size of sleeve (in.)	Number of half-turns to be made in sleeve
Parallel drop wire to parallel drop wire.	0.045	5
Parallel drop wire to No. 20 bridle wire.	0.045 x 0.032	5
Parallel drop wire to No. 18 bridle wire.	0.045	5
No. 20 bridle wire to No. 20 bridle wire.	0.032	4
No. 20 bridle wire to No. 18 bridle wire.	0.045 x 0.032	5

c. PRESSED-SLEEVE SPLICING. (1) The precautions to be observed when making pressed-sleeve splices are the same as the precautions in *a* above

(2) Sleeves for pressed-sleeve splicing are of two types:

(*a*) "S"-type sleeves are single-tube sleeves which have a uniform diameter bore and an indentation at the midpoint of their lengths which regulates the distance to which the conductors are inserted. The sizes and types of wires for which "S"-type sleeves are intended are given in table II.

Table II. "S" Brass Sleeves

Size (in.)	Length (in.)	Type of wire
0.032–0.025	1	Bridle wire (20-gauge). Wire W–69–A. Duct wire. WPB special wire. Wire W–117. Wire W–33. Bell System GN station wire.
0.045–0.040	1⅞	TP and TR drop wires. BP and RB drop wires. Bridle wire. Wire W–108 and W–108–A. Wire W–38.
0.064	1⅞	Wire W–50.

(*b*) Combination "S" sleeves are single-tube sleeves in which the bore diameter of one-half of the sleeve differs from the bore diameter of the other half. The sizes and types of wire for which combination "S" sleeves are intended are given in table III.

Table III. Combination "S" Sleeves

Size (in.)	Length (in.)	Types of wires	
		Large bore	Small bore
0.045–0.040 x 0.032.	1	TP and TR drop wire.. BP and BR drop wire.. Bridle wire........... Wire W–108 and W–108–A. Wire W–38...........	Bridle wire (20-gauge). Wire W–69–A. Duct wire. WPB special wire. Wire W–117. Wire W–33. Bell System GN station wire.
0.064 x 0.045–0.040.	1⅞	Wire W–50...........	TP and TR drop wires. BP and BR drop wires. Bridle wire. Wire W–108. Wire W–108–A. Wire W–38.

(3) The sleeve presser (No. 17–2, Nico press tool) is a hand-operated tool for pressing the single-tube sleeves used in splicing certain sizes of insulated wires and bare copper wires. The jaws of the sleeve presser have two grooves which accommodate the various sizes of sleeves.

(4) When making a pressed-sleeve splice, the correct size sleeve must be used, especially when two different sizes of wires are being joined. Proceed in the following manner:

(*a*) Remove the braid from the end of the parallel conductors for a distance equal to 1¼ times the length of the sleeve to be used. Separate the rubber-insulated conductors and remove the rubber insulation from the ends of the conductors for a distance equal to one-half the length of the sleeve to be used. If the wire to be spliced is a twisted pair, remove the braid and rubber insulation from the end of the conductors for a distance equal to one-half the length of the sleeve to be used. Clean the bare conductors thoroughly.

(*b*) Insert the proper sleeve on one of the conductors of one of the pairs to be spliced. Push the sleeve over the wire until the end of the sleeve touches the insulation.

(*c*) Crimp the sleeve on each side near the insulation with a pair of diagonal pliers, in order to hold the sleeve in place.

(*d*) Match the tracers and insert the proper conductor from the other pair into the sleeve, crimp the ends of the sleeve in order to hold the sleeve in place.

(*e*) Starting approximately 1/16 inch from the end of the sleeve, press the sleeve with the sleeve presser at equally spaced points on the sleeve, six times for the large sleeves, and four times for the smaller sleeves. (See fig. 2.)

(*f*) Wrap the joint with a single layer of 3/4-inch rubber (Commercial DR) tape, extending the tape 3/4 inch beyond each end of the sleeve.

(*g*) Repeat the above procedure with the remaining two wires.

(*h*) Wrap the entire splice with two layers of 3/4-inch friction tape as described in *b*(8) above.

NOTE. If DR tape is not available prepare the wire for splicing as described in paragraph 6b(1) to (3).

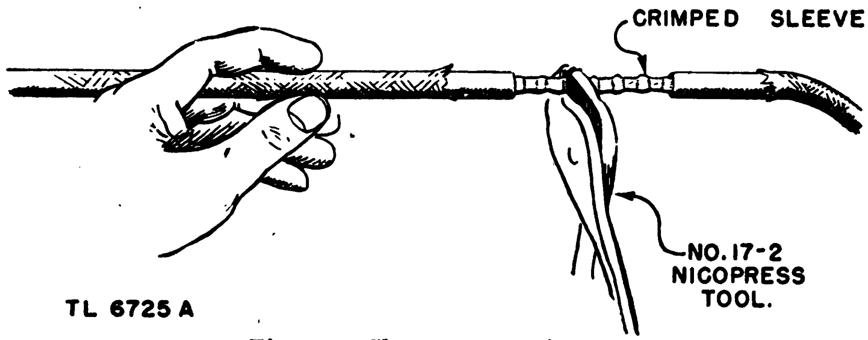

Figure 2. Sleeve presser in use.

SECTION II

OUTSIDE INSTALLATION

7. Drop Wire Clamps and Clips

a. INSTALLING DROP WIRE CLAMPS. (1) Drop wire clamps consist of two parts—a sleeve and a wedge. A copper wire loop is secured to the wedge and is used to attach the clamp to the point of support.

(2) When installing drop wire clamps, place copper wire loop over hook or knob, and pull tight.

(3) Place sleeve over wire to be secured, with narrow end of sleeve toward hook or knob.

(4) Place sleeve loosely over wedge, with wire between wedge and sleeve.

(5) Adjust slack by holding sleeve in place with thumb.

(6) Secure sleeve firmly against wedge. (See fig. 3.)

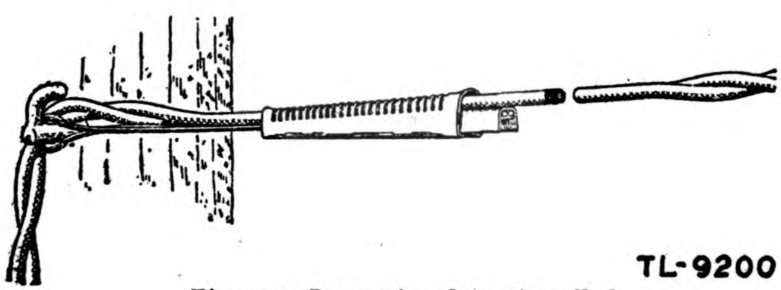

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Figure 3. Drop wire clamp installed.

b. INSTALLING SNUB R GRIP. (1) The Snub *R* grip consists of a piece of grooved metal shaped to form a spiral. (See fig. 4.) At one end of the spiral a wire loop is attached which is placed over a knob or drop wire hook to mount the grip. Friction between the wire and the grip acts to hold the wire in place.

(2) When installing the snub *R* grip, place the wire loop over the supporting attachment. Wind the drop wire in the grooves of the grip, starting from the side opposite the span, in order to prevent kinks from developing in the vertical run.

(3) *Do not bend the projections at the ends of the spiral against the wire.*

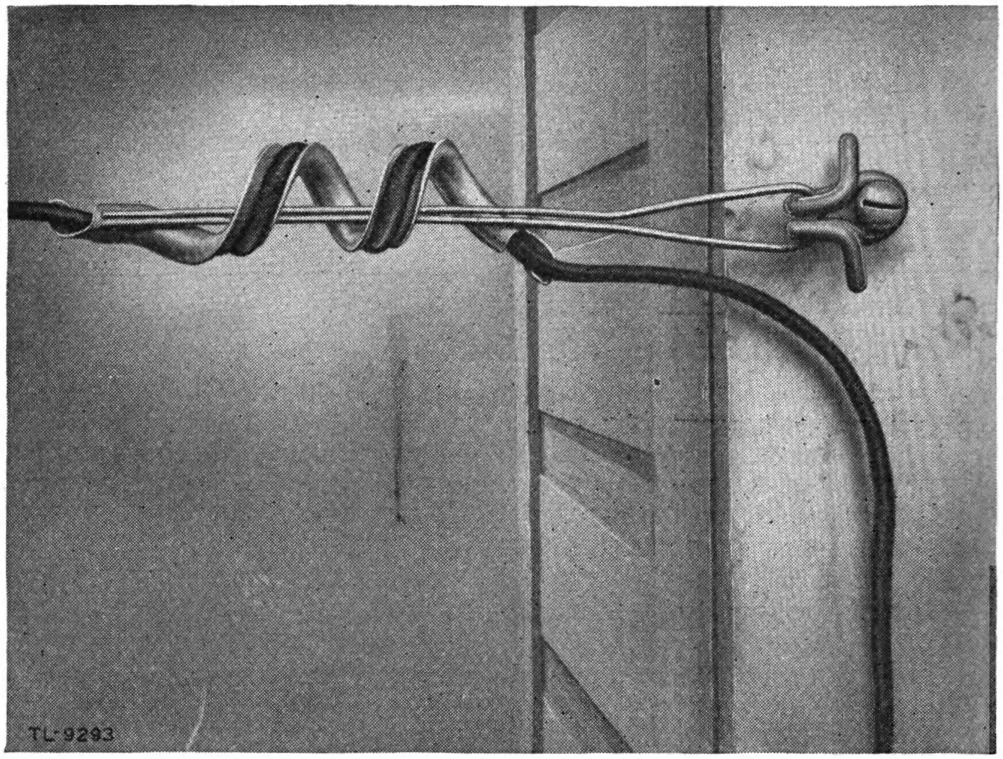

Figure 4. Snub R grip installed in unexposed area.

c. INSTALLING DROP WIRE CLIPS. (1) Place wire in back of clip so that the flat surface of the wire lies on the bottom of the clip.

(2) Use pliers to grip the top side of the clip near the edge and the bottom side near the back, and press the top side of each section of the clip over the wire.

(3) Use pliers to grip the projection near the edge and bottom side of clip near the back, and press the projections of each section over the top side of the clip. (See fig. 6.)

(4) If brackets and knobs have been previously installed and are only partially filled, use knob adapters in the vacant grooves of the knobs, and place the drop wire clips over the knob adapters.

(5) At corner attachments where there is a pull of more than 4 inches, use two drop wire clamps, dead-ending both ways. (Pull is defined as the distance measured as shown in fig. 5.)

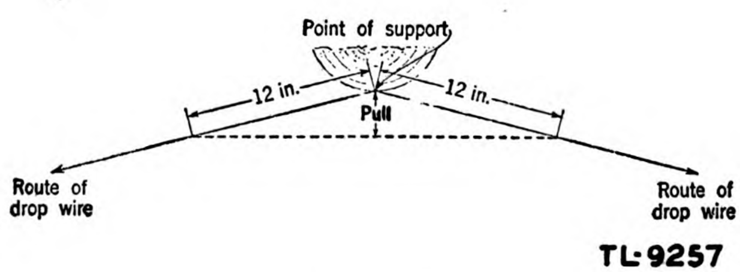

Figure 5. Pull.

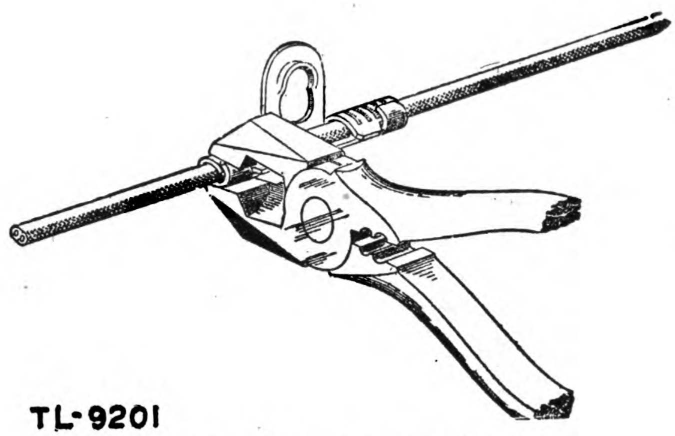

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Figure 6. Installing drop wire clip.

8. Equipping and Installing Attachments

a. Anchoring Devices. (1) Hammer drive anchors consist of an expansion shield and a nail. The nail serves as a wedging element and is used in attaching fixtures to masonry surfaces. For maximum holding power the diameter of the drilled hole must be exactly the same as the diameter of the unexpanded shield, and deep enough to accommodate the full length of the nail. (See fig. 7.)

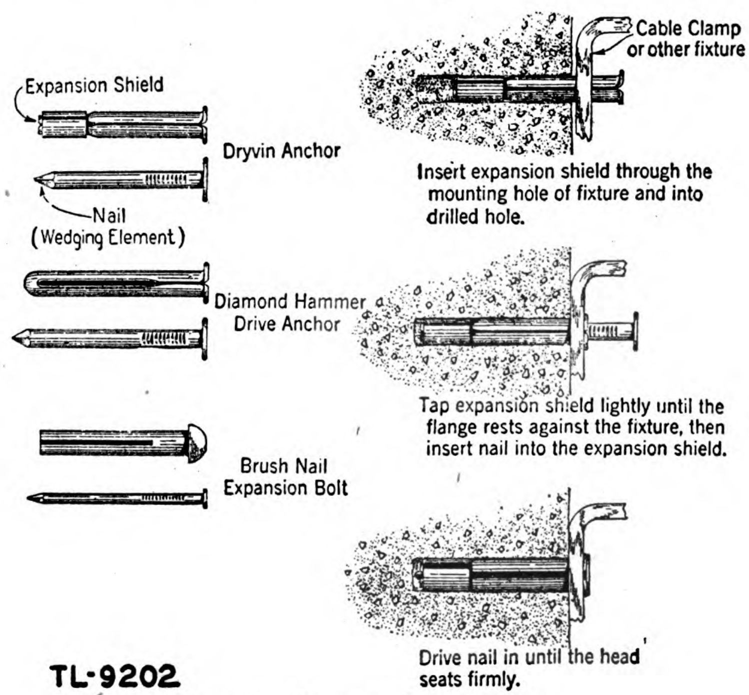

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Figure 7. Hammer drive anchors.

(2) Screw anchors consist of an expansion shield which is available in two general types: one to accommodate a wood-screw wedging element, and the other to accommodate a machine-screw wedging element. (See figs. 8 and 9.) Screw anchors are also intended for use in attaching fixtures to masonry surfaces.

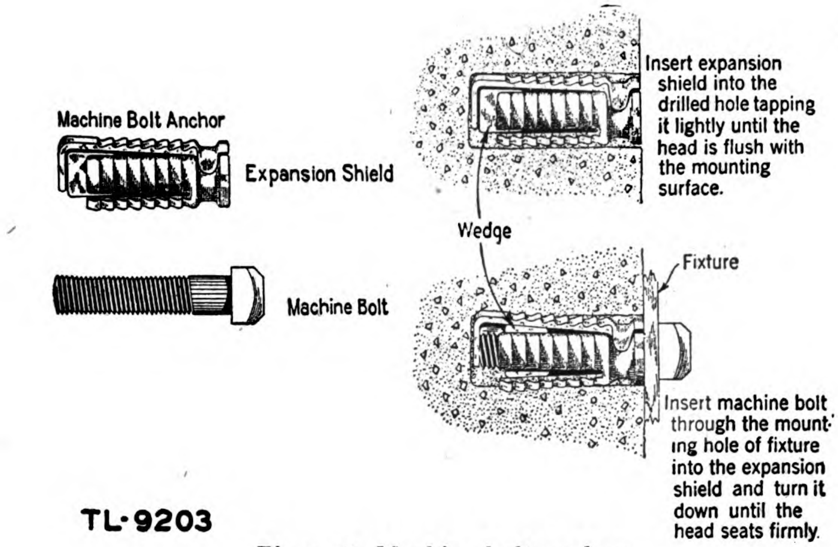


Figure 8. Machine bolt anchors.

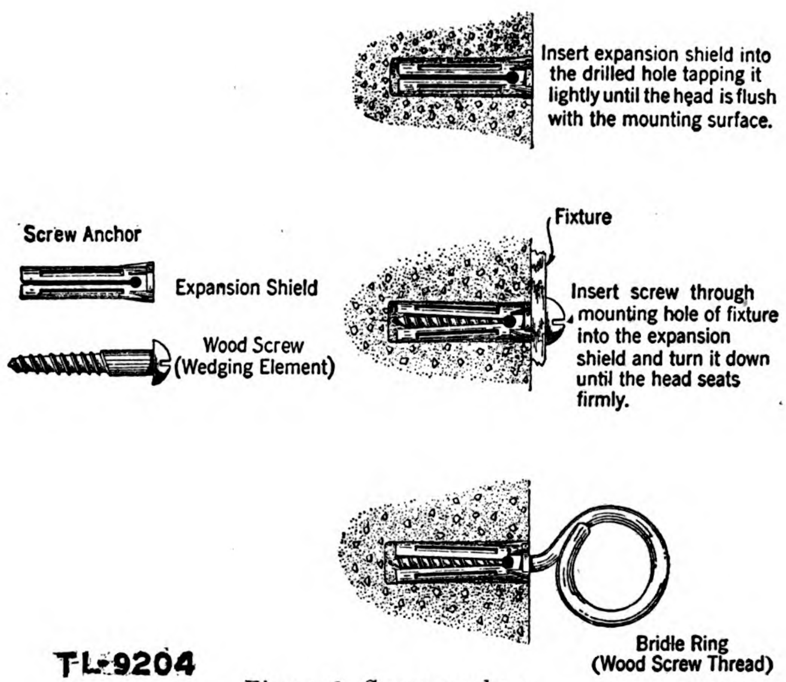


Figure 9. Screw anchors.

(3) Toggle bolts are of two general types, flop-over and spring, and are intended for use in attaching fixtures to hollow tile and similar surfaces. (See fig. 10.) The security of toggle bolt installation is dependent upon obtaining a satisfactory bearing area for the toggle. Table IV lists the various sizes of toggle bolts, giving the maximum spread of each toggle and the diameter to which the drilled hole should be restricted for most satisfactory results.

Table IV. Toggle bolts

Size of toggle bolt (in.)	Maximum spread of toggle (in.)	Diameter of drilled holes (in.)
1/8	2	1/2
3/16	2 1/4	5/8
1/4	2 1/4	3/4
5/16	2 3/4	7/8

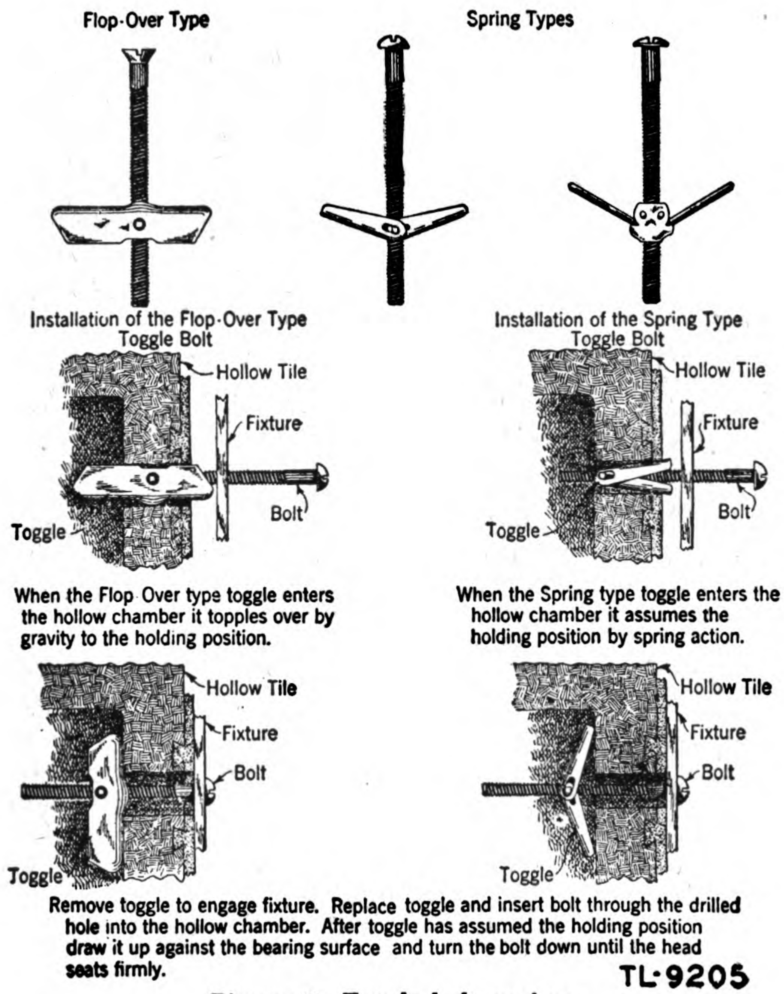


Figure 10. Toggle bolt anchors.

b. CABLE CLAMPS. (1) The cable clamp consists of a flat piece of metal which is bent to the shape of a "V" and has a hole for a mounting screw. (See fig. 11.)

(2) Cable clamps can be mounted on wood surfaces by means of wood-screws, double-headed nails, or, when used with drive rings, the pin of the drive ring. Cable clamps can be mounted on masonry surfaces by using one of the anchoring devices described in *a* above.

(3) Mount the anchor and cable clamp on brick walls as near the center of the brick as possible.

(4) On horizontal runs, space cable clamps 17 inches apart for cables 1 inch or less in diameter, and 26 inches apart for larger cables.

(5) On vertical runs, space cable clamps 24 inches apart for all sizes of cable.

(6) Whenever possible, locate cable clamps of horizontal runs so that the point of attachment is below the cable and on the inside of bends. On vertical runs cable clamps should be placed on the same side of the cable as the cable clamps used in the horizontal run. (See fig. 11.)

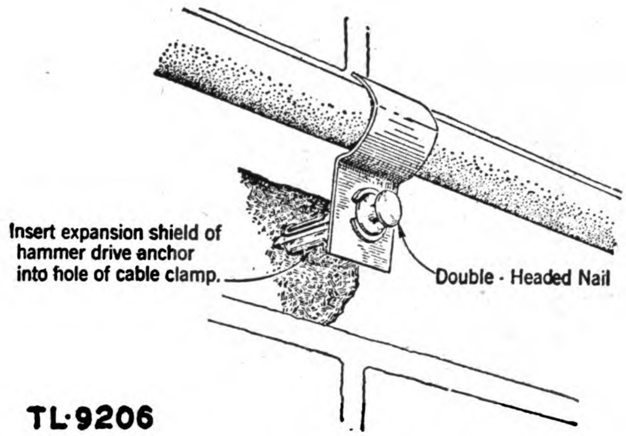


Figure 11. Cable clamp partially installed.

c. Drive Rings. (1) A drive ring consists of a pin and an open wire loop. (See fig. 12.) Three sizes of loops are available, 1/2-inch, 5/8-inch, and 7/8-inch. Drive rings can be driven into wood or into masonry by using the expansion shield of the 1/4 x 1 inch hammer drive anchor.

Note. The size of the drive ring will be determined by the number of drops to be installed.

(2) The 7/8-inch drive ring can be used to support wires paralleling cable runs which are attached to wood or masonry. The pin of the drive ring serves as the anchor expansion element of the cable clamp anchor. (See fig. 12.)

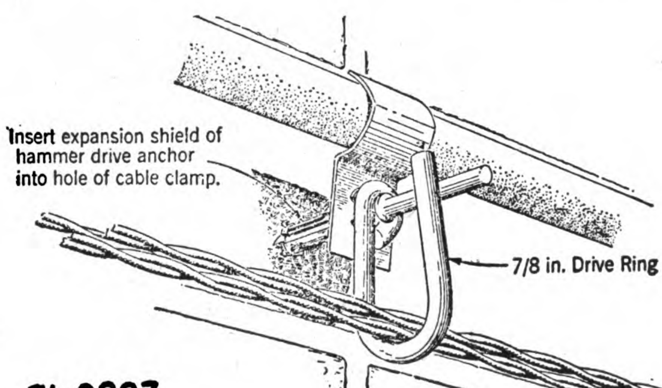


Figure 12. Drive ring partially installed on cable run.

(3) Space the drive rings as follows:

Cable clamp spacing	*Drive ring spacing*
17 inches, horizontal	Every third clamp
26 inches, horizontal	Every other clamp
24 inches, vertical	Every other clamp.

(4) Drive rings may be mounted independent of cable runs by driving the pin into a wooden mounting surface, or by using a 1/4 x 1 inch expansion shield when mounting drive rings in masonry.

(5) When using drive rings as intermediate supports for drop wire runs on buildings, space the drive rings as follows:

(*a*) Do not space attachments on horizontal runs more than 9 feet apart.

(*b*) Do not space attachments on vertical runs more than 12 feet apart.

(*c*) Where windows are available for making attachments on vertical runs, place an attachment on each floor.

(6) Drive rings installed independently of cable runs to support blocks wires should be spaced as follows:

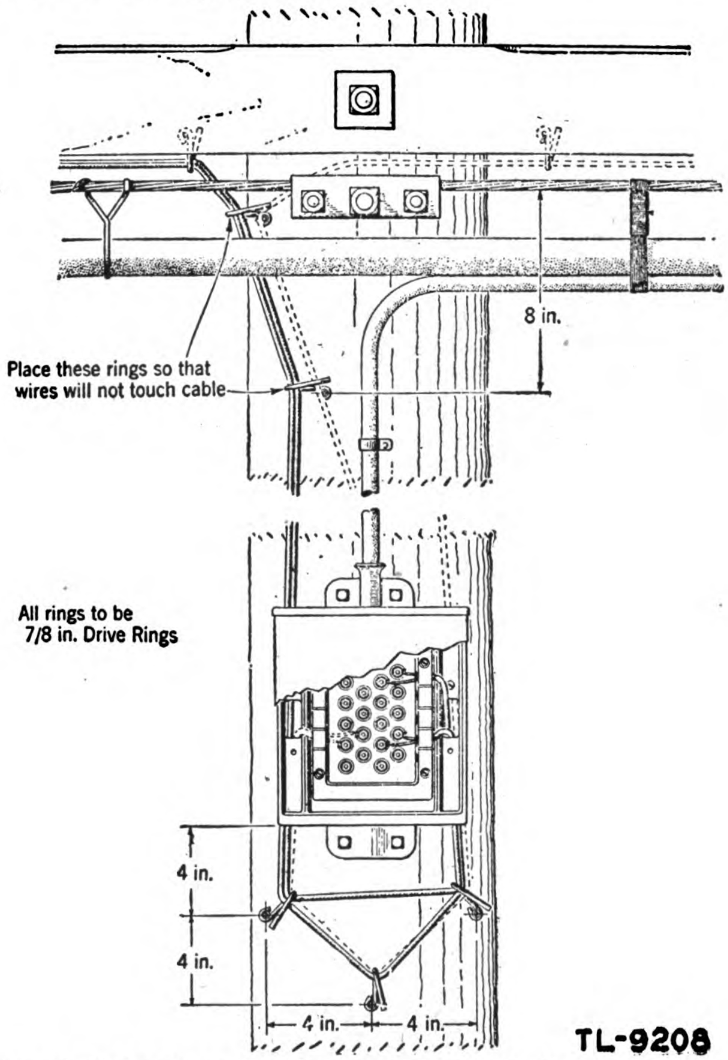


Figure 13. Drive rings installed at cable terminal mounted on pole.

(*a*) Approximately 50 inches apart on horizontal runs.

(*b*) Where windows are available for attachments on vertical runs, make an attachment on each floor.

(*c*) Where windows are not available for attachments on vertical runs, space the attachments approximately 8 feet apart.

(7) Where wire run is horizontal, place drive rings so that the opening of the drive ring is at the top.

(8) In a wire run that changes direction from horizontal to vertical, place two drive rings at the bend of the run and arrange the drive rings so that the wires will rest against the loops and not against the pins of the rings.

(9) Where a wire run turns an outside corner, place a drive ring not farther than 6 inches away from the corner, in each direction, and cover all the wires that come in contact with the corner, with at least two layers of 3/4-inch black friction tape at the point of contact.

(10) Where a wire run turns an inside corner, place a drive ring not farther than 6 inches away from the corner in each direction.

(11) Where drive rings are installed at distribution terminals (figs. 13 and 14), use the 7/8-inch ring, which will provide facilities for wiring at 16-pair (and smaller) distributing terminals.

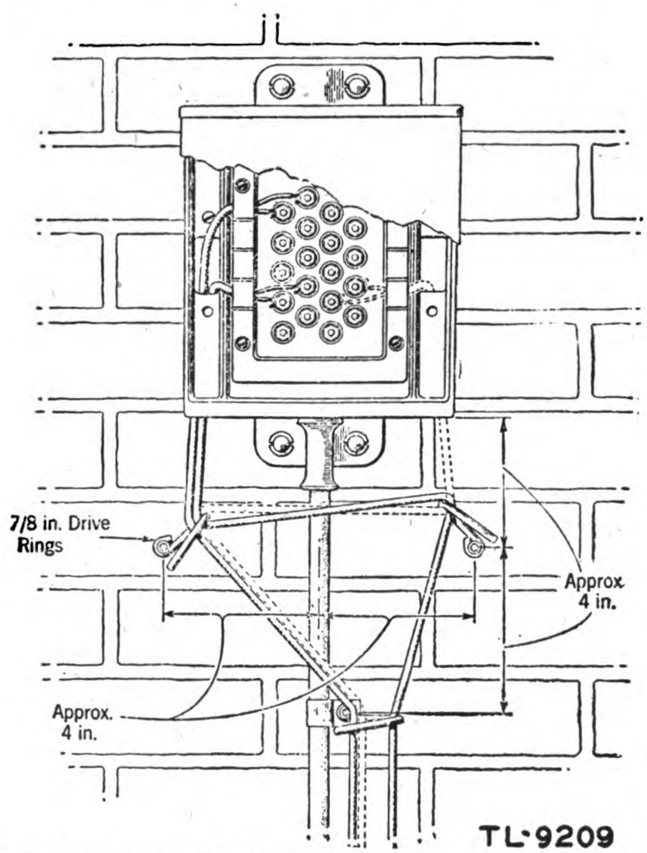


Figure 14. Drive rings installed at cable terminal mounted on wall.

(12) For wiring under crossarms, use the 5/8-inch ring.

(13) Use 7/8-inch drive rings for wiring facilities in the rear of guardarms, and mount the drive rings directly above the lead holes

provided for bridle rings having wood-screw threads. Locate the drive ring 1 inch above the bottom of the arm.

(14) Wires should be laid in, not drawn through, the drive rings.

(15) Pull the wires tight, to avoid unsightly sag, but not tight enough to cause undue strain on the wires. When more than one pair of wires is in the rings, allow the same amount of sag in all wires, to present a neat appearance.

d. EQUIPPING HOUSE BRACKET WITH "S" KNOBS. Equip house bracket with "S" knob as shown in figure 15.

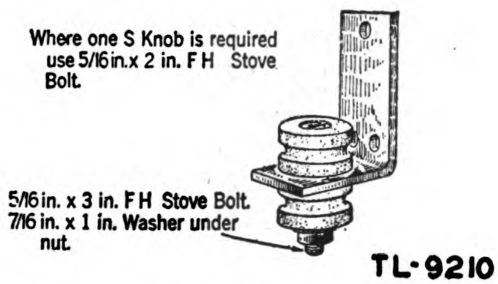


Figure 15. "S" knobs installed on house bracket.

e. EQUIPPING HOUSE BRACKET WITH "T" KNOBS. Equip house bracket with "T" knobs as shown in figure 16.

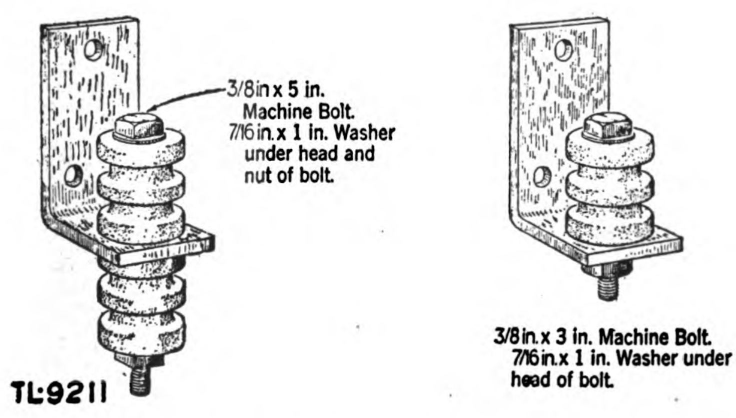


Figure 16. "T" knobs installed on house bracket.

f. Equipping Corner Bracket with "S" and "T" Knobs. Equip corner brackets with "S" or "T" knobs as shown in figure 17.

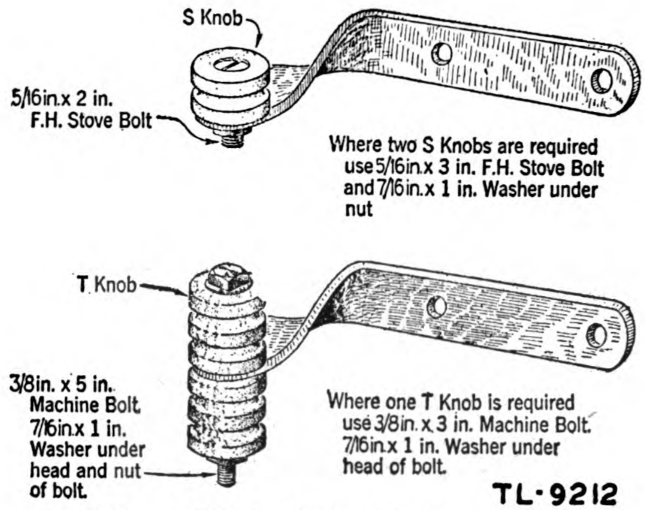


Figure 17. "S" and "T" knobs installed on corner brackets.

g. Equipping Angle Screws with "S" and "T" Knobs. Equip angle screws with "S" or "T" knobs as shown in figure 18.

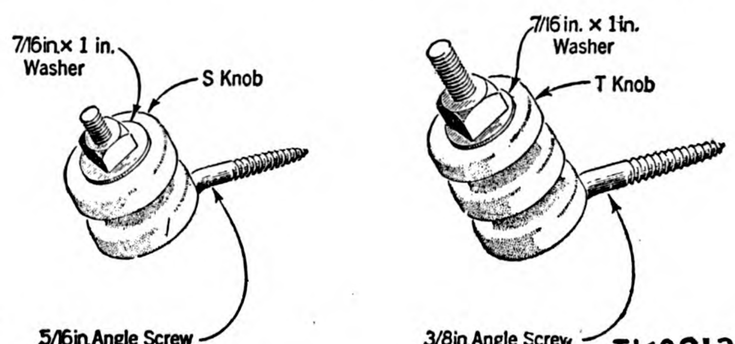


Figure 18. "S" and "T" knobs installed on angle screws.

h. Equipping Universal Insulator Supports with "S" and "T" Knobs. Equip universal insulator supports with "S" or "T" knobs as shown in figure 19.

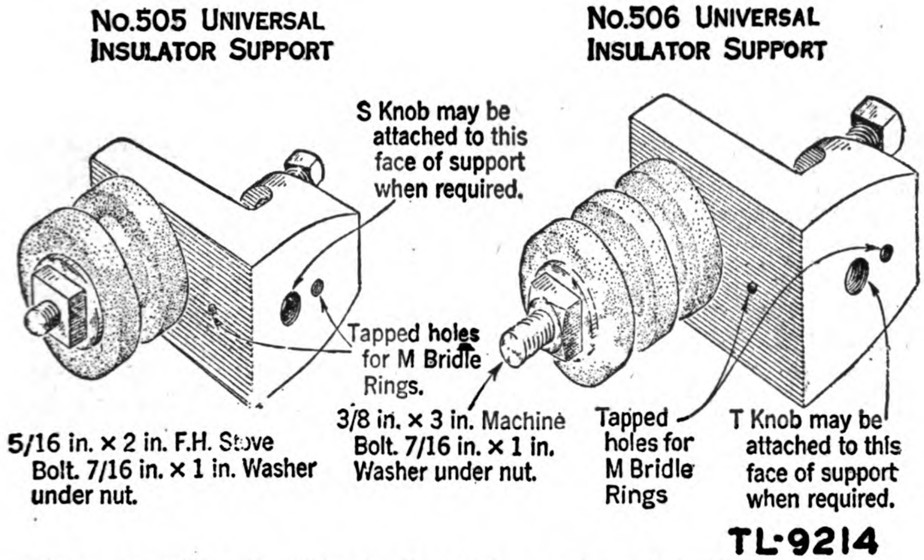


Figure 19. "S" and "T" knobs installed on universal insulator support.

i. INSTALLING "S" OR "T" KNOBS. (1) Attach "S" knobs to exposed frame portions of brick-veneer buildings, when practicable. A drop wire hook may be used instead of an "S" knob, provided that the hole can be drilled at the center of a brick without cracking the brick. To install an "S" knob on brick veneer, drill a 5/16-inch hole in the mortar between bricks in order to pass the wood screw through the brick portion of the wall.

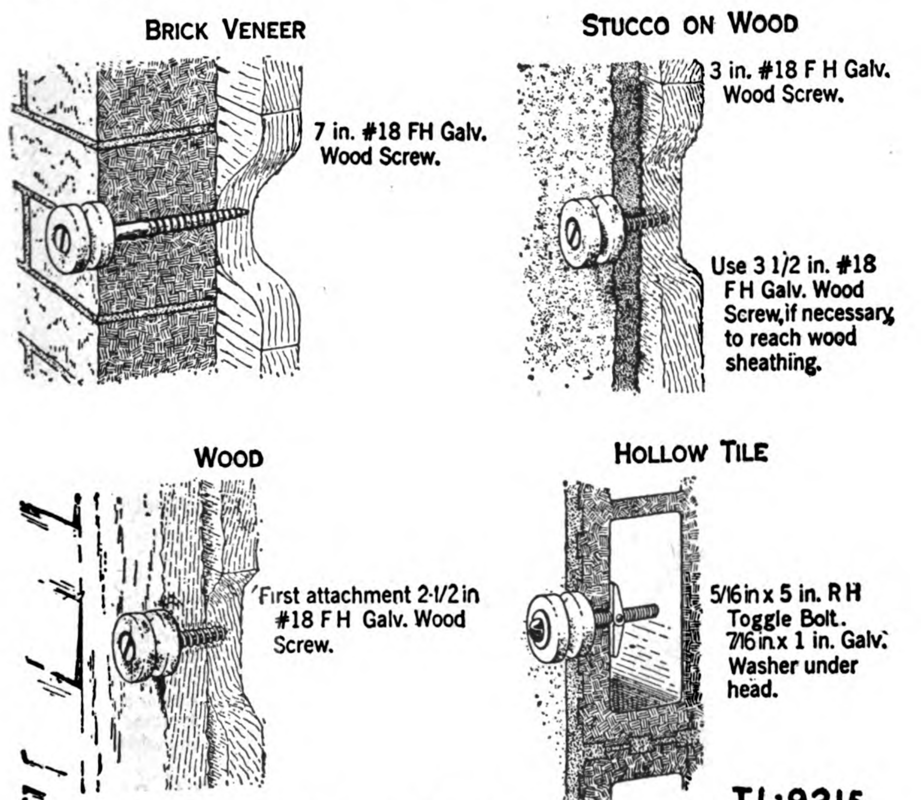


Figure 20. "S" knobs installed on various surfaces.

(2) On stucco-finished buildings attach an "S" or "T" knob to exposed frame portion of building when practicable. To install "S" or "T" knob on stucco-finished wall, drill stucco with a 5/16-inch, short masonry drill in order to obtain a hole to accommodate a wood screw.

(3) Install "S" and "T" knobs as shown in figures 20 and 21.

NOTE. Do not use "T" knobs on heavy loading areas.

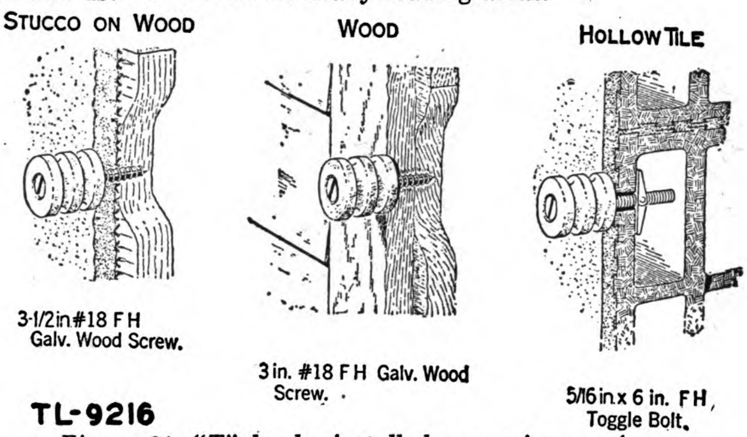


Figure 21. "T" knobs installed on various surfaces.

j. INSTALLING "C" KNOB. (1) On masonry and brick veneer, locate the "C" knob at the center of a brick. Seam attachments should be used only to avoid cracking the brick or to obtain a more satisfactory location for the "C" knob.

(2) When installing a "C" knob on a stucco-finished wall, drill stucco with a 1/4-inch, short masonry drill to obtain a hole that will accommodate a wood screw.

(3) Install "C" knob as shown in figure 22.

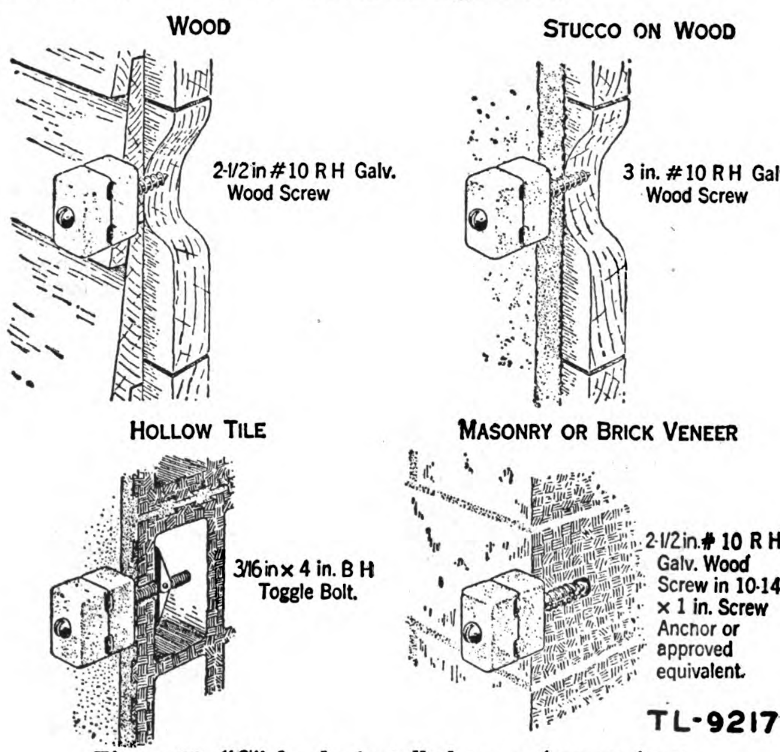


Figure 22. "C" knobs installed on various surfaces.

k. Installing Drop Wire Hook. (1) Place loops of two drop wire clamps over the small end of a drop wire hook before attaching the hook on masonry. On a brick wall, drill hole for anchor in the center of a brick.

(2) On brick-veneer buildings, attach the drop wire hook to an exposed frame portion of the building when practicable. A drop wire hook may be installed on brick veneer as on masonry, (1) above, provided that the hole for the hook can be drilled at center of brick without loosening or cracking the brick.

(3) When a drop wire hook is used on wood to support unexposed drops, place loops of the drop wire clamps over the small end of the drop wire hook before attaching the drop wire hook. Place screw in a stud, if practicable.

(4) Align drop wire hook with drop wire span before attachment is complete, as shown in figure 23.

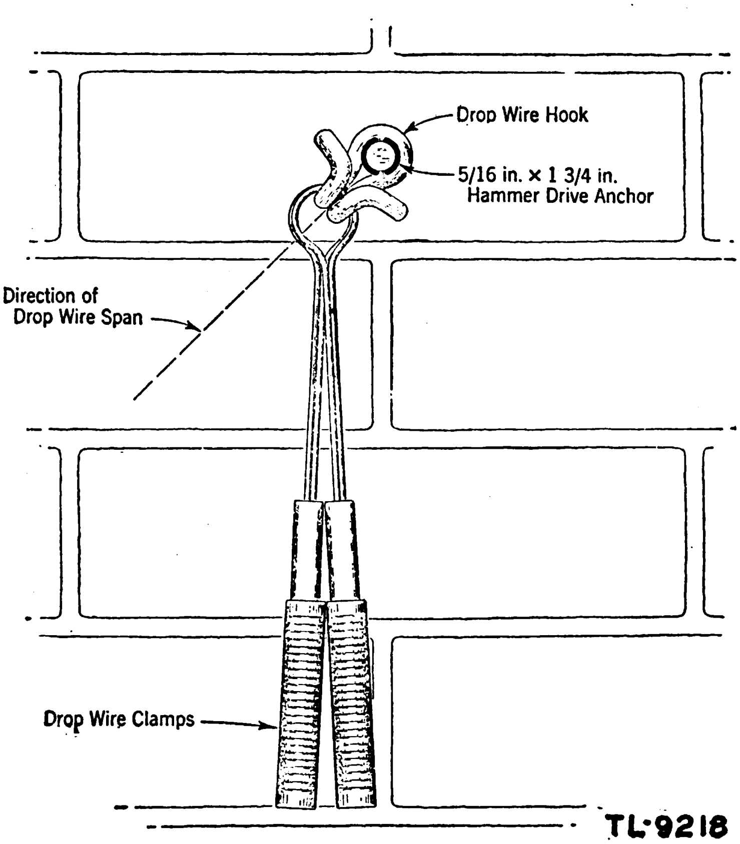


Figure 23. Drop wire hook installed on masonry surface.

(5) Various installations of drop wire hooks are shown in figure 24.

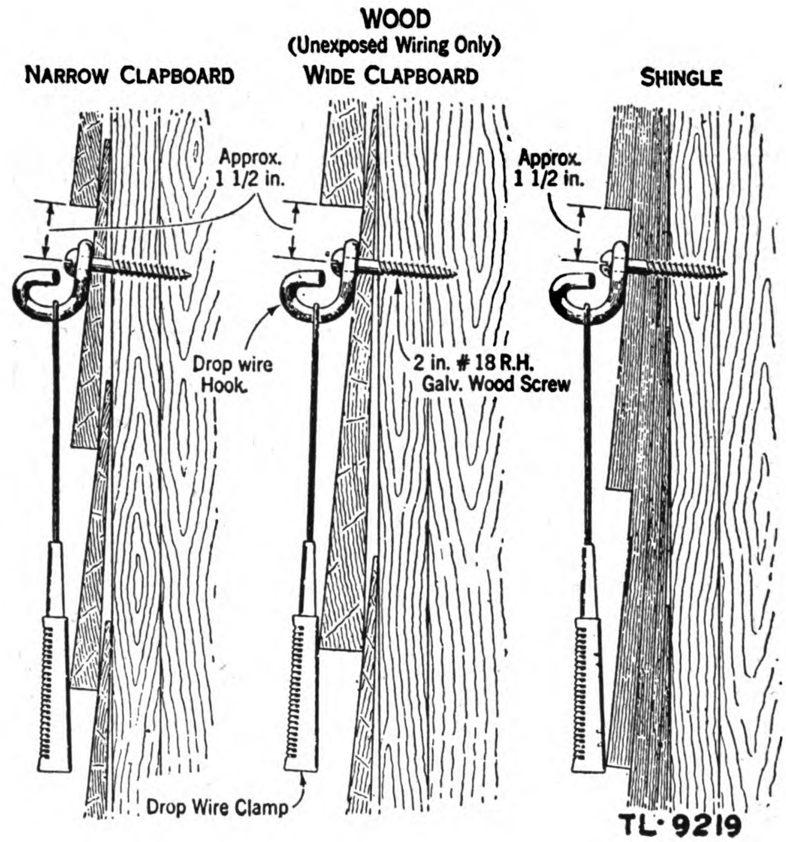


Figure 24. Drop wire hook installed on wood surface.

l. INSTALLING HOUSE AND CORNER BRACKETS. (1) To install house or corner brackets on brick veneer, drill 1/4-inch holes in mortar between bricks in order to pass wood screws through the brick portion. Attach brackets to exposed frame portion on brick-veneer buildings when practicable.

(2) On stucco-finished buildings, attach house bracket to exposed frame portion if practicable. To install house or corner brackets on stucco-finished wall, drill stucco with 1/4-inch, short masonry drill in order to obtain holes to accommodate wood screws.

(3) Various installations of house and corner brackets are shown in figures 25 and 26.

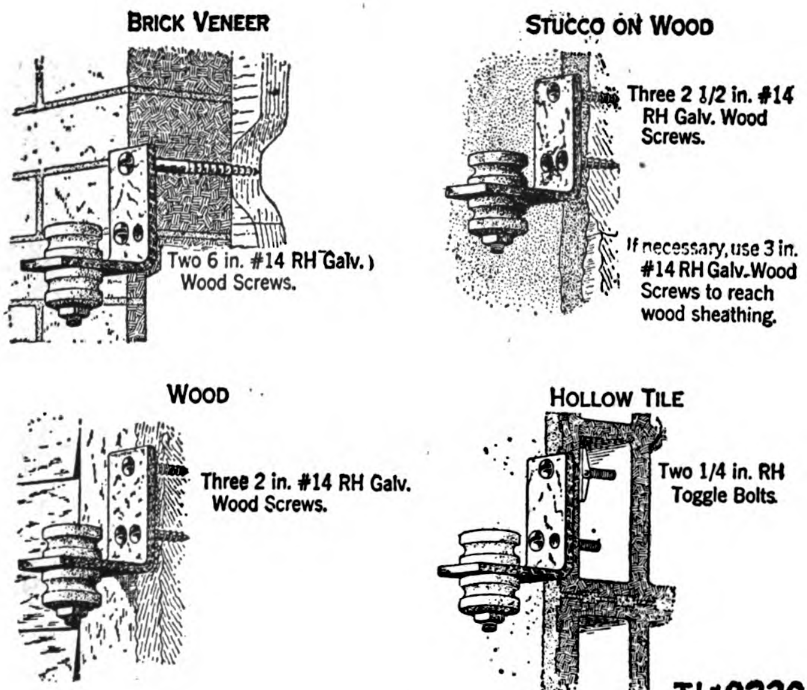


Figure 25. House brackets installed on various surfaces.

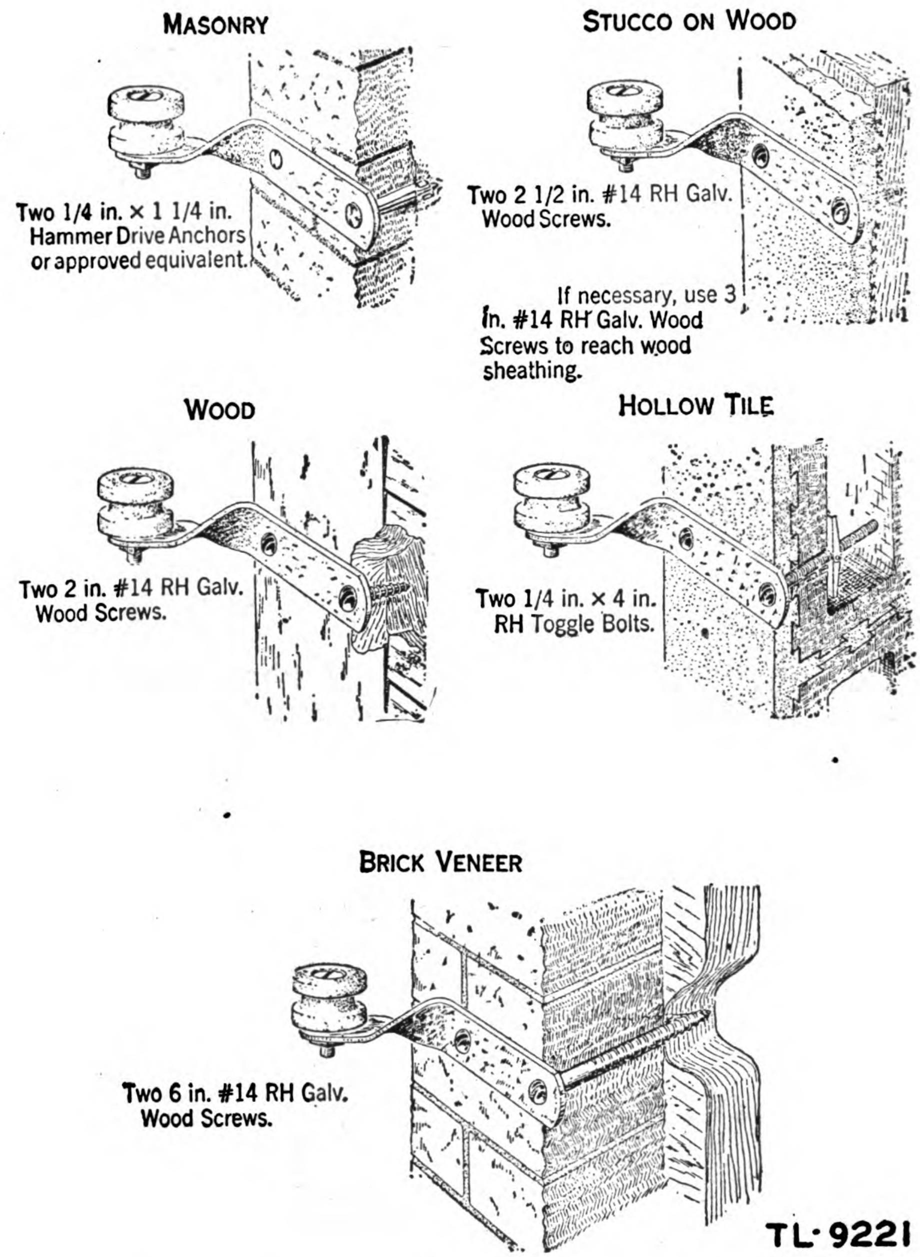


Figure 26. Corner brackets installed on various surfaces.

m. INSTALLING ANGLE SCREWS. (1) Place angle screw in stud, and screw into wall up to first bend.

(2) When mounting angle screws on stucco-finished wall, drill stucco with 5/16-inch, short masonry drill.

(3) Use a 1/4-inch auger bit to drill a lead hole in word for the 3/8-angle screw.

(4) Various installations of angle screws are shown in figure 27.

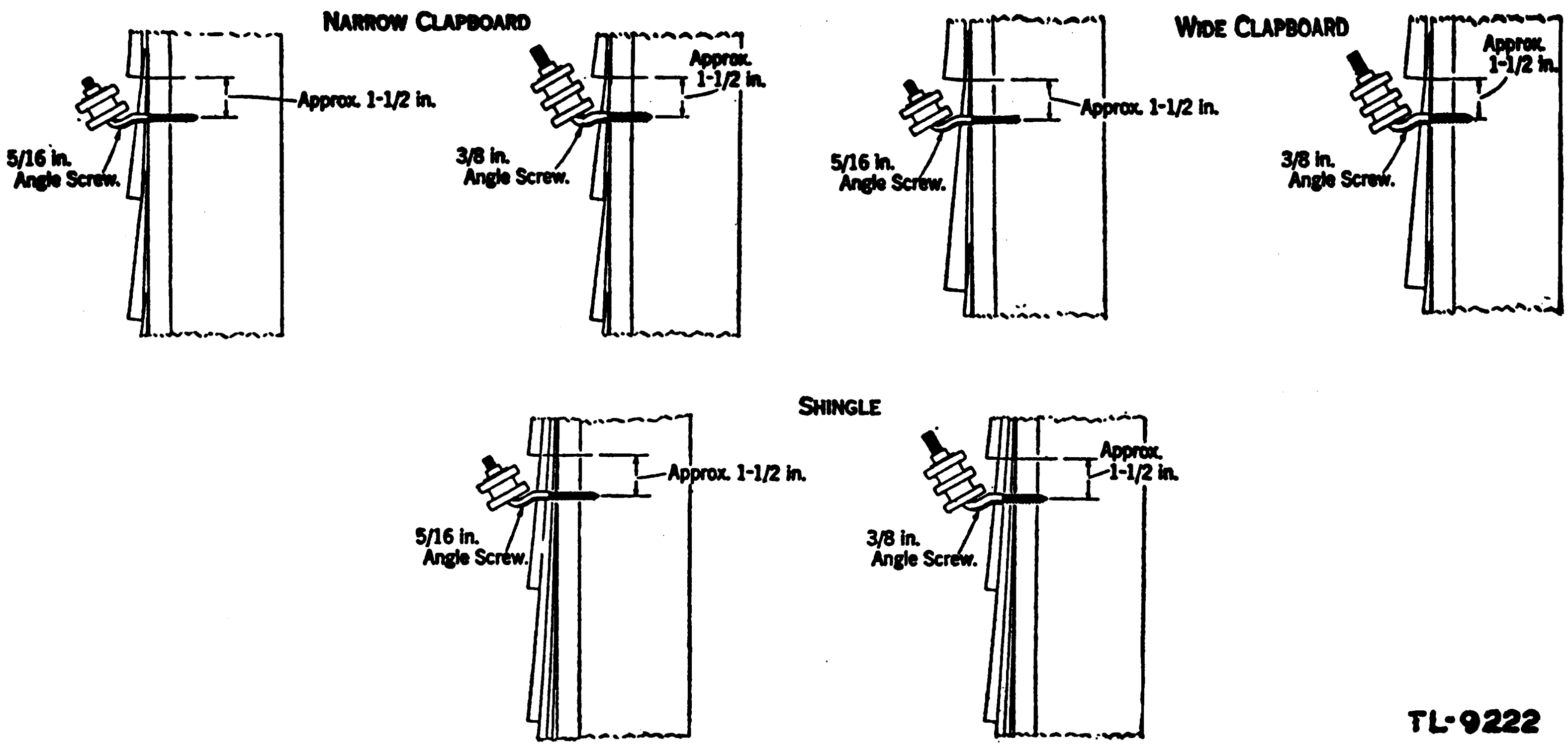


Figure 27. Angle screws installed on wood surfaces.

n. INSTALLING BRIDLE RINGS. (1) On masonry and bricks veneer, locate the bridle ring at the center of a brick. Seam attachments should be used only to avoid cracking the brick or to obtain a satisfactory location for the bridle ring.

(2) Install bridle rings as described in paragraph 8*e*(3) to (11).

(3) Figure 28 shows various installations of bridle rings.

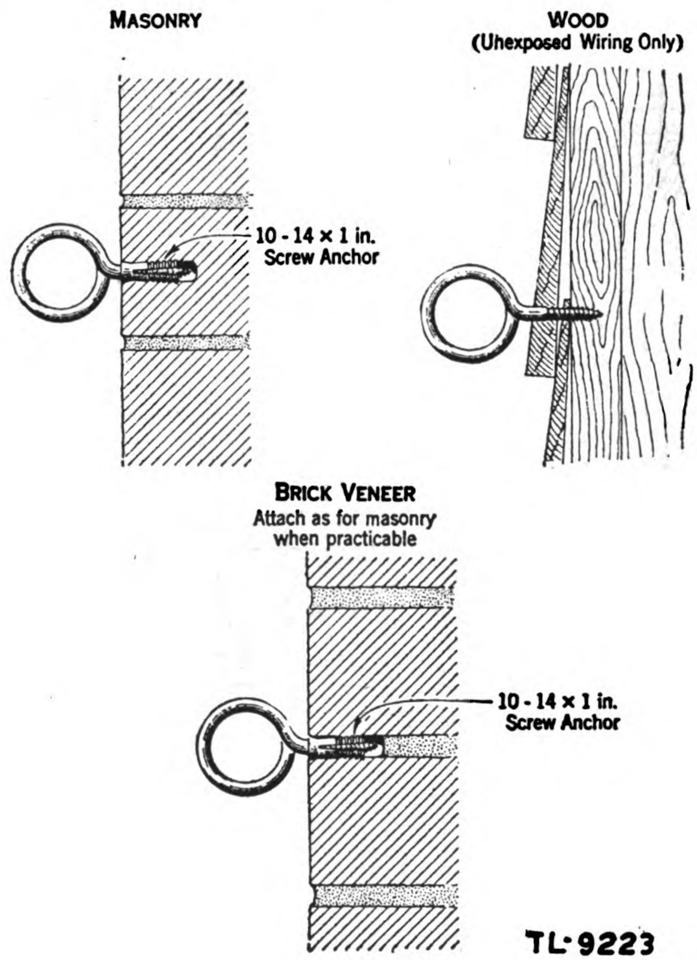


Figure 28. Bridle rings installed on various surfaces.

o. INSTALLING CORNER BRIDLE RINGS. (1) Attach corner bridle rings on brick veneer, using same procedure as for masonry, provided that holes can be drilled without loosening or cracking the bricks.

(2) On stucco-finished walls, drill stucco with 1/4-inch, short masonry drill to obtain holes to accommodate wood screws.

(3) Figure 29 shows various installations of corner bridle rings.

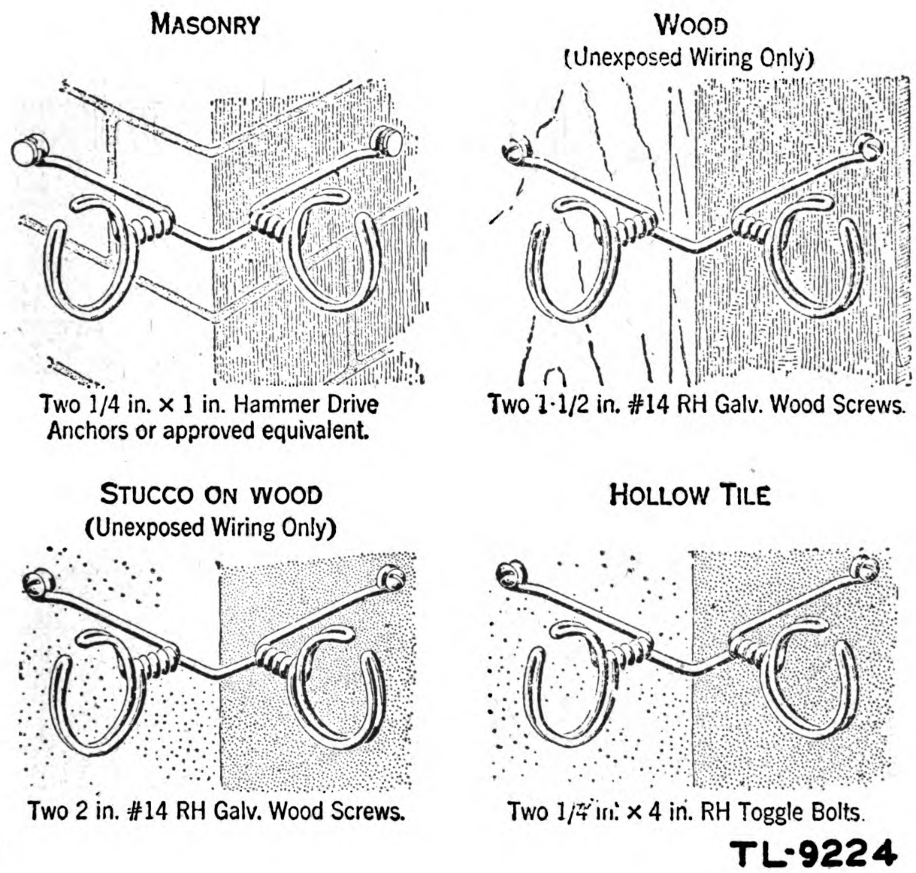


Figure 29. Corner bridle rings installed on various surfaces.

p. INSTALLING INSULATED SCREW EYES. (1) On stucco-finished walls, drill stucco with 3/16-inch, short masonry drill.

(2) Figure 30 shows various installations of insulated screw eyes.

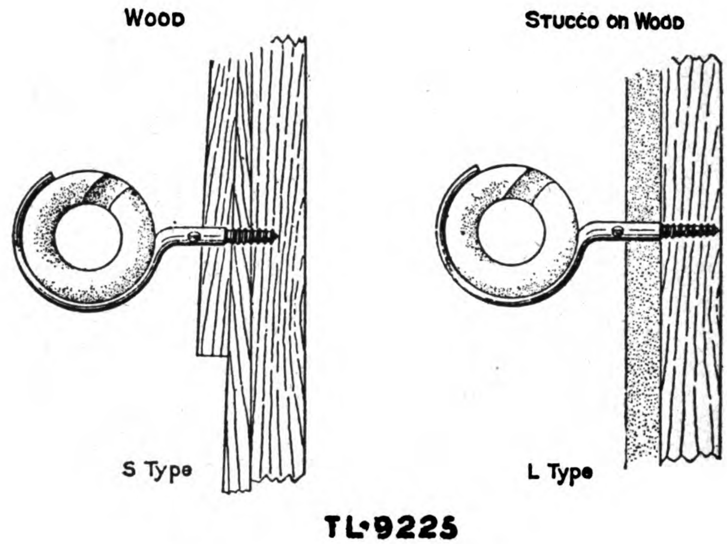


Figure 30. Insulated screw eyes installed on various surfaces.

q. INSTALLING DRIVE HOOKS. (1) In placing more than one drive hook on one side of a pole, stagger the drive hooks at least 1/2 inch to avoid splitting the pole.

(2) Figure 31 shows drive hooks installed on pole.

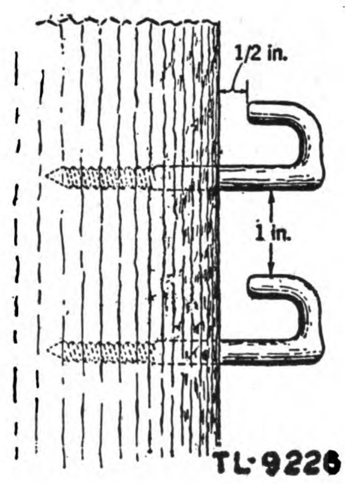


Figure 31. Drive hooks installed on pole.

r. INSTALLING GUARDARM HOOK. Figure 32 shows guardarm hook installed on guardarm.

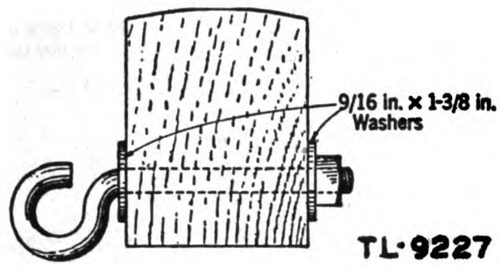


Figure 32. Guardarm hook installed on guardarm.

s. INSTALLING SPAN CLAMPS. (1) Remove the wingnut, raise the threaded end of bolt, and engage suspension strand at the grooves of the span clamp. Place the hook end of the span clamp on same side of the strand as the drop wire attachments on the pole or guardarm. If initial drops cross the strand, place drop wire clamps at the wingnut end of the span clamp before re-engaging the bolt. Replace wingnut, and tighten it securely by hand.

(2) Do not attach more than two drop wires spanning from a pole or guardarm attachment, to one span clamp.

(3) A span clamp mounted on a pole not requiring a guardarm is shown in figure 33.

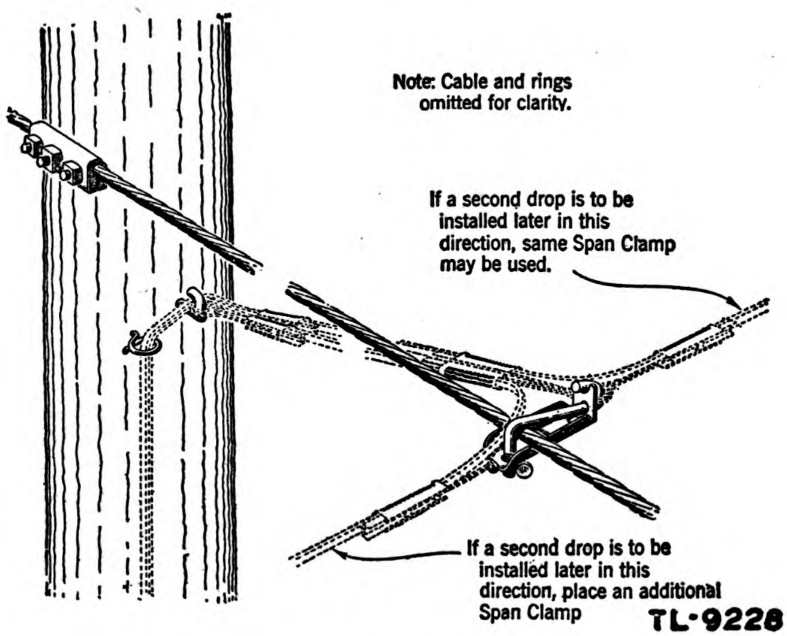


Figure 33. Span clamp installed on pole not requiring guardarm.

(4) A span clamp mounted on a pole requiring a guardarm is shown in figure 34.

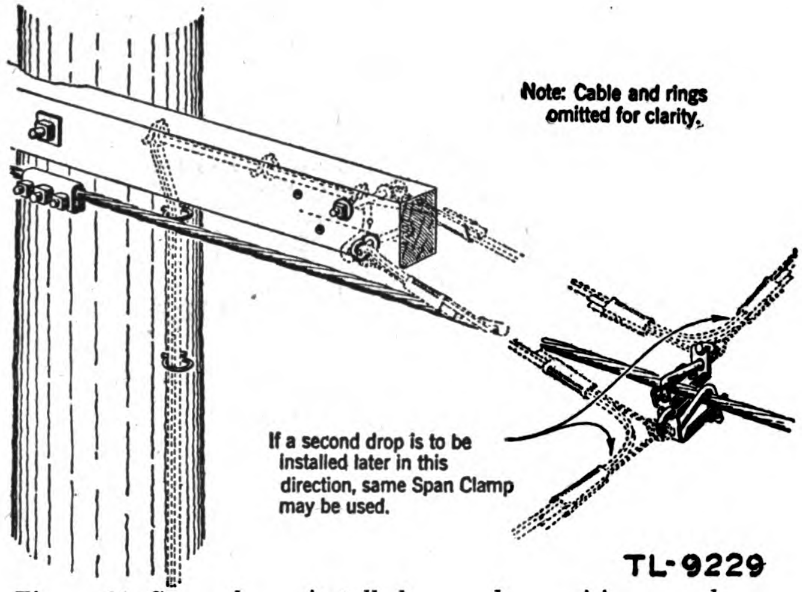


Figure 34. Span clamp installed on pole requiring guardarm.

t. Locating Studs in Frame Buildings. Studs in wood or stucco-on-wood buildings may usually be located by one of the following methods:

(1) Sounding.

(2) Locating studs in cellar or attic.

(3) Location of heads of nails used in fastening clapboards or trim to studding.

9. Tying Parallel Drop Wire

a. Straight Tie. The straight tie is made as shown in figure 35.

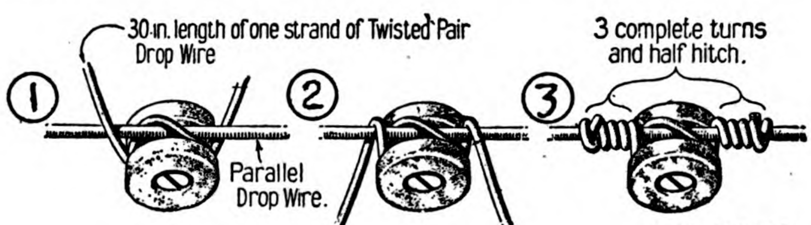


Figure 35. Straight tie (parallel drop wire).

b. Corner Tie. The corner tie is made as shown in figure 36.

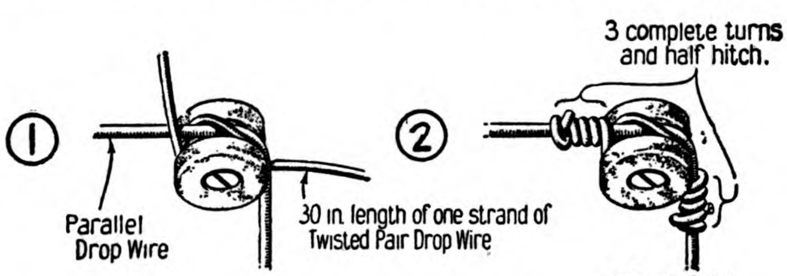


Figure 36. Corner tie (parallel drop wire).

c. **Dead-end Tie.** The dead-end tie is made as shown in figure 37.

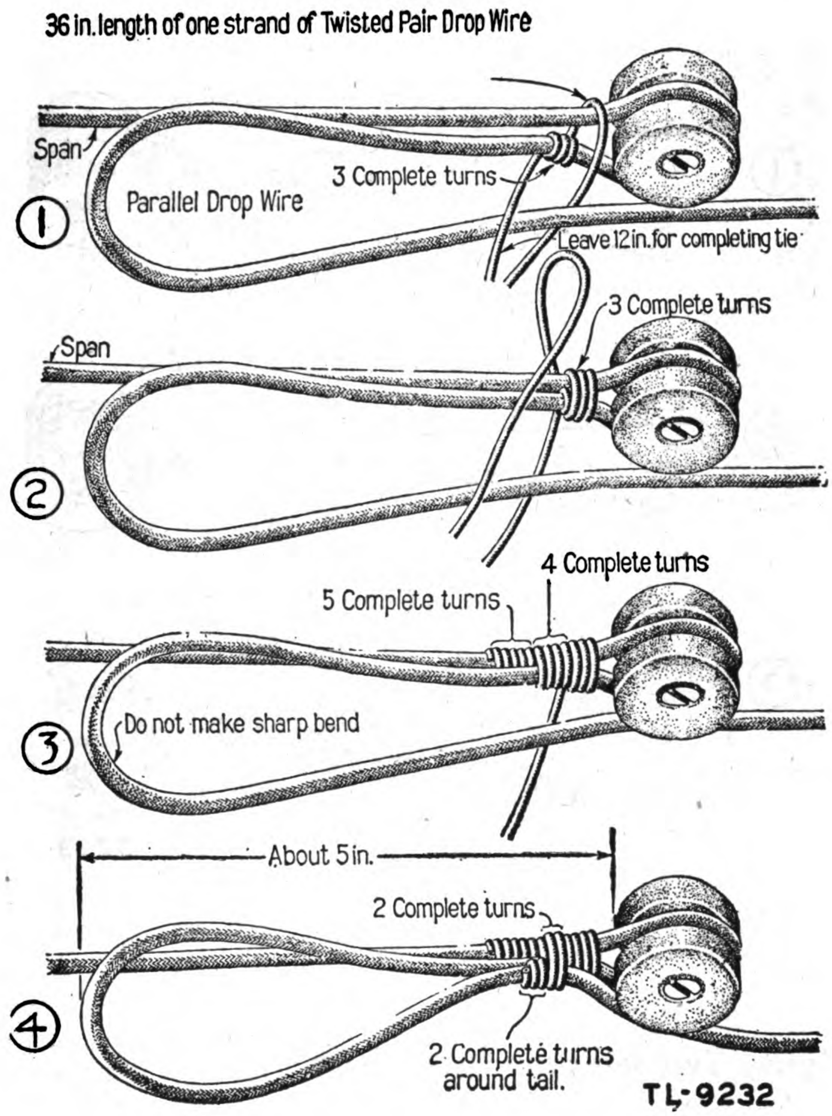


Figure 37. Dead-end tie (parallel drop wire).

d. Dead-end Tie (Without Loop). The dead-end tie, without loop, is made as shown in figure 38.

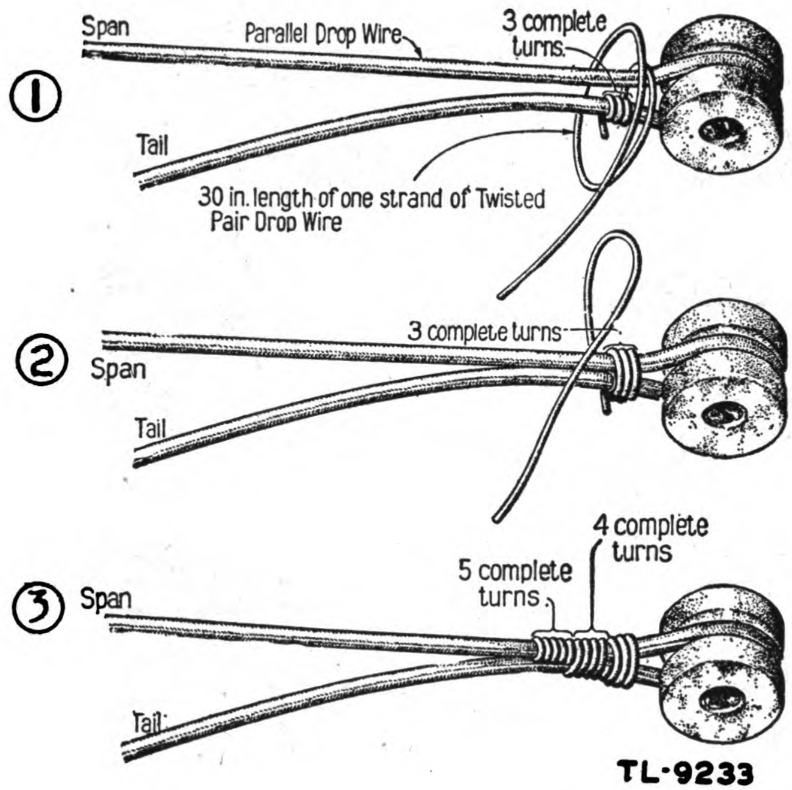


Figure 38. Dead-end tie, without loop (parallel drop wire).

10. Tying Twisted-pair Drop Wire

a. Slipover Tie. The slipover tie is made as shown in figure 39.

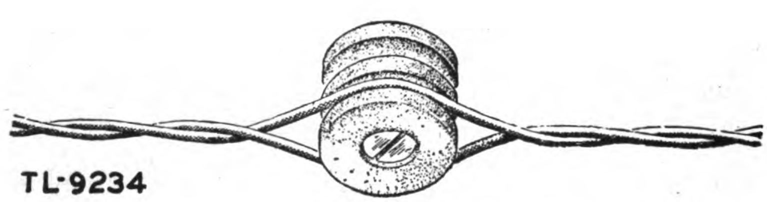


Figure 39. Slipover tie (twisted-pair drop wire).

b. Single Tie. The single tie is made as shown in figure 40.

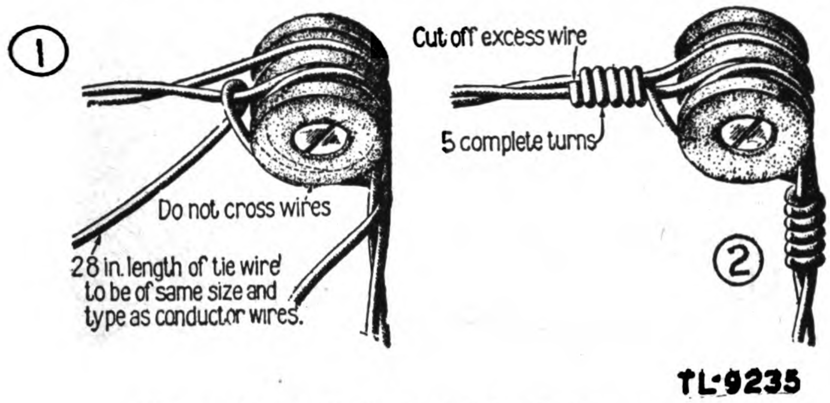


Figure 40. Single tie (twisted-pair drop wire).

c. Double Tie. The double tie is made as shown in figure 41.

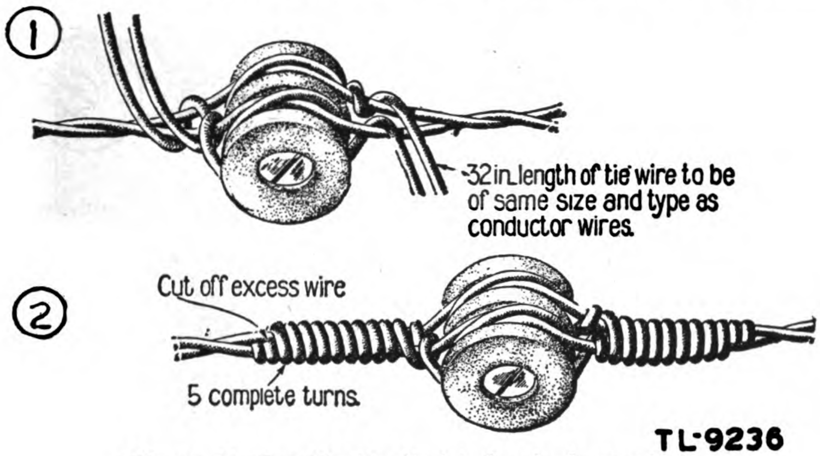


Figure 41. Double tie (twisted-pair drop wire).

d. Dead-end Tie. The dead-end tie is made as shown in figure 42.

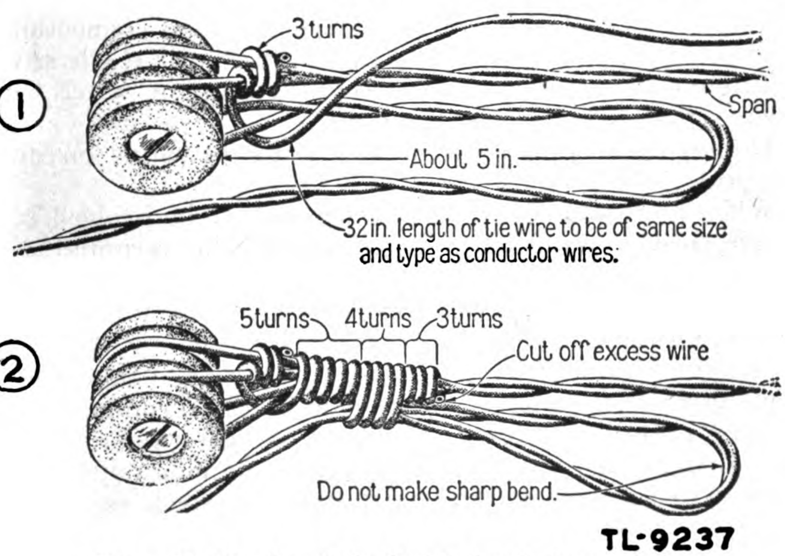


Figure 42. Dead-end tie (twisted-pair drop wire).

e. Dead-end Tie (Without Loop). The dead-end tie, without loop, is made as shown in figure 43.

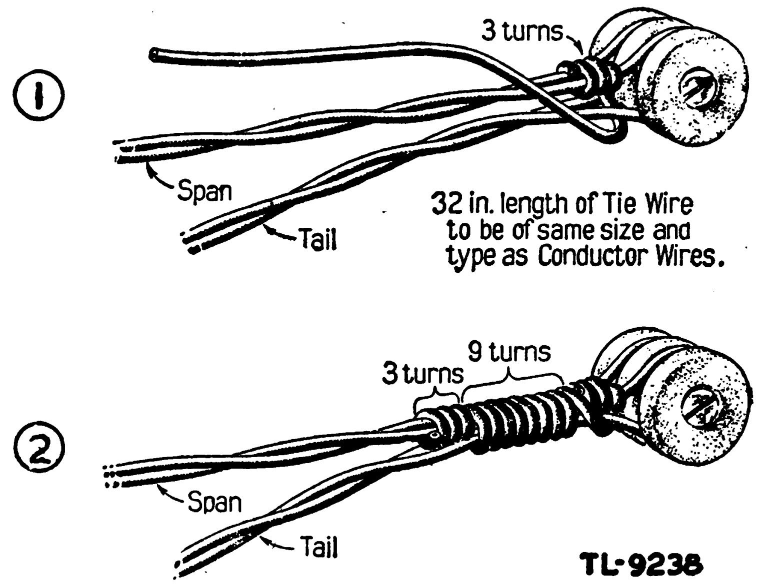


Figure 43. Dead-end tie, without loop (twisted-pair drop wire).

11. Wiring at Cable Terminals

a. General. (1) Leave enough slack on new connections at distributing terminals so that each pair of wires will reach any terminal post. Provide the necessary slack by running the wires through the bridle rings placed below the terminal.

(2) Do not bridge more than two pairs of wires on one pair of binding posts.

(3) When more than two pairs of wire are to be bridged to the same cable pair, bridge additional wires outside the terminal and in the vertical run.

b. Wiring at "F"-type Cable Terminals. (1) When entering "F"-type cable terminals from wire runs above the "F"-type cable terminal, always run wire through the three rings below the terminal, approaching the first ring from the side of the terminal farthest from the binding posts on which the wire is to be terminated. To obtain slack for transferring wire to another cable pair or reinstalling wire, if necessary skip the bottom rings. If sufficient slack cannot be secured in this manner, make a splice in the vertical run above the terminal, and route wire through the three rings.

(2) Figure 44 shows "F"-type cable terminal mounted on pole.

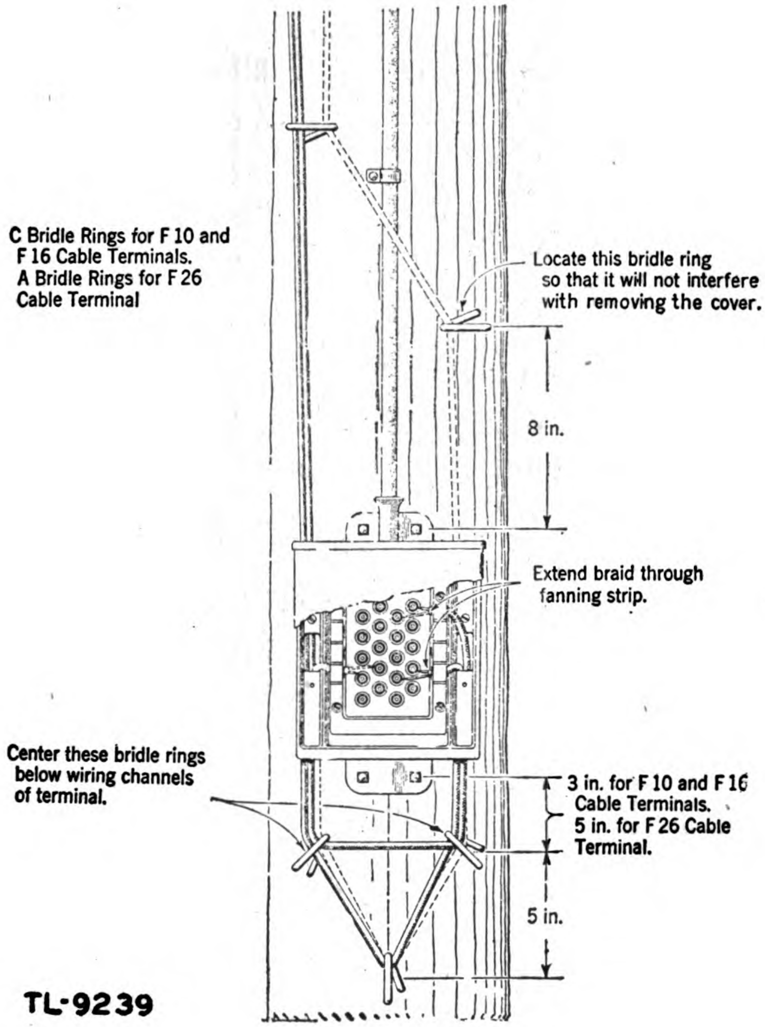


Figure 44. "F"-type cable terminal mounted on pole.

(3) Figure 45 shows "F"-type cable terminal mounted on wall, with stub cable at the top of the terminal.

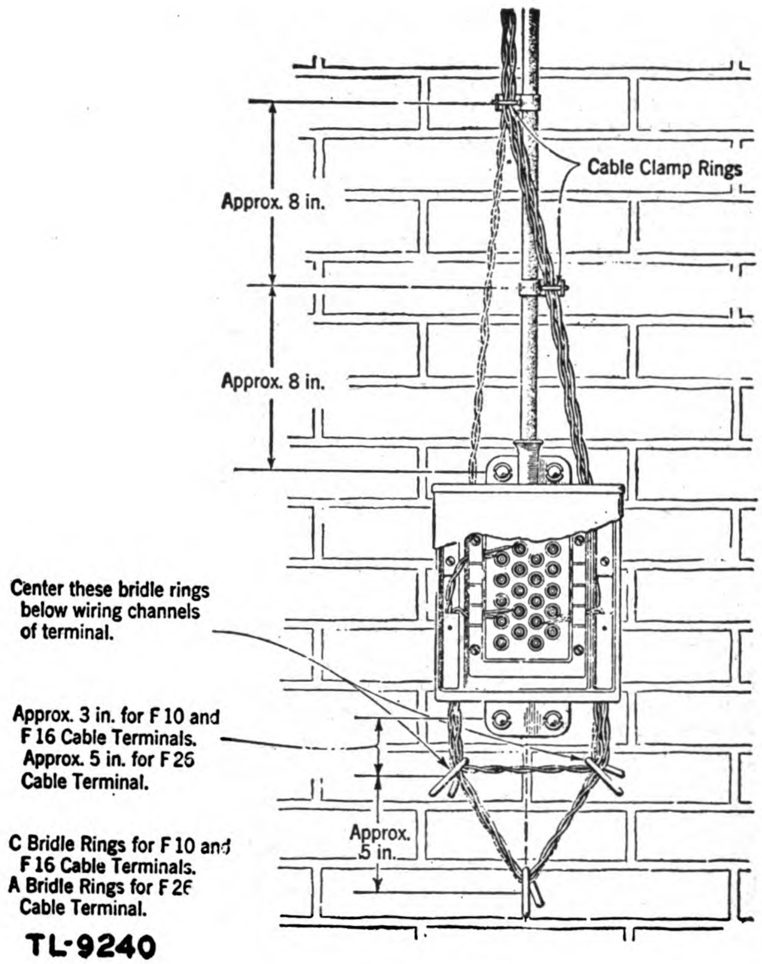


Figure 45. "F"-type cable terminal mounted on wall, with stub cable at top of terminal.

(4) Figure 46 shows an "F"-type cable terminal mounted on wall, with stub cable at the bottom of the terminal.

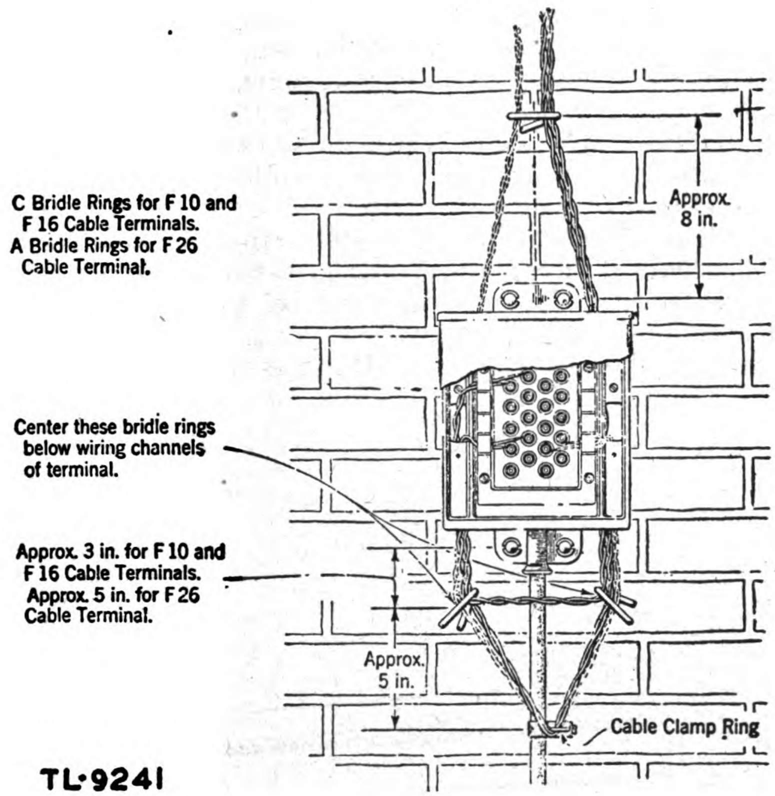


Figure 46. "F"-type cable terminal mounted on wall, with stub cable at bottom of terminal.

(5) When entering from wire runs below the "F"-type cable terminal, always run wire through the three rings below the terminal, selecting as the second ring the ring farthest from the binding post on which the wire is to be terminated.

c. WIRING AT "B"- AND "BB"-TYPE CABLE TERMINALS. (1) When installing drop wire, always run the wire through two rings at the end of the fuse chamber or binding post chamber on which the wire is to be terminated. Pull the drop wire taut through the fanning strip hole, and cut it off even with the fanning strip at the opposite side of the faceplate. Push excess wire back through the fanning strip in order to obtain proper slack. Terminate the wire as directed in d below.

(2) Where two BR drop wires are to be bridged together at a "B"-type binding post chamber, extend the braid of the top wire only to the outside edge of the fanning strip.

(3) Use duct wire for cross-connecting cable pairs of outside terminals. Install cross-connecting wire as follows:

(*a*) Run wire through cross-connecting rings.

(*b*) Terminate wire on binding posts or fuses of cable pair toward subscriber, as outlined in *d* below.

(*c*) Remove excess slack, and cut wire to the length prescribed in the following directions: To terminate a cross-connecting wire on a pair of binding posts to the right of the fanning strip, cut plain conductor at a point which would permit its termination on the right-hand post, but do not terminate the plain conductor on that post. Cut tracer conductor, so that it can be terminated on the right-hand post when the plain conductor is terminated on the left-hand post. To terminate a cross-connecting wire on a pair of binding posts to the left of the fanning strip, cut tracer conductor at a point which would permit its termination on the left-hand post, but do not terminate the tracer conductor on that post. Cut plain conductor so that it can be termminated on the left-hand post when the tracer conductor is terminated on the right-hand post.

(*d*) Terminate wire on binding posts or fuses of cable pair toward the central office. The cables and cable terminations toward the central office and toward the subscriber can be determined by inside and outside inspection of the terminal.

(4) Figure 47 shows wiring at a "B"-type cable terminal.

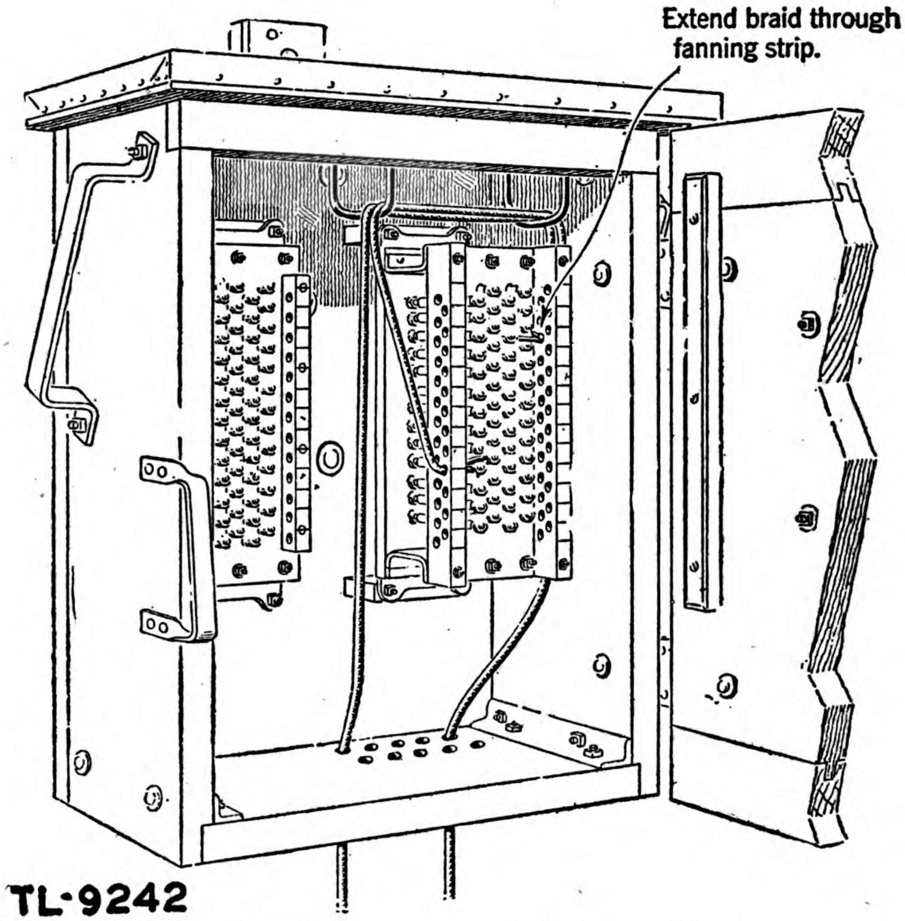


Figure 47. Wiring at "B"-type cable terminal.

d. TERMINATING WIRE AT CABLE TERMINALS. (1) Skin and clean the ends of the conductors.

(2) Loosen upper nut and washer of binding post. (If the nut and washer are corroded, replace them with new ones.)

(3) Terminate the tracer conductor on right-hand binding post or fuse, and terminate the plain conductor on left-hand binding post or fuse. Place first conductor under lower washer and around binding post, in the direction the nut tightens. Leave a 1/8-inch separation between the insulation and the washer. (See fig. 48.)

(4) Turn the nut down in order to obtain a firm contact.

(5) Arrange conductors so that they will not be in contact with adjacent binding posts. (See fig. 48.)

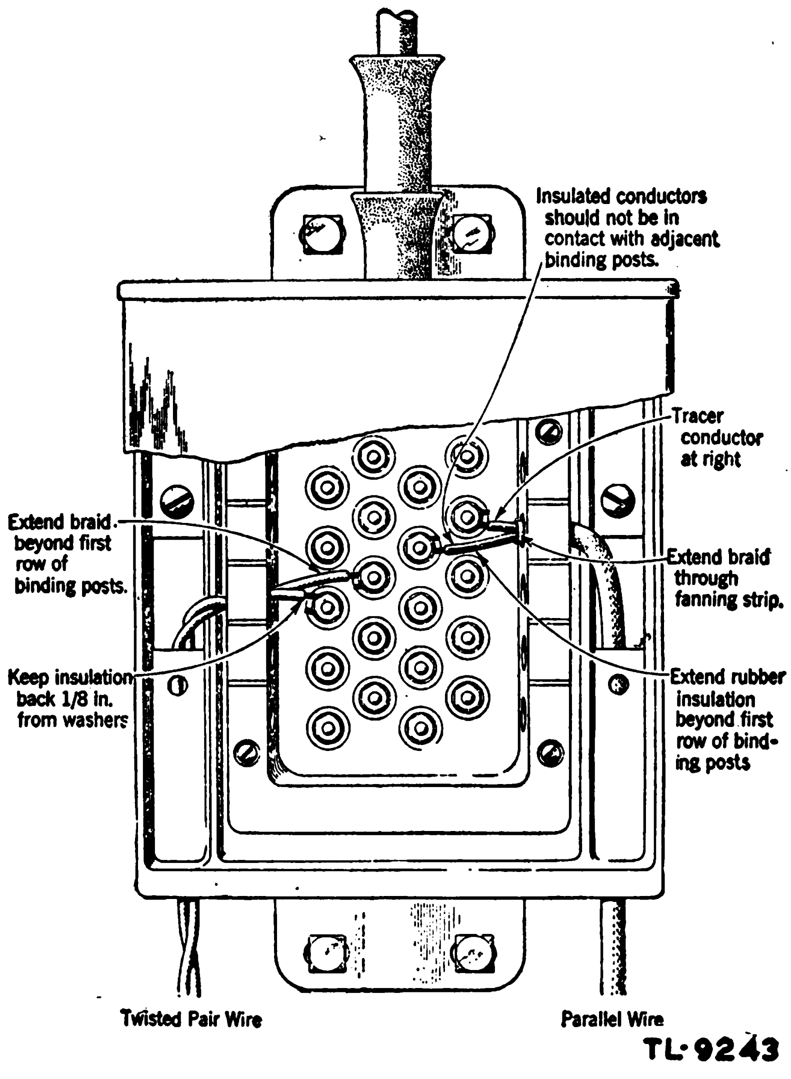


Figure 48. Wires terminated on terminal strip.

(6) When terminating a second wire on one binding post, insert the wire between the washers. Arrange the two wires so that the unassociated tip and ring conductors are not in contact. (See fig. 49.) When the lower wire is disconnected, it is not necessary to shift the upper wire to the lower position.

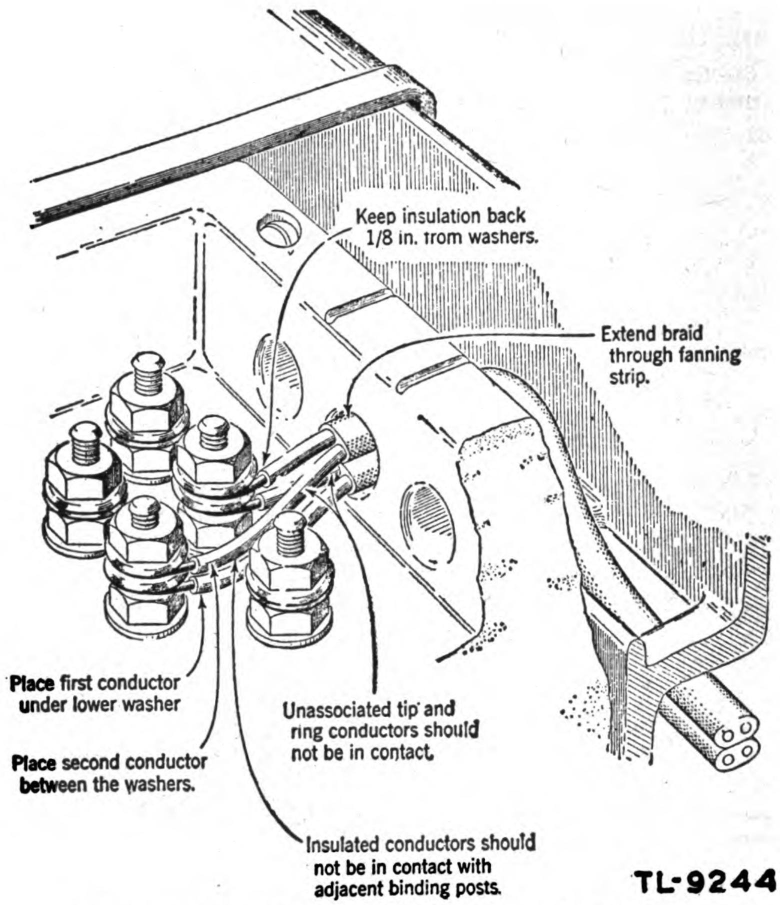


Figure 49. Two wires terminating on one binding post.

(7) When more than two wires are to be bridged to the same cable pair, run the additional wires through the rings below the terminal, and bridge outside of the terminal.

e. BINDING POST INSULATORS. (1) To prevent interruptions due to accidental contacts, place binding post insulators on binding posts of special service lines (such as picture transmission, teletypewriter, alarm, and power company remote control circuits) in all cable terminals at which the circuits are brought out.

(2) Insulators are available in two sizes. No. 1 binding post insulator is for use on 3/8-inch nuts of ordinary binding post and No. 7–T fuses. No. 2 binding post insulators is for use on the 7/16-inch nuts of No. 7–A fuses.

(3) Install binding post insulators as shown in figure 50.

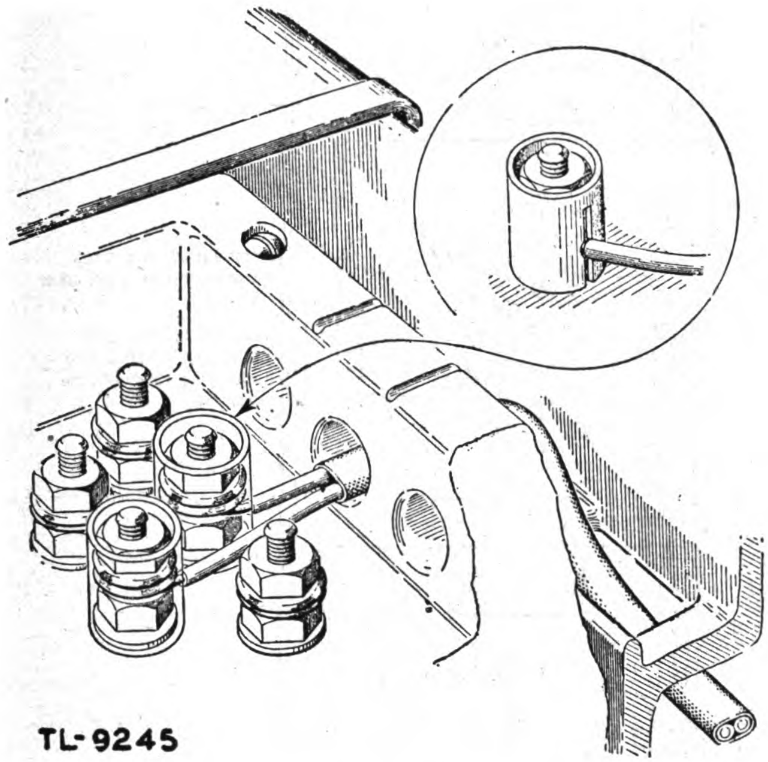


Figure 50. Binding post insulators installed.

(4) If the insulator does not fit securely, place a small piece of tape inside the insulator.

f. Avoiding Multiple Fusing. (1) Avoid multiple fusing of an underground pair when wiring underground cable terminals such as the FX–type cable terminal, where the fuses are connected directly to the aerial conductors, or where two or more aerial pairs are grouped to form a party line or a generator feed.

(2) Mount two No. 11–C fuses on two No. 16 protector mountings placed on the side of the terminal box in front of the binding post chamber. Cross-connect the aerial ring conductors to one binding post of the lower protector mounting, and cross-connect the aerial tip conductors to the other binding post of the same protector mounting. Cross-connect the binding posts of the upper protector mounting to the associated underground conductors.

(3) Where the battery feed serves a 1-position switchboard and a ground return is used, strap all binding posts of the feeder group together at the cable terminal, and terminate the service wire or cross-connecting wire. (See fig. 51.)

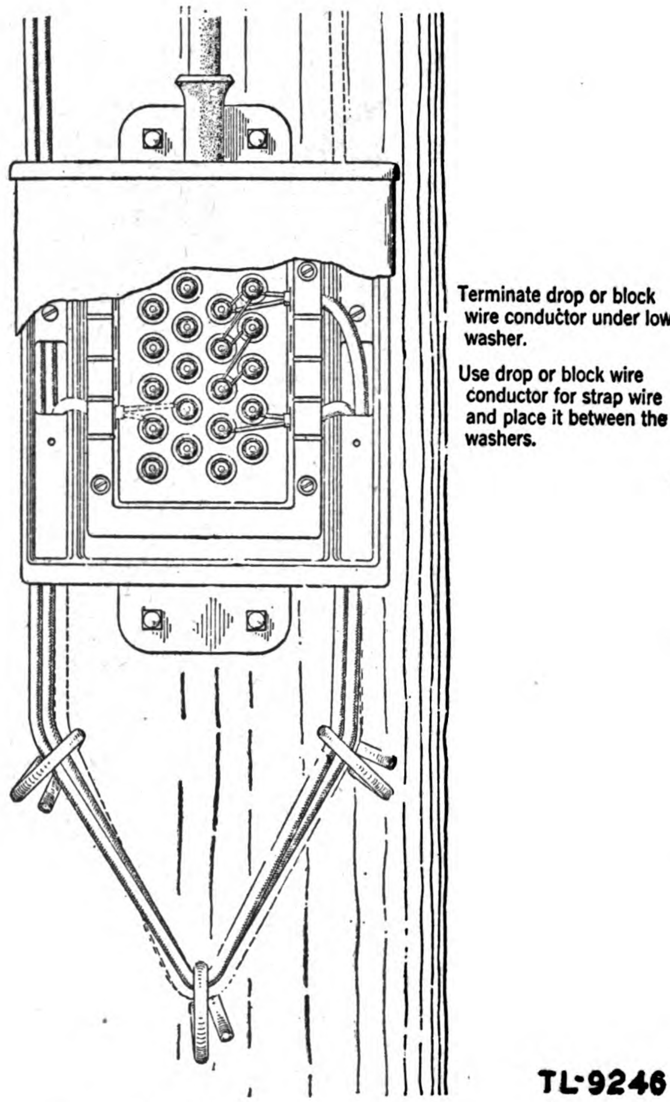


Figure 51. Cross-connecting at "F"-type terminal.

(4) Where a metallic return is used for a battery feed serving a 1-position switchboard, strap the positive binding posts together in one group and the negative binding posts together in another group. Terminate one conductor of the service wire or cross-connecting wire on a binding post of a positive group, and terminate the other conductor on a binding post of the negative group.

(5) Do not strap together groups of feeders operating through separate fuses at the central office. When each pair, including both conductors, is fused separately at the central office, terminate one conductor of the service wire, or cross-connecting wire, on each each strapped pair.

g. WIRING AT NO. 83–A PROTECTOR MOUNTING. When No. 83–A protector mounting is required in conjunction with cable terminals, wire as shown in figure 52.

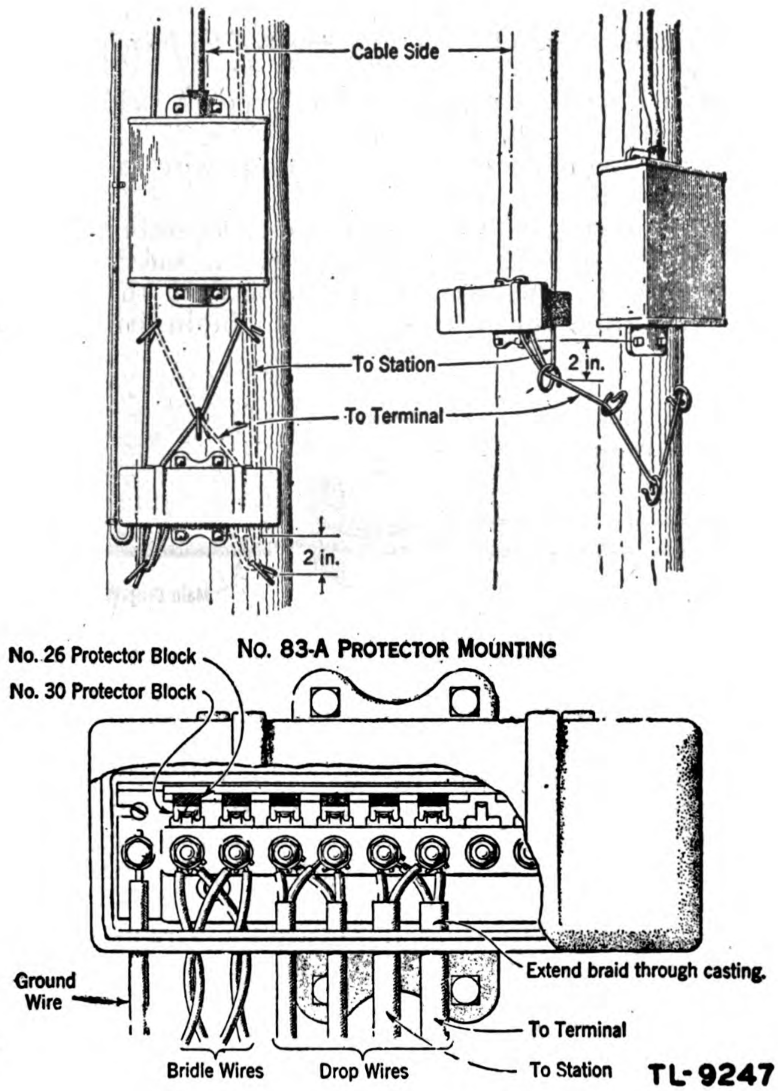


Figure 52. Wiring at No. 83–A protector.

h. BRIDGING CONNECTIONS. When two drops are terminated at a binding post and it becomes necessary to add a third drop to the pair, bridge the third drop with Type-1A bridging connectors about 10 inches above the terminal box.

(1) If parallel drop wire is used, prepare the wire as shown in figure 53.

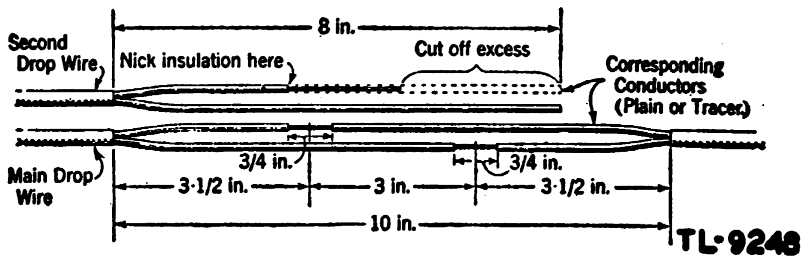


Figure 53. Parallel drop wire prepared for bridging.

(2) Loosen the nut and washers of the Type-1A bridging connectors sufficiently to uncover the slot.

(3) Place one conductor of the main drop wire on the bottom of the slot.

(4) Insert the corresponding conductor of the second drop wire between the washer and around the binding post, in the direction that the nut tightens. Leave a ⅛-inch separation between the insulation and the washer. Turn the nut down in order to obtain firm contact. (See fig. 54.)

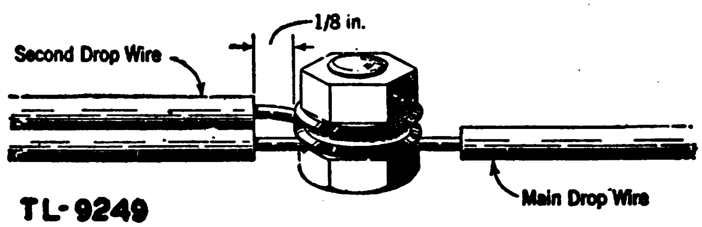


Figure 54. Type-1A bridging connector installed.

(5) Bridge the other conductor of the second drop wire to the main drop wire in a similar manner.

(6) Wrap each Type-1A bridging connector with two, reversed, half-lapped layers of 3/4-inch rubber tape. Start wrapping the tape between the wires, and extend it for 1 inch on each side of the connector.

(7) Cover the entire connection with two, reversed, half-lapped layers of 3/4-inch black friction tape.

(8) If a twisted-pair wire is used, prepare the wire as shown in figure 55. Proceed as directed in (2) to (7) above.

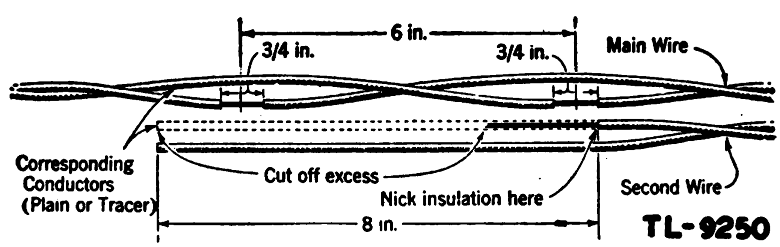


Figure 55. Twisted-pair drop wire prepared for bridging.

12. Clearances for Aerial Plant

a. Locate wires, cables, etc., and poles or stubs so that the clearances indicated in tables V, VI, VII, and VIII will be obtained.

Table V. Horizontal clearances involving telephone poles or stubs

Between nearest part of telephone poles or stubs and	Minimum horizontal clearance	Remarks
Fire hydrant and signal pedestals.	3 feet	Obtain 4 or more feet separation if practicable.
Nearest rail of main track.	12 feet	This clearance applies both to crossings over railroads and to lines running parallel with railroads.
Nearest rail of sidings.	7 feet	At loading sidings leave sufficient space for driveway.
Curb lines.	6 inches	Measured to street side of curb.
Trolley feeders, electric light and power wires (0–7500 volts) which are not to be attached to telephone pole.		Obtain a clearance of 3 or more feet if practicable. The minimum clearance. permitted is 1 foot plus 1 inch for each 2 feet of the distance between the telephone pole and the nearest pole of the electric line. Place telephone pole so that climbing space on it will not be reduced by the electric pole.

Table VI. Vertical clearance of telephone wires, cables, and guys above ground or rails

	Vertical clearance* (ft.)	Remarks
Where wire, cable, or guy runs along highway: In urban* districts generally.	18	
In rural districts generally.	15	
In rural districts only where no part of the line overhangs part of highway ordinarily traveled and where it is unlikely that loaded vehicles will cross under the line.	13	Anchor guys which do not cross over driveways, roads, or pathways are not required to have any clearance above ground. The lower end of a pole-to-pole guy is required to have a clearance of at least 8 feet above ground.
In both urban and rural districts where line is located relative to fences, ditches, embankments, etc., so that ground underneath is accessible to pedestrians only.	8	
Where wire, cable, or guy crosses over: Highways.	18	Where a guy crosses over a street or alley in urban districts, this clearance may be reduced to 16 feet at the side of the traveled way, provided the section of the guy above the street or alley is effectively insulated against the highest voltage to which it is exposed.
Street railways.		See "Trolley Wire Feeder," table VII.
Railways other than street railways.	27	25 feet where wire, cable, or guy parallels a trolley contact conductor.

Table VI. Vertical clearance of telephone wires, cables, and guys above ground or rails—Continued

	Vertical clearance* (ft.)	Remarks
Driveways, urban districts.	18	More clearance should be obtained where height of farm machinery or vehicles which might pass is such as to require greater clearance.
Driveways, rural districts	15	
Driveways to residence garages.	10	
Walks.	8	
Waterways.		Clearance as specified by proper authorities.
Obstacles (excluding foreign wires, cables, and equipment).	2	

* For spans of over 150 feet, increase clearance 0.1 feet for each additional 10 feet of span. This increase is equivalent to about 1 inch for each 8 feet of span.

Table VII. Vertical clearances at crossings

Between telephone wires, cables, and guys and	Vertical clearances* in feet for		Remarks
	Telephone wires and cables	Telephone guys	
Electric light or power lines and cables on fixed supports.			Place telephone wires or cables below electric light or power wires or cables except where authorized to place above.
Line wires. 0–300 volts to ground.	4	2	Where crossing is not within 6 feet of any pole concerned, the 4-foot clearance may be reduced to 2 feet for telephone wires or cables below supply wires.

Between telephone wires, cables, and guys and	Vertical clearances* in feet for		Remarks
	Telephone wires and cables	Telephone guys	
300 volts to ground to 750 between wires.	4	2	Where crossing is within 6 feet of any pole concerned, increase 4-foot clearance to 6 feet except for guys.
750–7,500 volts.	4	4	
7,500–50,000 volts.	6	4	
Service drops. 0–750 volts.	2	2	For wires above or below service drops and for cables below service drops.
	4	2	For cables above service drops.
750–7,500 volts.	4	4	For wires or cables above or below service drops.
Supply cables. Cables having permanently grounded continuous metal sheath. All voltages.	4	2	
Other supply cables.			Same clearance as shown above for open power wires of same voltage as cable.
Trolley wires feeders. 0–750 volts.	4	2	Secure greater clearance where practicable.
750–7,500 volts.	4	4	
Contact wires. 0–7,500 volts.	10	10	May be reduced to 4 feet for cables or guys protected by trolley guards, or for wires, cables, and guys located so that trolley pole cannot strike them.

Table VII. Vertical clearances at crossings—Continued

Between telephone wires, cables, and guys and	Vertical clearances* in feet for		Remarks
	Telephone wires and cables	Telephone guys	
Foreign communication wires, cables, and guys. For public use or similarly constructed.	2	2	May be reduced by mutual consent of interested parties, provided only communication wires other than fire alarm, railway, or light and power company communication wires are concerned.
For use with electric power or trolley systems and not similar in construction to circuits for public use.	4 from wires and cables		
	2 from guys	2	
Guys to power company poles.	2	2	Completely insulated sections of guys attached to poles carrying circuits of 7,500 volts or less may have less clearance from each other.

* For spans of over 150 feet, increase clearance 0.1 foot for each additional 10 feet of span. This increase is equivalent to about 1 inch for each 8 feet of span.

Table VIII. Minimum vertical clearances on jointly used poles.

Telephone construction	Electric light, power and trolley construction					
	Trolley feeders	Crossarms		Bracket and span wires		Nearest[1] metal parts of electric light and power construction (in.)
		Electric light or power (in.)	Trolley (in.)	Street light (in.)	Trolley (in.)	
Crossarms:						
Center to center.	—	48	48	—	—	—
Bottom of crossarm.	—	—	—	24	24	—
Line conductors.	—	—	—	—	—	40
Suspension strand for cable:						
Without guardarm.	—	72[2]	—	12	12	—
With guardarm.	—	Note[3]	—	12	12	—
Nearest part of cable.	40	—	—	—	—	—
Metal terminal.	—	—	—	12[5]	12[5]	—
Nearest metal parts not previously mentioned (bridle rings, metal pole brackets, etc.).	40	40[4]	—	—	—	40

[1] Except vertical runs, lamp brackets, span wires, guys, or braces which are attached to wooden crossarms but which are more than 1 inch from transformer cases or hangars.

[2] Measured to supply conductor on crossarm.

[3] Where guardarm hook distribution is employed 46 inches, where knob distribution is employed 48 inches, measured to nearest metal part of supply construction, such as supply conductor carrying 750 volts or less, or metal conductor support. When measuring to supply conductor carrying over 750 volts, increase clearance from the conductor by 8 inches.

[4] Measured to nearest metal part of supply construction, such as supply conductor carrying 750 volts or less, or metal conductor support. Where measuring to supply conductor carrying over 750 volts, increase clearance to 48 inches from the conductor.

[5] Where a clearance of 12 inches cannot be obtained, all metal parts of terminals shall have the greatest practicable separation from lamp and trolley fixtures, including all supporting screws and bolts of both classes of attachments.

b. Illustrations of various allowable clearances are shown in figures 56, 57, and 58.

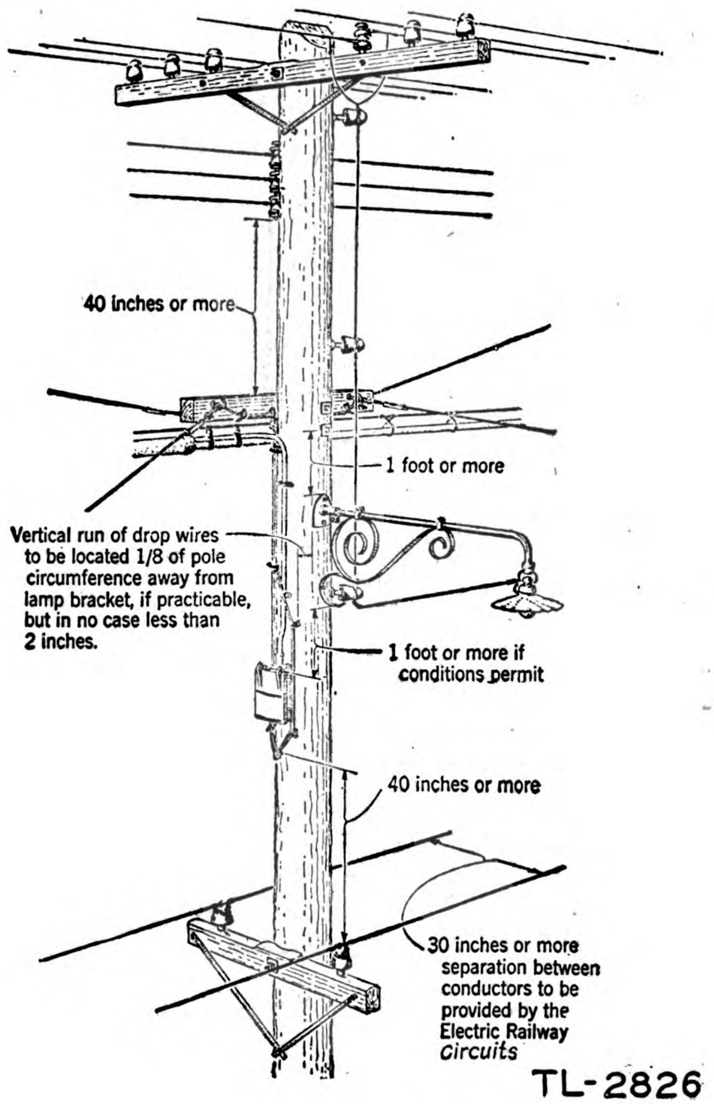


Figure 56. Clearances on jointly used poles.

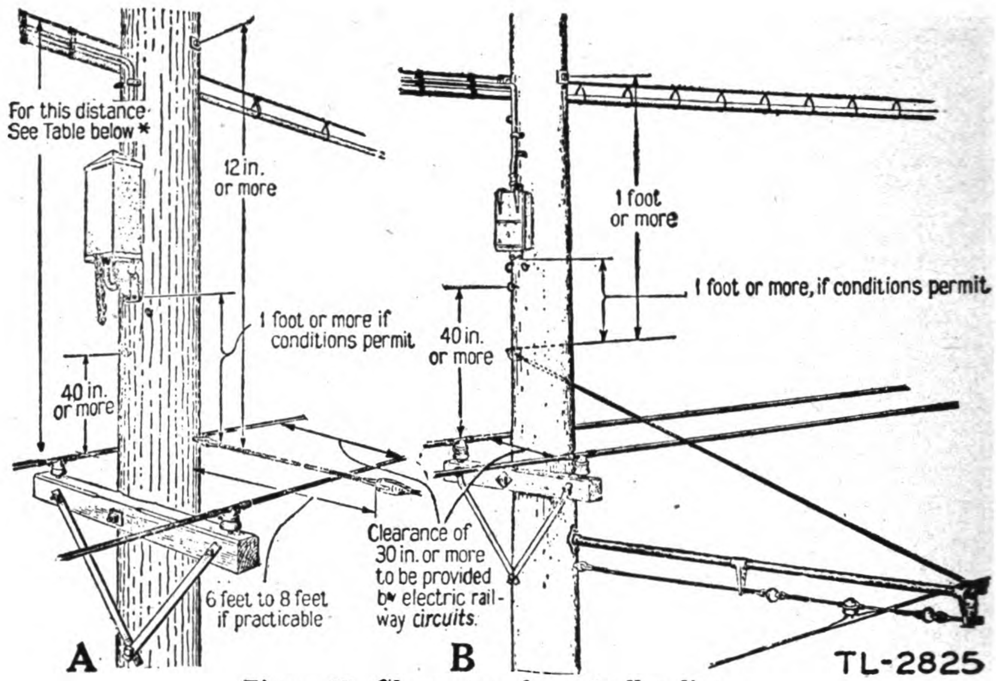
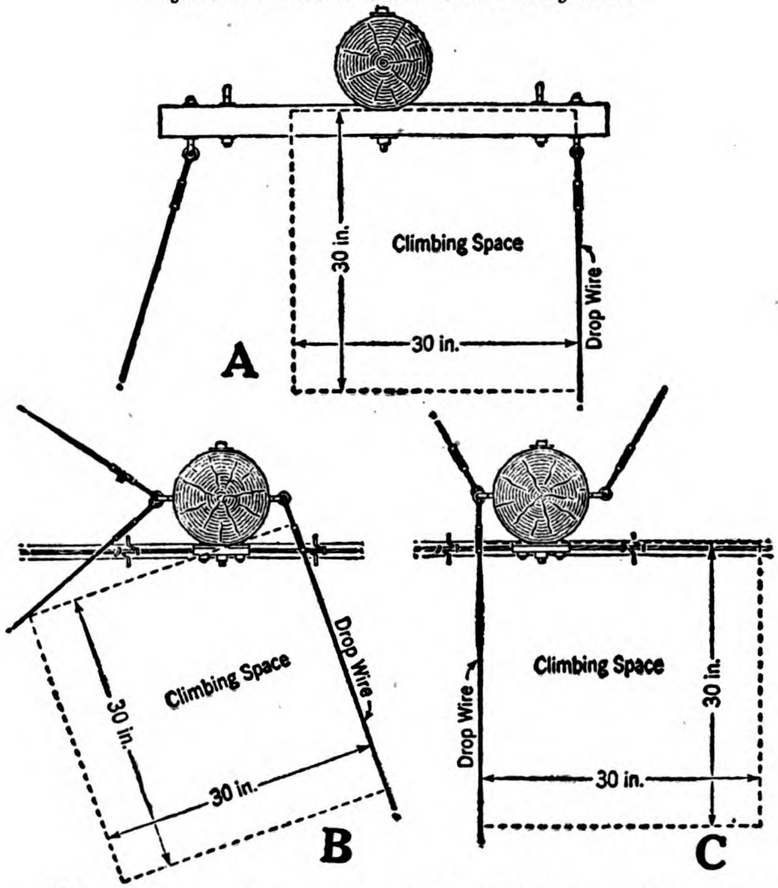


Figure 57. Clearances above trolley lines.



NOTE: Drop wires must not obstruct the specified climbing space.

TL-2827

Figure 58. Climbing space.

13. Drop Wire Runs from Poles

a. Runs from Poles Not Requiring Guardarms. (1) Distribute drop wire from drive hooks attached to the face or back of poles not requiring guardarms. (See fig. 59.) If brackets and knobs have been previously installed and are only partially filled, distribute drop wire from vacant grooves of the knobs. Do not attach more than two drops to a "T" knob, or more than one drop to an "S" knob.

(2) Vertical distance from suspension strand to drive hook may be varied to obtain proper clearances.

(3) Attach drop wire clamp to drive hook by passing the wire loop of the clamp over the drive hook. When the direction of the drop span is such that it will not tend to pull around to the hook end of the drive hook, place the loop of the drop wire clamp on the shank of the drive hook. Otherwise, place the loop over the hook. Place the drop wire through the hook of the drive hook only when the drop wire is run along the cable lead, or when drop wires are run to buildings on the opposite side of the street from the cable run.

(4) Pull the ring wiring on the vertical pole run tight, to avoid unsightly slack. Do not pull the ring wiring so tight, however, that strain is taken off the loop of the drop wire clamp.

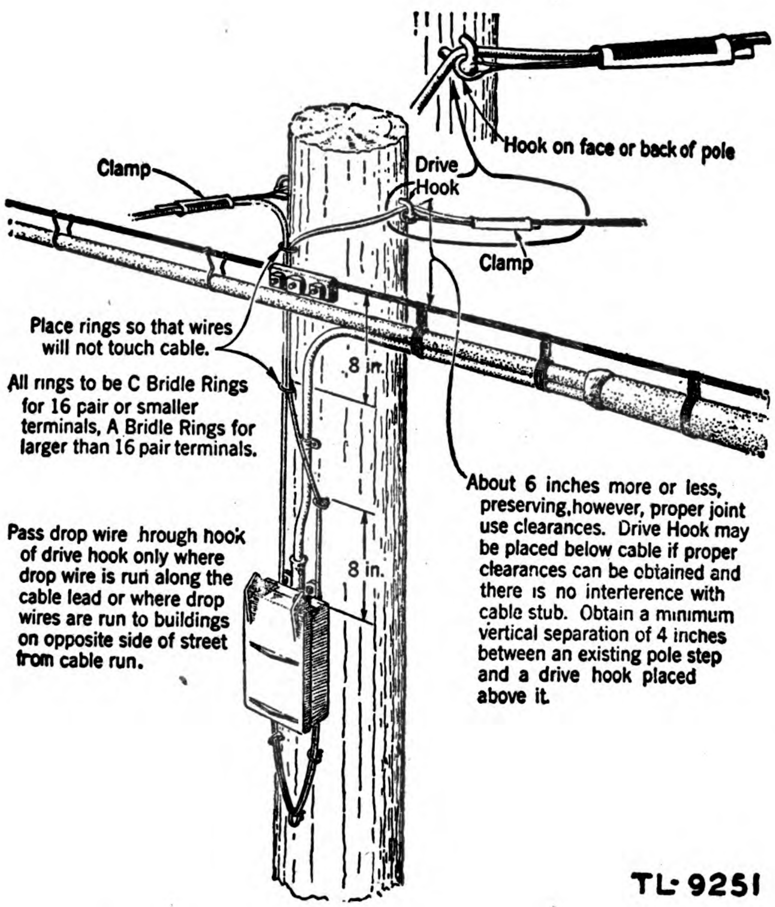


Figure 59. Typical drop wire runs from poles not requiring guardarms.

b. INSTALLING GUARDARMS. Install guardarms as shown in figure 60.

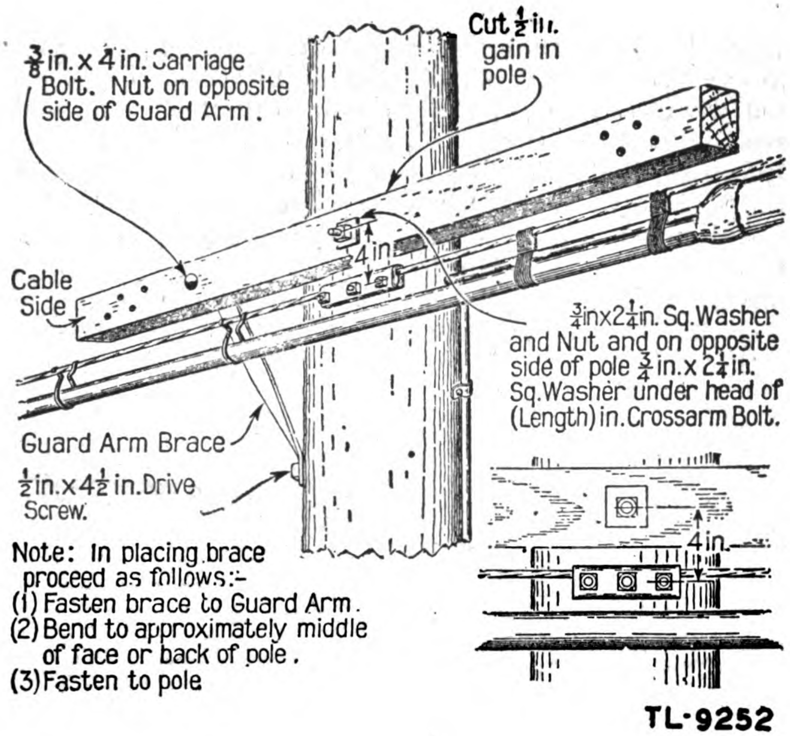


Figure 60. Installing guardarms.

c. RUNS FROM POLES REQUIRING GUARDARMS. (1) At poles requiring guardarms distribute drop wire from guardarm hooks attached to guardarm. (See fig. 61.) If brackets and knobs have been previously installed and are only partially filled, distribute drop wire from the vacant grooves of the knobs. Only two drops can be attached to a "T" knob, and only one drop to an "S" knob.

(2) Attach drop wire clamp to guardarm hook by passing wire loop of clamp over hook. Run drop wire through guardarm hook.

(3) Pull the ring wiring in the vertical pole run tight, to avoid unsightly slack. Do not pull the ring wiring so tight, however, that strain is taken off the loop of the drop wire clamp.

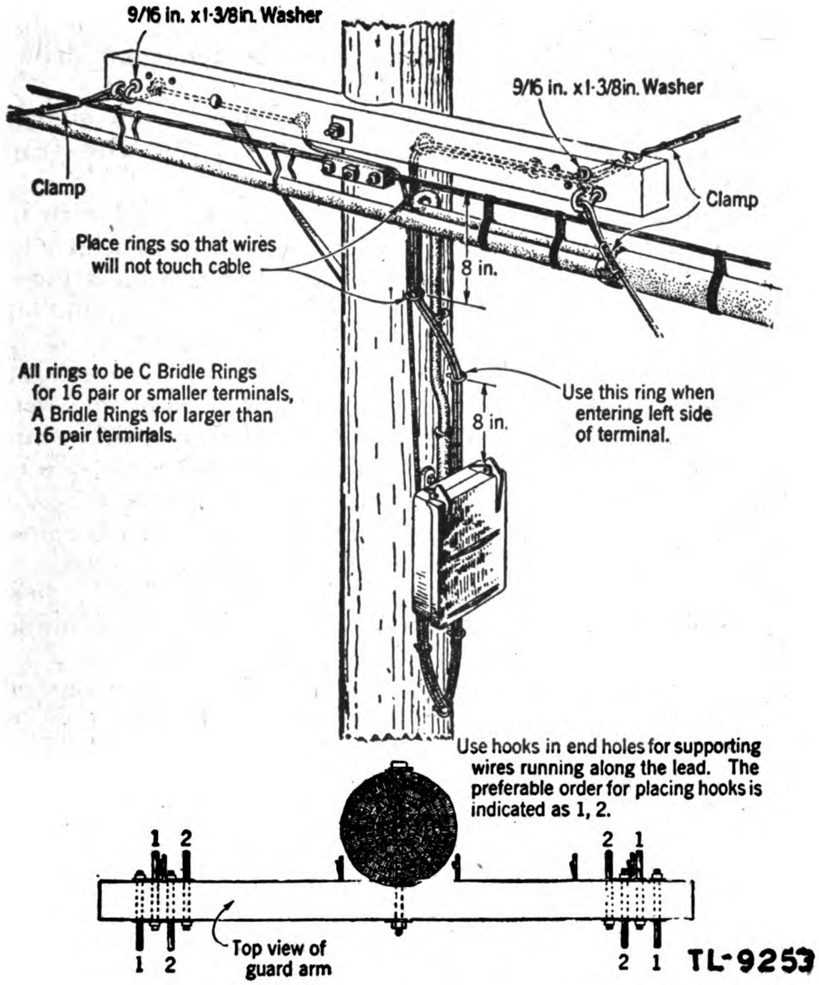


Figure 61. Typical drop wire runs from poles requiring guardarms.

d. Drop Wire Runs Along Lead. When it is necessary to furnish telephone service in advance of aerial cable, drop wire may be run along the lead attached to drive hooks or existing pole brackets, knobs, and crossarms. Place drop wire with proper clearances and, when practicable, at a height where it does not interfere with future placing of cable. On aerial cable lead, where terminals are not placed on every pole, it may be necessary to parallel the cable with drop wire. Various methods of paralleling the cable with drop wire follow.

(1) Where ground clearances permit, place the drop wire below the cable. Place drive hooks in the pole on the cable side about 6 inches below the strand for the run along the lead. At distributing points, attach the drop wire to a hook placed on the face or back of the pole.

(2) When proper ground clearances cannot be obtained with the drop wire placed below the cable run, and when sufficient space is available above the cable, place drive hooks above the strand at such a height that the drop wire will not whip against the strand or cable. Maintain proper joint clearances.

(3) If proper clearances can be obtained, drop wire runs along the lead, where guardarms are in place, should be made on drive hooks placed in the pole beneath the cable.

(4) When it is necessary to run the drop wire from guardarm to guardarm, place guardarm hooks and dead-end the wire from both directions with drop wire clamps.

(5) Make party-line taps to drop wire runs along lead with bridging connectors. Locate a bridging point near the pole from which the drop wire to the building is distributed from a drop wire lead. Bridge should be made in the span. Locate the center of the bridging point approximately 12 inches from the point of attachment on the pole.

e. NUMBER OF DROP SPANS PER DRIVE HOOK OF GUARDARM HOOK. (1) *Distribution points where no run along lead is involved.* (*a*) Three drop spans crossing a highway may be attached to one drive hook.

(*b*) Four drop spans attached to buildings on the same side of highway as the pole line may be attached to one drive hook.

(*c*) If the direction of the drops and the space on the drive hooks will permit, any combination of (*a*) and (*b*) above may be used.

(2) *Distribution points where run along lead is involved.* (*a*) Three drop spans along the lead may be attached to one drive hook, if no other spans are attached to the same drive hook.

(*b*) Two drop spans along the lead, one across the highway and one to a building on the same side of highway as the pole line, may be attached to the same drive hook.

(*c*) One drop span along the lead, two drop spans across the highway, and three drop spans on the same side of highway as the pole line, may be attached to the same drive hook, if the available space on the drive hook permits this number of drops.

(3) *Runs along lead.* (*a*) In straight sections of line where the drive hook is placed on the cable side of the pole, four drop wire clips can be placed on one drive hook.

(*b*) When there is a corner on the pole, and when the pull is away from the pole, three drop wire clips may be placed on one drive hook.

(*c*) When the pull on a corner pole is against the pole, four drop wire clips may be placed on one drive hook.

(*d*) If there is a corner on the pole and if the drop wire is attached by drop wire clamps, four clamps may be placed on one drive hook.

f. SPAN FROM SUSPENSION STRAND. (1) Span from a suspension strand only if right-of-way difficulties, tree interference, reduction of climbing space, etc., make it impracticable to run the drop directly to the station from a pole of an aerial cable lead.

(2) Note the following points in connection with the installation of spans from suspension strands:

(*a*) Do not attach more than two drop wires spanning from a pole or guardarm attachment to one clamp.

(*b*) Attach the span from the pole or guardarm to the clamp at the hook end. The span may also be attached from the building to either the hook or wingnut end.

(*c*) A second drop may be attached to the hook end of an existing span clamp, by passing the loop of the drop wire clamp over the hook of the span clamp without loosening the wingnut.

(3) Typical spans from suspension strands are shown in figure 62.

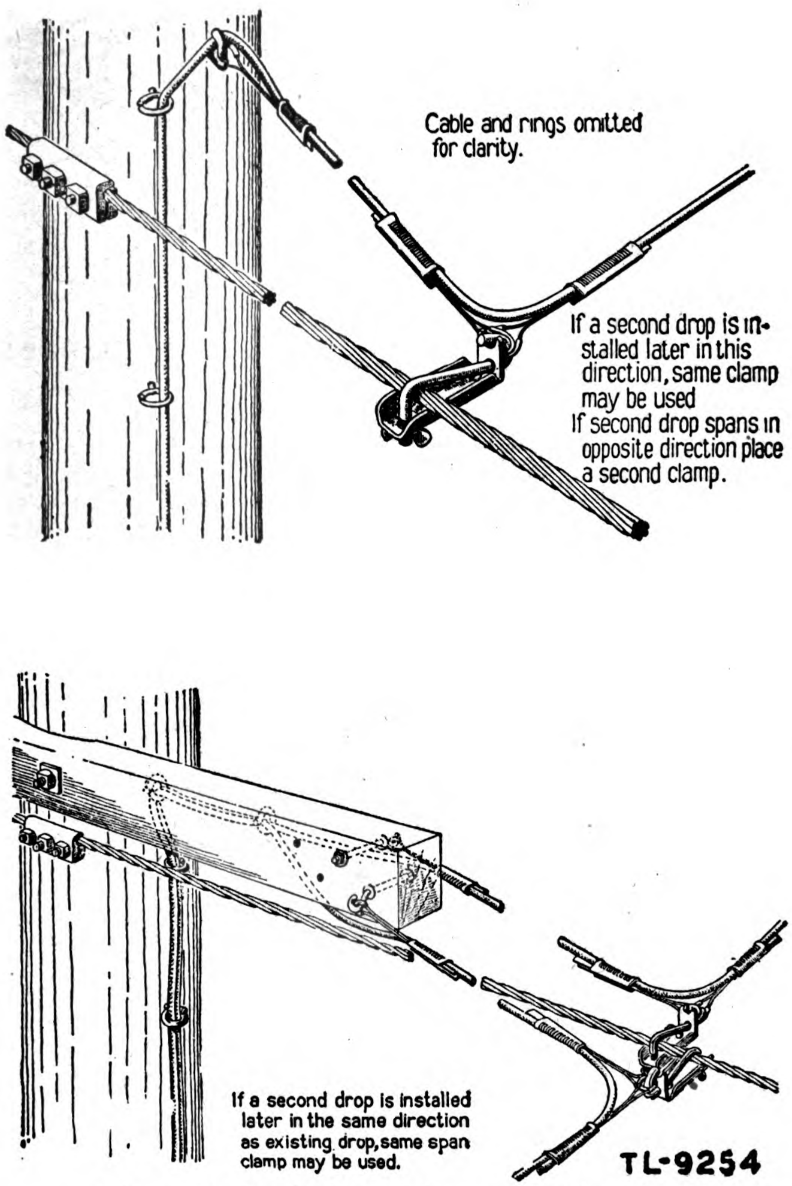


Figure 62. Typical spans from suspension strand.

g. DROPS FROM OPEN WIRE LINES. (1) Run drops from open wire lines from a guardarm hook. Bore a ⅝-inch hole for guardarm hook and install the hook. (See fig. 63.)

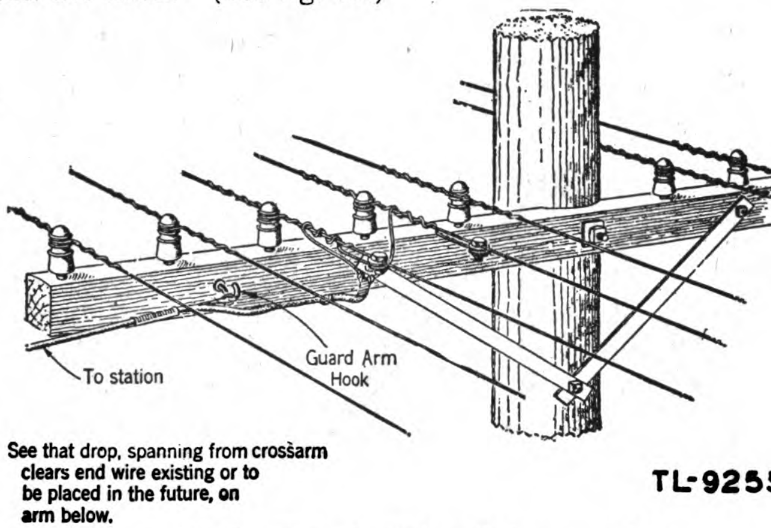


Figure 63. Guardarm hook installed on guardarm.

(2) Run drop from open wire lines attached to wooden pole brackets by dead-ending the drop wire on a drive hook. (See fig. 64.)

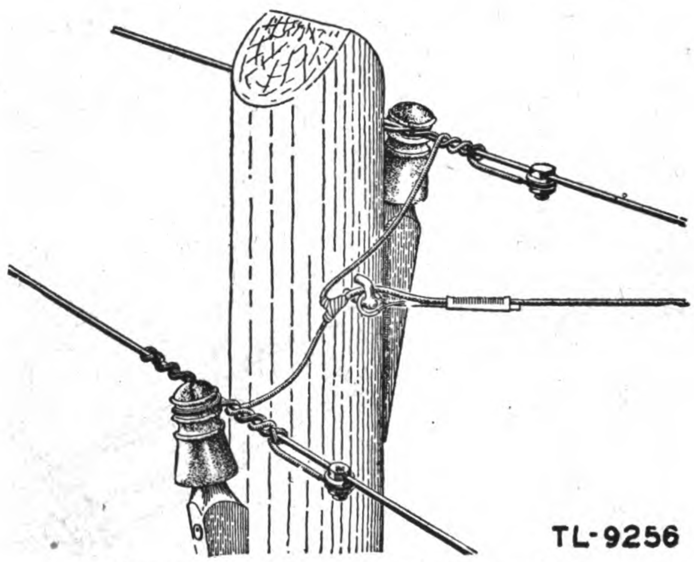


Figure 64. Drop wire run from open line.

14. Drop Wire Runs on Buildings

a. PLANNING. When planning building runs, observe the following rules:

(1) Locate the first attachment so that the drop will have necessary clearance above roadways and footways.

(2) Locate first attachments so that the drop will clear electric light, power, and trolley wires. (See table VII.)

(3) Separate drop wires requiring station protection from inflammable or conducting materials.

b. First Attachments on Buildings. (1) When the original installation is one drop attached to masonry or brick veneer, use a drop wire clamp to support the pole-to-building span; use another drop wire clamp to support the building run. (See fig. 65.)

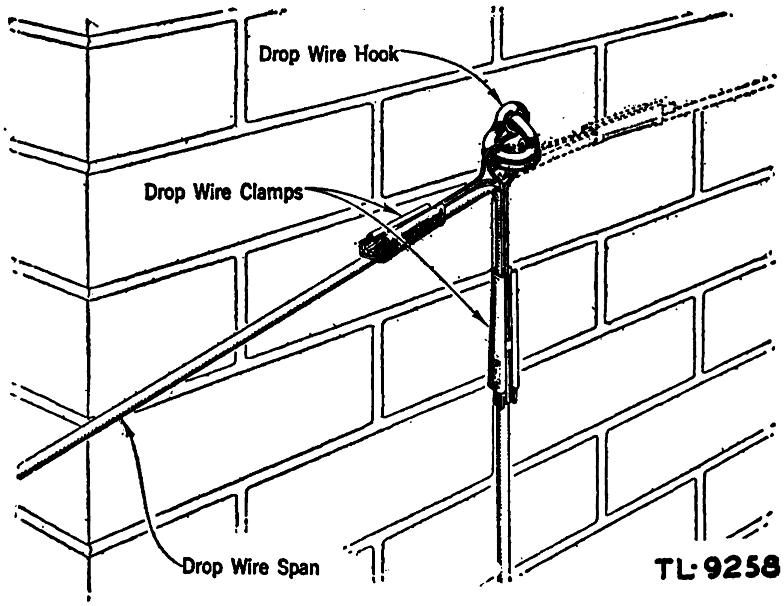


Figure 65. Drop wire span attached to building.

(2) When a second drop is to be attached to a drop wire hook on masonry or brick veneer, remove the drop wire clamp from the building run of the first drop and place a "C" knob about 6 inches behind the first span attachment. (See fig. 66.)

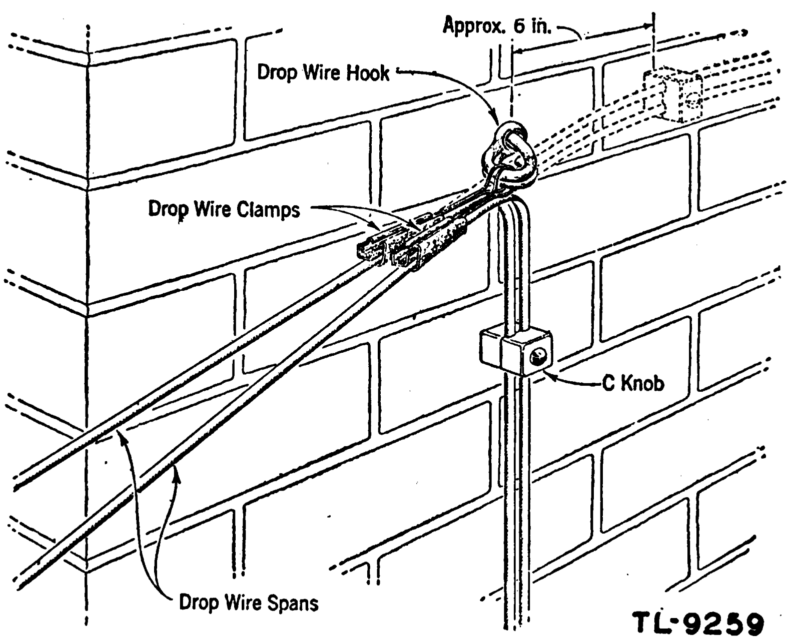


Figure 66. Double drop wire span attached to building.

(3) When installing a first attachment on an unexposed run on a frame building, use a drop wire clamp to support the pole-to-building span and place a "C" knob on the run about 6 inches from the drop wire clamp. (See fig. 67.)

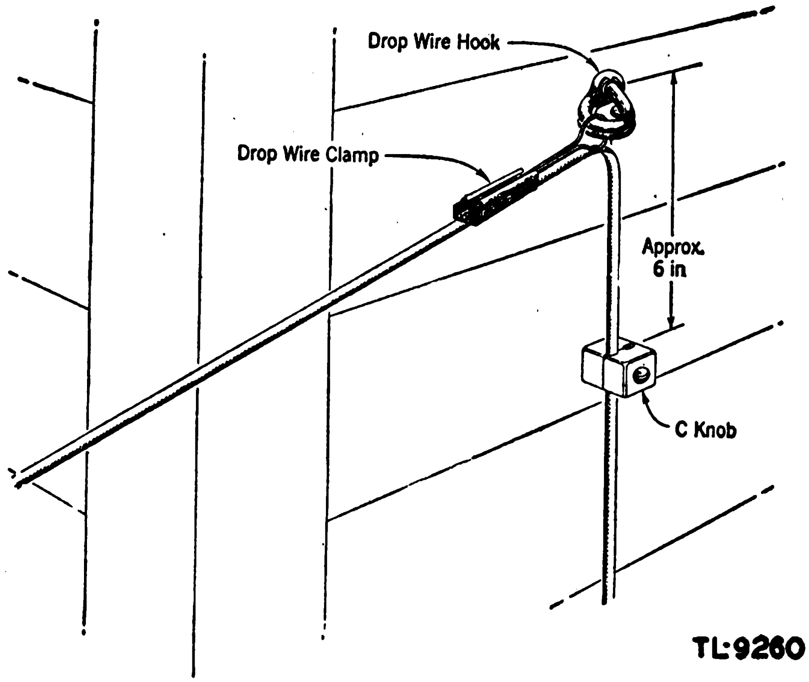


Figure 67. First attachment in unexposed area on building.

c. Installing Attachments. (1) Install all attachments as described in paragraphs 7 and 8.

(2) Use "S"-type corner bracket to pass corners and small obstructions; use "L"-type corner bracket to pass large obstructions.

(3) Mount all angle screws so that the pull of the drop wire span will not tend to turn the angle screw out of the wall.

d. Last Attachments. (1) Last attachment and entrance should be as close together as practicable, and should never be farther than 18 inches apart.

(2) Drip loops need not be provided where porcelain entrance tubes slope upward from the outside. Under other condition provide a 1½-inch drip loop.

(3) Use "C" knobs for last attachments on all inflammable and conducting materials.

(4) Bridle or drive rings may be used on conductors or materials which are not inflammable.

e. Typical Drop Wire Runs. Figures 68, 69, and 70 show typical drop wire runs on buildings.

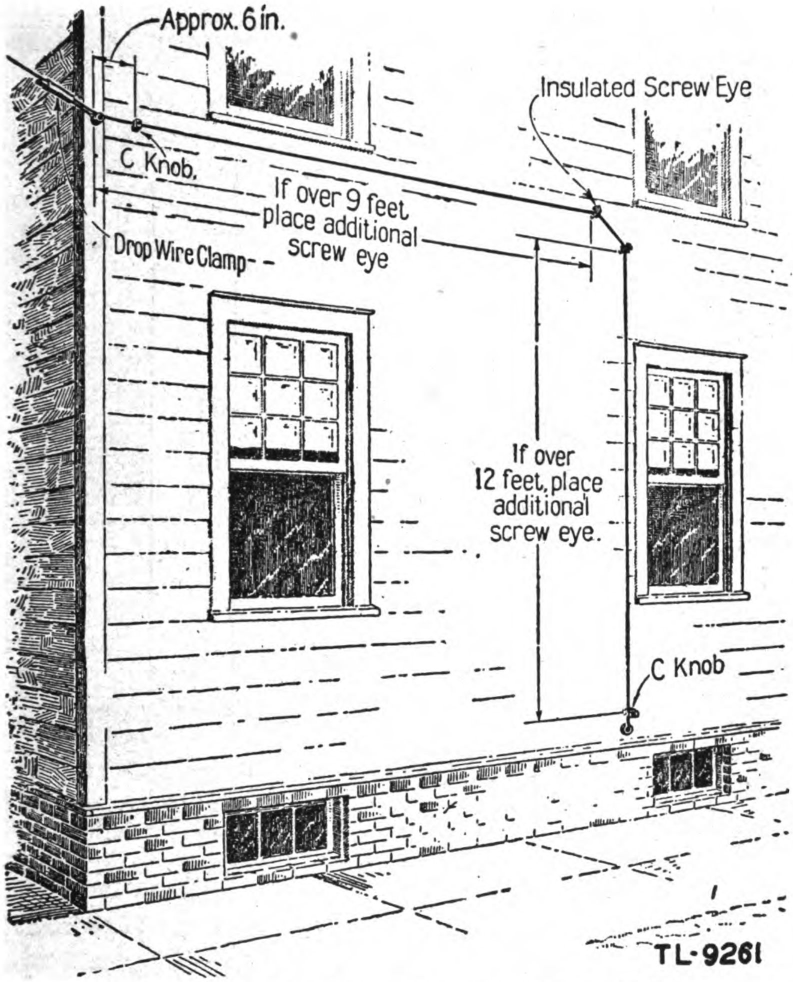


Figure 68. Typical drop wire run on frame building.

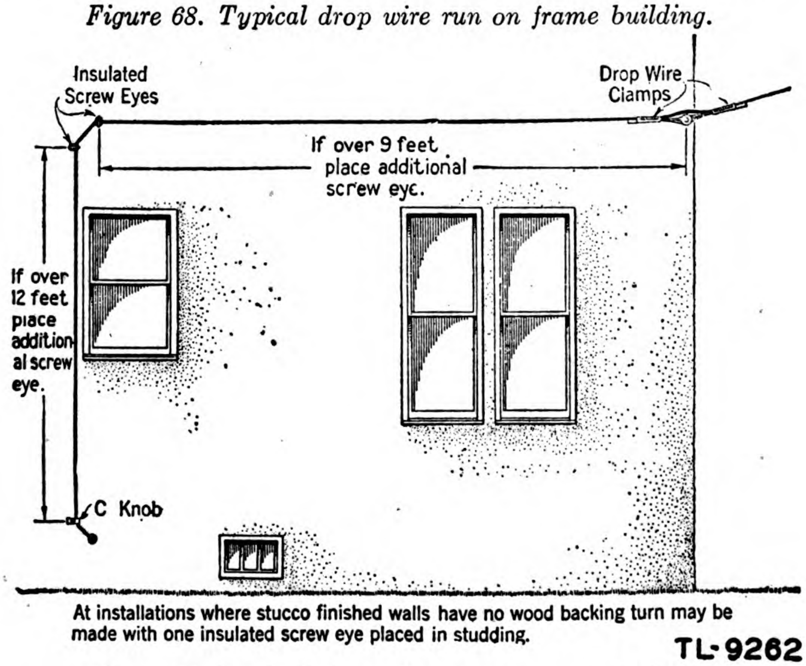


Figure 69. Typical drop wire run on stucco building.

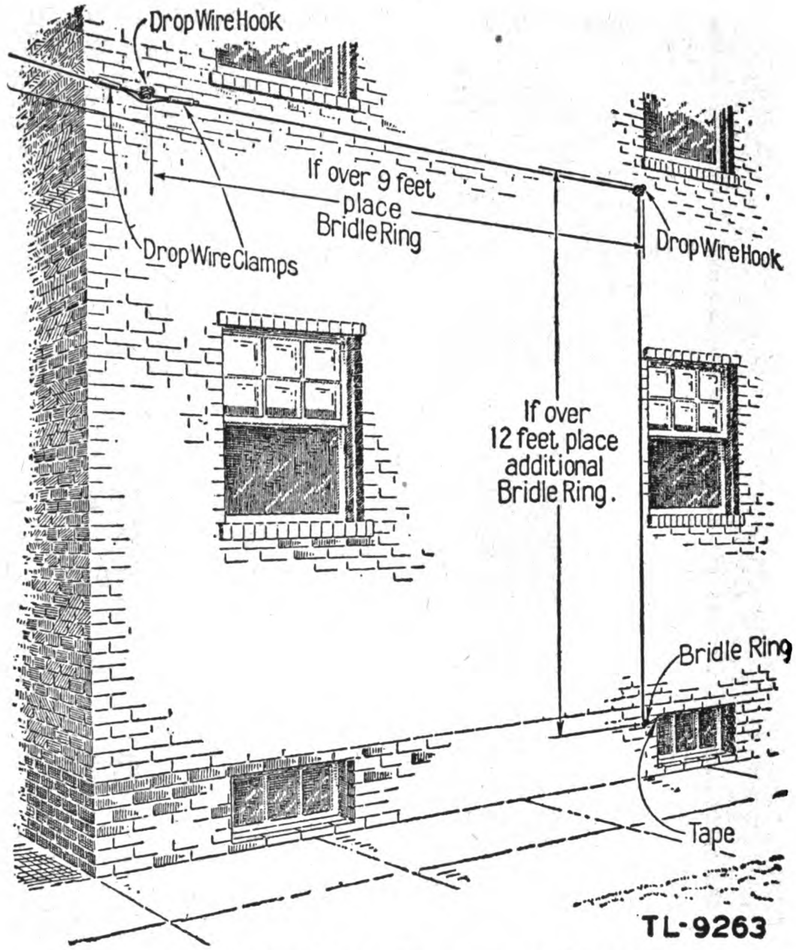


Figure 70. Typical drop wire run on brick building.

15. Block Wire Runs

a. PLANNING. (1) Use porcelain insulation for separation between a building and a block wire run requiring station protection and attached to inflammable or conducting materials.

(2) Do not run block wire in front of signs where it will interfere with fire escapes, hoists, doors, etc.

(3) Do not place ring runs on walls against which other walls may be built.

(4) Locate ring runs for permanency and accessibility as follows:

(*a*) Place run on rear or side wall of buildings whenever practicable.

(*b*) Place run along smooth part of brick wall rather than along rough foundations.

(*c*) Do not attach ring run to materials, such as tin or sheet metals, which will require frequent replacement.

(*d*) Avoid attaching runs to old, deteriorated, or temporary frame buildings.

(*e*) Locate runs so that wire will be reasonably free from mechanical injury.

(*f*) Make run as short and with as few turns as possible.

(*g*) Make all runs either vertical or horizontal.

(*h*) Avoid electric light and power lines.

(*i*) Locate the run so that it is subjected to as few obstructions as possible.

(*j*) Do not place anchors closer than 10 inches to the top or corner of a wall, except when the run extends around a corner.

(5) Follow the cable run when fastening a drop wire run on a building where the cable has already been placed.

(6) Reuse an existing block wire run whenever possible, but make a thorough check and replace any loose or worn equipment on the run before reusing it.

b. SELECTION OF ATTACHING DEVICES. (1) Use bridle or drive rings or insulated screw eyes when placing a ring run where no cable exists.

(2) Use metal rings on all nonconducting or noninflammable substances.

(3) Use insulated screw eyes on all conducting and inflammable materials when the wiring is exposed. Metal rings may be used on all types of materials when the wiring is unexposed.

c. INSTALLING ATTACHMENTS. Install attachments as described in paragraphs 7 and 8.

d. PLACING BLOCK WIRES. (1) On existing runs, lay wire in bridle rings or cable clamp rings; do not pull wire through the rings.

(2) In new installations wire may be drawn through the rings.

(3) Pull block wires tight, to avoid unsightly sag. Do not pull block wire so tight, however, that undue strain on the wires results.

e. AERIAL BLOCK WIRE SPANS. (1) Avoid aerial spans which may open an exposure that would not otherwise exist.

(2) Where an aerial span crosses a driveway or private property, provide proper clearances. (See Table VI.)

(3) Where a span is 5 feet or less, no special support is required.

(4) Where a span is 35 feet or less, the construction shown in figure 71 may be used.

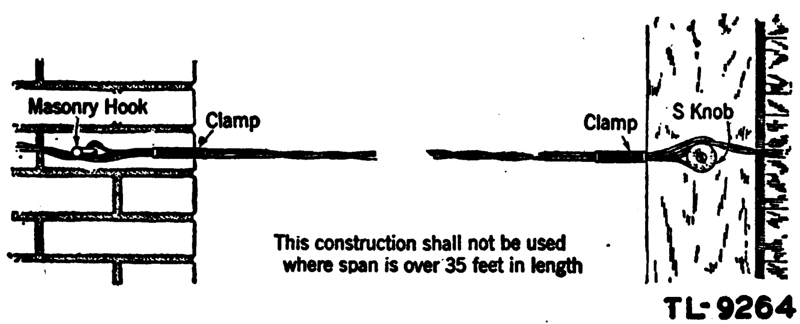


Figure 71. Span construction under 35 feet in length.

(5) Where the span is over 35 feet long, use the construction as shown in figure 72.

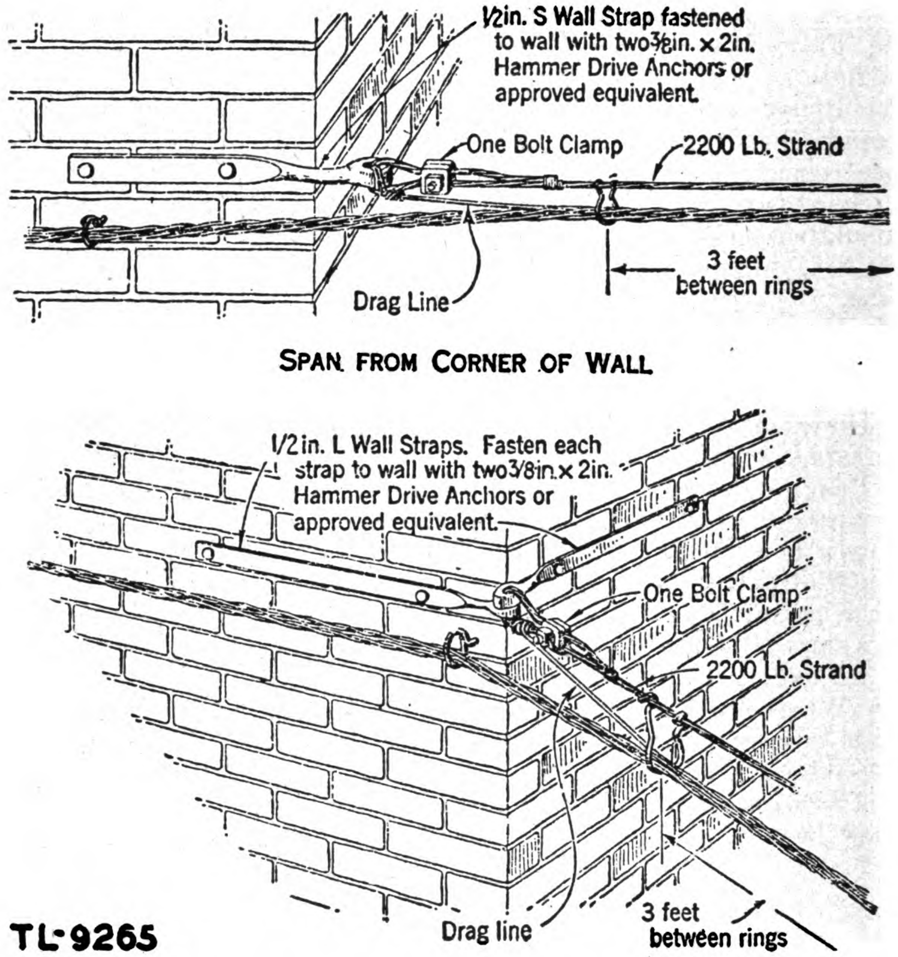


Figure 72. Span construction over 35 feet in length.

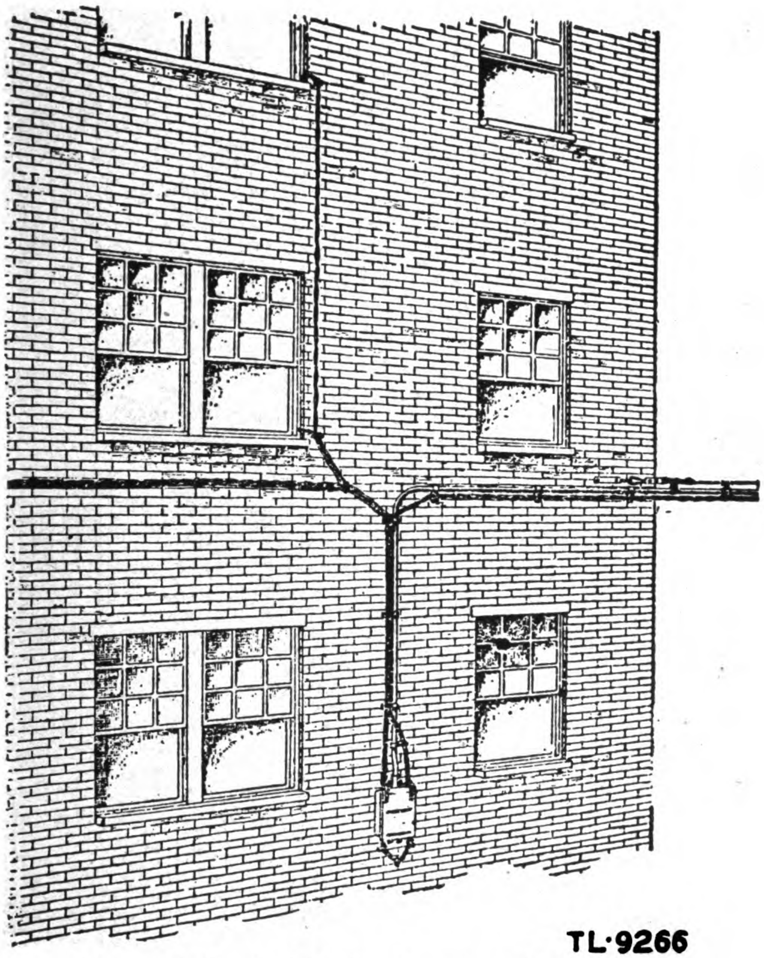
f. Last Attachments. (1) Last attachment and entrance should be as close together as possible, and not more than 18 inches apart.

(2) Where practicable, place the last attachment below the entrance hole.

g. Party-line Taps. (1) Bridge the party line at the terminal if the most convenient spot for attaching the drop to the lead is at the pole or within the terminal. The party line can be bridged at the terminal if two wires are not already on the binding posts of the terminal.

(2) The bridge may be made directly to the wire with a type-1A bridging connector and a span clamp, if the most convenient spot is more than 50 feet from terminal.

h. Typical Block Wire Runs. Figures 73 and 74 show typical block wire runs on buildings.



TL·9266

Figure 73. Typical block wire run on brick building

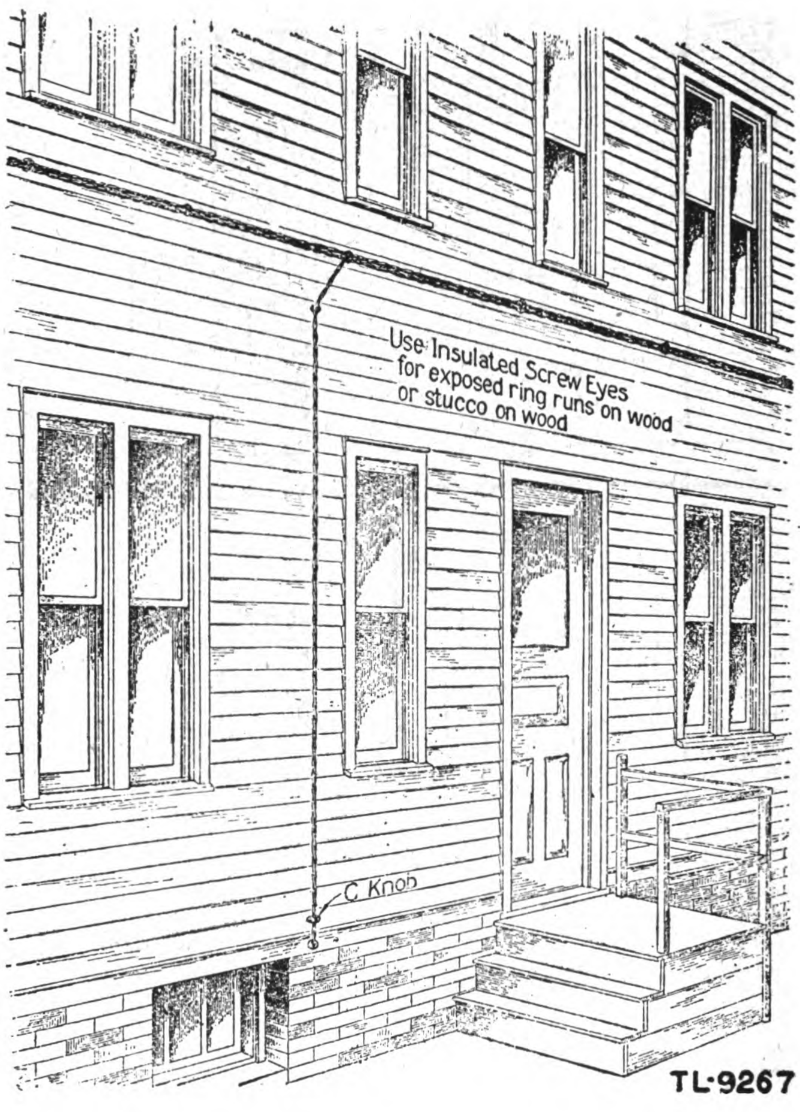


Figure 74. Typical block wire run on frame building.

SECTION III

STATION PROTECTION

16. Station Protectors

a. USE. (1) Telephone lines (except underground systems) are subject to electrical hazards from two sources: electric light and power lines, and lightning.

(2) The primary means of protecting telephone lines against electric light and power lines is planning aerial construction to prevent contact between the two kinds of lines. The best methods of aerial construction, however, cannot be relied upon to prevent all accidental contacts. Station protectors are the only practicable means of protecting the station apparatus against lightning and possible contact with electric light and power lines, and are required wherever such accidental contacts are possible.

b. STATIONS REQUIRING PROTECTION. All telephone stations served by conductors need protection, if the stations are subject to disturbance from lightning or to direct or indirect contact with a foreign circuit operating at more than 250 volts. Such stations are called "exposed stations" and the lines serving them, "exposed lines."

c. LOCATING PROTECTORS INSIDE. (1) The location of protectors inside of buildings is dependent on the following considerations:

(*a*) Available points of entrance for line wires.

(*b*) Location of approved protector ground.

(*c*) Location of the telephone.

(*d*) Available mounting surfaces for the protector.

(2) Place the protector where it is accessible for inspection and maintenance, and where those making the inspection or repairs will not be exposed to contact with power wires, moving machinery, etc.

(3) Do not mount the protector near inflammable materials or in a room where dust or gas of combustible materials is in the atmosphere. Mount the protector in a dry well-ventilated location.

(4) Mount the protector at least 1 foot from electric light or power wires, meters and accessories, and gas and water meters (unless the protector is mounted in the same protector cabinet as the other services).

d. LOCATING PROTECTORS OUTSIDE. If a suitable location for the protector cannot be found inside the building, place the protector on the outside of the building in a place well sheltered from rain, sleet, and snow.

e. MOUNTING PROTECTORS INSIDE. (1) Protectors may be mounted on any substantial surface. If a substantial surface is not available or if the surfaces available are rough or damp, mount protector on a suitable wood backboard.

(2) Do not mount protectors horizontally, with fuses one above the other.

(3) Protectors may be mounted on ceilings.

(4) When protectors are installed side by side, mount them so that their centers are at least 5 inches apart. (See fig. 75 (F).)

(5) On backboards or solid wood surfaces, use 1¼-inch No. 8 round head, blued, wood screws; on wood lath and plaster, use 2-inch No. 8 round head, blued wood screws. (See fig. 75 (D).)

f. WIRING PROTECTORS. (1) A porcelain tube should extend ¼ inch beyond the wall. In locations where appearance is not important, the tube need not be cut unless there is a possibility of breaking the exposed portion. (See fig. 75 (A).)

(2) The braid on wires should be allowed to extend ¼ inch beyond the "C" knob. (See fig. 75 (B).)

(3) Mount "C" knobs 1 to 4 inches from the top of the protector. The 4-inch distance is most practicable, for if the line wires are broken, the knob can be moved closer to the protector, in order to obtain slack. (See fig. 75 (C).)

(4) Terminate the line and inside tracer wires to the right-hand side of the protector. (See fig. 75 (E).)

(5) The last fastener placed on inside wires at the protector will be an inside wiring cleat. This fastener must be within 2 inches of the protector. (See fig. 75 (G).)

(6) Strip the insulation back ⅛ inch at all terminals. Wire should circle the terminal for a three-quarter turn, and should extend slightly beyond the edge of the washer. Place wire around the terminal in a clockwise direction. (See fig. 75 (H).)

(7) No fasteners are needed on a ground wire strap between protectors. (See fig. 75 (I).)

(8) In making corner turns, place inside wiring nails about 1 inch apart. (See fig. 75 (J).)

(9) When protectors are not mounted on a backboard, place line terminals in line with each other, if practicable. (See fig. 75 (K).)

(10) Slots in fuses are faced toward the protector. (See fig. 75 (L).)

(11) In multiple wire runs, stagger fasteners ¼ inch. (See fig. 75 (M).)

(12) Slotted portion of washers on the Cook Type B–7 protector are open toward the wire, permitting the wire to pass through the slot. (See fig. 75 (N).)

(13) Place ground wire behind the pronged washer on W. E. 98–A protectors. (See fig. 75 (O).)

(14) Make equal in length the line wires which go to protectors. (See fig. 75 (P).)

g. MOUNTING PROTECTORS OUTSIDE. (1) When it is not practicable or permissible to place a protector inside a building, or when maintenance conditions make an outdoor mounting advisable, the protector can be mounted outside on a proper protector mounting.

(2) Many types of protectors and mountings are available for outdoor use, the most common protector being the Cook Type 0.

(3) The Cook Type 0 protector is mounted as shown in figure 76 and is wired as shown in figure 77.

17. Protector Grounds

a. PUBLIC WATER SYSTEM. (1) Grounds on a public water system are preferred to any other type of ground.

(2) Make connections only to cold-water pipes which are in service.

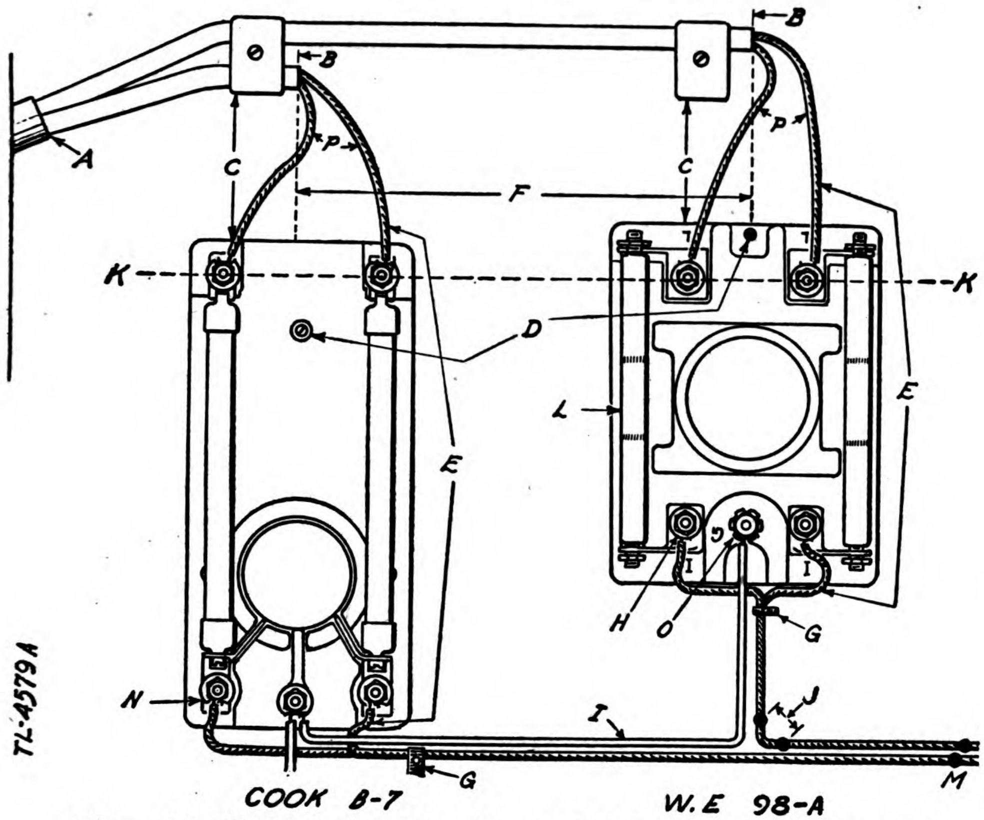


Figure 75. Wiring at Cook Type B-7 and W.E. Type 98-A protectors.

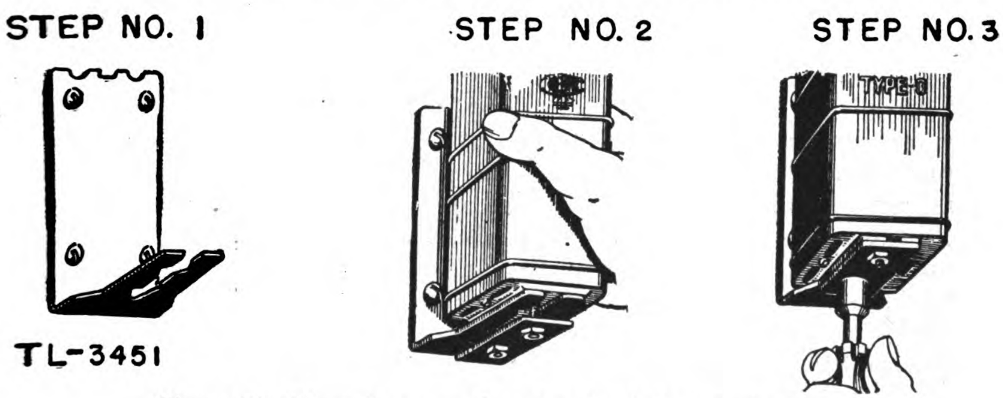


Figure 76. Mounting procedure for Cook Type 0 protector.

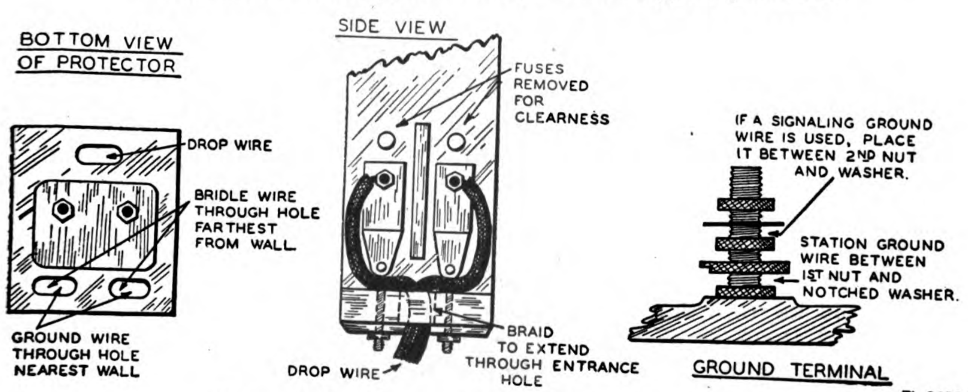


Figure 77. Wiring at Cook Type 0 protector.

(3) Connect ground wires to the street side of insulating joint if an insulating joint is present in the water pipe.

(4) If a supply tank is used in a building, connect ground to inlet pipe only.

b. PUBLIC GAS SYSTEM. (1) Use a public gas system as ground only when a public water system is not available.

(2) Connect ground only to pipes which are in service.

(3) Connect ground wire to street side of meter; if no meter is present, connect ground wire to pipe where the pipe enters the building.

c. PRIVATE WATER SYSTEM. (1) Do not use a private water system as ground unless a public water or a public gas system is not available.

(2) Use private water systems in preference to ground rods only if more than 10 feet of the private water system is underground.

(3) Connect ground only to cold-water pipes which are in service.

d. GROUNDED METALLIC STRUCTURES. Grounded metallic structures, such as buried tanks, conduits, and pipes, may be used for protector grounds, but only when such structures are evidently permanent.

e. GROUND RODS. When grounds described in a to d above are not available, use standard "S" type ground rods, one for each protector. Drive the ground rod below the level of the ground. When two or more ground rods are needed, strap the ground rods together.

f. GROUND WIRE CAPACITY. Following is the protector capacity of various types of ground wire.

Wire	*No. of protectors*
No. 14 B.&S. gauge, solid	3
No. 12 B.&S. gauge, solid	5
No. 6 B.&S. gauge, solid	Any number

g. INSTALLING GROUND CLAMPS. (1) Locate ground clamps where they will be subject to minimum disturbance and damage. When a ground clamp is located under a sink or other fixture, place the clamp as far up and under the fixtures and as close to the wall as possible.

(2) Clean pipe of paint, rust, dirt, and other foreign matter. Nickel, chromium, and other finished pipes need only to be wiped off with a damp cloth. Copper pipe should be cleaned with emery cloth lightly applied.

(3) Install ground clamp on cleaned pipe surface as in the following manner. (See figs. 78 and 79.)

(*a*) Remove nut from bolt.

(*b*) Place ground clamp around pipe with the flat side of the wire lug toward the pipe.

(*c*) Insert the bolt in the hole in the strap which will give a tight fit when the clamp is pulled together.

(*d*) Bend the ground wire around the head of the bolt in a clockwise direction, so that the wire lies flat in the lug.

(*e*) Tighten the bolt with a screw driver until the clamp is firmly seated against the pipe.

(*f*) With a side-cutting pliers nick the end of the strap at the next unused hole beyond the bolt. Break the strap off at the nicked place.

(*g*) Bend the end of the strap from which the cut was taken down over the projecting part of the bolt. File off any rough edges on the end of the strap.

(*h*) To keep any movement of the pipe from breaking the ground wire at the ground clamp, leave sufficient slack between the ground clamp and the first attachment. Make the first attachment of the ground wire within 6 inches of the ground clamp.

(4) Typical installations of ground wire clamps are shown in figures 78 and 79.

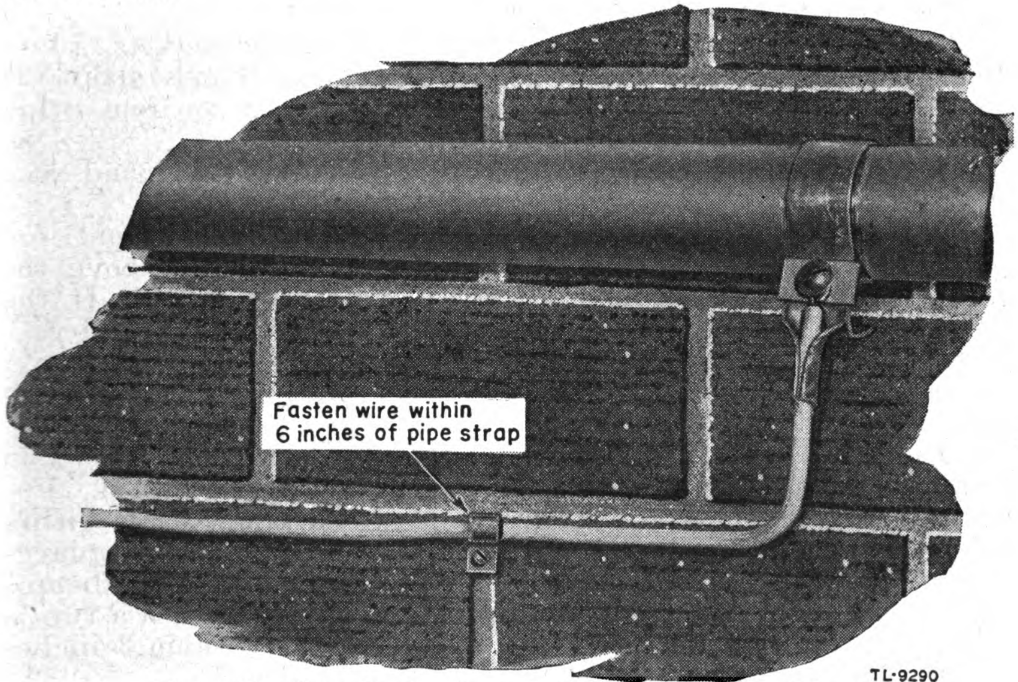


Figure 78. Ground wire clamp installed on a horizontal run.

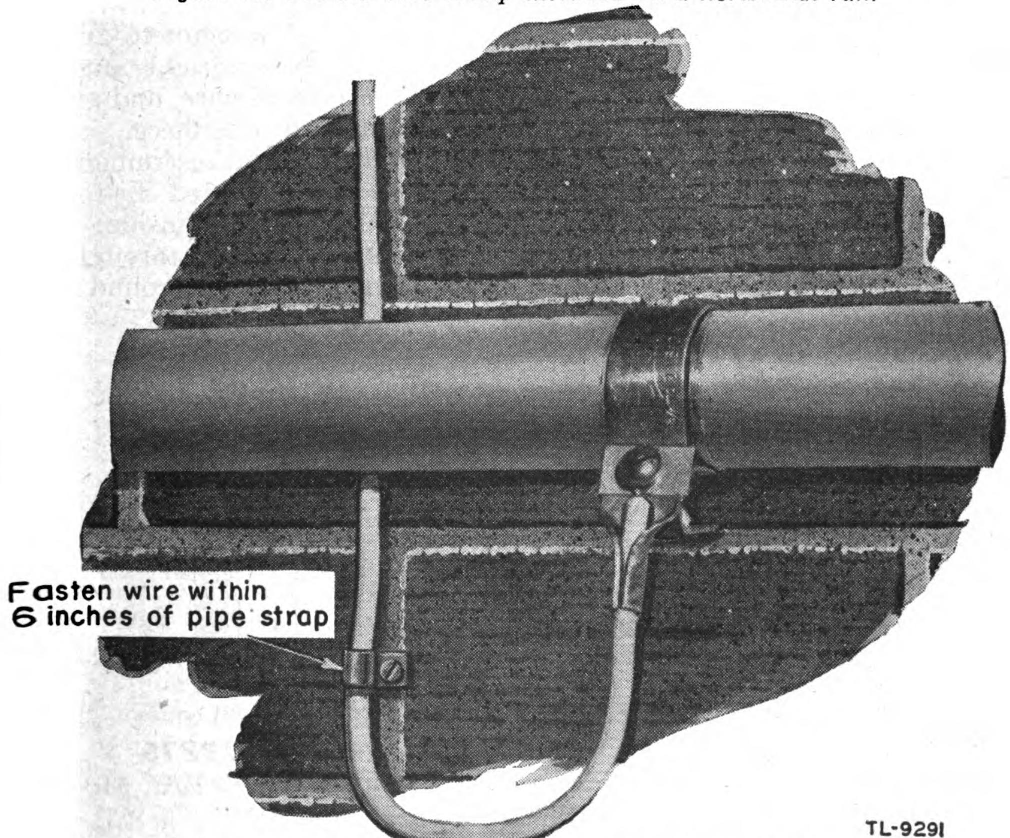


Figure 79. Ground wire clamp installed on a vertical run.

h. **Installing Ground Rods.** (1) Locate a ground rod where it will be least open to breakage or tampering. Avoid placing a ground rod in public alleys, or on the street or sidewalk side of a building.

(2) Inspect the ground rod before and after installation, to make sure that the tail wire is not broken. If the tail wire is broken, use another ground rod.

(3) To minimize electrolysis and the effect of air pockets, place ground rods at least 12 inches apart. Place ground rods about 24 inches away from wood poles and about 12 inches away from other structures (except in locations inside a building).

(4) Keep the ground wire at least 6 feet away from the ground rods of other services.

(5) Make a splice between the ground wire and the ground rod tail wire just above the ground, unless a splice located just above the ground would be next to conducting or combustible material. If the splice is near combustible or conducting material, bury the splice.

(6) The basement of a building is the most suitable location for a ground rod. Drive the ground rod as close as possible to the masonry wall.

i. **Fastening Ground Wire.** (1) Fasten ground wires as shown in figure 80. Locate the run where it will not be broken or detached. For ordinary runs, place fasteners 24 inches apart. On wire which is within 5 feet of the floor (or otherwise placed so that it is liable to displacement), place fasteners 16 inches apart. When spanning wire on beams in cellars or basements, place fasteners on every beam. When a run is made on beams, and parallel to a wall, run the wire within 3 inches of the wall; place a fastener on each beam.

(2) When running ground wire, observe the following rules:

(*a*) Run the wire as directly as practicable from protector to ground clamp. Do not make spirals or bends greater than a right angle.

(*b*) Except for splice to ground rod or No. 6 ground wire, and strapping between protectors, the ground wire must be in one piece.

(*c*) On open runs the protector ground wire and the instrument, or inside, wires must be placed under separately mounted fasteners. However, the protector ground wire and the instrument, or inside, wires may be in contact with each other at times and may pass through the same holes, conduits, etc. Do not twist inside wires and ground wire together.

(*d*) Do not place protector ground wires in ring runs.

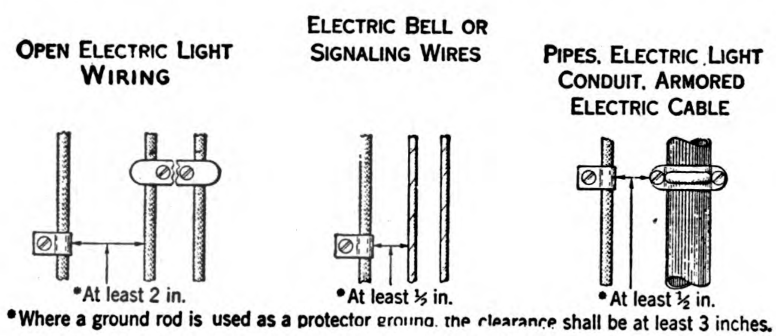


Figure 80. Minimum clearances between ground wires and electric light, power, or signaling wires.

SECTION IV

INSIDE INSTALLATION

18. Building Entrances

a. General. (1) The selection of a point of entrance is dependent on the locations of the telephone, the protector or connecting block, and the exterior and interior wire runs. Before selecting a point of entrance, survey the building premises for the location of the abovementioned apparatus.

(2) A point of entrance for a masonry or stucco-on-masonry building can be a window or door frame (except a metal door frame). On a frame or stucco-on-frame building, a point of entrance can be established immediately above or through the foundation sill. Make the entrance hole through the foundation sill so that the hole clears joists or studs. (See fig. 81.)

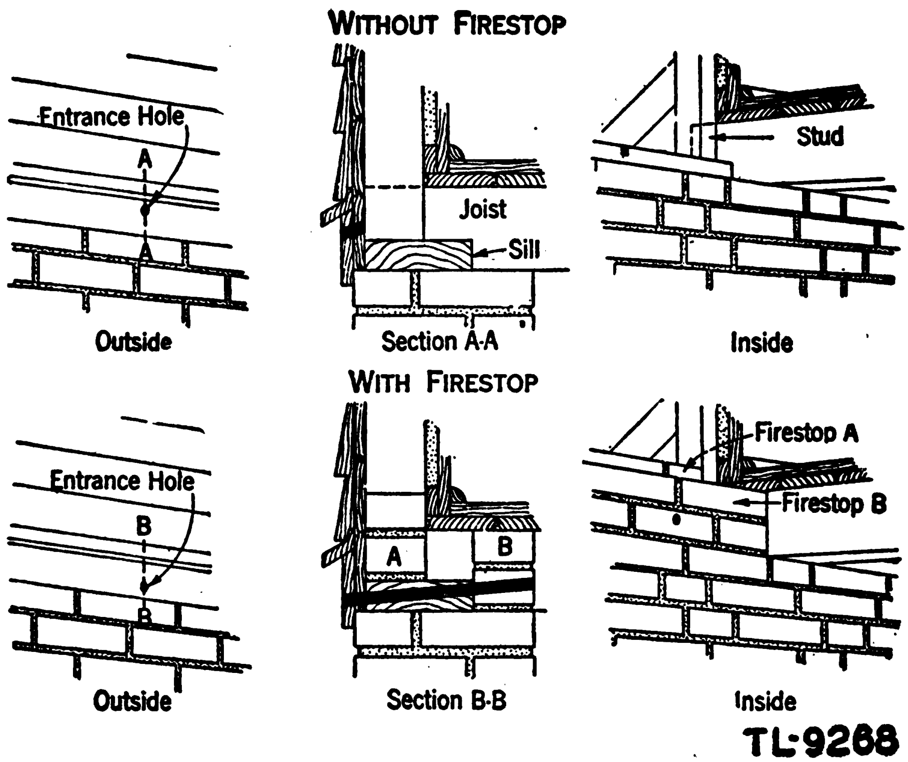


Figure 81. Entrance holes in foundation sill.

b. Wood Window Frames. (1) Place entrance holes in wood window frames so that the holes do not interfere with the opening or closing of the windows.

(2) When the side of the window frame at the top is selected as the site of the hole, bore the hole as close as possible to the top of the window frame, to avoid interfering with the cord pulleys.

(3) When the side of the window frame at the bottom is selected as

the site of the hole, bore the hole within 3 inches of the sill, to avoid entering the sash-weight pocket.

(4) Figure 82 shows typical entrances through wood window frames.

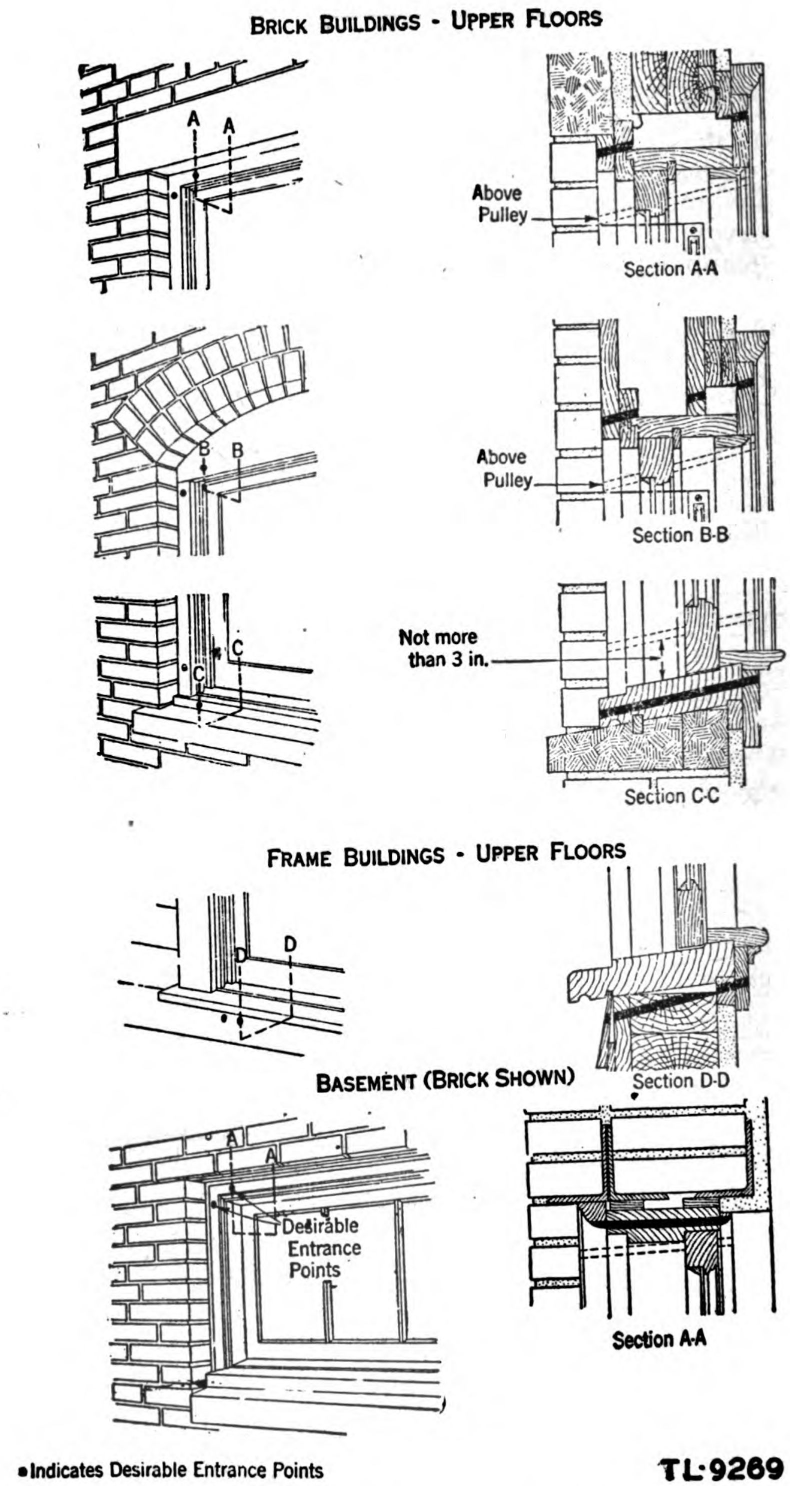


Figure 82. Entrance holes through wood window frames.

(5) Where metal shutters or fire screens are placed over a window, cut a slot in the seam between the bricks or tiles at the edge of the shutter or screen. Run the wire along the slot between the tiles or bricks to a desirable point of entrance. (See fig. 83.)

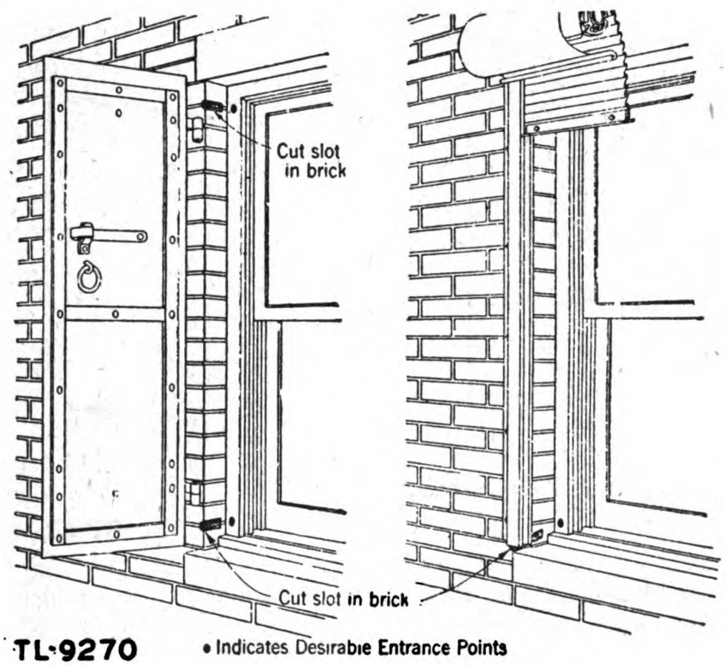


Figure 83. Entrance holes through windows with metal fire screens and shutters.

c. METAL WINDOW FRAMES. (1) If the metal window frame is set in masonry, drill the entrance hole halfway from the outside and halfway from the inside of the window frame. In drilling from the outside and the inside, slant the hole away from the window frame in each case so that the two drilled holes meet at an angle. (See fig. 84.)

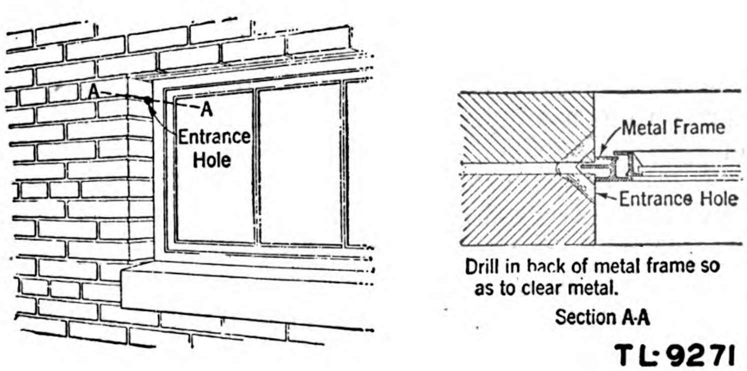


Figure 84. Entrance holes through metal window frames set in masonry.

(2) If the metal window frame is set in wood, make the entrance hole as shown in figure 85.

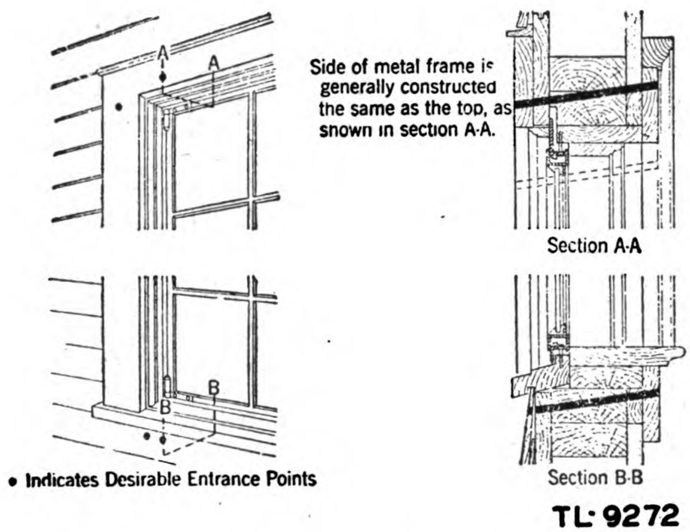


Figure 85. Entrance holes through metal window frames set in wood.

d. Wood Door Frames. Entrance holes in wood door frames are drilled in the same manner as those in wood window frames. (See par. 18b(1) through (4).)

e. Metal Door Frames. Do not drill entrance holes through metal door frames.

f. Size of Entrance Holes. (1) The diameter of an entrance hole should not be greater than one-half the width of the material through which the hole is made. If necessary, drill several holes of small diameter rather than a single large hole.

(2) When a hole is drilled in a window frame below the sash-cord pulley, the diameter of the hole must not exceed 3/8 inch.

g. Making Entrance Holes. Wherever practicable, slant entrance holes upward from the outside. When drilling an entrance hole through a brick wall, make the hole in a seam between bricks. Start drilling the hole on the side of the wall on which a neat appearance is desirable.

h. Porcelain Tubes in Entrance Holes. (1) Porcelain tubes are required in entrance holes of the size and capacity indicated in Table IX.

Table IX. Entrance holes requiring porcelain tubes

Wire	No. of wires		
	3/8-in. tube 3/4-in. hole	3/4-in. tube 1 1/4-in. hole	1-in. tube 1 1/2-in. hole
Bridle wire or Wire W–69–A.	2	7	13
BP or TP drop wire, Wire W–108, or Wire W–108–A.	2	6	11
BR or TR drop wire.	1	4	7
Wire W–50.	1	2	4

(2) Porcelain tubes are not required in entrance holes of the size and capacity indicated in table X.

Table X. Entrance holes not requiring porcelain tubes

Wire	No. of wires			
	3/8-in. hole	1/2-in. hole	3/4-in. hole	1-in. hole
Bridle wire or Wire W–69–A.	2	3	7	13
BP or TP drop wire, Wire W–108, or Wire W–108–A.	2	3	6	11
BR or TR drop wire.	1	2	4	7
Wire W–50.	1	1	2	4

(3) When porcelain tubes are required, place them as shown in figure 86.

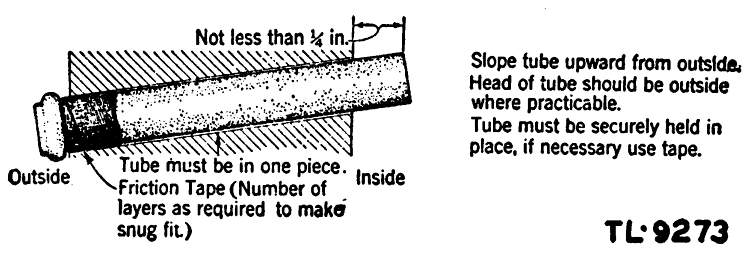


Figure 86. Porcelain tube in place.

19. Selection of Wire

a. Bell System GN Station Wire or Wire W–117. Use Bell System GN station wire or Wire W–117 for all interior station wiring, except in ducts, wet conduits, or other locations where severe moisture conditions are present. Use brown Bell System GN station wire on dark surfaces and ivory Bell System GN station wire on light surfaces.

b. Bridle Wire. (1) Use bridle wire when a stronger wire than Bell System GN station wire or Wire W–117 is required. Use bridle wire in factories and warehouses where the wire may be subject to physical damage or where the standard spacing of fasteners for interior wiring must be exceeded. Use bridle wire under buildings that do not have basements, and for all station wiring extended outside a building, such as wiring to an outdoor telephone set, to a loud-ringing bell, or from an outside protector mounting to a telephone inside the building.

(2) If appearance is not important, run bridle wire or drop wire directly to the telephone location. If appearance is important, make the exposed length of wire as short as possible and tape the exposed wire with ivory or brown friction tape.

c. Cross-connecting. Use Bell System GN station wire in inside cross-connecting boxes, frames, and terminals where severe moisture is not present.

d. Splicing. (1) Do not splice inside house wire at new installations where the run is 50 feet or less.

(2) Wire at reinstallations may be spliced under the following circumstances:

(*a*) Where the old run is 20 feet or more in length and in good condition.

(*b*) Where removal of the old run would leave an unsightly appearance.

(*c*) Where the old run is less than 20 feet in length but more labor would be involved to replace it than to make a splice.

20. Minimum Clearances and Protection

a. Clearances. (1) Maintain clearances of at least 6 inches between telephone wiring and foreign ground wires.

(2) When it is convenient to run wire outside the building from the station side of the protector (in cases where the main station requires a protector), or when it is convenient to run wire outside the building to an extension station or extension ringer, interior wiring extending outside the building must be separated from the line wire by at least 2 inches and from electric service wires by at least 6 inches. Where proper clearances cannot be obtained, protect the wire as shown in figure 87.

(3) Other minimum clearances are shown in figure 80. If the proper clearances cannot be obtained, protect wire crossing or paralleling pipes or foreign wires as shown in figure 87.

(4) Do not place wire in a pipe, conduit, or compartment containing electric light or power wires. Unless the telephone wire is separated from the electric light and power wires by a suitable partition, do not place wire in the same outlet box, junction box, or similar fitting or compartment, with electric light and power wires. If the power wires are introduced into an outlet box, junction box, or compartment solely for power supply to signaling equipment, or for connection to

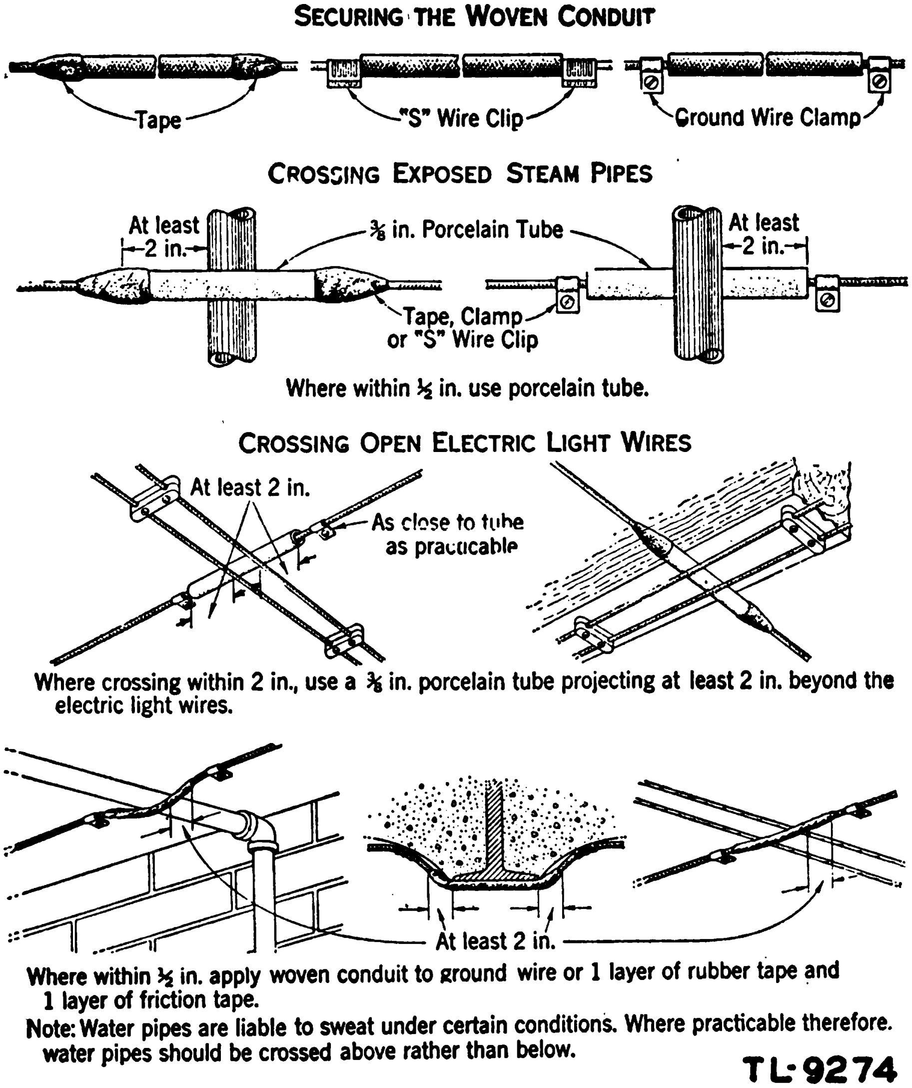


Figure 87. Protecting a wire crossing metallic object.

remote control equipment, telephone wire need not be separated from power wires by a partition.

(5) It is permissible to place telephone wire in same conduit or runway with signaling wire provided that the voltage for operating the signals does not exceed 48.

b. PROTECTION. (1) Run wire from the telephone, protector, connecting block, or cable terminal so that the wire is not exposed to injury, and so that the run is as short as is consistent with neat appearance.

(2) Protect wire with two layers of friction tape, half-lapped and reversed, where wire is run in back of fire shutter or fire screen, across metal beams, through gratings, over any metal obstruction (such as a cable), or over sharp corners.

(3) Protect wires passing through floors and walls as shown in figure 88.

(4) Where wire (except ground wire) passes through the floor near wall or baseboard and may be exposed to mechanical injury, protect the wire with a pipe or conduit. (See fig. 89.)

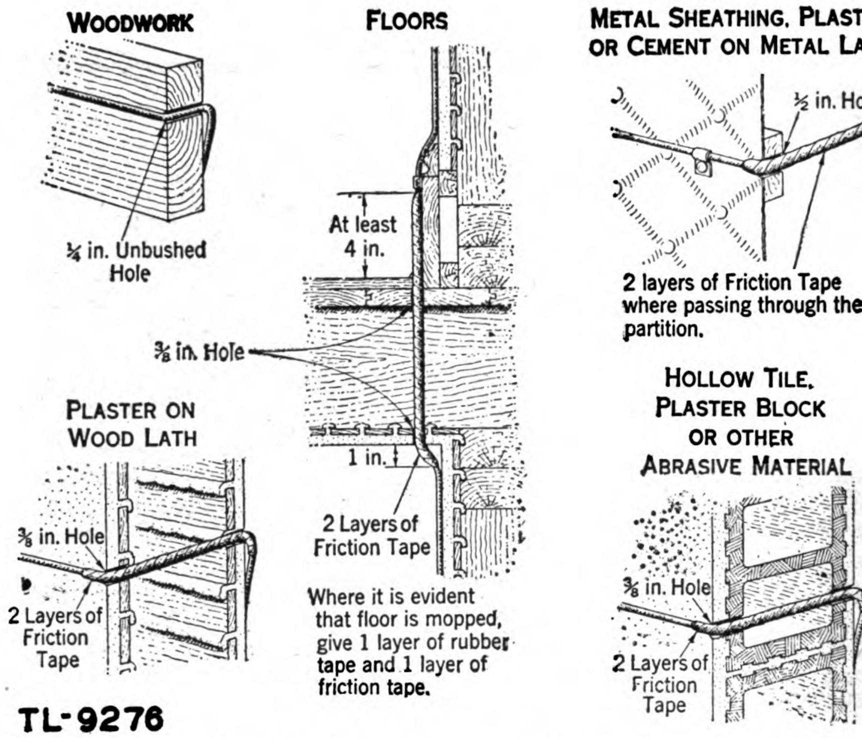


Figure 88. Protecting wires passing through woodwork, floors, and walls.

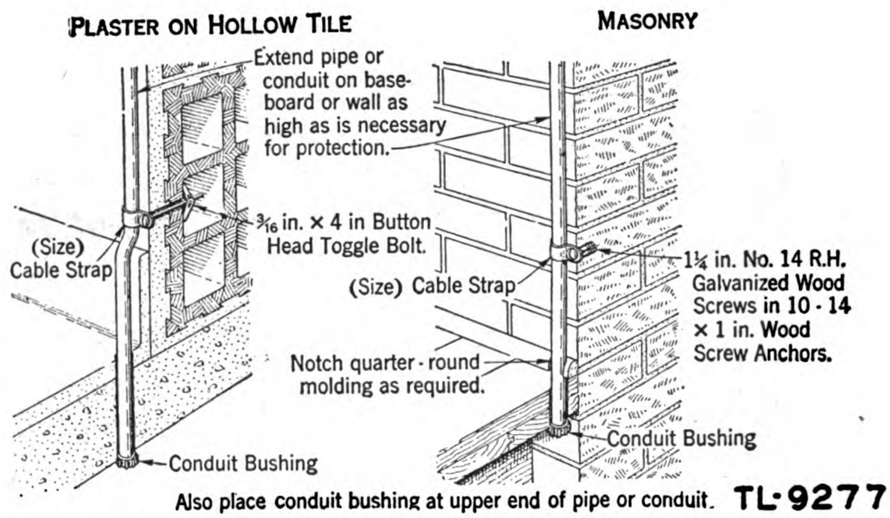


Figure 89. Protecting wires passing through floors and exposed to severe mechanical injury.

(5) Where interior wiring passes through the floor away from wall or baseboard, protect the wiring from mechanical injury with a floor outlet or standpipe.

(6) Taping or other protection is not necessary when wire parallels or crosses other telephone wires, electric light wires in wood moulding, or covered steam pipes. Protection is not necessary if wiring passes ½ inch or more above water pipes.

21. Passing Wire Through Floors and Walls

a. SIZE OF HOLES AND WIRE. The approximate size of holes required for passing wire through floors and walls is given in table XI.

Table XI. Size of holes required to pass wire through floors and walls

No. of runs	Size of hole (in.) for inside wire and duct wire		Size of hole (in.) for bridle wire	
	Pair	Triple	Pair	Triple
Untaped wire				
1	1/4	1/4	3/8	3/8
2	1/4	3/8	1/2	1/2
3	3/8	3/8	1/2	5/8
4	3/8	1/2	5/8	5/8
Taped wire*				
1	3/8	3/8	3/8	3/8
2	1/2	1/2	1/2	5/8
3	1/2	1/2	1/2	5/8
4	1/2	5/8	5/8	3/4

* Two layers of friction tape, or one layer of friction tape and one layer of rubber tape.

b. TEMPORARY PARTITIONS. Telephone wire or cable should not be installed on temporary partitions, unless other routes are impracticable or require considerable additional wiring.

22. Wiring Distributing Systems

a. GENERAL. In office buildings, apartments, hotels, factories, storerooms, and some private residences, various types of distributing systems are installed. See *b* through *g* below for descriptions of the more common types of distributing systems.

b. STEEL DUCT SYSTEM UNDER FLOOR. This system consists of a gridwork of steel ducts connected to distributing terminal cabinets. The ducts are laid in parallel branches with junction boxes at intersections of cross ducts. Floor outlets generally occur every 24 inches; each floor outlet has a cap that is removed when the outlet is used. (See fig. 90.)

c. FIBER DUCT SYSTEM UNDER FLOOR. This system consists of a gridwork of fiber ducts connected to distributing terminal cabinets by conduits or wall elbows. The ducts are laid in parallel branches with junction boxes at intersections of cross ducts. Floor inserts and standpipes for use as telephone outlets may be placed anywhere along the gridwork by penetrating the floor and duct. (See fig. 91.)

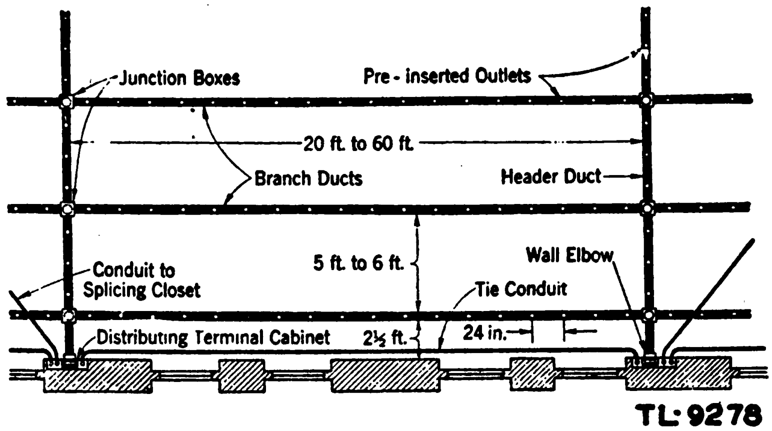


Figure 90. Steel duct system under floor.

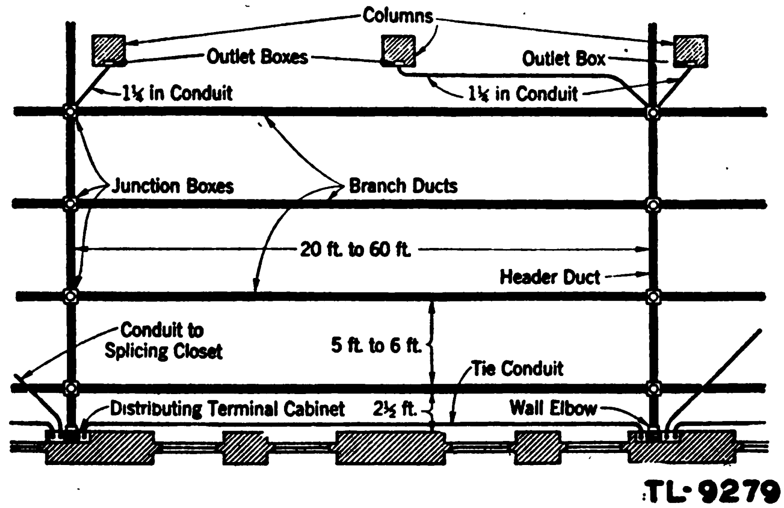


Figure 91. Fiber duct system under floor.

d. Conduit Running Under Floor from Distributing Terminal Cabinet. This system of distribution consists of a network of iron conduits extending from distributing terminal cabinet or supply closet, through the floors to outlets in the walls or columns of the building, or to outlets in the floor. (See fig. 92.)

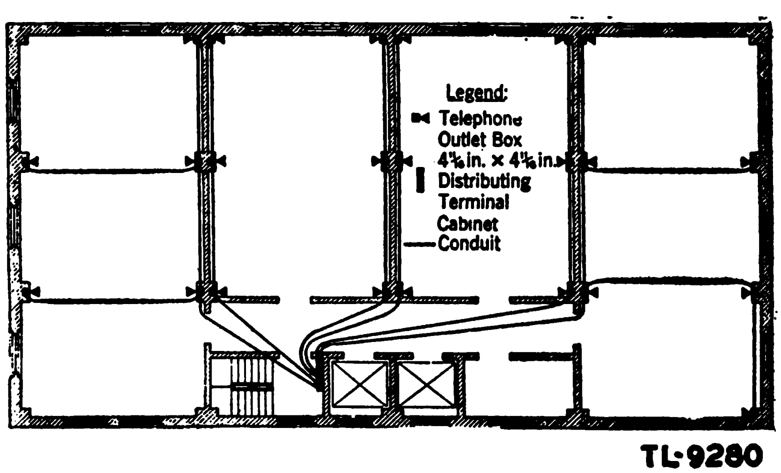


Figure 92. Conduit and ducts running under floor from distributing terminal cabinet.

e. METAL BASE RACEWAY. A metal base raceway takes the place of the usual baseboard. The front part of the raceway is removable, exposing two compartments: the upper one for branch electric light wires and the lower one for telephone wires. (See fig. 93.) The metal base raceway is used principally in small floor areas where it is probable that desks will be placed against the wall.

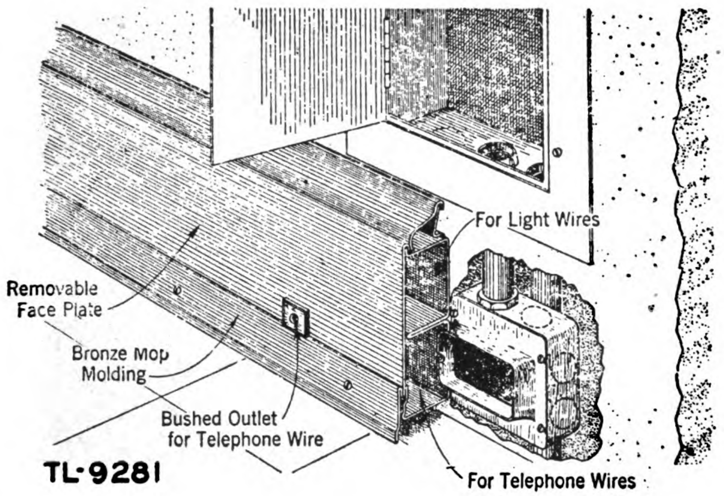


Figure 93. Metal base raceway.

f. WOOD BASE RACEWAY. This system of distribution consists of wood baseboards with space behind for telephone wires. The conduit from the floor terminal terminates in an outlet box behind the baseboard. (See fig. 94.) A brass plate covers the opening in the outlet box.

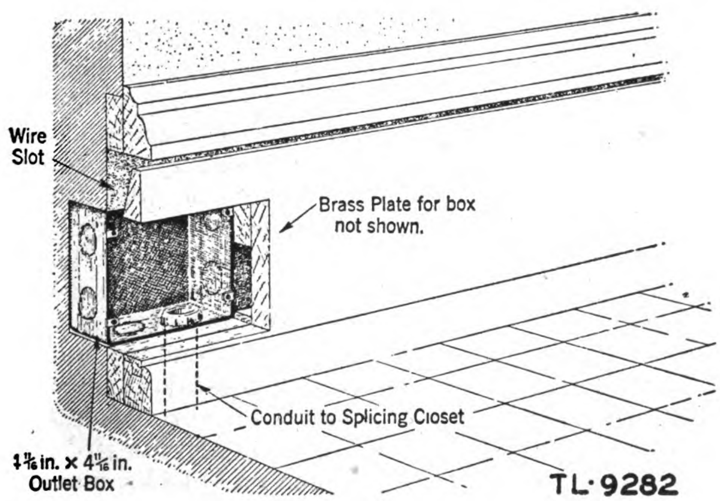


Figure 94. Wood base raceway.

g. Moulding Raceway. Moulding raceways are of various types. (See fig. 95.) Picture moulding is obtainable for use in small rooms; large metal or wood moulding is designed for use in assembly halls, etc. The conduit is placed through the walls between rooms or assembly halls and connects the moulding to distributing terminals.

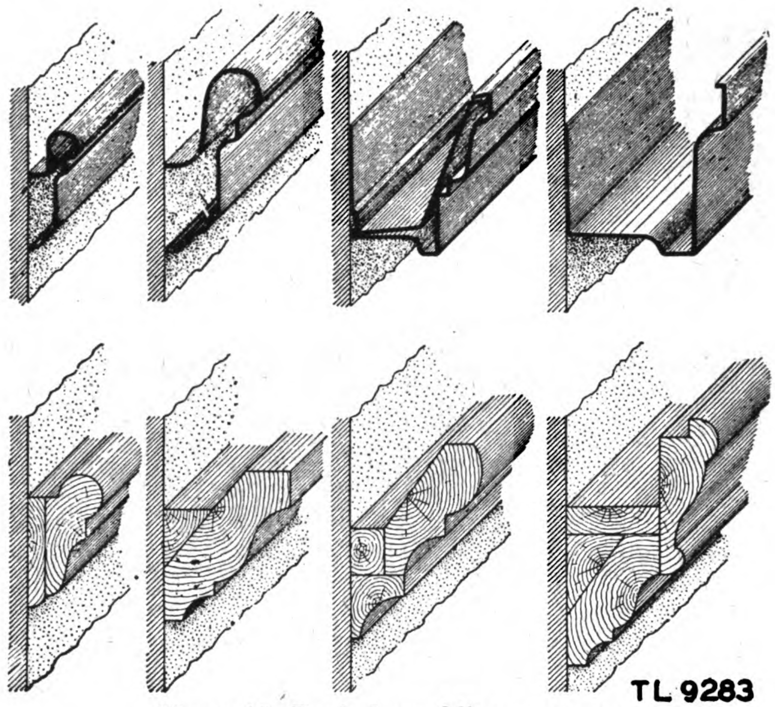


Figure 95. Typical moulding raceways.

23. Connecting Blocks

a. General. (1) No. 42 type connecting block has four terminals and is equipped with either an ivory or a brown cover.

(2) No. 44 type connecting block is a new 10-terminal block for terminating cords with more than four conductors. By using No. 44–A type connecting block, one, two, or three connecting blocks can be mounted under a single cover to provide 10, 20, or 30 terminals. No. 101 type covers, in ivory or brown, are provided separately for use with No. 44–A connecting blocks.

b. Locating Connecting Blocks. (1) To make connections between wires, cords, etc., use No. 42 or No. 44 type connecting blocks on desks, tables, baseboards, beams, window or door frames, or other permanent woodwork in rooms, cellars, or basements. If necessary, connecting blocks may be located on wall surfaces. A backboard must be installed, however, if the wall is damp, uneven, or does not present a surface suitable for mounting a connecting block.

(2) Many desks are constructed so that one or more connecting blocks can be mounted inside the desk pedestals. In such desks the telephone mounting cord can be brought out through a slot or hole in or near the desk top and within a few inches of the front of the desk. If special facilities for mounting connecting blocks inside a desk are not provided, mount the connecting block on the side of the desk near the top and within 6 or 8 inches of the front. If more than one No.

44–A type connecting block is required on a desk, mount the blocks on a backboard and mount the backboard on the desk, to avoid placing more than two holes in the desk.

(3) Do not place connecting blocks where installers or repairmen would be liable to injury in making tests or inspections at the connecting blocks. Place the blocks and associated wiring so that the equipment is not exposed to sources of damage.

c. INSTALLING CONNECTING BLOCKS. (1) In unexposed areas (not requiring a protector), line wires may be terminated on connecting blocks located near the point of entrance to a building.

(2) Wherever space permits, station wires should be wound once around the connecting block, a procedure which takes strain off wires at connecting block terminals and provides slack for reterminating a station wire in case the bare end breaks off. If necessary, install inside wiring cleats on station wires to take strain off wires at the connecting block.

(3) The following fasteners are recommended for No. 42 and No. 44 type connecting blocks:

Surface	*Fasteners*
Hardwood or backboard	¾-inch No. 8 round head, blued, wood screws
All other wood	1-inch No. 8 round head, blued, wood screws
Lath and plaster	2-inch No. 8 round head, blued, wood screws
Metal	⅝-inch No. 8 round head, self-tapping screws

24. Locating and Mounting Telephone Sets

a. GENERAL. (1) In locating a telephone set, the installer should be guided primarily by the wishes of the subscriber. The installer should try, however, to find a location that meets the following requirements:

(*a*) The telephone set should be located where the bell will be clearly heard by the subscriber.

(*b*) The telephone set should be installed in a dry location. The set should not be placed over or near a grounded metallic object, such as a radiator or sink, or near any electrical appliance. If it is impossible to obtain adequate separation from metallic objects or electrical appliances shorten the desk set or handset cord so that the subscriber cannot touch the metallic object or electrical appliance when he is using the telephone.

(*c*) Dial sets should be placed where there is sufficient light at all times.

(*d*) The telephone set should be located where it is accessible for inspection and repair, and where the inspector or repairman is not subject to injury from machinery, power wires, etc.

(*e*) The telephone set should not be placed where it is subject to excessive vibration.

(2) Types of sets to be used in various installations are indicated in table XII.

b. USE OF BACKBOARDS. (1) Use backboards when wall sets or bell boxes are to be mounted on masonry walls, solid metal walls, metal lathed walls, or metal sheath walls. Use backboards on rough, uneven, or damp mounting surfaces.

(2) Use wood backboards when mounting wall sets or bell boxes with bakelite cases on metal desks or cabinets. Use wood backboards, also, when mounting wall sets or bell boxes with metal cases on masonry walls, solid metal walls, metal lathed walls, or metal sheath walls. Do not use wood backboards to mount equipment on wooden baseboards if the wall is not metal sheathed.

(3) Use metal backboards when mounting wall sets or bell boxes on surfaces other than those mentioned in (2) above.

c. MOUNTING BACKBOARDS. (1) Fasten backboards securely to mounting surface.

(2) Use two fasteners to mount backboards on hardwood, solid metal (except metal baseboards), plaster on hollow tile, corrugated metal, and metal desks. Use three fasteners to mount backboard on sides of panel desks under table and in the knee-wells of desks. On all other surfaces mount backboards with four fasteners.

(3) Methods of fastening backboards to various surfaces are shown in figures 96 and 97.

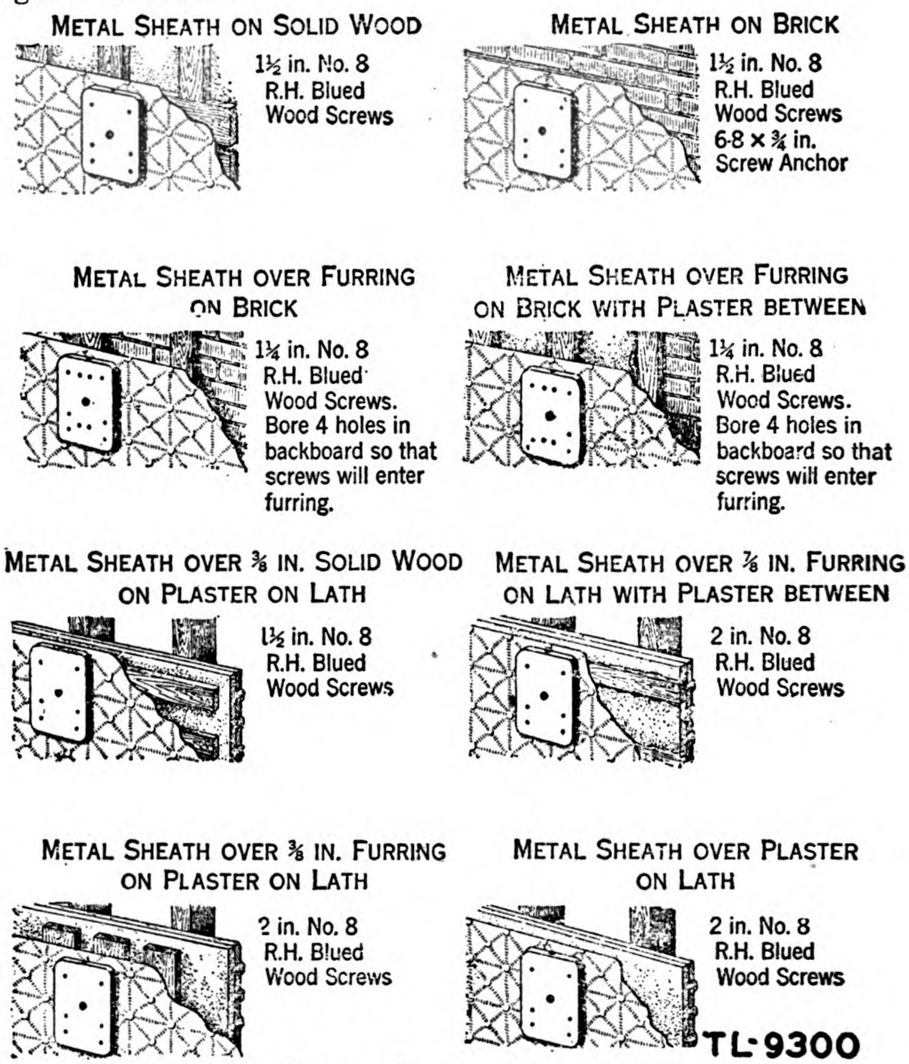


Figure 96. Backboards fastened to various surfaces.

Type of service	Subscriber set						Hand telephone set, manual		Desk stand, manual
	Wall set		Bell box						
	Main	Extension	Main	Extension with ringer	Extension without ringer	Extension ringer	Desk type	Hanging type	
Sidetone: Individual lines or regular switchboard stations.	W. E. 1553A	W. E. 1553A	W. E. 584-A-3	W. E. 584-A-3	W. E. 584-C-3	W. E. 584DF-3	W. E. 102A-3	W. E. 211A-3	W. E. 51AL
Antisidetone: Individual lines or regular switchboard stations.	Kellog 9917	Kellog 9917	W. E. 684A-3	W. E. 684A-3	W. E. 684C-3	W. E. 584DF-3	W. E. 302AW-3	W. E. 211A-3	W. E. 151AL
Two or more telephones connected to the same subscriber set.	—	—	—	—	—	—	W. E. 215A-3	W. E. 211A-3	W. E. 151R
Local-battery-talking, common battery-signaling (sidetone): Individual lines or regular switchboard stations.	W. E. 1553Y	W. E. 1553Y	W. E. 534Y	W. E. 534Y	W. E. 534Y	W. E. 584DF-3	W. E. 102A-3	W. E. 211A-3	W. E. 51AL
Local-battery-talking, common battery-signaling (antisidetone): Individual lines or regular switchboard.	W. E. 653YD	W. E. 653YD	W. E. 634YD	W. E. 634YD	W. E. 634YD	W. E. 584DF-3	W. E. 302AW-3	W. E. 211E-3	W. E. 51AL

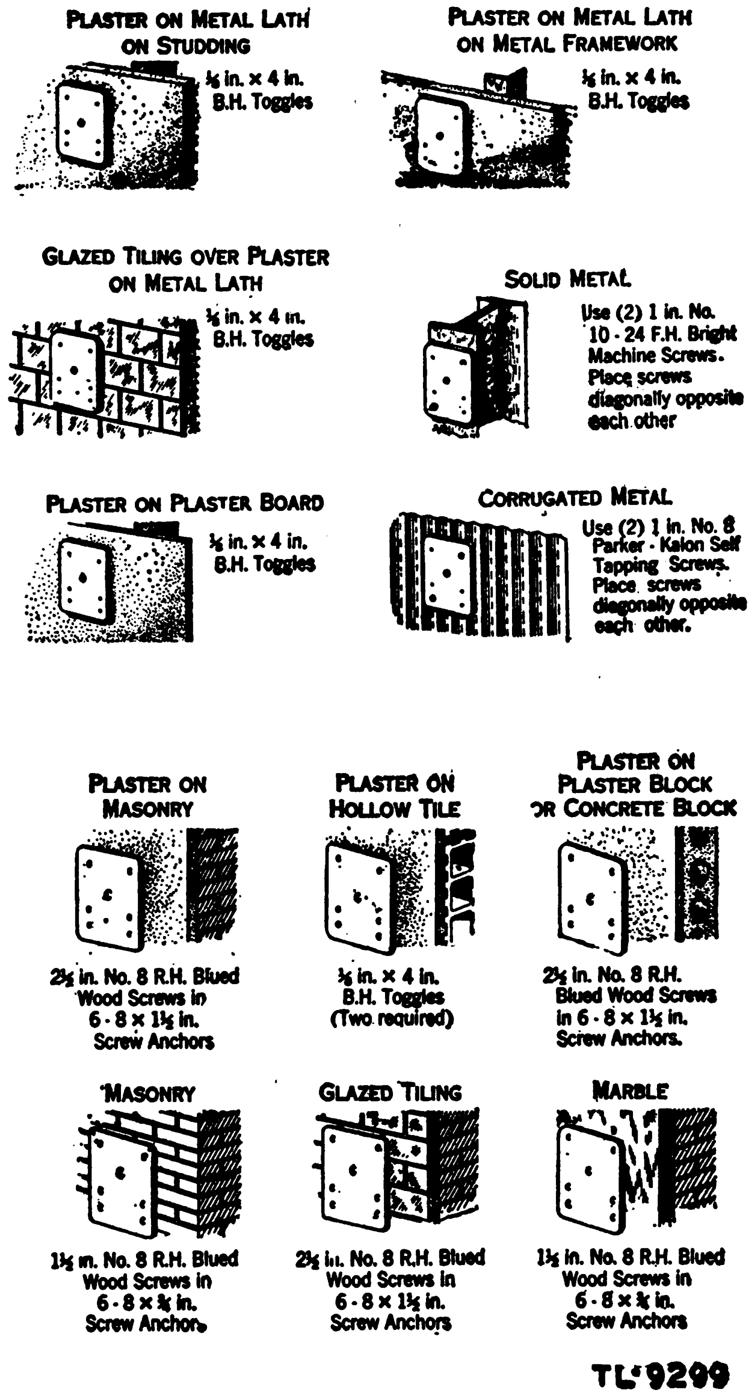


Figure 97. Backboards fastened to various surfaces.

d. LOCATING AND MOUNTING WALL SETS. Except in special cases, mount wall sets with the center of the transmitter 56½ inches from the floor. Mount wall sets on appropriate backboards, *b* and *c* above. Fasten a wall set to a wood backboard with three 1-inch No. 10 round head, blued, wood screws; fasten a wall set to a metal backboard with three 12–24 x 9/16-inch round head, iron, machine screws.

e. LOCATING AND MOUNTING HANGING TYPE DESK SETS. Locate hanging type desk sets in accordance with paragraph 24*a*. Mount a hanging type desk set as shown in figure 98.

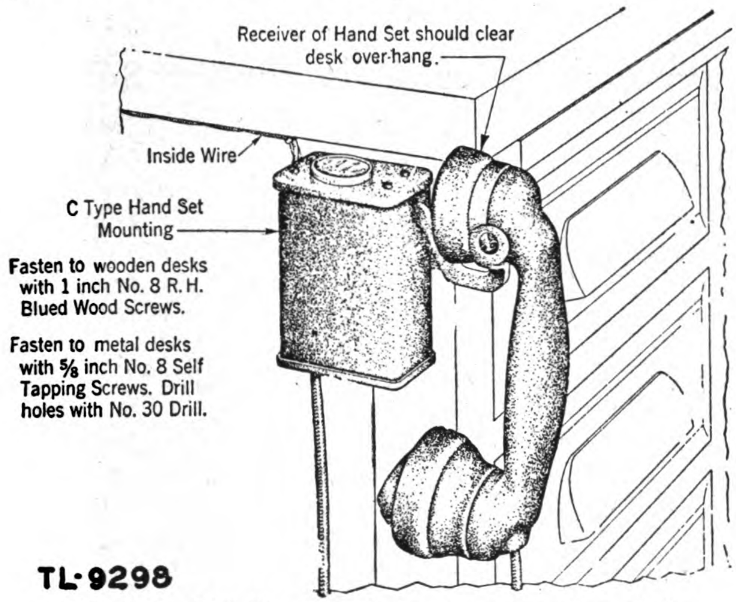


Figure 98. Hanging type desk set mounted on desk.

f. LOCATING AND MOUNTING BELL BOXES FOR DESK SETS. (1) When the telephone set is to be placed on a desk or table, locate the bell box on the wall at a point where the box will be least liable to damage.

(2) If the distance between the desk or table and the wall exceeds 8 inches, mount the bell box directly on the desk or table.

(3) Locate bell boxes on desks as shown in figure 99. Location 1 (fig. 99) is preferable for bell boxes with bakelite covers; location 2 (fig. 99) is preferable for bell boxes with metal covers.

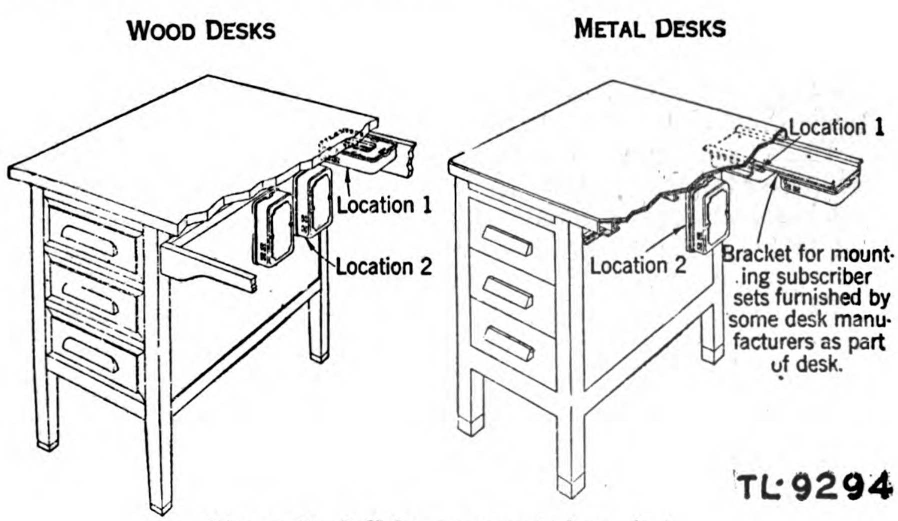


Figure 99. Bell boxes mounted on desk.

(4) Place bell boxes on the left when mounting bell boxes underneath tables.

(5) If the bell box is mounted so that the bells are above one another,

ringing efficiency is decreased. Whenever possible, mount the bell box so that the gongs are down.

(6) Fasten the bell box on the backboard and mount the backboard, *c* above.

25. Fastening and Terminating Wires at Subscriber Sets

a. FASTENING WIRE. No fasteners in or at the subscriber set are required if no strain is placed on the conductors at the set terminals or if the wire is concealed at the subscriber set (when the set is mounted in a bell box or when the wire is run through a partition directly to the set). If the conductors are subject to strain, place a cleat on the surface inside the set or on the backboard behind the set. If wire is not concealed at the subscriber set, place a fastener within 2 inches of the set.

b. TERMINATING WIRE. (1) Pull wire tight and cut off each conductor 3 inches beyond the far end of its associated terminal, allowing 2 inches of slack in the wire inside the set, and 1 inch for connecting conductors to associated terminals. Skin the insulation off the end of each conductor and place the bared end three-quarters of the way around the screw, in the direction that the screw tightens. Insulation should be 1/8 inch from the edge of the screwhead.

(2) When terminating cords in subscriber sets which are equipped with screw fasteners, fasten the stay hook on the cord to the screw eye or eyelet. (See fig. 100.)

(3) When terminating cords are provided with tie-strings, tie the tie-string to the screw eye provided in the telephone set. If a small eyelet is provided in the telephone set for use with cords with stay hooks, pass the tie-string once through the eyelet and tie the tie-string to the end of the cord with several cable-form stitches.

(4) When terminating cords with tie-strings in metal subscriber sets without screw eyes or eyelets for securing cords, tie the tie-string around the terminal screw and to the end of the cord with several cable-form stitches placed close together.

(5) In case it is difficult to fasten cords with any of the methods described above, fasten the cord in the subscriber set so that—

(*a*) Possible interference with the ringers, etc., will be avoided.

(*b*) There is no strain on the free conductors.

(*c*) The stay hook or stay hook collar cannot short-circuit terminals in the subscriber set, or cause a cross between a terminal and the metal case of the set either directly or through some other metal part in the set.

(6) Figure 100 shows typical examples of a cord terminated in a subscriber set.

26. Testing

a. GENERAL. To make sure that the substation is in good working order upon the completion of an installation, the installer should perform ringing, transmission, and noise tests with the wire chief or switchboard operator.

b. TRANSMISSION TESTS. (1) When testing wall sets, adjust the transmitter so that it is tilted up as far as possible. With desk sets make the test with the handle in a vertical position.

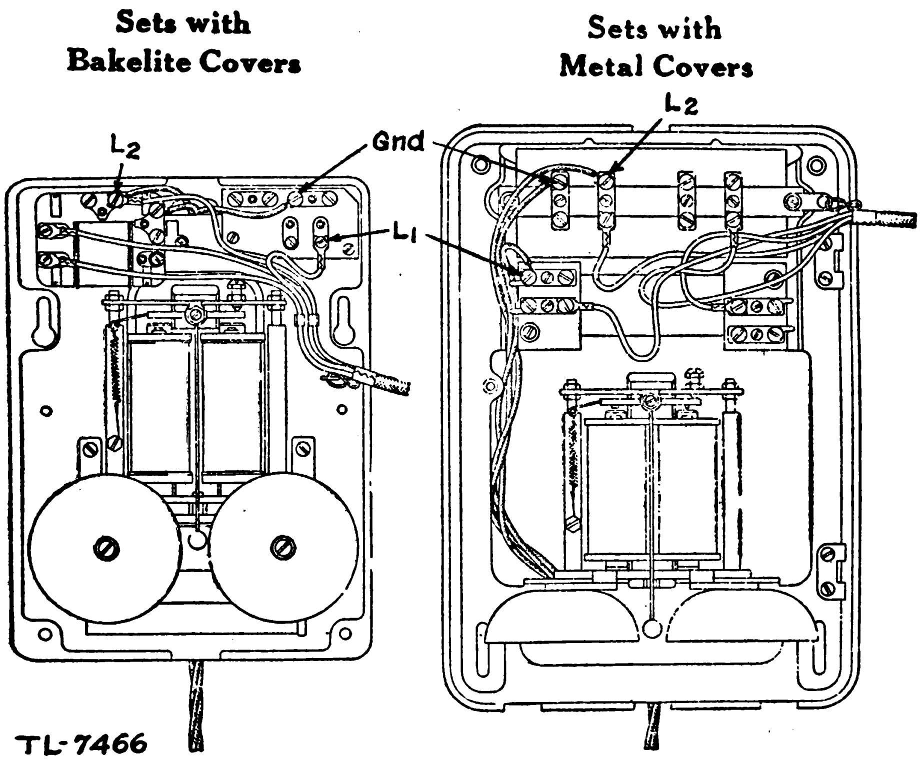


Figure 100. Cord terminated in a subscriber set.

(2) Talk directly into the transmitter in a natural conversational tone. Do not talk across or around the transmitter. The lips should be almost touching the mouthpiece.

(3) During the conversation with the wire chief or switchboard operator, note any difficulties in hearing or in being heard. If trouble is present, find and correct the cause.

c. Noise tests. (1) Listen for a scraping noise when the cords and transmitter are at rest.

(2) Test the cords for scraping noise by shaking them, particularly where the cords enter the apparatus. A scraping noise which changes in volume when a cord is shaken indicates a defective cord which should be replaced.

(3) Blow gently into the transmitter to test for scraping noise. A scraping noise which changes in volume indicates a defective transmitter which should be replaced.

SECTION V

STATION WIRING PLANS

27. Description and Use

A station wiring plan consists of one or more telephone stations with associated keys, which place convenient operating features at the disposal of the using personnel. The specific apparatus to be provided at any station depends on the operating features desired by the subscriber and the conditions under which he wishes to use the apparatus. The principal use for station wiring plans is on individual lines in common battery central office districts and on common battery switchboard extensions.

28. Limitations

a. At local-battery-talking, common-battery-signaling switchboard extensions, loop resistance considerations and other factors may restrict the use of certain plans having the holding feature.

b. In general, wiring plan stations should be arranged so that not more than five stations can be connected to one central office or switchboard line. Limiting the number of stations to five reduces the possibility of interference and of poor transmission caused by the use of the line by several stations at the same time (for listening-in or conference purposes). If no more than two stations are to be used at the same time on one line, the limit of five stations may be exceeded.

c. No more than four ringing bridges may be connected to a central office switchboard line. At least one ringer or equivalent signal must be connected to each line at all times.

29. Definitions

a. PICKUP. A key-operating feature by which the subscriber transfers his talking set to any one of two or more lines available for his use. The ringing signal for a specific line remains permanently connected to the line during key operation, unless the plan includes a ringer cut-off or transfer arrangement.

b. INTERCOMMUNICATION (USUALLY ABBREVIATED "INTERCOM."). A feature permitting conversations between wiring plan stations without utilizing any of the central office or switchboard lines associated with the plan.

c. KEY CUT-OFF. A feature permitting the user of a master station to connect or disconnect any controlled stations that may be connected to the same line.

30. Station Designation

a. MASTER STATION. Master stations are the principal stations in the station wiring plan. All plans must have at least one master station; some plans may have more than one. A master station with a bell is designated as *M*, and a master station without a bell, as *MX*.

b. CONTROLLED STATIONS. Controlled stations do not have all the operating features provided at a master station and are often dependent upon a master station for some of their functions. A controlled station with a bell is designated as *C*, and a controlled station without a bell, as *CX*.

c. Line Stations. Line stations are permanently connected to a line and are independent of all key operation. A line station with a bell is designated as *L*, and a line station without a bell, as *LX*.

d. Intercommunicating Stations. Intercommunicating stations, designated as *CR*, are stations that have access only to an intercommunicating line.

31. Specific Station Wiring Plans

a. Pickup Plans. The *M* or *MX* stations of the plans illustrated in figures 101, 102, 103, and 104 have a key which permits the stations to pick up any one of the incoming lines.

b. Key Cut-off Plans. Plan 100 is a 1-line plan in which *M* station has a key permitting it to cut off one or more *C* or *CX* stations. If an *L* station is provided and its bell is within hearing of *M* station, the bell at *M* station may be omitted. (See fig. 105.)

32. Keys

a. Switchbox BE–54–A is a contact key designed to connect a telephone to either of two lines. Switchbox BE–54–A can be used with wiring plans 100, 203, 204, 205, and 206. The cam lever on the key is connected to and operates the contact springs inside the key. (See fig. 106.) The cam lever has two positions, normal (vertical) and off normal, and will lock in either position.

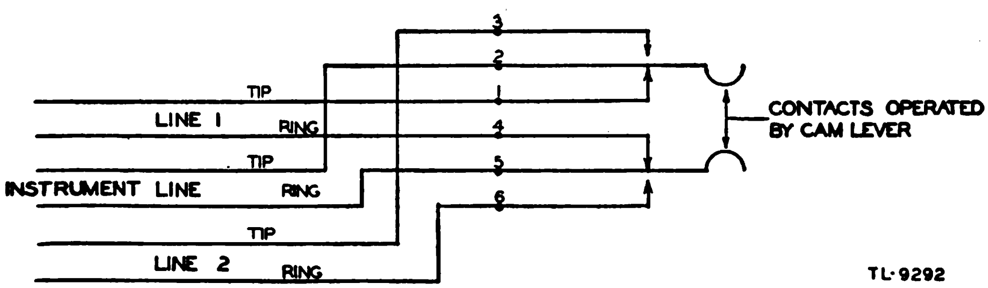


Figure 106. Wiring of Switchbox BE–54–A (2-line).

b. Western Electric Key No. 6021 is a 5-button contact key designed to connect a telephone to any one of five lines. W. E. Key No. 6021 may be used with wiring plans 100, 203, 204, 205, and 206. W. E. Key No. 6021 operates on the same principle as Key BE–54–A, except that instead of a cam lever, a push button (which is self-locking in the down position) operates the contacts.

c. Western Electric Key No. 6021–E is of the same general construction as W. E. Key No. 6021. However, W. E. Key No. 6021–E has six buttons, three of which are nonlocking and activate a relay for holding purposes.

d. Western Electric Key No. 6023–A is similar in construction to W. E. Key No. 6021, except that it has eight buttons. Four of the eight buttons are black, locking keys used to connect a telephone to any one of four lines; the other four buttons are red, nonlocking buttons used for activating relays for holding purposes.

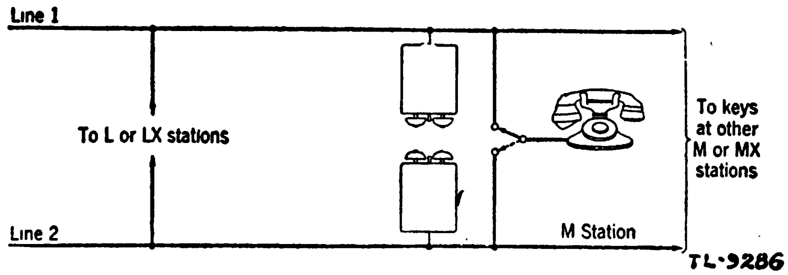


Figure 101. Wiring plan 203.

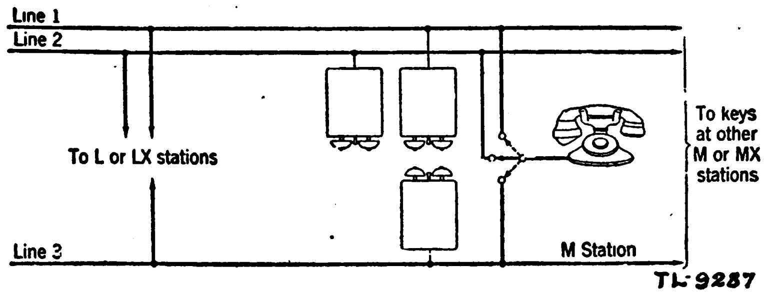


Figure 102. Wiring plan 204.

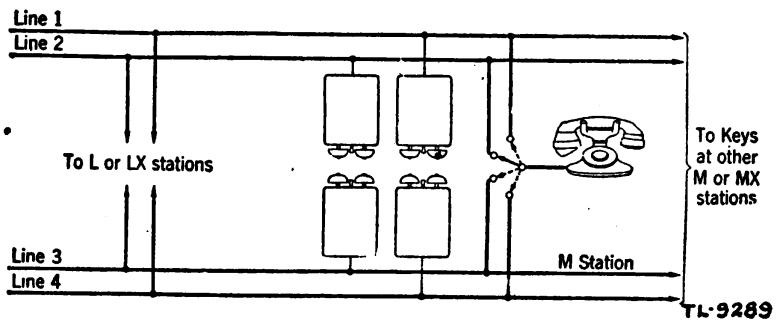


Figure 103. Wiring plan 205.

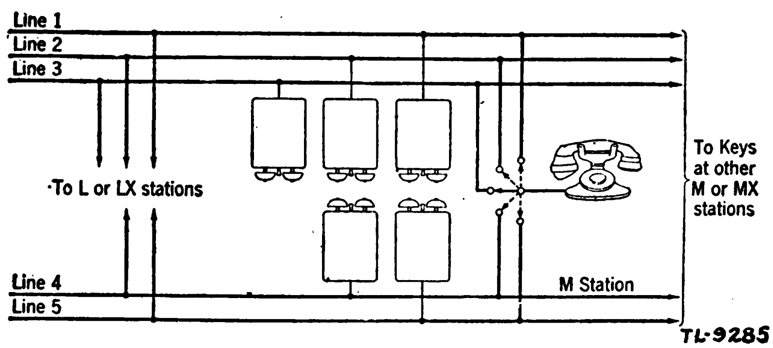


Figure 104. Wiring plan 206.

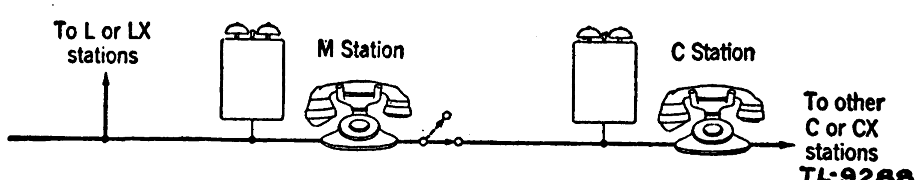


Figure 105. Wiring plan 100.

SECTION VI

SPECIAL EQUIPMENT

33. Explosion-proof Telephone

a. DESCRIPTION. (1) Many types of explosion-proof telephones are available, but all types have approximately the same characteristics.

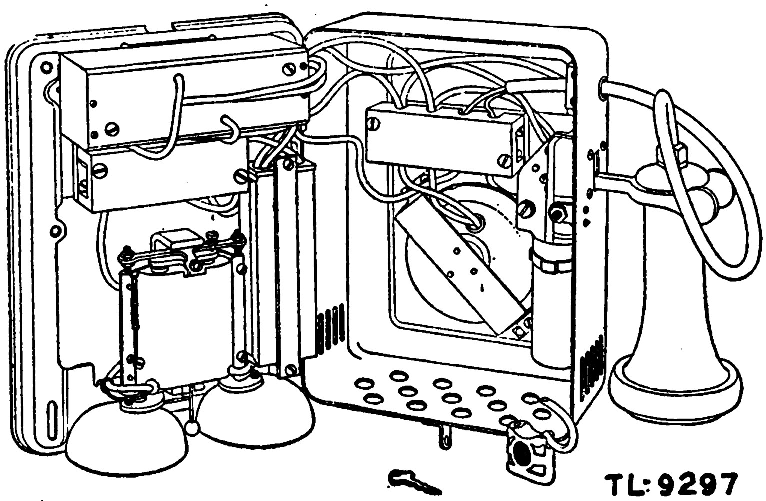


Figure 107. Explosion-proof telephone.

(2) The explosion-proof telephone shown in figure 107 consists of a metal chamber which incloses the hook switch assembly and which is sealed with lead to prevent an explosion caused by sparks from the hook switch. The induction coil is sealed in a wooden case, and the ringer coils are shielded with metal to protect the winding against injuries which might become a source of spark. The terminal blocks are equipped with wooden covers to guard against accidental crosses. The cord and wiring of the telephone set are provided with closed cord tips to minimize the possibility of loose connections; as a further precaution, lockwashers secure the cord and wiring. A lock is provided to prevent an unauthorized person from opening the telephone set.

b. INSTALLATION. The explosion-proof telephone is installed in the same manner as other types of subsets for indoor use. The following precautions should be observed:

(1) If possible, install the telephone set when the location is free of explosive material. Choose a location where there is sufficient ventilation to prevent an explosion resulting from an accidental spark.

(2) Do not use any electrically operated testing equipment when making installations or testing in an explosive atmosphere.

(3) Complete all connections in the explosion-proof telephone and lock the set before making connections at the protectors or cable terminal.

(4) All station wire used in explosive atmospheres must be rubber-covered and weatherproof.

(5) Locate all associated equipment, such as loud-ringing bells, protectors, keys, etc., outside the explosive area.

34. Outdoor Telephones

a. DESCRIPTION. Outdoor telephones are wall sets inclosed in a heavy metal case equipped with a waterproof locking door to protect the telephone from rough usage and the effects of weather. (See fig. 108.)

b. INSTALLATION. Outdoor telephone sets are installed in the same manner as wall sets. (See par. 24*a*.)

c. USE. Outdoor sets may be used as military police call boxes or fire alarm call boxes, on rifle ranges, or in any place where the telephone set is exposed to weather or rough usage.

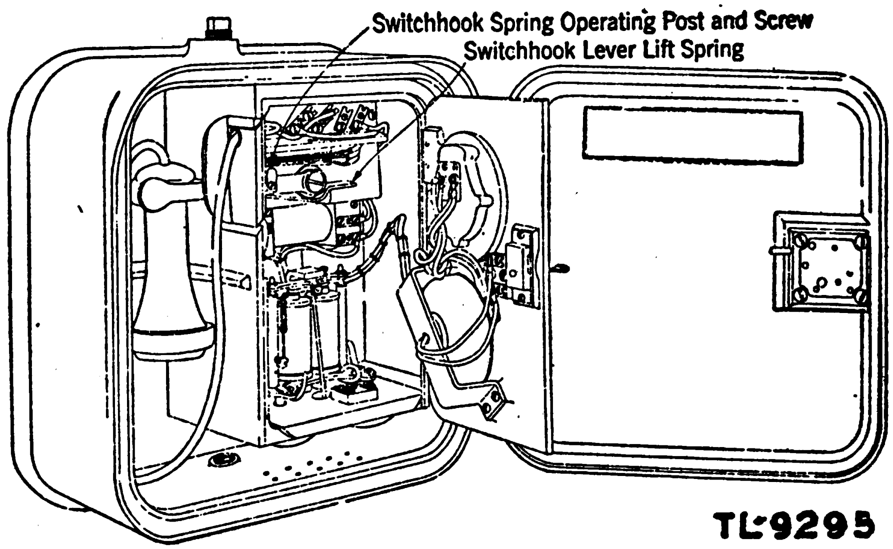


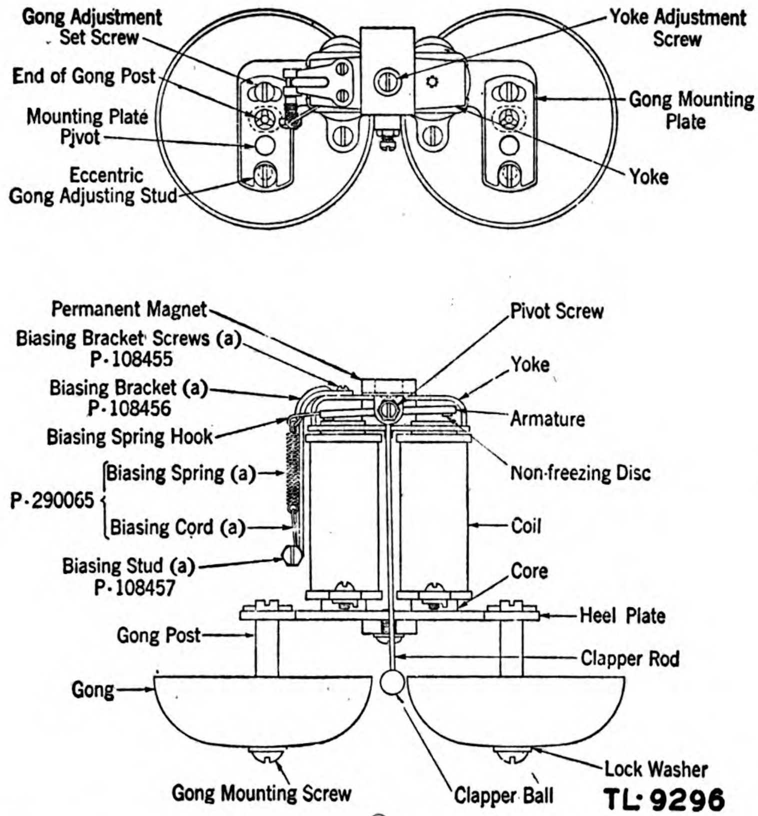
Figure 108. Outdoor set.

35. Loud-ringing Bells

a. GENERAL. Loud-ringing bells are special telephone ringers installed in warehouses, factories, storerooms, etc., where the ordinary telephone ringer might not be heard above the normal noise level.

b. DESCRIPTION. Various types of loud-ringing bells may be used in specific situations. Some loud-ringing bells operate on normal ringing current; others, through a system of relays, operate on alternating current at 110 volts. The type of installation determines the type of bell to be used. A typical loud-ringing bell is shown in figure 109.

c. INSTALLATION. Locate a loud-ringing bell where it is most likely to be heard by the personnel for whom it is intended. In most cases, connection to the telephone consists of bridging across the ringer in the subset.



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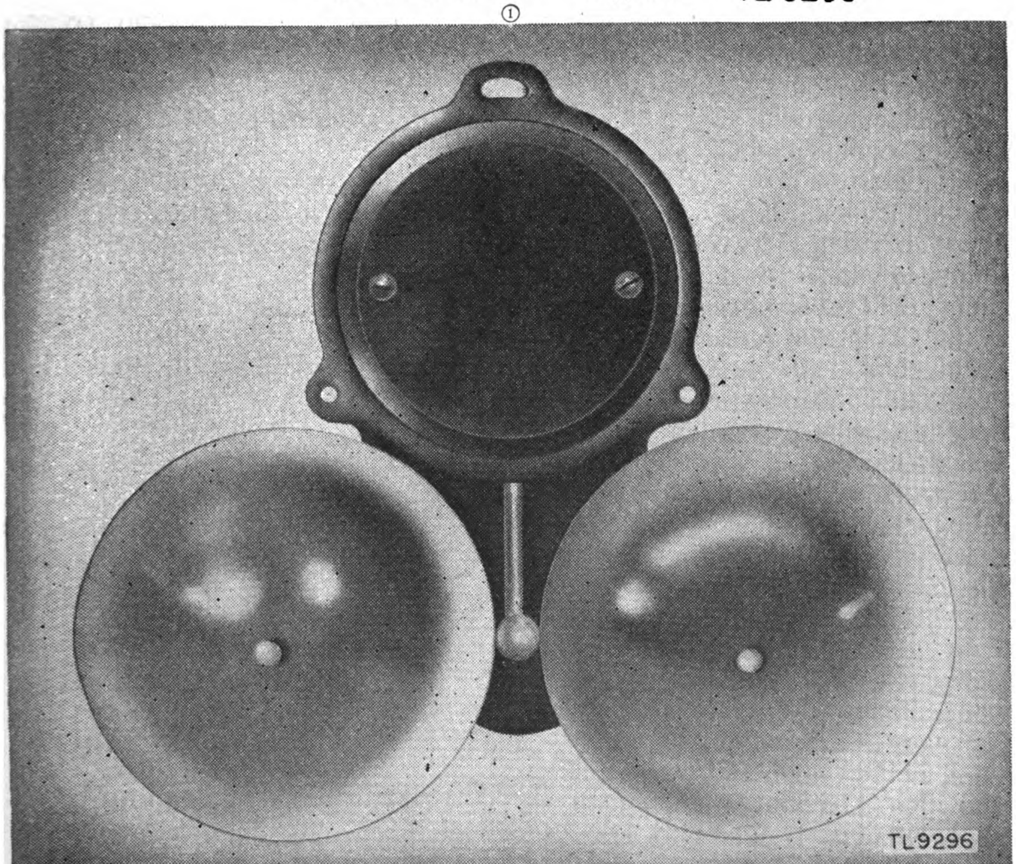

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Figure 109. Loud-ringing bell.

SECTION VII

SUPPLEMENTARY DATA

36. Tools

The following tools are used in substation installation:

Name and description	*Signal Corps Stock No.*
Belt, body, lineman's	604523A
Blade, for braid stripper	6R41701-1
Blade, hack saw	6Q8010–24
Brace, ratchet, loin sweep	6Q13010
Chisel, wood, $\frac{3}{4}$-inch	6Q21112
Climbers, lineman's	6Q28315
Drill, automatic	6R19100
Drill, installer's, $\frac{3}{8}$ x 24-inch	6Q5906–24
Drill, masonry (short), $\frac{1}{4}$-inch	6Q34904–4
Drill, masonry (short), 5/16-inch	6Q34905–4-14
Drill, stone, star point, diamond, $\frac{5}{8}$ x 12-inch	6Q35210–12
File, round, half, 3-inch	6Q38120–3
File, flat, smooth, 8-inch	6Q38034–8
Flashlight, angle	6Z4002.1
Frame, hack saw	6Q41000
Gloves, rubber, lineman's	6Z4829–10
Hammer, drilling	6Q49001
Hammer, riveting, 7-ounce	6Q50007
Hand line, aerial	6Z7904A
Holder, drill, Type C	6Q52019
Knife, lineman's	6Q60229–1
Pad, climber's, plain	6R2244
Pliers, cutting, side, 6-inch	6R4513
Pliers, longnose	6R4626
Point, drill, automatic, 5/64-inch	6Q34900/2
Point, drill, automatic, 3/32-inch	6Q34900/3
Point, drill, automatic, $\frac{1}{8}$-inch	6Q34900/5
Point, drill, automatic, 11/64-inch	6Q34900/8
Rule, measuring, Stanley, 6-foot	6R9623
Saw, keyhole	6R10412–8
Screw driver, cabinet, 3$\frac{1}{2}$-inch	6R15410
Screw driver, cabinet, 6$\frac{1}{2}$-inch	6R16250
Screw driver, 4-inch	6R15680
Screw driver, 5-inch	6R15811
Screw driver, 8-inch	6R16420
Strap, climber's, 22-inch	6R31045.1
Strap, climber's, 26-inch	6R31045.2
Strap, lineman's, safety	6R32500
Stripper, braid	6R41701
Tool, No. 63 open end wrench	6R40863
Tool, No. 110 double end socket	6R40910
Tool, No. 129–B open end wrench	6R40929–B
Tool, No. 216–B double end socket wrench and screw driver	6R41016

Name and description	*Signal Corps Stock No.*
Tool, No. 265–B contact burnisher	6R41065B
Tool, crimping (Nicopress 17–2)	6R38500
Twister, sleeve LC–24	6Q27024

37. Materials

The following materials are used in substation installation:

Anchor, hammer drive, ¼ x 1-inch	6Z284–4
Anchor, machine bolt, 6-inch	6Z308–6
Anchor, wood-screw, ⅛ x 1-inch (No. 5 to No. 8 screw)	6Z322–3
Anchor, wood-screw, 3/16 x 1⅝-inch (No. 9 to No. 12 screw)	6Z323–4
Anchor, wood-screw, ¼ x 1½-inch (No. 14 to No. 16 screw)	6Z324–6
Block, 42–A, connecting	4B202
Block, 26–A, protector	4E926
Block, 27–A, protector	4E927
Block, 30, protector	4E930
Bolt, toggle, ⅛-inch	5B1708–5
Bolt, toggle, 3/16-inch	5B1703–5
Bolt, toggle, ¼-inch	5B1704–4
Bolt, toggle, 5/16-inch	5B1705–5
Bracket, corner "L"	5B2372.1
Bracket, corner "S"	5B2372
Bracket, house	5B2365
Clamp, drop wire Type "P"	5B3084
Clamp, ground	5B3349
Clamp, ground, station	6Z1906
Clamp, span, Hubbard 8917	5B3520
Cleat, fiber, inside wiring No. 2	3G202.1
Connector, bridging, 1A	3Z1401
Connector, bridging 3A	3Z14.3
Fuse, Cook, A–7	3Z2427
Fuse, 7–A	3Z2107A
Fuse, 7–T	3Z2107T
Fuse, 11–C	3Z111C
Hook, drive, Hubbard 1316	5B5081
Hook, guardarm, Hubbard 9245	5B4725
Knob, "C", IN–74	3G574
Knob, "S", IN–75	3G575
Knob, "T", IN–77	3G577
Nail, inside wiring, ½-inch	6L32009
Nail, inside wiring, ⅞-inch	6L32010
Nail, roofing, 1-inch, No. 12	6L2001
Nail, slating, 6d	6L1406
Nail, staple, insulated	6L31006
Protector, Cook B–7	5C2200
Protector, "O"	5C2209
Ring, bridle, "A", 1⅝-inch eye, wood-screw thread	5B9326
Ring, bridle, "C", 1¼-inch eye, wood-screw thread	5B9320
Ring, bridle, "E", 1¼-inch eye, toggle	5B9310

Name and description	Signal Corps Stock No.
Ring, bridle, "M", machine screw thread	5B9320.1
Ring, drive, ½-inch, National	5B9508
Rod, ground	3Z3329
Screw, angle, 5/16-inch	5B9789
Screw, angle, ⅜-inch	5B9789
Screw, lag, ¼ x 2½-inch	5B10004–2.5
Screw, machine, 10-inch—24 x 1 inch long	6L7032–6.13
Screw, wood, R. H., ¾-inch, No. 6, blued	6L9706–6
Screw, wood, R. H., 1-inch, No. 6, blued	6L9706–8
Screw, wood, R. H., 1¼-inch, No. 6, blued	6L9706–10
Screw, wood, R. H., 1½-inch, No. 6, blued	6L9706–12
Screw, wood, R. H., 2-inch, No. 6, blued	6L9706–16
Screw, wood, R. H., 2½-inch, No. 6, blued	6L9706–20
Screw, wood, R. H., ½-inch, No. 8, blued	6L9708–4
Screw, wood, R. H., ¾-inch, No. 8, blued	6L9708–6
Screw, wood, R. H., 1-inch, No. 8, blued	6L9708–8
Screw, wood, R. H., 1¼-inch, No. 8, blued	6L9708–10
Screw, wood, R. H., 1½-inch, No. 8, blued	6L9708–12
Screw, wood, R. H., 2-inch, No. 8, blued	6L9708–20
Screw, wood, galv. R. H., No. 10, 2½-inch	6L9710–209
Screw, wood, galv. R. H., No. 10, 3-inch	6L9710–249
Screw, wood, galv. R. H., No. 14, 1-inch	5B14014–8
Screw, wood, galv. R. H., No. 14, 1¼-inch	6L9114–129
Screw, wood, galv. R. H., No. 14, 1½-inch	5B14014–12
Screw, wood, galv. R. H., No. 14, 2-inch	5B14014–16
Screw, wood, galv. R. H., No. 14, 2½-inch	6L9114–209
Screw, wood, galv. R. H., No. 14, 3-inch	6L9114–249
Screw, wood, galv. F. H., No. 18, 2½-inch	6L9018–209
Screw, wood, galv. F. H., No. 18, 3-inch	6L9018–249
Solder, rosin core	6N7531
Tape, friction, black, ¾-inch	6N8583
Tape, rubber, black, ¾-inch	6N8594
Telephone, desk type, W. E. 302AW–3 (antisidetone)	4B5490
Telephone, wall, W. E. 1553–A (sidetone)	4B6633
Telephone, wall, Kellog 9917 (antisidetone)	4B6303BA.1
Thread, linen, waxed	6Z8813
Tube, porcelain, ⅜-inch	3G2002–4
Tube, porcelain, ¾-inch	3G2005–8.
Tube, porcelain, 1-inch	3G2006–6
Washer, round, 7/16 x 1-inch	5B20080
Washer, round, 9/16 x 1⅜-inch	5B20190
Wire, W–33, 19-gauge B.&S., twisted pair	1B33
Wire, W–38, 17-gauge B.&S., twisted pair	1B38
Wire, W–50, 14-gauge B.&S., twisted pair	1B50
Wire, W–69–A, 22-gauge B.&S., twisted pair	1B69A
Wire, W–108, 17-gauge B.&S., parallel, drop	1B108
Wire, W–108–A, 18-gauge B.&S., parallel, drop	1B108A
Wire, W–117, 22-gauge B.&S., twisted pair	1B117
Wire, W–118, 22-gauge B.&S., 3-conductor	1B118
Wire, W–119, 12-gauge B.&S., ground, 1-conductor	1B119
Wire, ground, 14-gauge B.&S., 1-conductor	1B142

APPENDIX

REVIEW QUESTIONS

The questions included in this appendix are for review purposes and are listed under the headings of the sections to which they pertain.

Section I. GENERAL

1. Name three types of drop wire.
2. Give four general uses of drop wire.
3. What type of wire is used in completing the run from the protector to the instrument?
4. How is the tracer designated in this wire?
5. What is the difference between Wire W–38 and Wire W–50?
6. Which is the heavier gauge of the two types of twisted-pair drop wires?
7. How many protectors can be grounded to a water pipe when No. 14 B.&S. gauge ground wire is used for running the ground?
8. What other gauge wire is commonly used for grounding purposes?
9. What should be done if a kink develops in a drop wire and is pulled tight?
10. Is a span of parallel wire required to have any twists in it?
11. Give three general rules to follow in splicing drop wire.
12. What tool is used to remove braid from Wire W–108?
13. How much braid is removed?
14. By approximately how many inches are the splices staggered?
15. How many half turns are taken in the sleeves?
16. How many turns are taken in the buttons at the ends of the sleeves?
17. Why is it necessary to exercise care in measuring lengths, etc., when splicing drop wire?
18. What tool is used to twist up the sleeves?

Section II. OUTSIDE INSTALLATION

19. Of what two parts does the drop wire clamp consist?
20. To which part is the copper loop attached?
21. For what is the drop wire clip used?
22. What is the maximum pull allowable on a clip?
23. If this maximum pull is exceeded, what should be done?
24. What piece of hardware is usually used to support a clamp or a clip?
25. Are any tools necessary to install a clamp?
26. Is the "S" knob a single or a double-groove knob?
27. Is it permissible to mount two "T" knobs on one house bracket in a heavy loading area?
28. How many wood screws are required to mount a house bracket on a wood surface?
29. How many wood screws are required to mount a corner bracket?
30. How many toggle bolts are required to mount a house bracket on a hollow tile wall?

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31. Is a masonry hook mounted in the brick itself or in the mortar between the bricks?

32. Are drive hooks installed in a straight vertical line on the same side of a pole? If not, why not?

33. What is the vertical clearance required between drive hooks?

34. What is the distance left from the end of a drive hook to the pole?

35. Name four methods of locating studding in buildings.

36. What is the approximate length of the tie wire necessary to tie in parallel wire on a straight run tie?

37. Where is the straight run tie started?

38. How many turns are taken on each side of the knob when making the straight run tie?

39. How is the straight run ended?

40. Is the corner tie made in the same manner as a straight run tie?

41. What two types of dead-end ties may be made in parallel drop wire?

42. Are dead-end ties in parallel and in twisted-pair wires made in the same manner?

43. When a single or double tie is made on a "T" knob, is one conductor of the twisted-pair wire placed in each groove of the knob or are both conductors placed in the same groove?

44. How much braid is retained on Wire W–108 when it is to be connected to a terminal pair?

45. If a wire is to be terminated on the left side of a terminal can and runs down from above the terminal, on which side of the terminal can is the wire brought down?

46. On which lug of the terminal pair is the tracer wire terminated?

47. How many bridle rings are installed at the base of "F"-type cable terminals?

48. If, after a drop is installed, it is found to be too short to reach the terminal pair, where is the splice made to extend the drop?

49. When attaching a wire to a terminal lug, how far should the insulation be kept from the washer?

50. Should two wires placed on the same lug be placed under a single washer?

51. If the same terminal pair serves more than two drops, how is the third drop connected?

52. How should this third drop be run with relation to the other two drops?

53. Is it permissible to place drive hooks both above and below the cable, for drop wire supports?

54. Should the drop wire always be fed through the drive hook?

55. When running drops from a guardarm, are the drops run through the guardarm hook?

56. To what are the drop clamps attached on a pole that contains a guardarm?

57. What piece of hardware is used in making this attachment?

58. When placing drop wire along a lead of poles containing no cable, what factor should be kept in mind with reference to the height the drop wire is placed?

59. When drop wire is run along a lead where cable is installed, on which side of the pole is the drop run?

60. What determines the number of drop clamps that may be placed on one drive hook?

61. Where trees or other obstructions prohibit a direct run from a pole which contains cable, how is a drop taken from the lead?

62. How are drop connections made to open wire runs?

63. How many men are required when drops are being run over power wires?

64. What precaution should be taken when drops are being run over power wire?

65. May the regular drop wire clamps and clips be used for tree attachments?

66. What should be done before starting work on a building drop run?

67. Should drop wires ever be run diagonally across a building?

68. Give three methods of turning a corner on a building run.

69. How many rings are required to turn an inside corner?

70. How may an inside corner be turned without the use of rings?

71. What should generally be the distance between the last point of attachment on a building run and the point of entrance?

72. How should drop wires be protected from abrasion, when contact with some object is unavoidable?

73. Should an installer have specific information as to type of circuit carried on poles which he must use to install a drop wire?

74. Under ordinary conditions should any telephone construction be placed on high-tension pole lines?

75. Give two examples of high-tension circuits.

76. What is the clearance required for line drops over trolley feeders?

77. Is there any standard clearance for navigable streams?

78. What is the clearance required over residence driveways?

79. What is the clearance between vertical runs on poles?

80. When drops are run from a pole, should the drops leave the pole in a direct lead on the field side?

81. Define climbing space.

82. Why is climbing space provided?

83. What clearance must be provided over a sidewalk?

Section III. STATION PROTECTION

84. Are protectors a primary or secondary protection for substations?

85. If protectors are not the primary means of protection, what is?

86. Give two general classifications of telephone construction with reference to installation of protectors.

87. In which of these two types would protectors be installed?

88. Give one general definition of an exposed area.

89. Give one general definition of an unexposed area.

90. What is the minimum distance to be left between centers when installing substation protectors?

91. How is the metallic connection made between the two porcelain sections of a protector?

92. What capacity or types of fuses are used in protectors?

93. Should protectors be installed on the outside or inside of buildings?

94. Give the main point to be considered when locating a protector.

95. At what minimum height from the floor should protectors be installed?

96. Is it permissible to install protectors on an inclosed porch?

97. Should protectors be installed horizontally?

98, How is a drop insulated where it enters a frame building?

99. What size tube insulator will accommodate two drops?

100. Should the hole drilled for a porcelain tube insulator be on a horizontal plane?

101. May the porcelain tube insulator be omitted when the drop enters a brick building?

102. If no tube insulator is used, what protection is given the drop wire where it enters a brick building?

103. Is it permissible to use a ground wire made up of several sections of wire soldered together?

104. Can a ground wire run be concealed?

105. Is it necessary to thoroughly insulate foreign wires from ground wires?

106. Is it permissible to install ground wire on knobs?

107. How are ground wires fastened to water pipes?

108. Which is the preferable ground, a hot or a cold water pipe?

109. When attaching ground wire to a ground rod, should the joint be soldered?

110. Should the top of a ground rod protrude above the surface on the ground?

111. Is it permissible to place ground rods in cellars that have an earth floor?

112. Should a water pipe be cleaned before a ground clamp is installed?

Section IV. INSIDE INSTALLATION

113. May inside house wire runs be concealed?

114. Should inside house wire runs be made diagonally, as a general rule?

115. Should inside house wire be run in damp places?

116. What clearance is required between an inside house wire run and an open electric light wire run?

117. May inside house wire be run through floors without added insulation?

118. May inside house wire be run through woodwork without added insulation?

119. What spacing is required when inside wire cleats are used?

120. Is it permissible to splice inside house wire?

121. Name one condition in a new installation under which a splice is permissible.

122. Name one condition in a reinstallation under which it is permissible to make a splice.

123. Is it necessary to solder the splice made in inside house wire?

124. When connecting wire to the protector, what is the distance required from the lug to the point where the insulation has been cut and removed from the wire?

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