

CABLE AND TERMINAL GROUNDING IN SUBSCRIBER'S BUILDING—GENERAL

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5. ESTABLISHING TELEPHONE GROUNDS	2	1.01 This section describes the <i>rules</i> and <i>methods</i> used to ground entrance feeder cable, house cable, and cable terminals within subscriber's premises. This section also covers the use of splice cases, closures, or lead sleeves on plastic or lead sheath cables for purposes of protective and equipment grounding.	
A. General	2	1.02 This section contains information previously contained in Section 631-460-200. Whenever this section is reissued, the reason for reissue will be listed in this paragraph.	
B. Selecting Grounds	3	1.03 Section 626-759-170 covers the National Electrical Code requirements concerning the installation of cables in open riser shafts in buildings.	
C. Installing Ground Wires	7	1.04 Cables entering power stations, radio stations, etc, require special treatment. The treatment should be specified on detailed plans or work prints.	
D. Grounding Hardware	7	2. DEFINITIONS	
6. RULES FOR GROUNDING EXPOSED AND UNEXPOSED CABLES AND FOR INSULATING JOINTS	11	2.01 In order to provide a common language base for the terms used in this and related sections, the following definitions are given.	
A. Exposed Cables	11	(a) Exposed Cable: Cable sheath or cable conductors are considered exposed when they are subject to possible contact with power wires operating at over 300 volts to ground; or the effects of lightning; or a rise in ground potential; or low-frequency induction.	
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- (b) **Unexposed Cable:** Cable sheath or cable conductors are considered unexposed when not subjected to any of the conditions listed under (a).

3. PURPOSE OF GROUNDING

3.01 The purpose of grounding cable sheath is to limit voltages that may be present on the cable sheath from external sources, such as lightning or power contact. Grounding will facilitate rapid deenergization of power lines that contact communications plant and will provide a path to ground for lightning. Cables entering a subscriber's building must be bonded together to reduce the overall resistance to ground and to equalize the potentials which might otherwise appear between cable sheaths. ***The continuity of the grounding path must be maintained at all times.*** The length of the ground wire should be as short as possible and continuous to provide a low resistance path to ground. Cable plant that is effectively grounded yields the following benefits:

EXPOSED CABLE

- (a) Safety to the public
- (b) Safety to telephone company personnel
- (c) A minimum of public damage during severe electrical storms
- (d) A minimum of service interruptions and telephone plant damage
- (e) Noise suppression

UNEXPOSED CABLE

- (a) Noise suppression
- (b) The proper operation of telephone equipment on the premises.

4. APPROVED GROUNDS (NATIONAL ELECTRICAL CODE)



Before selecting an approved ground for any of the building terminals, determine how the power service is grounded. (See 4.01 through 4.03.)

4.01 Where An Acceptable Waterpipe System Is Available:

The National Electrical Code requires that, where available, an acceptable ***buried metallic water pipe system*** shall always be used as the ***first choice*** grounding electrode for the power system. (An acceptable water pipe electrode is one that has at least ten feet of metallic pipe buried in the earth and may be either part of a municipal water system or a private well.)

4.02 Where An Acceptable Waterpipe System Is Not Available:

The National Electrical Code requires that if ***an acceptable buried metallic water pipe is not available, the interior metallic cold water pipe*** of the premises ***must be bonded to the power ground.*** The National Electrical Code also provides that the power service may be grounded to any of the following grounding electrodes:

- (a) The metal frame of a building where effectively grounded
- (b) Or a copper wire or steel reenforcing that is encased in the concrete footing of the building
- (c) Or a ground rod, galvanized pipe, or plate buried in the earth.

4.03 Where power is grounded to a ground rod, it is necessary to know if the power is MGN (multigrounded neutral). This information should be obtained through supervisory channels as it is necessary to properly ground the protector.

5. ESTABLISHING TELEPHONE GROUNDS

A. General



Caution should be exercised before installing cable and terminal grounds in subscriber's buildings where the structures are under construction or are being remodeled. At these locations temporary power and water pipe arrangements are often encountered. Therefore it is very important to select a ground electrode of a permanent nature. Also ground wire runs should be made in such a manner they will not be removed, changed, broken, or present a hazard to employees.



A protector or protected building terminal must be connected to the best available ground electrode with a No. 6 ground wire. This connection must be made even though the cable sheath is grounded as described in 5.01. Before selecting a ground electrode, determine how the power service is grounded.

B. Selecting Grounds

5.01 Use the flowchart in Fig. 1 to select the best cable and terminal grounds in the subscriber's building. The flowchart is designed to help the employee to identify the best choices of ground available in most job situations. The decision blocks contain questions regarding the installation conditions, the responses to which will lead to selection of an acceptable ground. The flowchart should be followed until the last block in the path is reached. The referenced notes and figures (2 through 8) provide additional information of actual installation procedures.

5.02 Verify that the power ground is bonded to the interior metal cold water pipe as described in 4.02. If this installation has not been made, place a bond between the power service ground and the nearest metallic cold water pipe using a No. 6 ground wire (Fig. 1).

5.03 Due to possible corrosive action, do not connect cable and building terminal grounds to aluminum power ground conductors.

5.04 If the power ground wire is encased in metallic armor or conduit, the metallic armor or conduit may be used as the telephone ground.

5.05 Metal power service entrance conduit may be used for the cable and building terminal ground instead of a power ground wire. The power service entrance conduit is the conduit through which the power service conductors feeding the premises enters the box containing the main power breakers or fuses.

5.06 Building terminals located remotely from the power service may be grounded to either an ***acceptable*** or an ***unacceptable*** metallic water pipe or to building steel, ***provided that the water pipe or building steel is bonded to the power service ground.*** This is preferable to making very long ground wire runs to the power service ground.

5.07 An acceptable metallic water pipe is the preferred ground where the power ground is inaccessible, or there is no power.

5.08 Do not connect terminal ***ground to:***

- Gas pipe
- Electric service branch circuit conduit
- Armor of BX cable
- Interior of any electrical box
- Aluminum conductor or conduit.

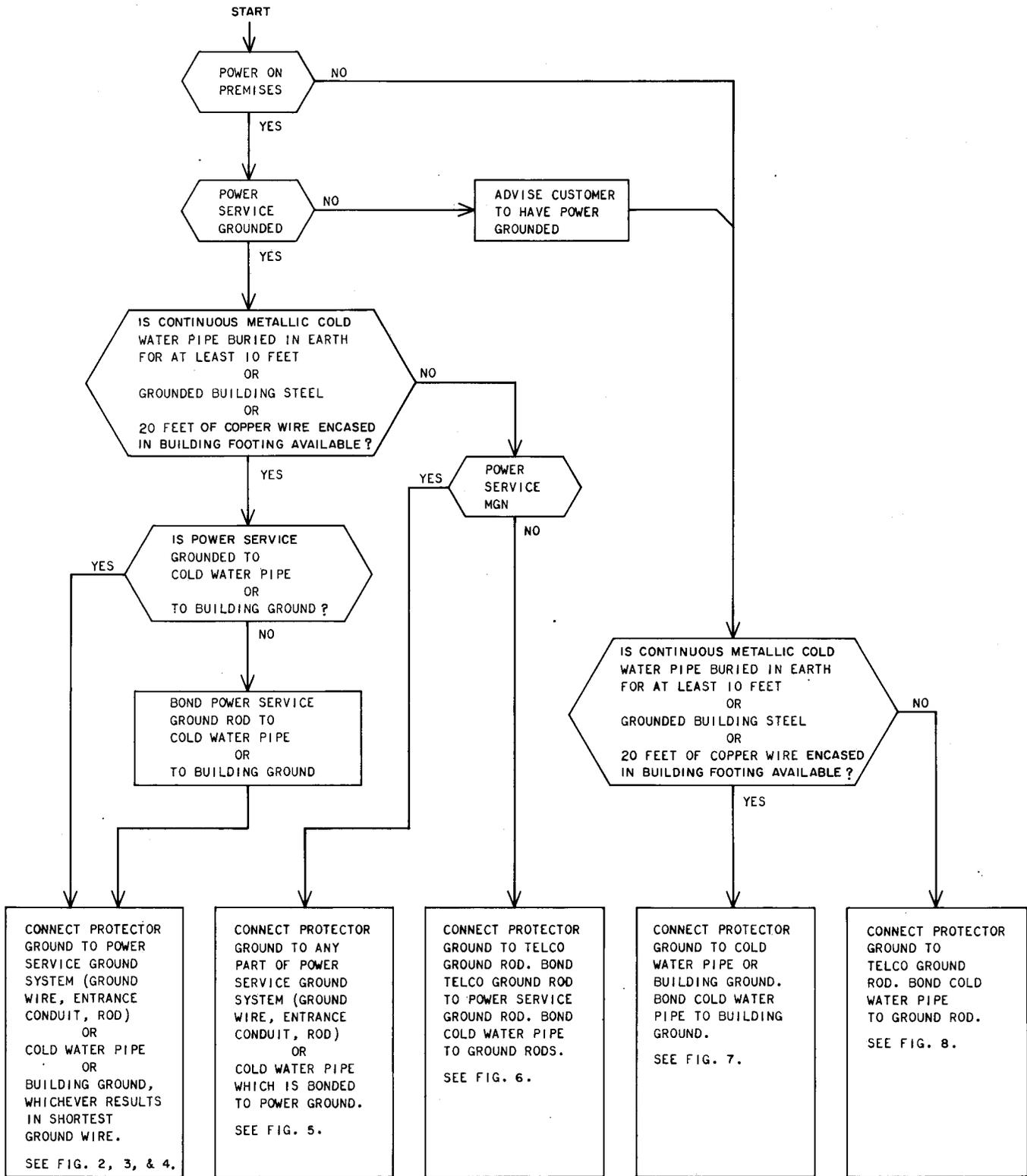


Fig. 1—Protector Ground Selection

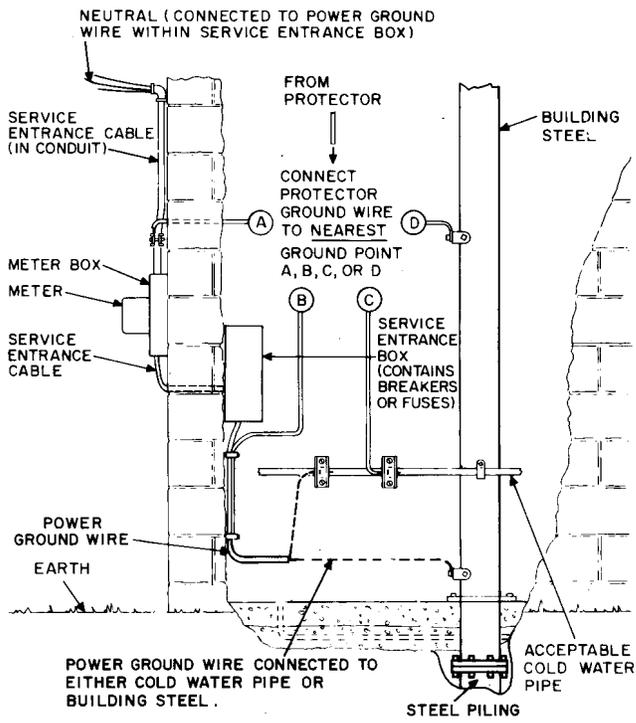


Fig. 2—Acceptable Water System or Building Ground—Power Service Grounded to Cold Water Pipe or Building Steel

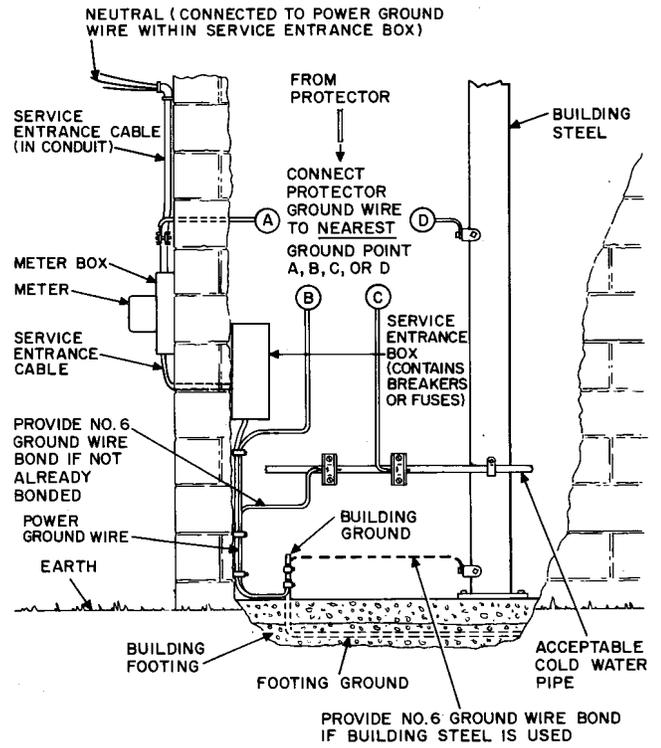


Fig. 3—Acceptable Water System or Building Ground—Power Service Grounded to Building Ground

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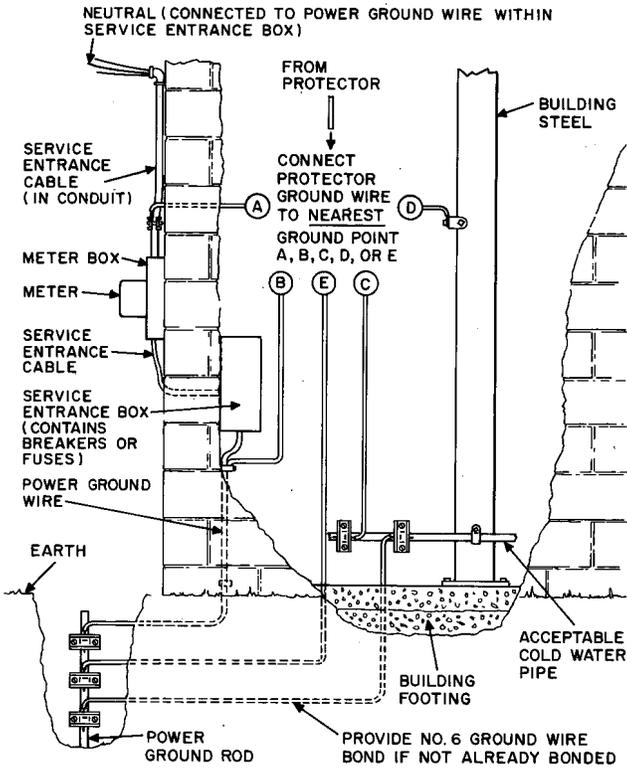


Fig. 4—Acceptable Water System—Power Service Grounded to Ground Rod

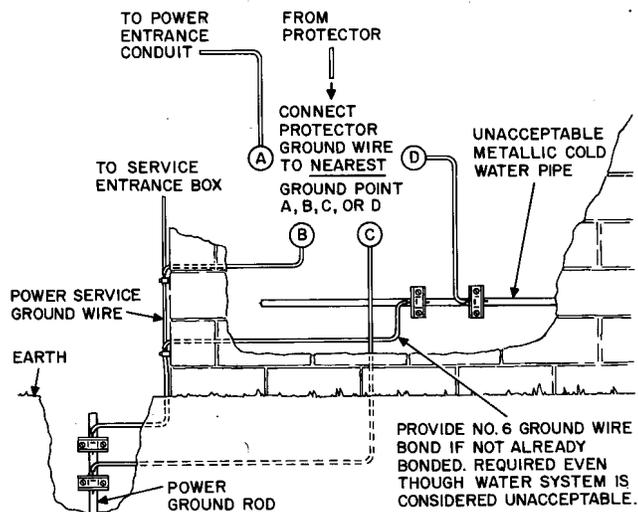


Fig. 5—Acceptable Water System or Building Ground Not Available—MGN Power Service Grounded to Ground Rod

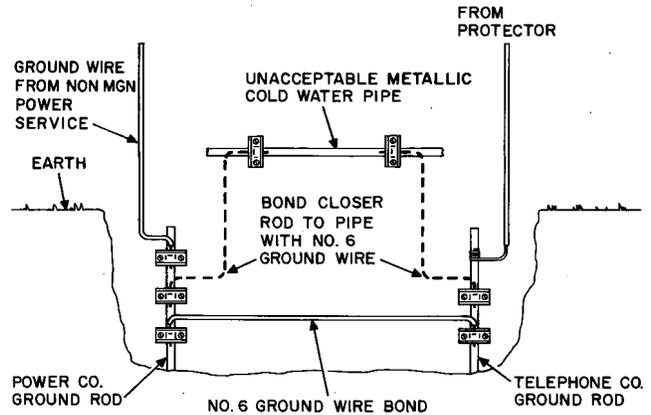


Fig. 6—Acceptable Water System or Building Ground Not Available—Non-MGN Power Service Grounded to Ground Rod

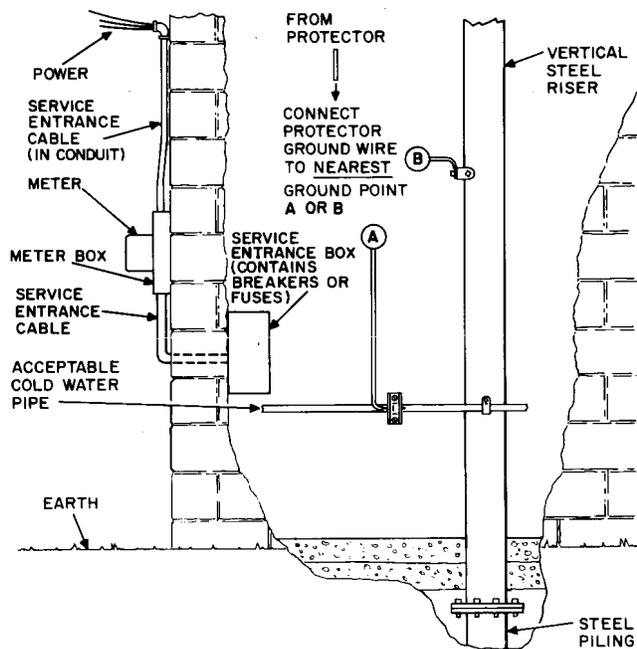


Fig. 7—Acceptable Water System or Building Ground—Power Service Not Grounded

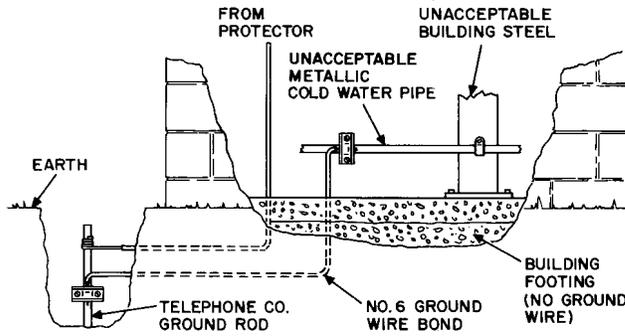


Fig. 8—Acceptable Water System or Building Ground Not Available—Power Service Not Grounded

C. Installing Ground Wires

5.09 A continuous length of No. 6 ground wire should be used for the building terminal ground. However, the ground wire may be spliced using sleeve type splices. When splicing ground wire, consider the following:

- A new ground wire run should be installed without a splice.

- Do not splice existing ground wire runs of less than 10 feet in length. Instead, install a new ground wire.
- Under no conditions splice a smaller gauge wire to extend a large gauge wire.
- Use proper size sleeves for splicing ground wires rather than other types of wire connectors.
- Concealed ground wire runs may be spliced if the continuity of existing wire is checked and the splice will be accessible.
- Do not tape ground wire splices.
- A ground wire run shall have no more than one splice.
- A ground wire run should be as straight as possible.

D. Grounding Hardware

- 5.10** See Tables A and B for selection of ground clamps and wire connectors.
- 5.11** Form E-3013B should be placed on all ground wire terminations to warn people not to disturb clamps or wire.

TABLE A
GROUND CLAMPS

TYPE OF GROUND CLAMP	FIG. NO.	PIPE, CONDUIT, GROUND ROD (INCHES)	FOR TERMINATING NO. 6 GROUND WIRE
L ground clamp	9 through 11 12	1 through 3 3 and larger	On water pipe or on service entrance conduit
B ground clamp	13 and 14	1/2 through 1	On ground rod
Building steel ground clamp (See Note)	15	—	On building structural steel

Note: Parts must be ordered and assembled locally.

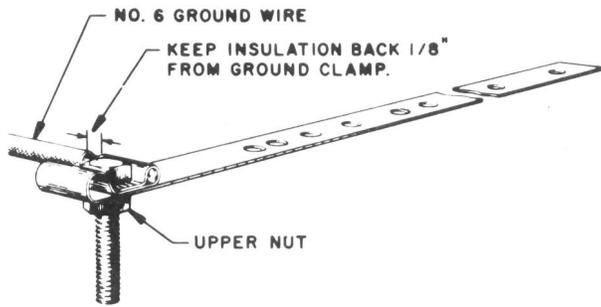


Fig. 9—Attaching No. 6 Ground Wire to L Ground Clamp

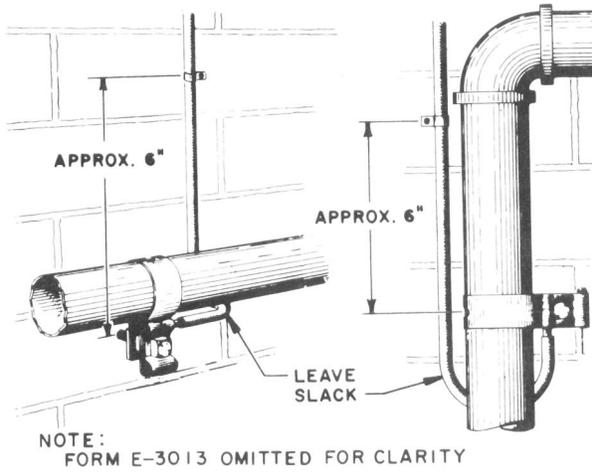


Fig. 12—Typical Installation—L Ground Clamp

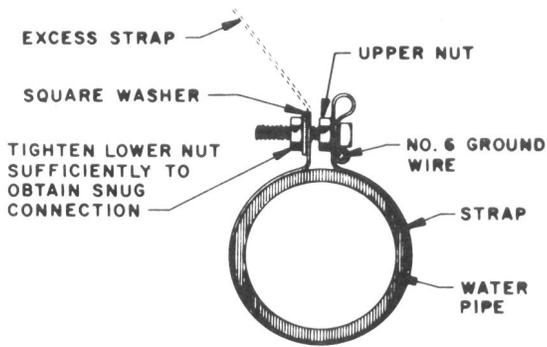


Fig. 10—Attaching L Ground Clamp to 3-Inch and Smaller Pipe

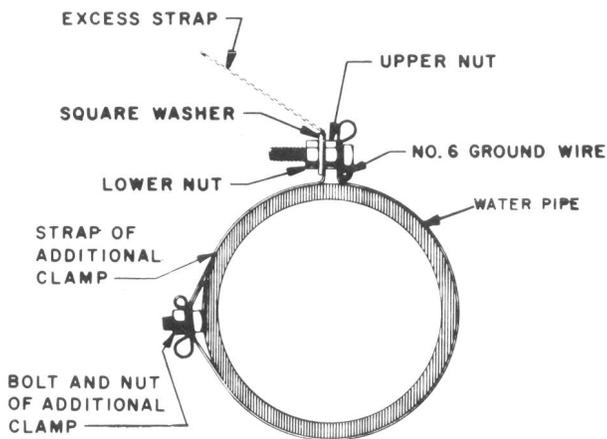


Fig. 11—Attaching L Ground Clamp to Pipes Larger Than 3 Inches

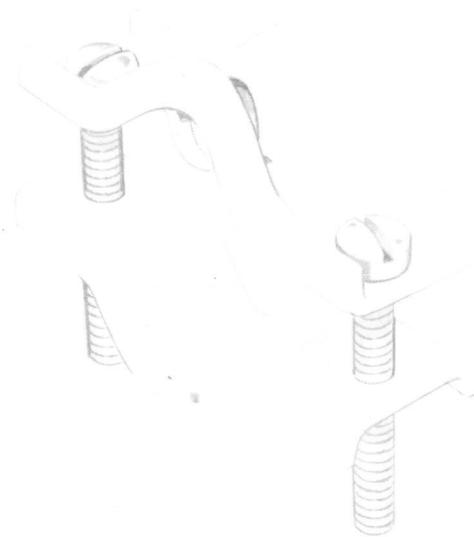


Fig. 13—B Ground Clamp

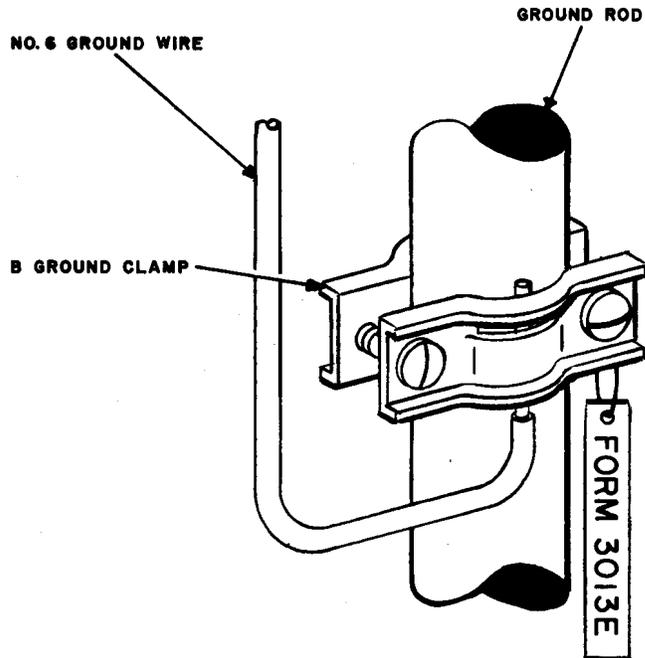
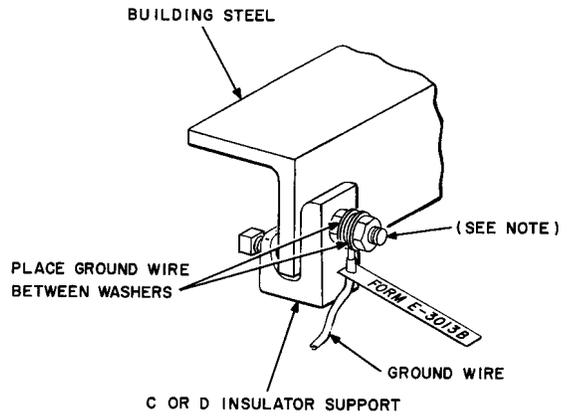


Fig. 14—Typical Installation of B Ground Clamp



NOTE:
 BOLT, NUTS, AND WASHERS ARE NOT PROVIDED WITH INSULATOR SUPPORT. INSTALL AS FOLLOWS: PLACE BOLT THROUGH INSULATOR SUPPORT, INSTALL BOTTOM NUT AND TIGHTEN. ATTACH INSULATOR SUPPORT TO BUILDING STEEL IN USUAL MANNER. PLACE WASHERS AND TOP NUT ON BOLT. REMOVE ONE-INCH INSULATION FROM GROUND WIRE AND BEND BARE CONDUCTOR AROUND BOLT BETWEEN WASHERS. TIGHTEN TOP NUT.

Fig. 15—Grounding to Building Steel

TABLE B
 WIRE CONNECTORS

TYPE OF CONNECTOR	FIG. NO.	CONDUCTOR SIZE	USE
E connector size 7	16	No. 14 through 4	To connect or bond No. 6 ground wire to bare copper power ground wire
E connector size 2	16	No. 14 through 1/0 and No. 8 through 4 armored ground wire	To connect or bond No. 6 ground wire to armored power ground wire
AT-7796X size 6 size 4 size 2	17	No. 14 through 6 No. 8 through 4 No. 6 through 2	To ground shield of cable at terminals or cable closures
Blackburn Pac 3 or Fargo GA610C	18	No. 6 through 8 copper or No. 2 through 4 aluminum	To connect No. 6 ground wire to aluminum power ground wire for bonding water pipe.

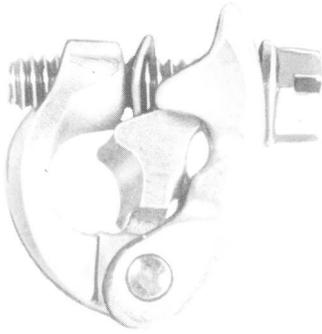


Fig. 16—E Connector

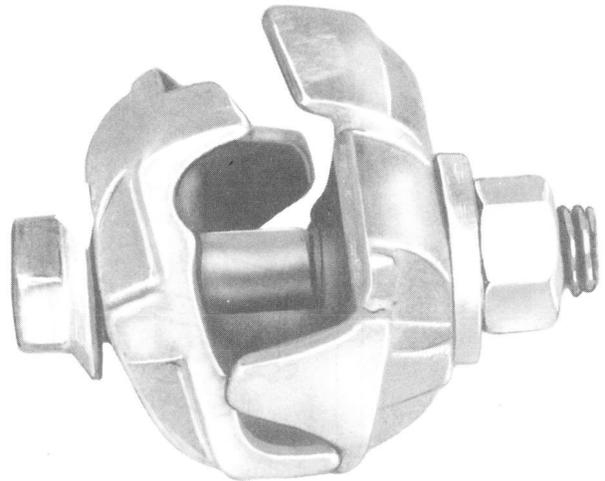


Fig. 18—Fargo (GA610C) Connector



Fig. 17—AT-7796X Connector

6. RULES FOR GROUNDING EXPOSED AND UNEXPOSED CABLES AND FOR INSULATING JOINTS

A. Exposed Cable

6.01 All exposed cables entering buildings *must be grounded as close as possible to the entrance point, and must not exceed 50 feet from the entrance point.* When the protected terminal is located *within 50 feet* of the cable entrance no further ground is necessary. Where the terminal is located *more than 50 feet* from the entrance, the shield of the cable must be grounded as close to the entrance point as possible. The shield should be connected by means of No. 6

ground wire to either the protector grounding electrode or to the protector ground lug, whichever results in the shortest length of ground wire.

Figures 19 and 20 illustrate and define the general rules for grounding exposed entrance feeder cables in the building.

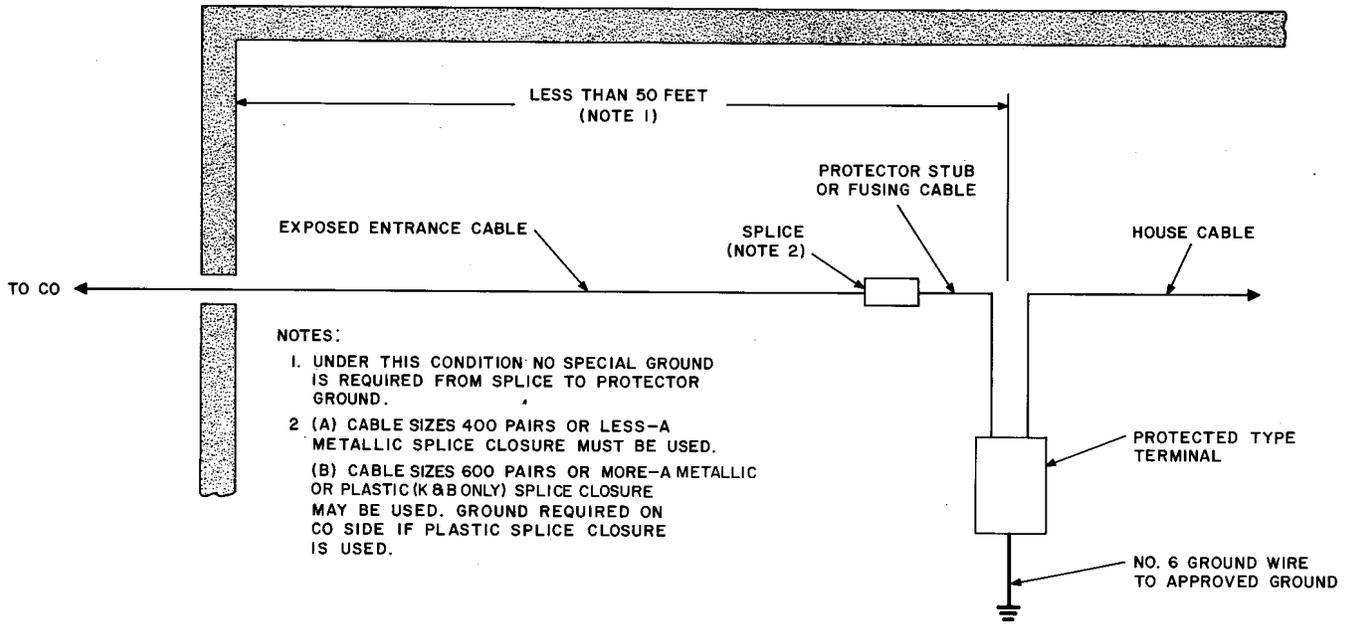


Fig. 19—Exposed Entrance Cable Grounding Requirements (50 Feet or Less)

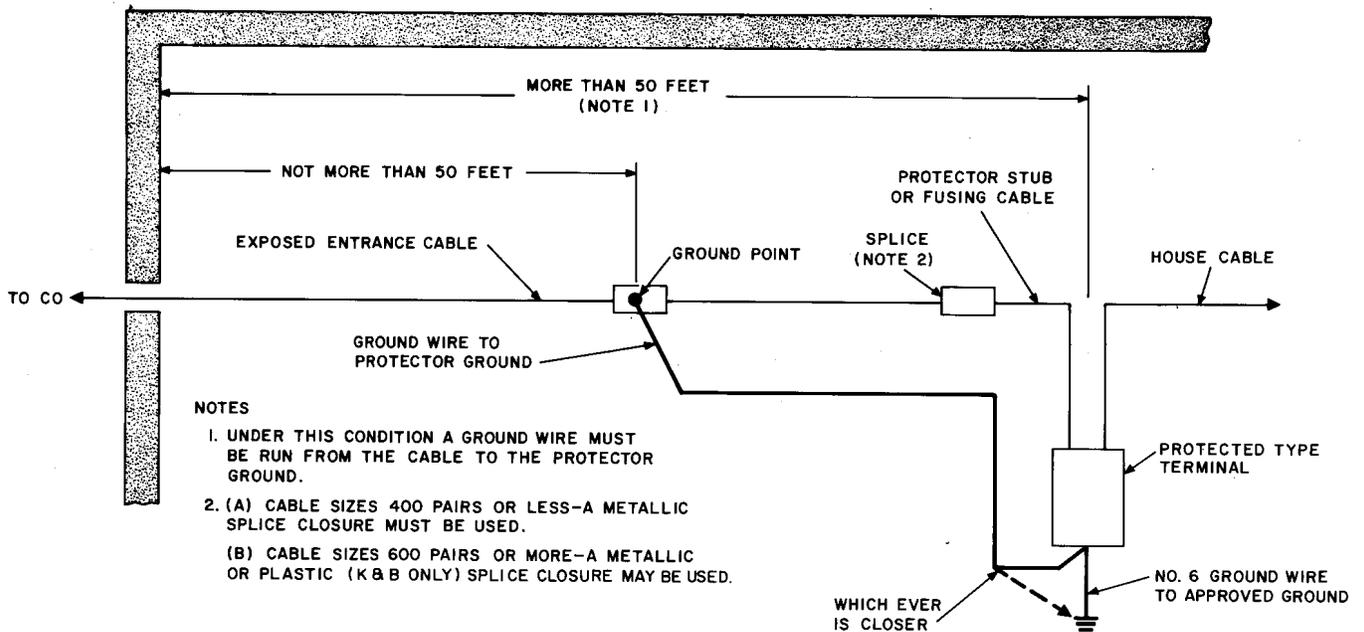


Fig. 20—Exposed Entrance Cable Grounding Requirements (More Than 50 Feet)

6.02 Where an *exposed plastic sheath feeder cable containing 400 pairs or less* is spliced to a protected terminal inside the building, *the splice must be enclosed in a metallic splice case*. This requirement is to provide a safer closure around the cable pairs that could be carrying excessive current under power cross conditions. Cables larger than 400-pairs are judged to contain sufficient copper to act as a "heat sink" under power fault conditions permitting the use of nonmetallic splice cases.

Note: Under *no circumstances* are plastic closures (such as 2-type) to be used to enclose the splice described in 6.02.

6.03 *Waterproof cables* can be used for building entrances provided the following rules are observed:

- (a) Waterproof cable must not be used as distribution cable because it is not fire resistant.

- (b) Conductors of waterproof cable must never be fanned out and terminated on connector or protector block.
- (c) Waterproof cable should not extend more than 50 feet into a building.

B. Unexposed Cable

6.04 Where the cable sheath is electrically continuous or can be made continuous, the cable is considered adequately grounded if the cable is grounded in an effectively grounded metallic terminal housing. *Sheath continuity must be maintained at all times. Figure 21 defines the rules for grounding unexposed entrances feeder cables in a building.*

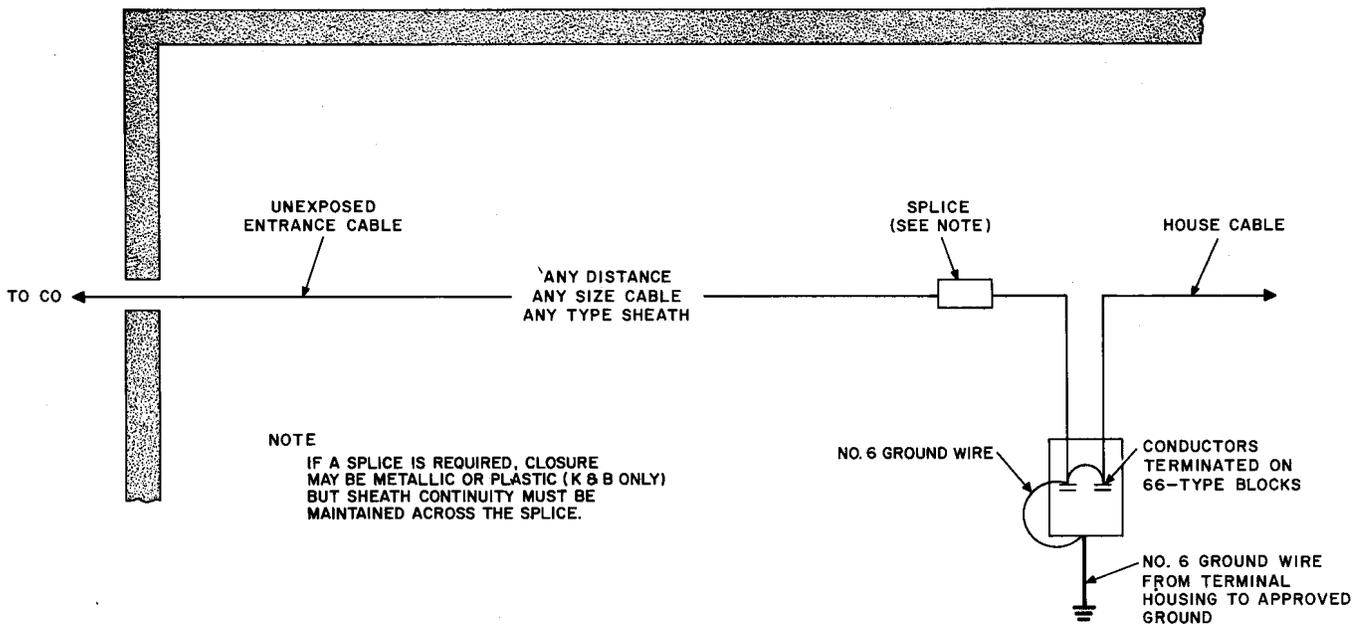


Fig. 21—Unexposed Entrance Cable Grounding Requirements

C. Insulating Joints

6.05 Where local practices require an insulating joint and KS-14595 capacitor inside the building, make the ground wire attachment to the cable sheath on the building side of the insulating joint (Fig. 22). Attach the other end of the ground wire to the protector ground or if the protector is closer, connect the ground wire to the lug of the protector. The cables on the street side of the insulating joint should be bonded together with No. 6 copper conductor and insulated from ground. The cables on the building side of the insulating joint should be bonded together and grounded as described in 6.01.

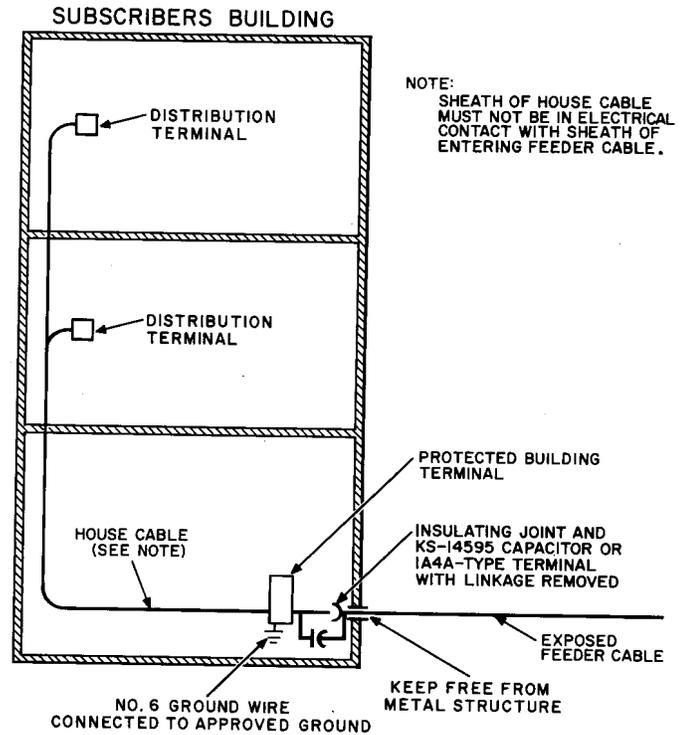


Fig. 22—Insulating Joint in Building

7. METHODS FOR GROUNDING EXPOSED AND UNEXPOSED CABLES AND FOR INSULATING JOINTS**A. Exposed Cable**

7.01 Grounding Methods: Exposed cable that is to be grounded must be identified by

sheath, conductor insulation, and pair size. Table C lists the types of cable. The referenced figures (23 through 27), paragraphs (7.02 through 7.04), and section numbers listed in Table C provide additional information for the grounding methods.

TABLE C

METHODS FOR GROUNDING EXPOSED BUILDING ENTRANCE CABLES

TYPE OF CABLE	FIG. OR PAR. NO. IN THIS SECTION	SPLICE CLOSURE OR SLEEVE	BELL SYSTEM PRACTICE
Lead sheath, plastic-, paper-, or pulp-insulated conductors	Fig. 23		633-200-201
Plastic sheath, paper-or pulp-insulated conductors	Fig. 24	(a) For less than 400-pair size use metallic splice case: (1) 20-type or (2) 30-type or (3) 9A, 10A, or 40E	633-400-200 633-400-210 633-460-210
	Fig. 25 Fig. 23	(b) For more than 400-pair size cable use: (1) K&B closure or (2) Auxiliary sleeve	633-560-101 633-300-210
Plastic sheath, plastic-insulated conductors, air core	Fig. 24	(a) For less than 400-pair size cable use metallic splice case (1) 20-type or (2) 30-type or (3) 9A, 10A, or 40E	633-400-200 633-400-210 633-460-210
	Fig. 26 and 27 Fig. 23	(b) For more than 400-pair size cable use: (1) 9-type closure or (2) Auxiliary sleeve	631-600-215 633-300-210
Plastic sheath, plastic-insulated conductors, waterproof	Par. 7.02, 7.03 and 7.04	20-type splice case	633-400-200

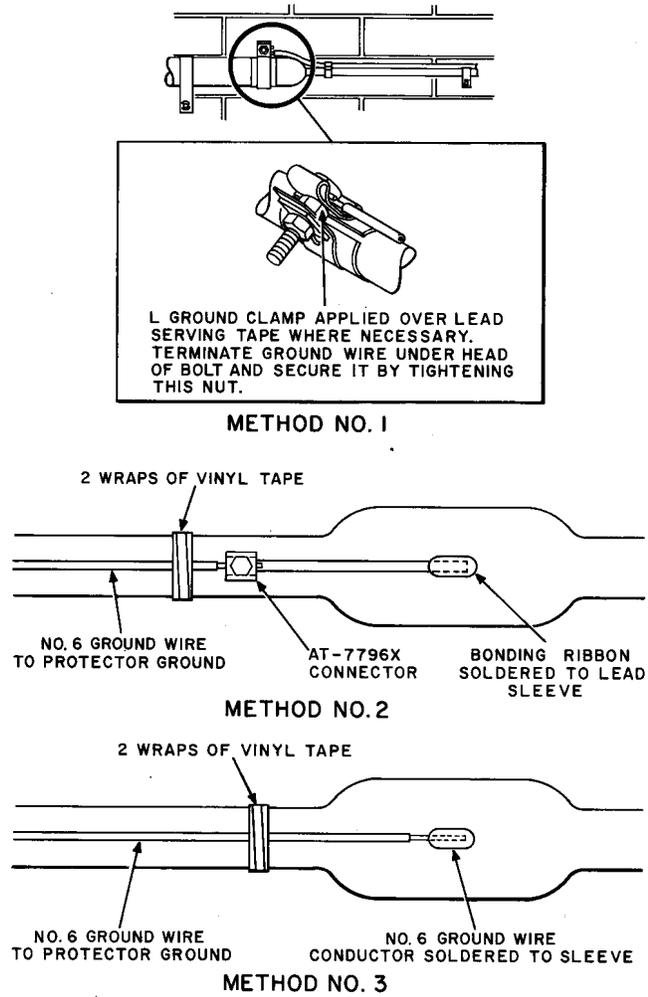


Fig. 23—Three Methods of Grounding Exposed Lead Sheath Cables in Buildings

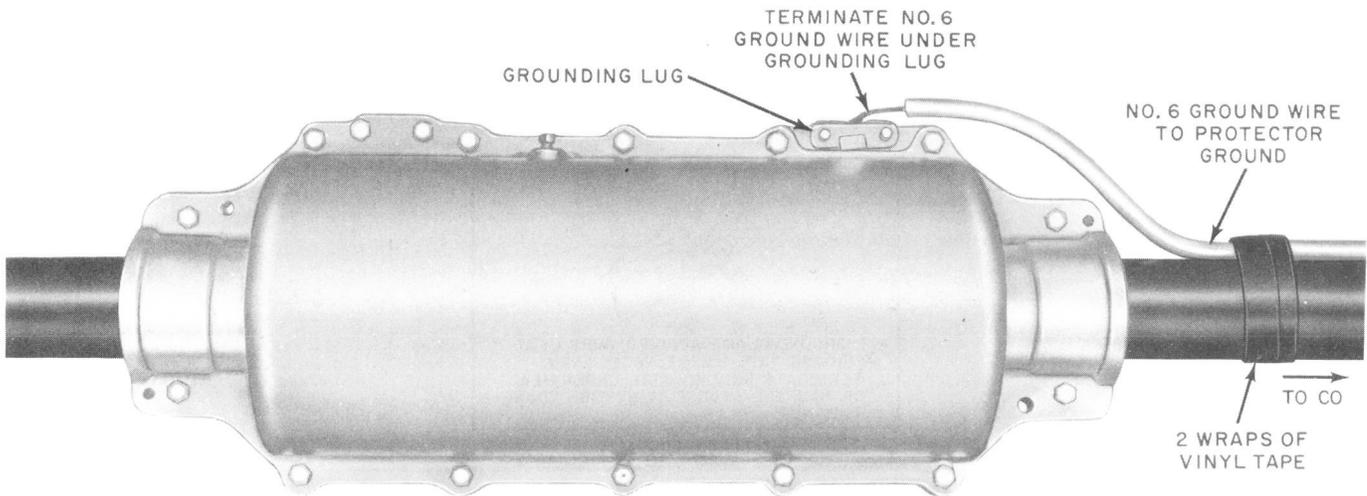


Fig. 24—Grounding Metallic Splice Case

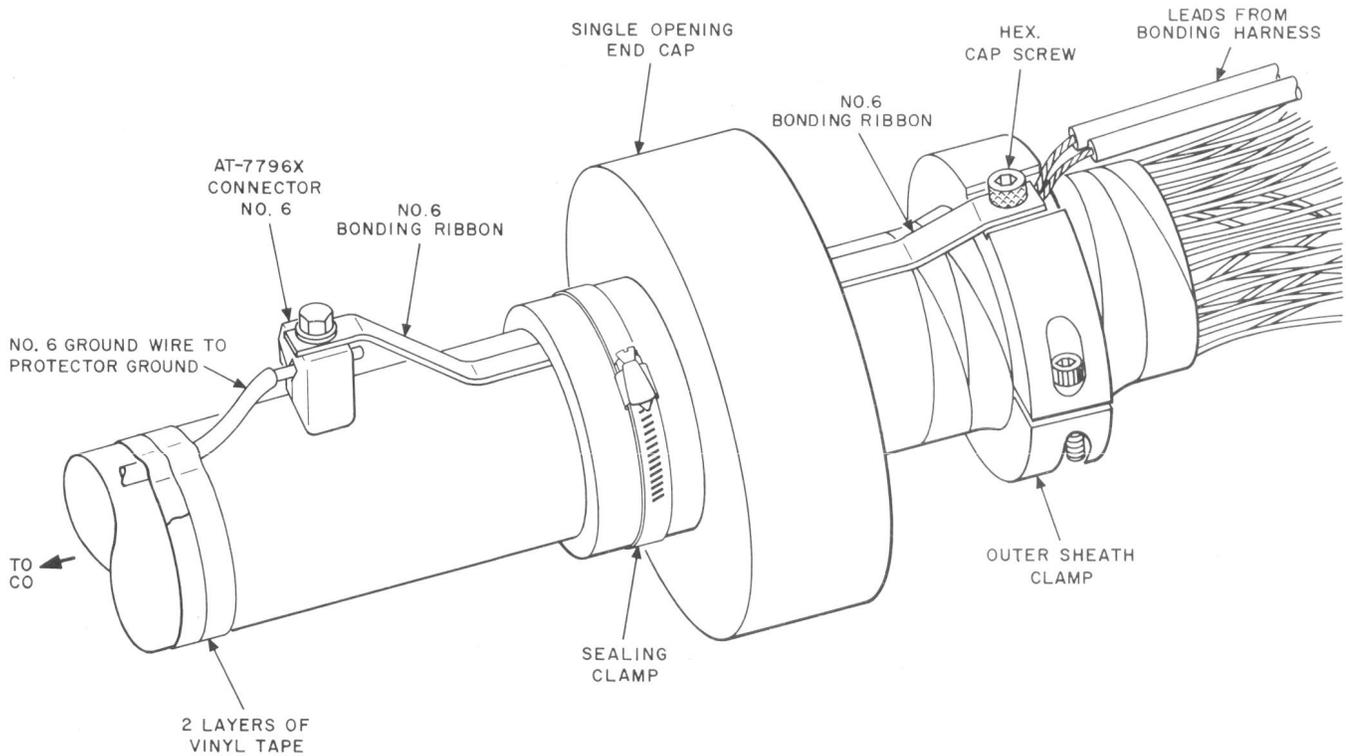


Fig. 25—Method of Grounding Exposed Plastic Sheath Cable in K&B Closure

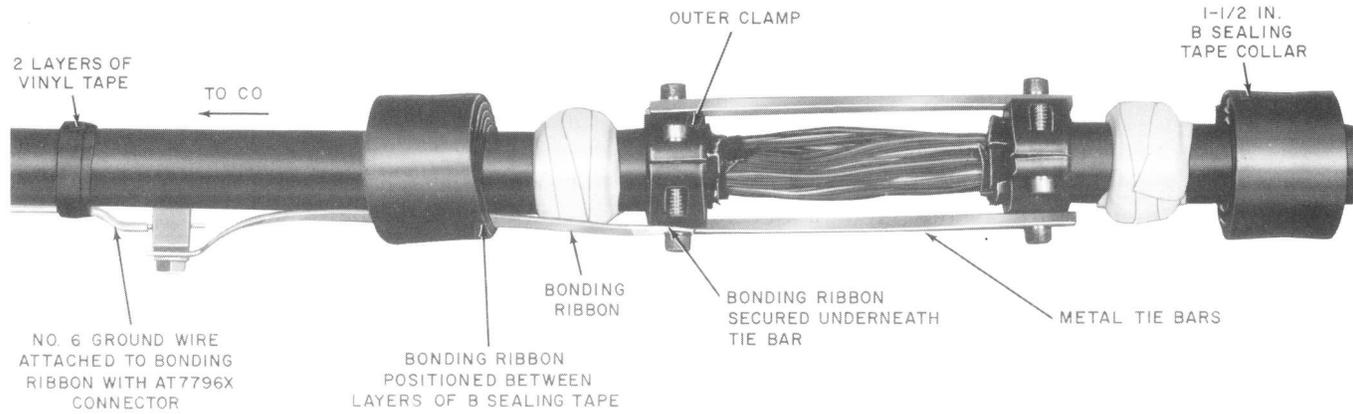


Fig. 26—Grounding Cable Sheath in 9-Type Closure

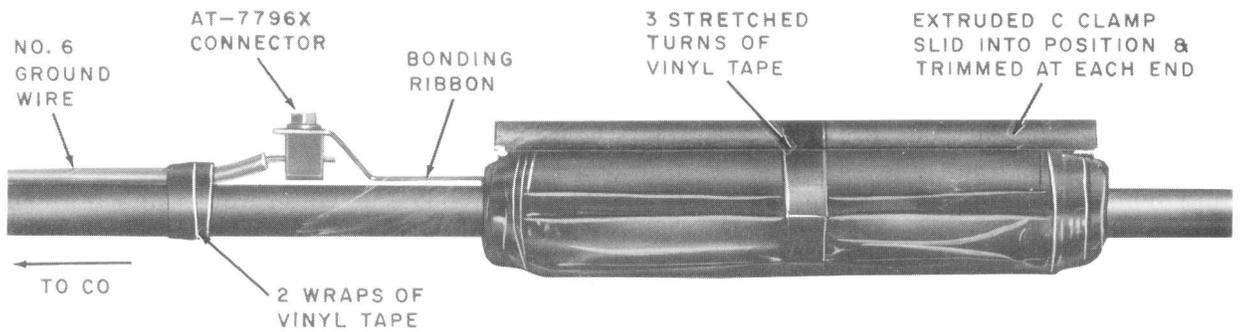


Fig. 27—Completed Installation of 9-Type Closure (Grounding)

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7.02 Methods for terminating waterproof cable *when the protector is located within 50 feet of the cable entrance* are:

- (1) Splice the waterproof cable to the stub cable of the protector block using any of the approved connectors as outlined in Section 632-410-204.
- (2) Wrap the splice with a mesh serving tape as outlined in Section 631-600-216, except **do not fill splice with AT-8721 filling compound.**
- (3) Modify single seal metallic splice case for filling by drilling and tapping two 1/4-inch National Pipe Thread (NPT) holes approximately 3/4 inches inside the shoulder on one side of the splice case.
- (4) Install splice case as outlined in Section 633-400-200 and fill with D encapsulant.
- (5) Close both holes with 1/4-inch NPT pipe plugs.

7.03 Methods for terminating waterproof cable *when the protector is located more than 50 feet from the cable entrance* are:

- (1) Splice an air core PVC jacketed stub cable to the waterproof cable at a suitable location within 50 feet of the cable entrance. Use an approved connector as outlined in Section 632-410-204.
- (2) Wrap the splice, enclose, and fill as outlined in Steps 2 through 5 in 7.02.
- (3) With No. 6 ground wire or bonding ribbon, bond the splice case to the building ground.
- (4) Connect the other end of the stub cable to the protector.

7.04 Methods for *placing waterproof entrance cable* in a metallic conduit are:

- (1) Assure the metallic conduit is bonded with a No. 6 ground wire to the building ground at or near the entrance point.

(2) Splice an air core PVC stub cable to the waterproof cable as close as possible to the station end of the conduit using an approved connector as outlined in Section 632-410-204.

(3) Wrap the splice, enclose, and fill as outlined in Steps 2 through 5 in 7.02.

(4) With a No. 6 ground wire bond the splice case to the metallic conduit.

(5) Connect the other end of the stub cable to the protector.

B. Unexposed Cable

7.05 *Lead or Plastic Sheath, Paper-, Pulp-, or Plastic-Insulated Conductors, Air Core Cables:* Where an unexposed entrance cable is electrically continuous (or can be made so) and is grounded to an effectively grounded metallic terminal housing, such grounding is adequate. The method for grounding unexposed entrance feeder cable in the metallic housing of the building terminal is discussed in Part 9.

7.06 *Plastic Sheath, Plastic-Insulated Conductors, Waterproof Cables:* Waterproof unexposed entrance cable can be used as building entrance facility as follows:

- When the Waterproof Cable Extends No More Than 50 Feet Into the Building:

(1) Splice a PVC jacketed stub cable to the waterproof cable using an approved connector as outlined in Section 632-410-204.

(2) Install a 20-type splice case as outlined in 7.02. The electrical continuity is provided across the splice by the metallic splice case (Section 633-400-200).

(3) Terminate the other end of the stub cable on the building terminal.

(4) The method of grounding this end of the stub to the metallic housing of the building terminal is discussed in Part 9.

● Where Metallic Conduit Is Provided For the Entrance Cable:

- (1) Assure the metallic conduit is bonded with a No. 6 ground wire to the building ground at or near the entrance.
- (2) Splice a PVC jacket stub cable to the waterproof cable using an approved connector as outlined in Section 632-410-204. This splice should be located as near to the end of the conduit as possible.
- (3) Install a 20-type splice case as outlined in 7.02.
- (4) With a No. 6 ground wire bond the splice case to the metallic conduit.
- (5) Terminate the other end of the stub cable on the building terminal.

C. Insulating Joints

7.07 Refer to Section 633-320-200 for placing an insulating joint in plastic sheath cable with paper- or pulp-insulated conductors.

7.08 Where local practices require an insulating joint in a plastic-insulated conductor cable, the 9-type closure is adaptable by substituting fiberglass reinforced plastic tie bars for the steel tie bars across the splice opening. This isolates the feeder cable from the house cable. Ground the cable on the building side of the splice as shown in Fig. 22.

7.09 If called for on detailed plans or work prints in severe electrolysis areas, install a KS-14595 electrolytic capacitor across the insulating splice by adding an additional bonding ribbon as shown in Fig. 28.

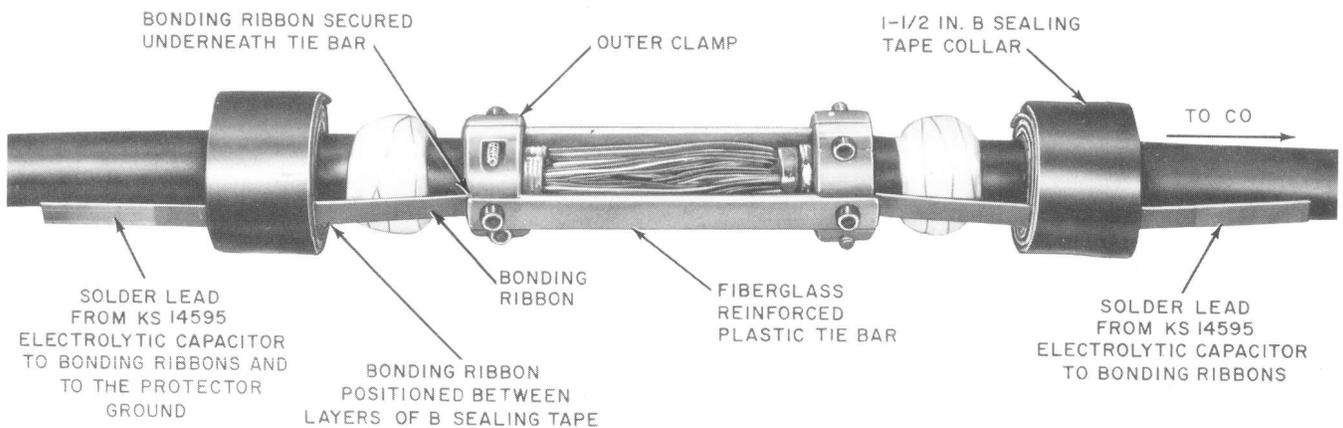


Fig. 28—Splice Prepared for Insulating Joint and Capacitor Mounting

8. GROUNDING PROTECTED TERMINALS IN BUILDINGS

8.01 For terminating exposed feeder cables in subscriber's buildings, use 134A1A protectors, 1A4A terminal blocks, or NH cable terminals.

8.02 Where more than one protected terminal is installed, connect all of the ground lugs together with a No. 6 ground wire (Fig. 29).

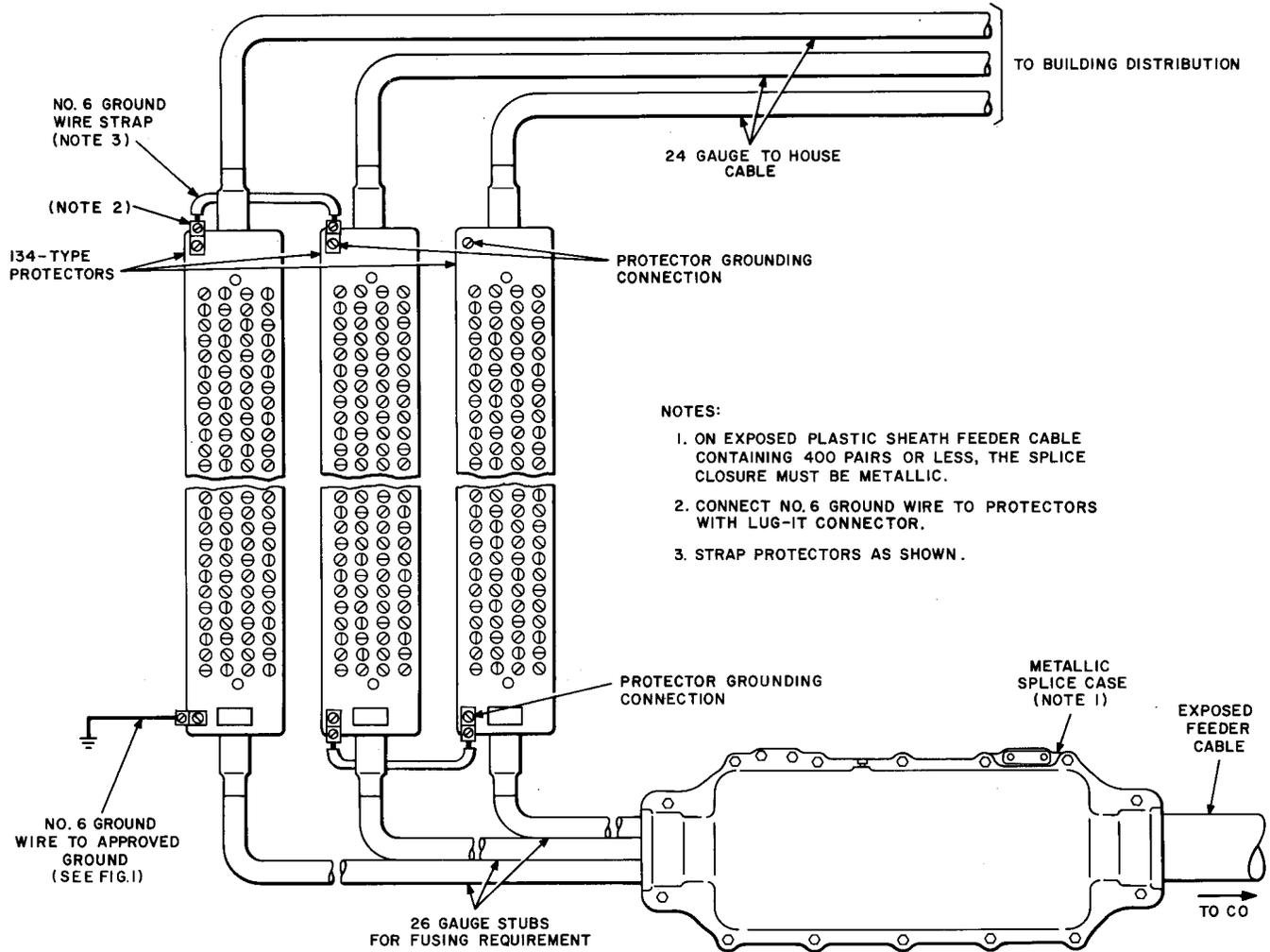


Fig. 29—Grounding 134-Type Protectors

8.03 In the construction of the 1A4A-type cable terminal, a removable ground linkage is provided between the exposed feeder cable sheath and the grounding strip of the protector. Where a 1A4A cable terminal is installed within 50 feet

of the building entrance and the sheath is not grounded between the entrance and the terminal, an insulating joint can be made by removing the ground bar linkage (Fig. 30).

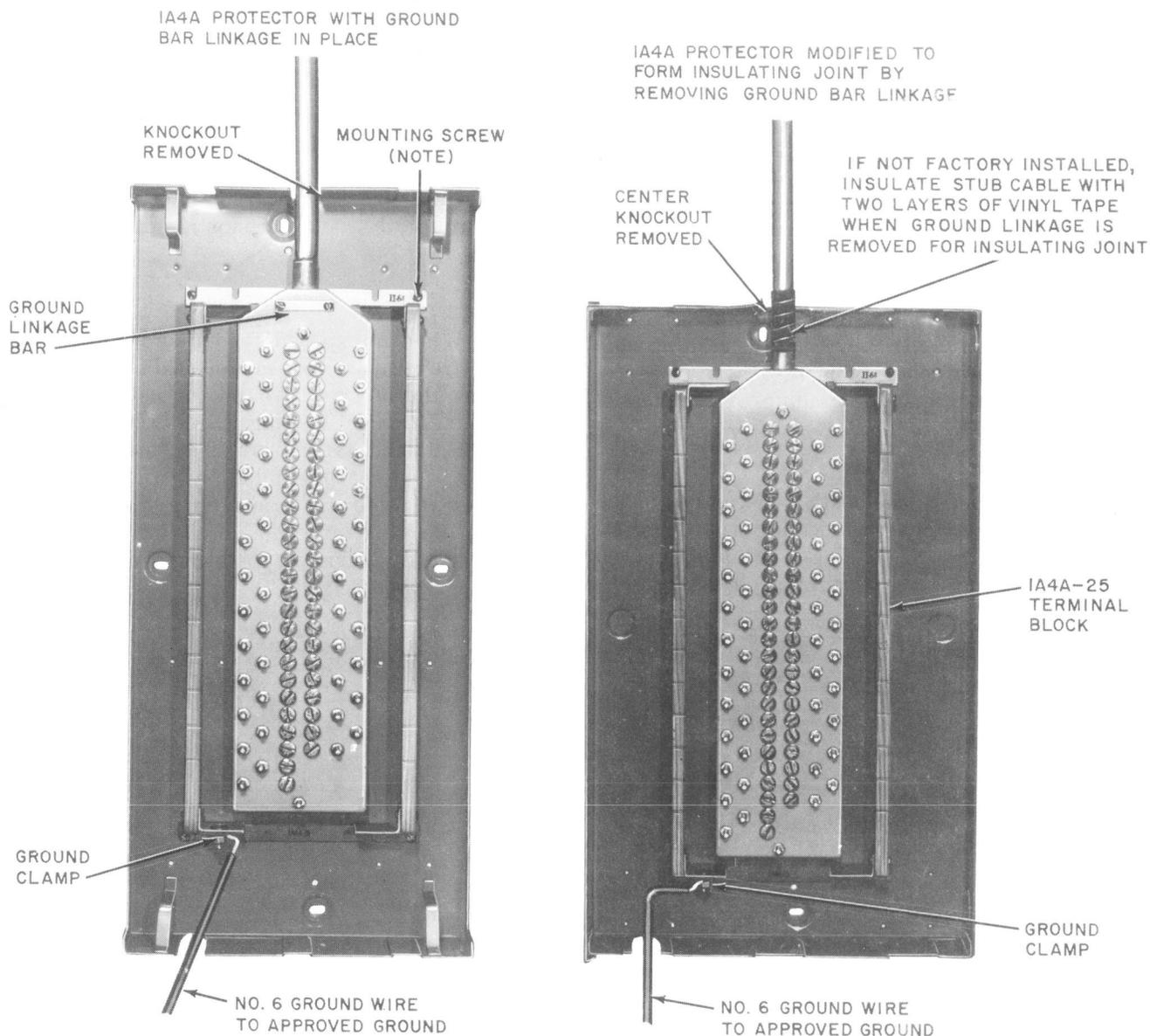


Fig. 30—Grounding 1A4A-Type Protectors

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8.04 Should it be necessary to remove the linkage bar on the 1A4A terminal for an insulating joint, place the two layers of vinyl tape on the terminal stub cable to prevent contact with the grounded metal terminal housing (Fig. 23). The entrance cable and splice case must also be kept isolated from ground.

8.05 The 134A1A protector is not equipped with a removable ground linkage for establishing an insulating joint. Where local practices require an insulating joint, it must be provided external to the 134A1A protectors.

9. GROUNDING HOUSE CABLE

9.01 Where the feeder cable and house cable sheaths are electrically continuous or can be made so, and the feeder cable sheath is properly grounded, no additional grounding of the house cable is required.

9.02 If the house cable sheath is or can be bonded to an effectively grounded protector or metal terminal housing, such bonding is adequate and no other direct connection to ground is necessary.

9.03 Where, for electrolysis reasons, a separation between the house and exposed feeder cable sheaths is provided either by an insulating joint or 1A4A-type terminal with the linkage removed (8.04), no bond shall be placed around the insulating joint on the terminal. In these cases, run a No. 6 ground wire from a convenient point on the house cable sheath to the protector ground by any method described in this section which may apply.

Note: H-type terminal sections, unless equipped with backboards, do not provide electrical separation between feeder and house cable sheaths since electrical continuity is maintained through the metal terminal section.

9.04 When unexposed feeder and house cables are terminated on unprotected terminal blocks, such as the 66-type, ground the cable shields in the metal terminal housings as described in Section 631-460-201 and 631-470-201. The terminal housing must in turn be grounded by running a No. 6 ground wire to an approved ground (Fig. 1). Figure 31 illustrates bonding of the house and feeder cable shields to the ground metal housing by using D bond clamps.

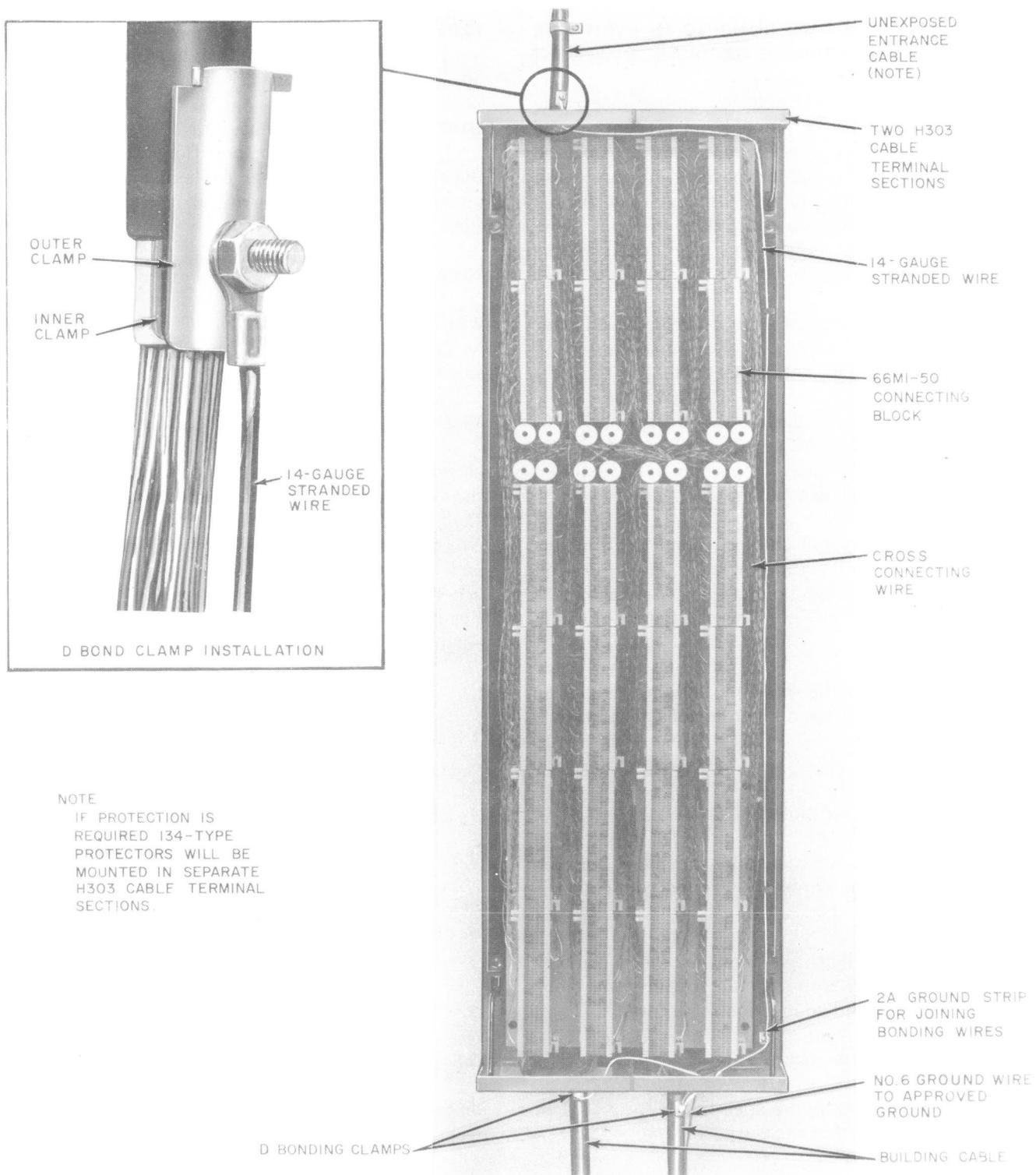


Fig. 31—Grounding Unexposed Feeder Cable and House Cable

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10. BONDING AND GROUNDING IN HIGH RISE BUILDINGS CONTAINING ELECTRONIC EQUIPMENT

10.01 High rise buildings containing electronic PBX or Key equipment can present special protection problems, even where they are located in areas considered to be unexposed. This is because electronic equipment may be damaged by surges caused by lightning striking the building. The magnitude of these surges can be reduced by the procedures outlined in 10.02 through 10.09.

10.02 Shield continuity shall be maintained over the entire length of the house cable and between the house and entrance cable.

10.03 The entrance cable shall be grounded to an approved ground (Fig. 1) as outlined in 6.01, 6.02 and 6.05. This applies to both exposed and unexposed entrance cables.

10.04 The riser cable shall be bonded by means of a No. 6 ground wire to an approved ground (10.05) at every point where the conductors enter or leave the cable. This should be done in the riser closet.

10.05 For grounding riser or building cables an approved ground shall be considered to be:

- (a) Building steel
- (b) Metallic water pipes
- (c) Power feed conduit supplying panel board(s) on the floor where the ground connection is required
- (d) The grounding conductor on the secondary side of the transformer feeding the floor where the ground connection is required
- (e) Power ground risers
- (f) A grounding point specifically provided in the building for the purpose.

10.06 The shields of cables which do not have pairs entering or leaving on a floor need not be grounded on that floor.

10.07 Where pairs enter or leave the cable to feed more than one floor above or below the floor where the riser cable shield is grounded, an additional sheath ground is required on the floor that is fed.

10.08 Where an unshielded riser cable is used, run a No. 6 ground wire in close proximity with the riser cable. The No. 6 ground wire should be grounded as outlined in 10.05 for riser cable shields.

10.09 A No. 10 ground wire shall be run on each floor from each equipment room or apparatus closet to the riser closet where the pairs feeding the floor leave the riser cable sheath. This conductor shall be bonded to the riser cable shield or to the No. 6 ground wire installed with unshielded cable and be run together with the inside wiring cable. Where more than one inside wiring cable follows the same route, a single grounding conductor is adequate for that route.

Note: The No. 10 size ground wire is specified for mechanical reasons, not because it is expected to carry significant currents.

11. BATTERY FEED GROUND

11.01 Where central office battery is supplied to telephone equipment on the subscriber's premises, the grounding system should not be used for a battery return. ***Metallic return is mandatory.***

12. TEMPORARY CABLE SHEATH OPENINGS

12.01 When openings are made or taped splices are left in house cable (other than insulating joints), maintain sheath continuity as outlined in Section 627-020-201.