

## STATION PROTECTOR AND SIGNALING GROUNDS SELECTION AND INSTALLATION

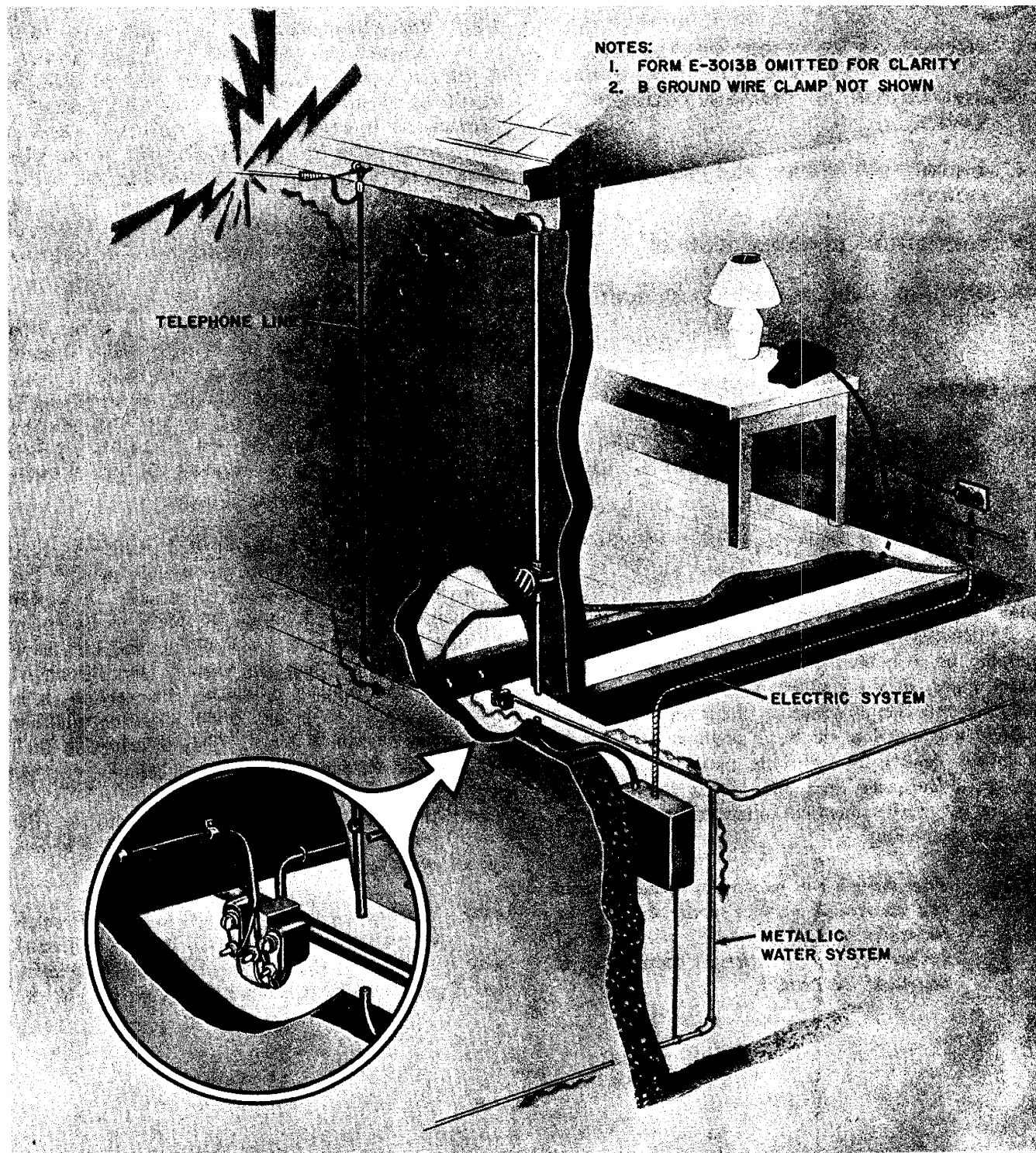


Fig. 1—Effective Ground

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## 1. GENERAL

**1.01** This section covers the selection of protector and signaling grounds and the installation of ground-connecting apparatus.

**1.02** This section replaces Section 638-210-100, which is canceled.

**1.03** When telephone equipment and wiring are isolated from ground (earth) and from other metallic or grounded structures such as metallic water pipes, power conduit, power ground wiring, and foreign communication facilities, abnormal voltage may develop on these systems as a result of power contact or lightning disturbances. The voltage differences that may exist between the various structures must be equalized or limited by common grounding.



*The telephone protector ground and the electrical service ground shall be interconnected. The method of interconnecting these facilities is outlined in Part 5.*

**1.04** On visits to previously installed stations, inspect the grounding system. Systems not properly grounded must be changed to meet the current grounding and bonding requirements. The preferred effective ground is illustrated in Fig. 1.

**1.05** When available, a public metallic water pipe provides the preferred grounding medium. A private metallic water system with at least 10 feet of buried metallic pipe is an acceptable grounding medium and is preferred to a ground rod. Connect the ground wire to the metallic cold water pipe at a point where normal maintenance of water meters, pumps, or the installation of insulating sections for reducing vibrations will not interrupt the circuit to ground or common bonding to power ground.

**1.06** When the interior metallic cold water pipe is insulated from the buried water system by an insulating joint or when the water system is nonmetallic, the interior metallic water piping is not an acceptable ground and an alternate method (Part 3) must be employed. The alternate selected ground shall always be bonded to the interior metallic cold water piping system.

**1.07** The MGN (multigrounded neutral) type power system is an acceptable ground but it is not in general use in all areas. A power company may have adopted the MGN as its policy on new or rearranged construction and still have a portion of its plant operating without a multigrounded neutral. To properly interpret this section, it is necessary to know in any given situation whether the power system is MGN. This information shall be obtained through supervisory channels.

**1.08** In selecting a location for a protector, the length of drop wire inside a building should be as short as possible.

**1.09** Whenever possible, use a 72A or 90A Bracket to ground a fuseless protector. If a ground wire is necessary, the run should be short, straight, and if possible a continuous piece of wire, (Fig. 2).

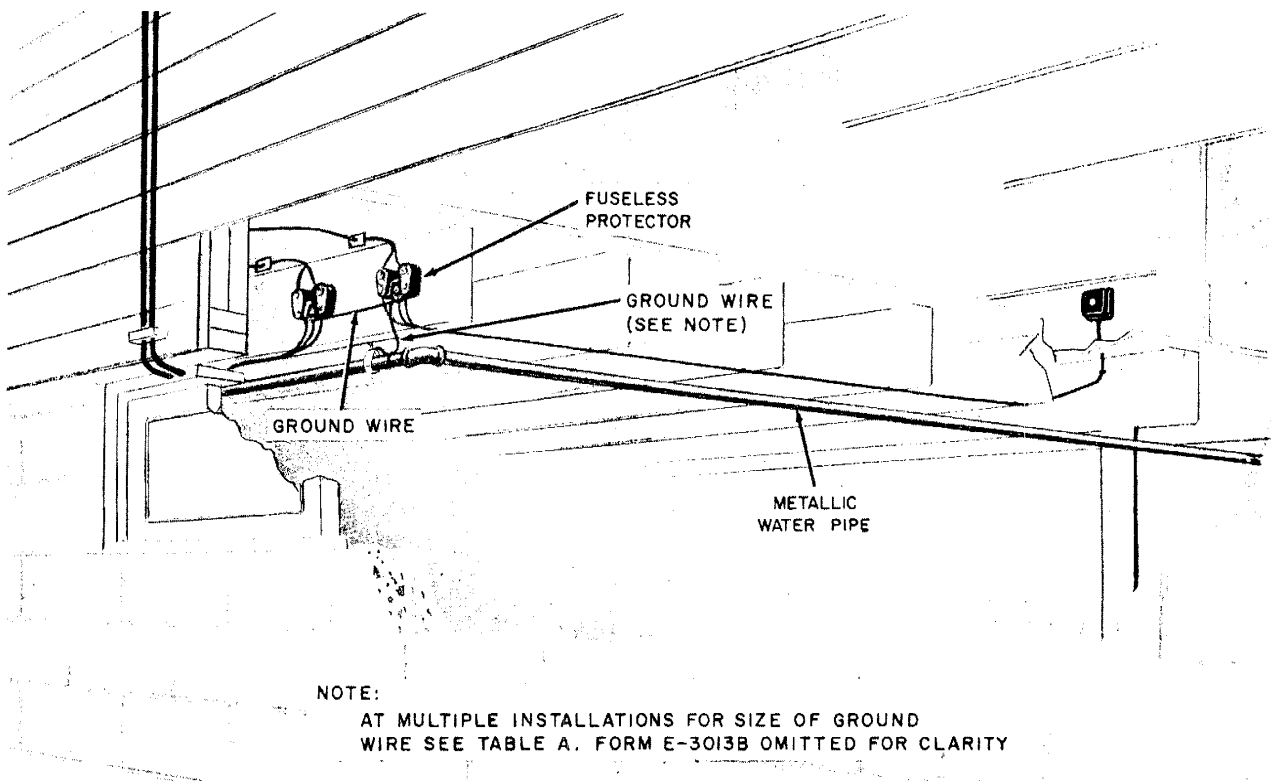


Fig. 2—Ground Wire Run—Fuseless Protector

**1.10** If it is necessary to use a fused protector, the length of drop wire indoors should be as short as possible. The ground wire run should be short, straight, and if possible a continuous piece of wire, (Fig. 3).

## 2. PRECAUTIONS

**2.01** Before connecting the protector ground wire, test the power company ground rod, ground wire, cabinet, meter box, etc, with a B Voltage Tester as prescribed in Section 620-105-010 of the Bell System Practices. The voltage test shall be as prescribed for vertical power ground wires or metallic conduit. If the grounding mediums are energized, proceed no further with the work. Report this condition to the proper supervision so that the power company or customer owned power system may be informed of the situation.

**2.02** To prevent damage to copper pipe or tubing, place the B Ground Clamp on fittings only.

**2.03** Do not spiral the ground wire around the pipe.

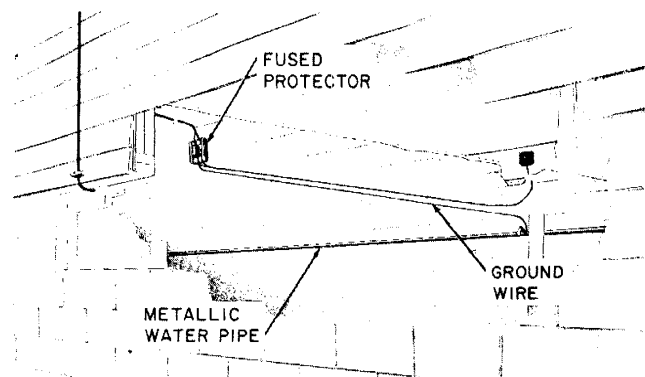


Fig. 3—Ground Wire Run—Fused Protector

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**2.04** Do not attach ground wires to the interior of any service entrance box, fuse box, meter box, etc.

**2.05** Due to corrosive action, do not attach ground wire to power service aluminum ground wire, aluminum conduit, aluminum service boxes, etc.

**2.06** Do not attach ground wire to gas pipes because gas companies generally isolate the exterior piping at the meter.

**2.07** Do not splice the ground wire. The ground wire shall be a continuous wire from the protector ground lug to the grounding clamp attached to the grounding medium.

### 3. SELECTION OF PROTECTOR GROUND

**3.01** The gauge of station ground wire is dependent on the type and number of protectors as listed in Table A.

TABLE A — GROUND WIRE CAPACITY <sup>1</sup>		
SIZE	NO. OF PROTECTED CIRCUITS	
	FUSELESS	FUSED
No. 14	1	3
No. 12	2	6
No. 10	6	7
No. 6	7 or More	8 or More
Note 1: The ground wire between protectors shall be the same size as the ground wire between the protector and the grounding electrode.		

**3.02** The selection of the protector ground should be made as outlined in Table B and illustrated in Fig. 4 through 19. No exceptions other than those covered in 3.07 and 3.08 are permitted except by the approval of the supervisor or as stated in authorized instructions.

**3.03** The grounding conductor of the power system is the wire that is directly connected to the metallic cold water pipe or other grounding medium. If this wire is encased in metallic armor or metallic conduit, the armor or conduit may be considered as the grounding conductor.

**3.04** The metallic entrance conduit of the power service is that portion of conduit from the power drop attachment to the service equipment enclosure. The conduit or armoring on the branch circuits in the building must not be used as protector ground.

**3.05** Fig. 4 illustrates the 123A1A Protector attached to a metallic cold water pipe by means of a B Station Ground Clamp and a 72A Bracket. This arrangement should be the first choice of grounding to an acceptable metallic cold water pipe.

**3.06** The 128A1A-2 Protector can be grounded to a metallic cold water pipe by means of a B Station Ground Clamp and 90A Bracket. This arrangement should be the first choice of grounding to an acceptable metallic cold water pipe.

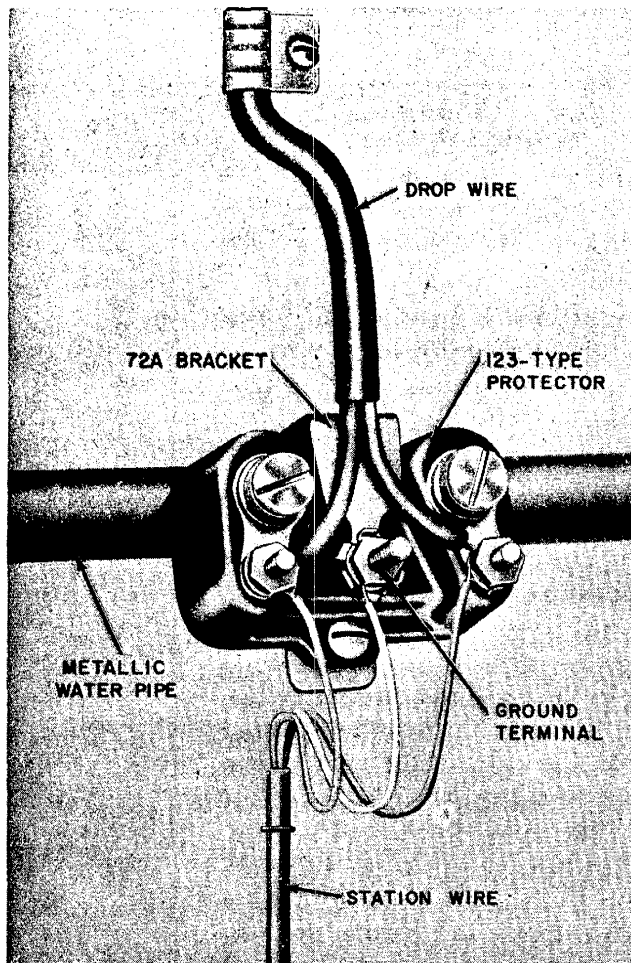
**3.07** Stations located at power company stations, or in explosive atmosphere, or connected to foreign communication circuits usually require special protection. These installations are covered in other sections of the Bell System Practices.

**3.08** At radio or television stations connect the protector ground to the radio or television station ground.

**Note:** In Fig. 4 through 19 the E-3013 Form (Caution Tag) has been omitted for clarity.

TABLE B — PROTECTOR GROUNDING

A1 — MGN System on acceptable metallic water pipe A2 — MGN System on ground rod B1 — Non-MGN System on acceptable metallic water pipe B2 — Non-MGN System on ground rod C — Power not grounded at premises D — No power			
WATER PIPE	POWER CONDITION	WHAT TO DO FOR PROPER PROTECTOR GROUNDING	FIG.
Acceptable metallic water pipe (at least 10 feet in moist soil)	A1 or B1	Ground protector to metallic water pipe or to power service conduit or ground wire	4, 5, or 6
	A2 or B2	Ground protector to metallic water pipe and bond power to water pipe	7
	C or D	Ground protector to metallic water pipe (if C, refer to 5.03)	8
Metallic interior water piping not acceptable because of plastic entrance, insulating joints, etc.	A2	Ground protector to MGN ground rod. Bond with No. 6 station ground wire to metallic water pipe. If ground rod not accessible ground to power service conduit or ground wire	9 or 10
	B2	Ground protector to best available ground or telephone ground rod. Bond to power ground rod and interior metallic water pipe with No. 6 station ground wire. If power ground rod is not accessible bond to power service conduit or ground wire.	11 or 12
	C or D	Ground protector to best available ground or ground rod, bond to interior metallic water pipe using same size station ground wire as protector ground wire (if C, refer to 5.03).	13
No metallic water pipe or not possible to connect to metallic water pipe	A2	Ground protector to MGN power ground rod, or, if ground rod is not accessible, ground protector to power service conduit or ground wire.	14 or 15
	B2	Ground protector to telephone ground rod and bond with No. 6 station ground wire to power ground rod.	16 or 17
	C or D	Ground protector to best available ground (if C, refer to 5.03).	18 or 19
<b>Note:</b> Verify existing power and telephone bonding and grounding. If they meet these requirements no further action is required.			



NOTE:  
B STATION GROUND WIRE CLAMP NOT SHOWN  
FORM E-3013B OMITTED FOR CLARITY.

Fig. 4—Protector Mounting—72A Bracket

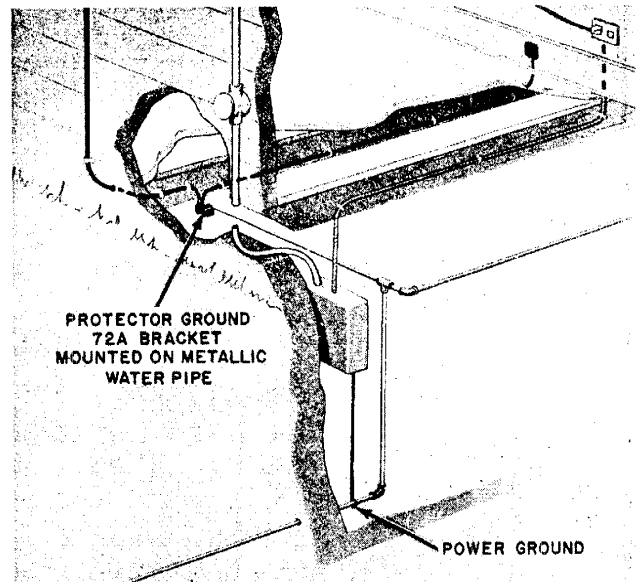


Fig. 5—Protector Ground—72A Bracket

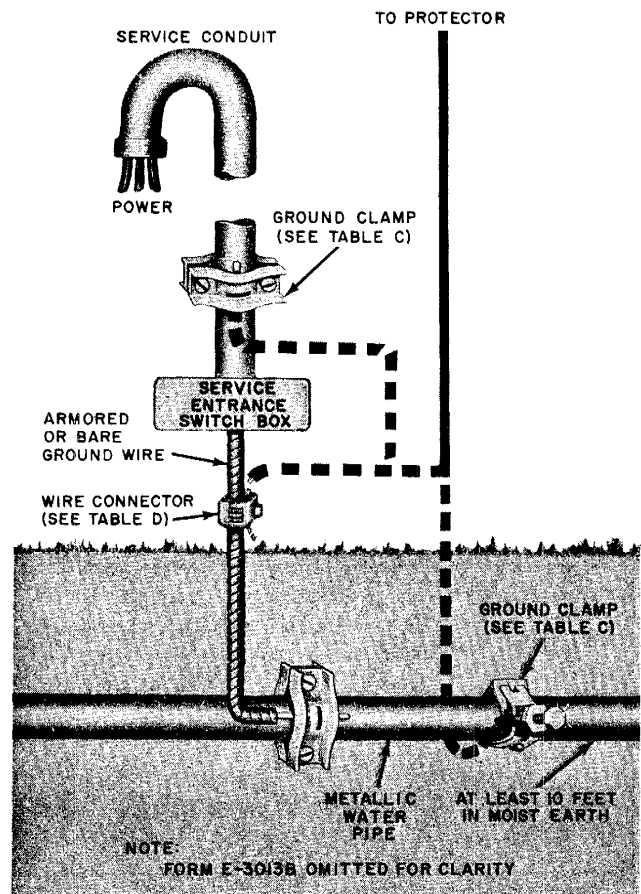
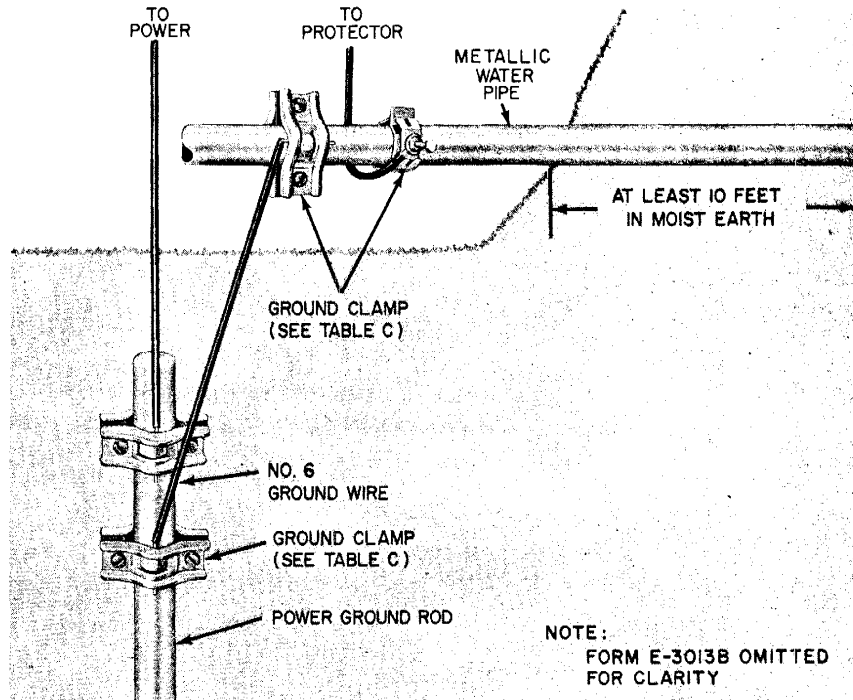
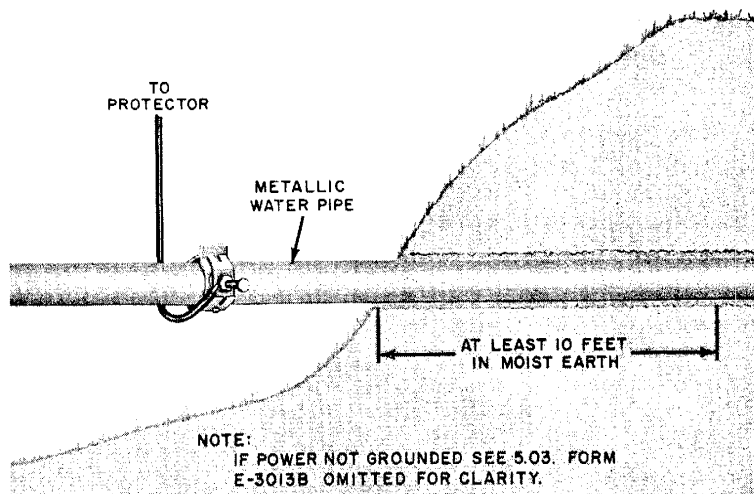


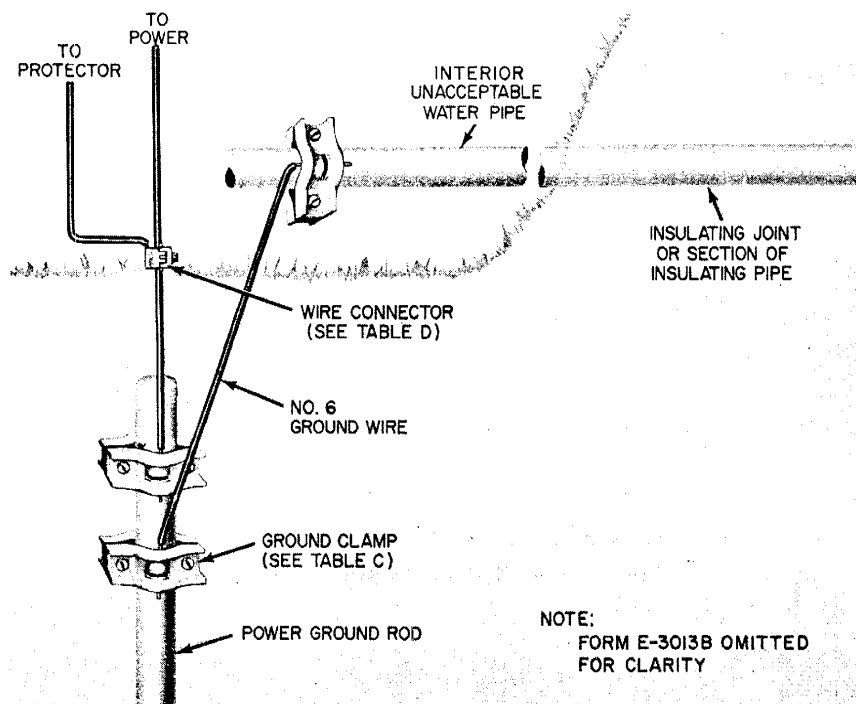
Fig. 6—Power Grounded to Acceptable Water System



**Fig. 7—Grounding to Metallic Water System—Power on Ground Rod at Premises**

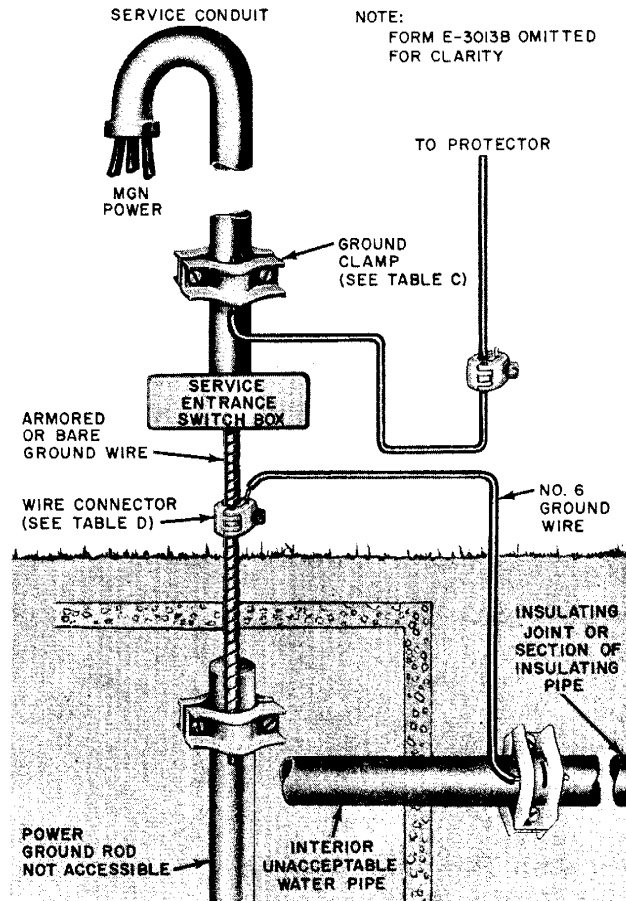


**Fig. 8—Grounding to Metallic Water System—Power if Any Not Grounded at Premises**



**Fig. 9—MGN Power Grounded to Ground Rod—Unacceptable Interior Water System**





**Fig. 10—MGN Power Grounded to Inaccessible Ground Rod—Unacceptable Interior Water System**

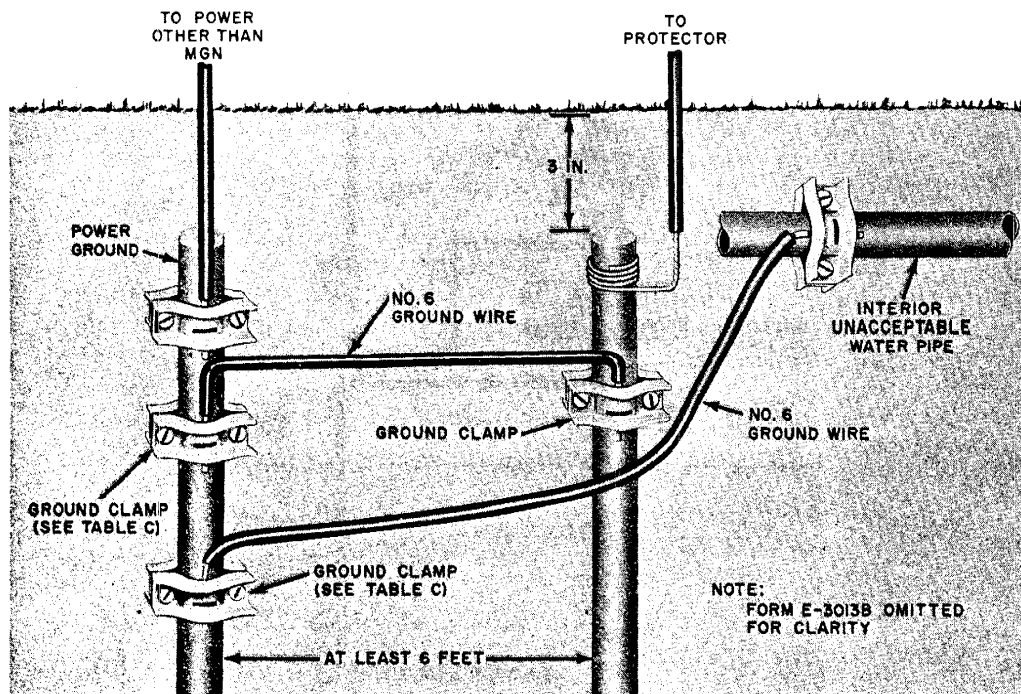
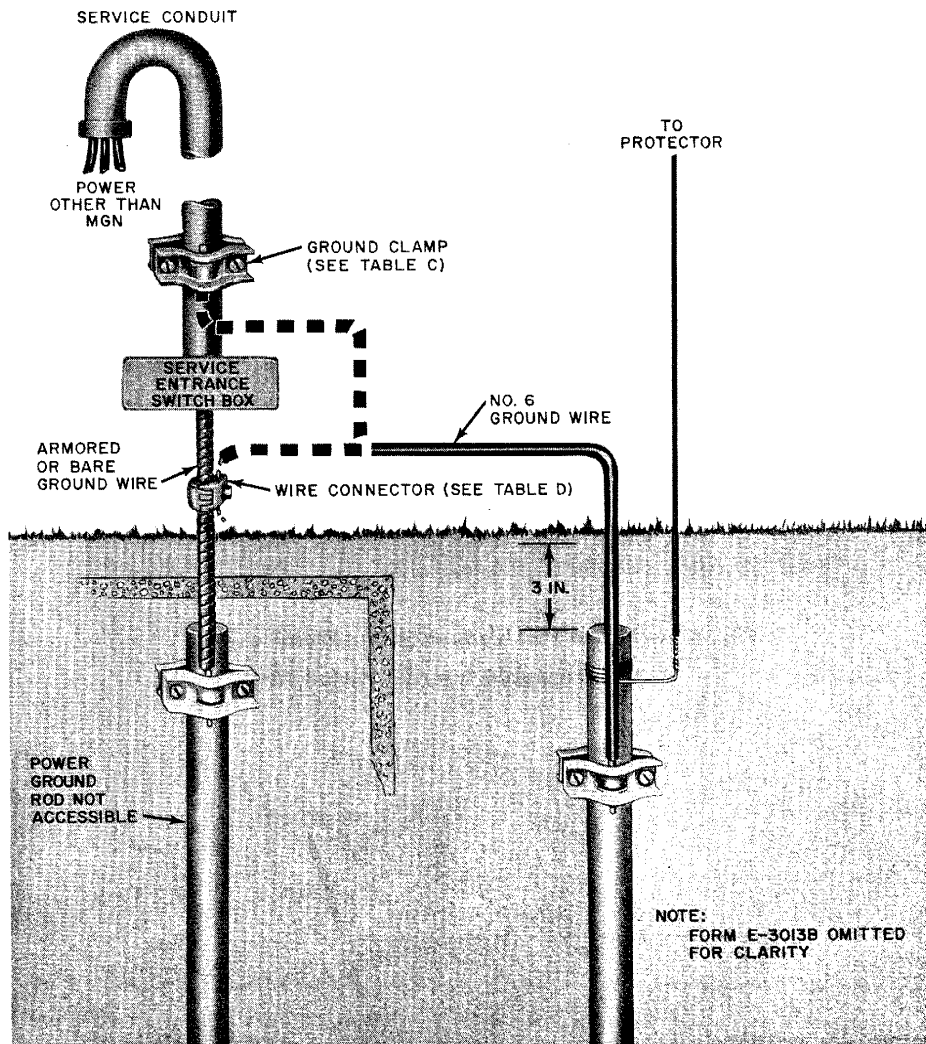
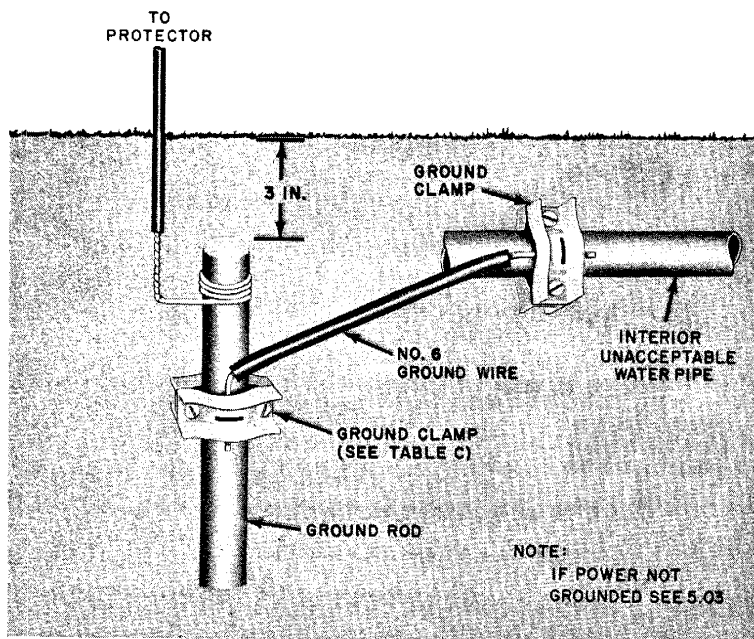


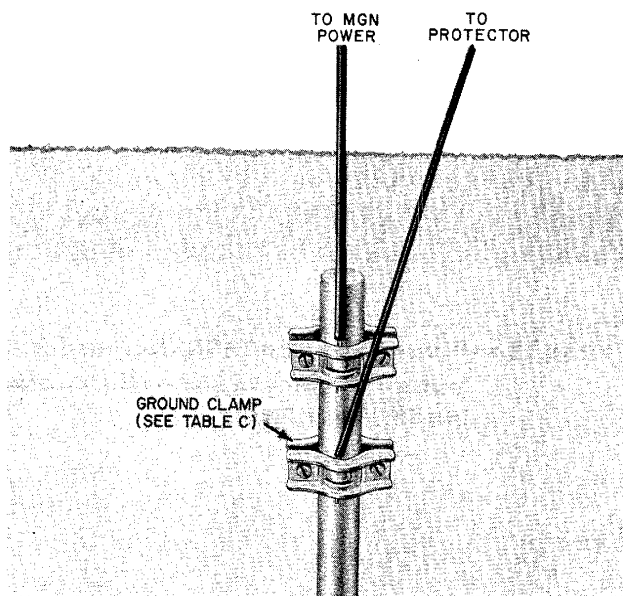
Fig. 11—Power Other Than MGN Grounded to Ground Rod—Unacceptable Interior Water Pipe



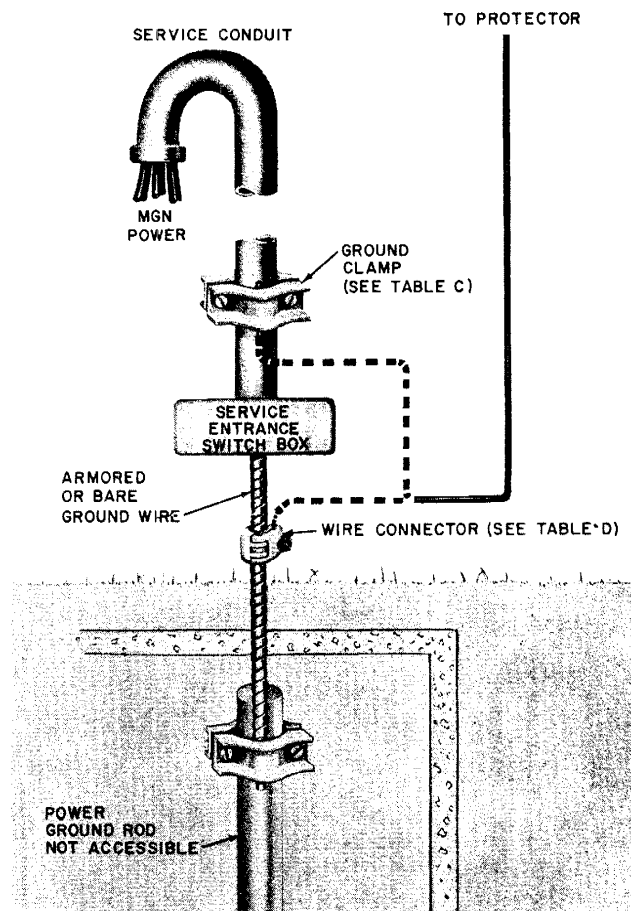
**Fig. 12 — Power Other Than MGN Grounded to Inaccessible Ground Rod — Unacceptable. Interior Water Pipe**



**Fig. 13—Power Not Grounded on Premises—  
Unacceptable Interior Water Pipe**



**Fig. 14 — MGN Power Grounded to Ground Rod —  
No Water Pipe — Connection to Pipe Not  
Possible**



**Fig. 15—MGN Power Grounded to Inaccessible Ground Rod—No Water Pipe—Connection to Pipe Not Possible**

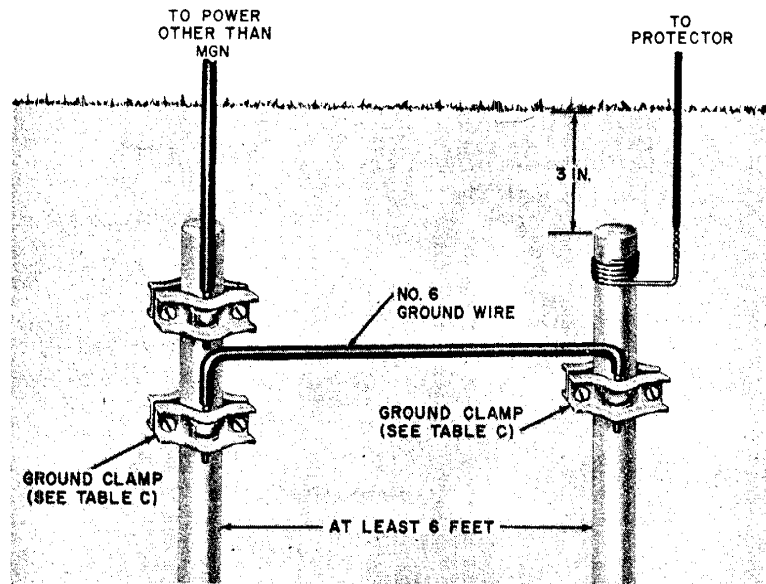


Fig. 16—Power Other Than MGN Grounded to Ground Rod—No Water Pipe—Connection to Water Pipe Not Possible

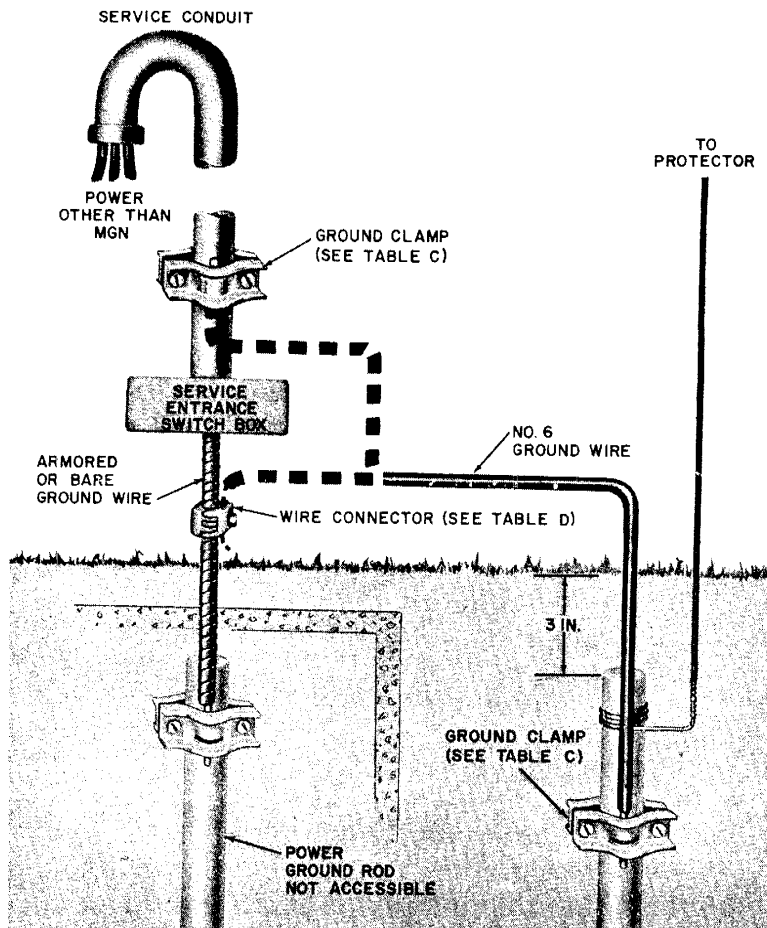
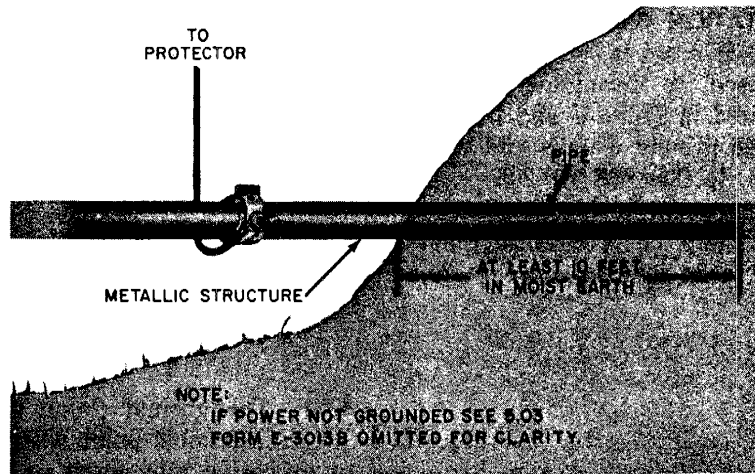
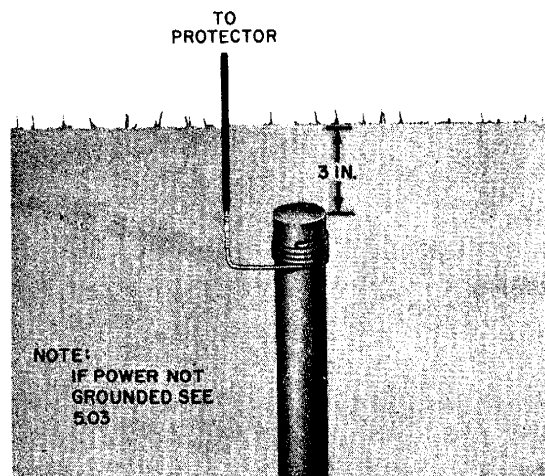


Fig. 17—Power Other Than MGN Grounded to Inaccessible Ground Rod—No Water Pipe—Connection to Pipe Not Possible



**Fig. 18—Grounding To Best Available Ground—Power Ground Rod, etc Not Available**

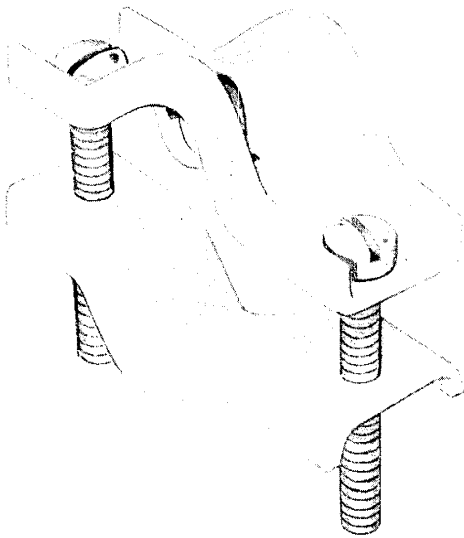


**Fig. 19—Grounding to Telephone Ground Rod—Water Pipe, Power Ground, or Metallic Structure Not Available**

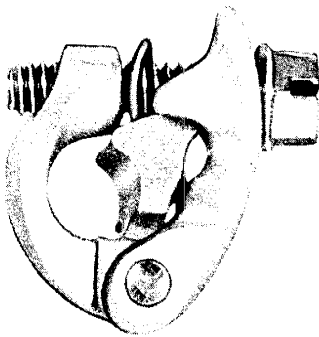
#### 4. INSTALLATION OF STATION GROUND CLAMPS

**4.01** The hardware used to terminate station ground wire is listed in Table C and D. The method of installing these ground clamps and wire connectors is outlined in Section 638-310-205.

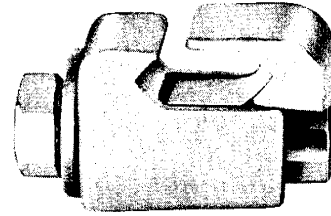
**4.02** The B Ground Clamp, E Connector, and AT-7796X Connector are illustrated in Fig. 20, 21, and 22, respectively.



**Fig. 20—B Ground Clamp**

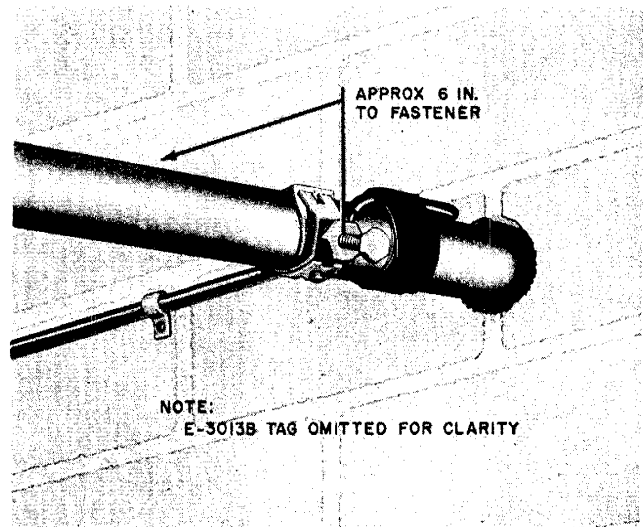


**Fig. 21—E Connector**



**Fig. 22—AT-7796X Connector**

**4.03** The ground clamp should be located at an accessible point where it will not be subject to excessive movement or vibration and where it will least likely be damaged by plumbers or other workmen. If the pipe is insecure or subject to vibrations, tape the ground wire to the pipe in close proximity to the ground clamp (Fig. 23).



**Fig. 23—Typical Ground Clamp Installation**

**4.04** Where insulating joints are found (usually at meters, pumps, valves, etc), the ground clamp should be installed at a point where the insulating joint will not break continuity to ground. Where pumps, meters, etc, may be removed for seasonal overhaul, the ground clamp should be installed at a point where the continuity to ground will not be broken.



**TABLE C — GROUND CLAMPS AND WIRE CONNECTORS**

GROUND CLAMPS	CONDUCTOR SIZE	SERVICE PIPE INTERIOR OR ABOVEGROUND SIZE (IN.)	SERVICE PIPE OR GROUND ROD (BURIED) SIZE (IN.)
72A or 90A Bracket with B Station Ground Clamp Size 6-3/4		3/8 through 1-3/4	
72A or 90A Bracket with B Station Ground Clamp Size 12-1/2		1-7/8 through 3	
B Station Ground Clamp Size 6-3/4	No. 14, 12, or 10	3/8 through 1-3/4	3/8 through 1-3/4
B Station Ground Clamp Size 12-1/2	No. 14, 12, or 10	1-7/8 through 3	1-7/8 through 3
B Ground Clamp	No. 8, 6, or 4	1/2 through 1	1/2 through 1
L Ground Clamp	Small opening No. 6 Large opening No. 4 through 1/0	3/8 through 3	

**TABLE D — WIRE CONNECTORS**

GROUND CLAMPS	WIRE CONNECTOR	CONDUCTOR SIZE
E Connector Size 1	—	No. 14 through 4
E Connector Size 2	—	No. 4 through 1/0 and 8 through 4 armored bare wire
—	AT-7796X Connector Size 6	No. 14 through 6
—	AT-7796X Connector Size 4	No. 8 through 4
—	AT-7796X Connector Size 2	No. 6 through 2

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**4.05** Make certain that the surface of the metallic pipe to which the ground clamp is being fastened is free of paint, rust, etc.

**4.06** The E-3013B Form (Fig. 24) should be placed at all ground wire terminations to warn people not to disturb the clamp or wire.

**4.07** The E-3013B Form is attached to the B Station Ground Clamp by placing the elongated slot over the hexagonal screw (Fig. 25). An alternate means of attaching the E-3013B Form is to insert the B Station Ground Clamp through the elongated slot before it is attached to a pipe (Fig. 25). The E-3013B Form is attached to other ground clamps with station wire or its equivalent.

**Note:** After the installation is complete, check the ground clamps to be sure that the E-3013B Form has been placed.

### 5. BONDING OF POWER AND TELEPHONE GROUNDS

**5.01** The selection of protector grounds listed in Table B and illustrated in Fig. 4 through 19 is intended primarily to provide the best available ground for the telephone protector. It is also intended to accomplish bonding between the power and telephone grounds where there is a choice of acceptable grounds. Fig. 26 illustrates the necessity for bonding.

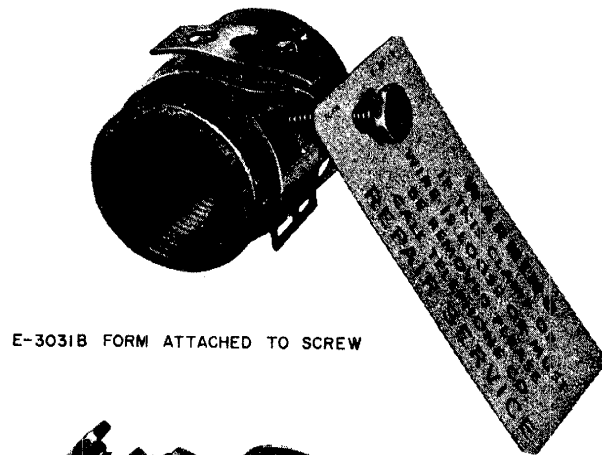
**5.02** When a situation exists where the power and telephone grounds are not common, the following corrective arrangements should be made:

(a) If an acceptable public or private water system is available and the power service is grounded to a ground rod, connect the telephone protector to the metallic water system. In addition, a No. 6 Station Ground Wire should be bonded to the interior metallic water pipe and the power ground rod.

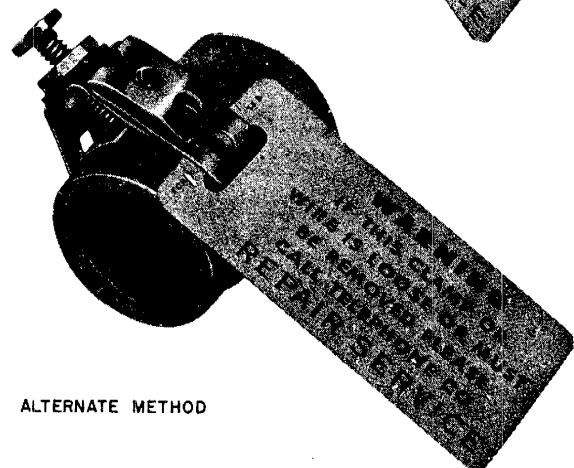
(b) If the power service and the telephone protector are connected to separate ground rods, bond the two rods together as shown in Fig. 11 and 12.



Fig. 24—E-3013B Form



E-3013B FORM ATTACHED TO SCREW



ALTERNATE METHOD

Fig. 25—E-3013B Form Attached to B Station Ground Wire Clamp

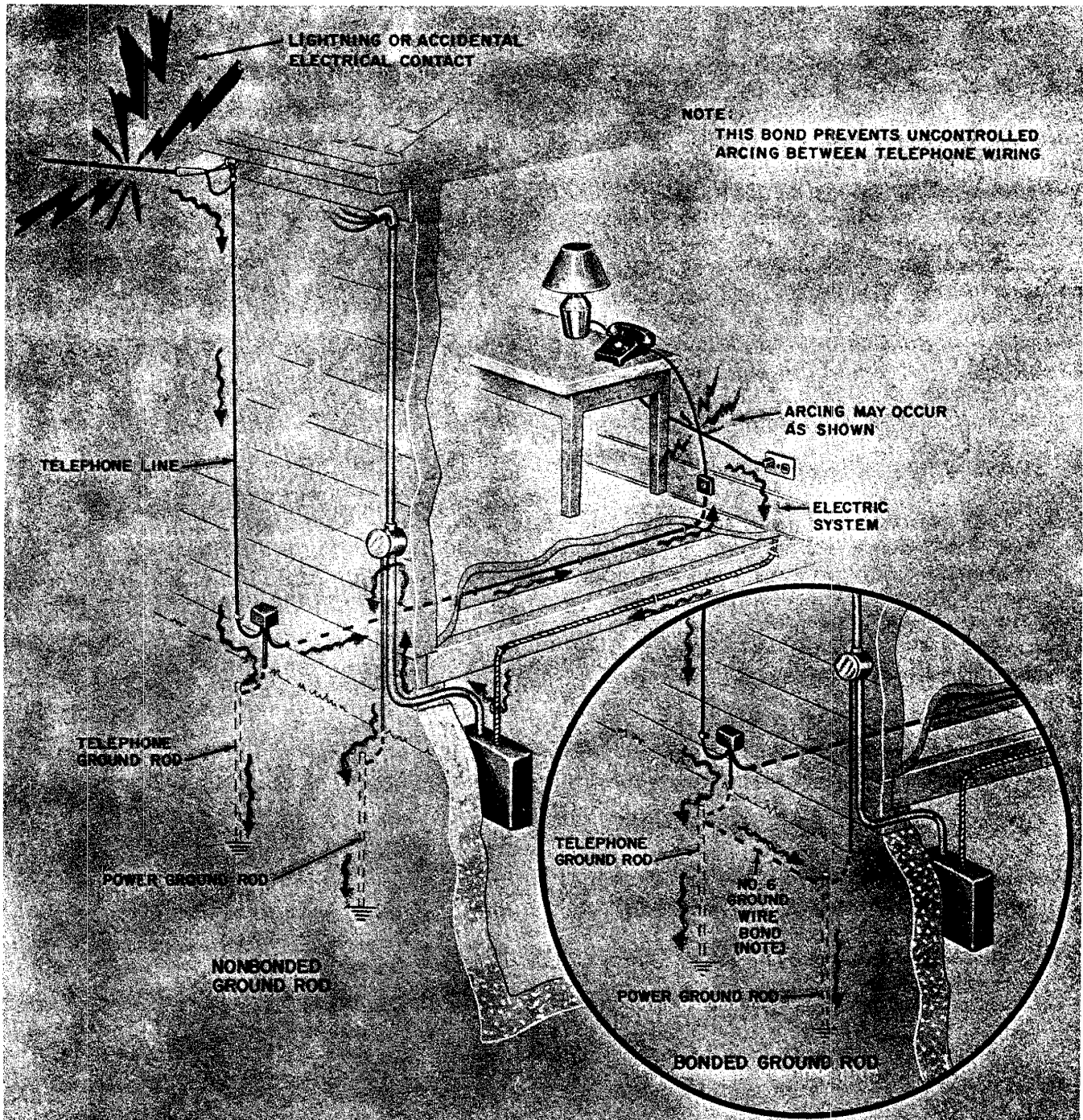


Fig. 26—Effects Of Bonding

**5.03** The customer's telephone service may be installed where a power ground is not provided. However, the customer should be informed immediately of the need for a power ground and should be requested to notify the telephone company when the ground has been provided. *The procedure for notifying the customer shall be covered by local instructions.* Where telephone service is already being furnished and there is no power ground, the same procedure should be followed. When installing telephones at contractor shacks, trailers, etc. and an acceptable metallic cold water pipe is not available, the telephone protector must be connected to a telephone ground rod. This ground rod must be bonded to a power ground rod as soon as the power ground rod has been installed and connected.

## 6. SELECTION OF SIGNALING GROUND

**6.01** When selecting the signaling ground, the protector ground may be used. Do not use the signaling ground for protector grounding unless the station ground wire and grounding medium meet the requirements for protector grounding as covered in Part 3. Ground strips connected to grounded sheath cables are suitable for signaling grounds.

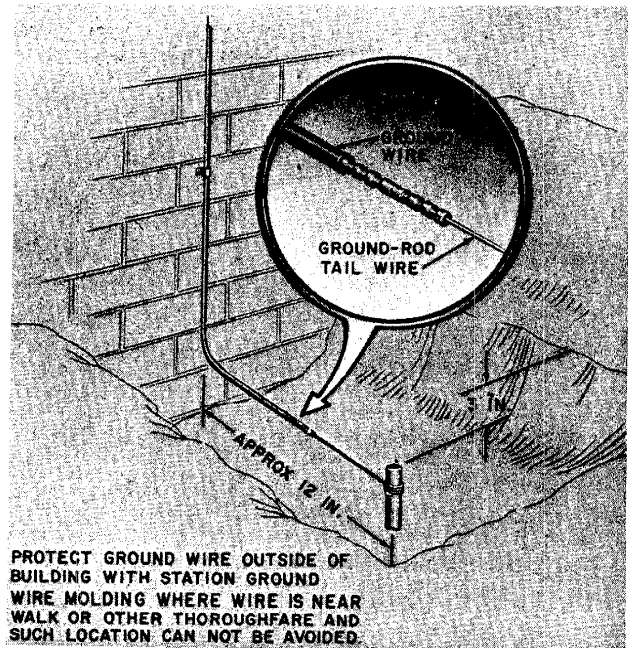
**Note:** Sections 638-310-100 and 638-310-105 cover the description and use of ground strips.

## 7. LOCATING AND INSTALLING GROUND RODS

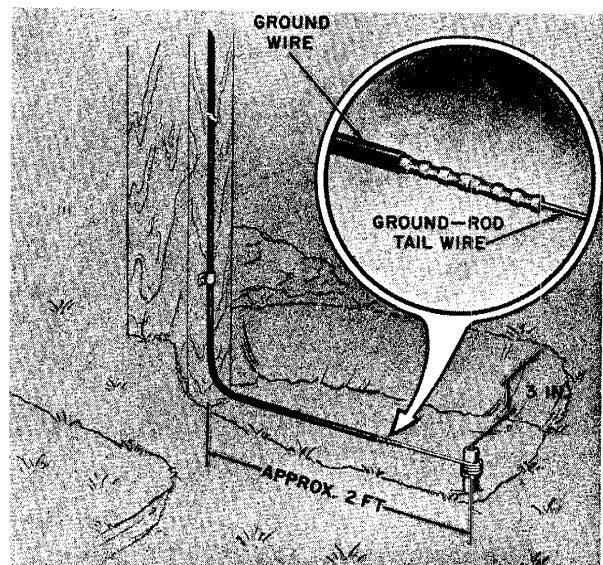
**Caution:** *Avoid personal injury by protecting eyes and hands when driving ground rods.*

**7.01** Locate and install ground rods as follows:

- (a) Where least likely to be damaged or tampered with.
- (b) As near as practical to masonry walls in earth-floor basements.
- (c) Approximately 12 inches from outside wall (Fig. 27).
- (d) Approximately two feet from base of wooden poles or posts where conditions permit (Fig. 28).



**Fig. 27—Ground Rod Installation Near Wall**



**Fig. 28—Ground Rod Installation Near Pole**

- (e) At least 6 feet from power service ground rod.
- (f) Do not unspiral the tail wire attached to the ground rod until the driving operation is complete.
- (g) Drive ground rods until the top of the rod is approximately 3 inches below ground level (Fig. 27 and 28). Increase depth where damage from digging is likely.
- (h) If the vertical or horizontal station ground wire run is located so it can be damaged or tampered with and such a location cannot be avoided, protect the ground wire with station ground wire molding.

**7.02** Inspect ground rods before and after driving to make certain that tail wires are not broken. If the tail wire is broken replace with another rod or use a ground clamp of the proper size as listed in Table C.

**7.03** After the ground rod is installed, No. 14 station ground wire is spliced to the tail wire with a 0.064 brass sleeve. Press the sleeve 6 times, 3 times each side of center (Fig. 27 and 28). Do not tape splice. When a larger size of ground wire must be terminated on the ground rod, select the proper size and type of ground clamp as listed in Table C.

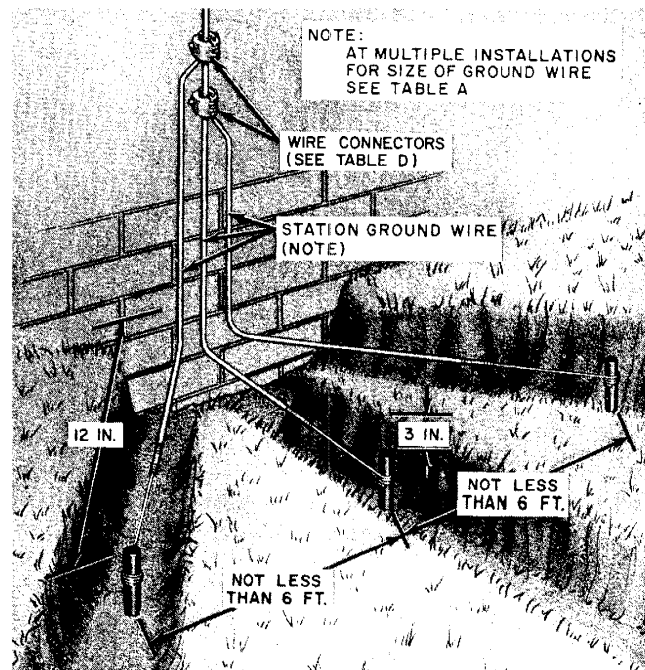
**7.04** When two or more protectors requiring ground rods are installed at the same location proceed as follows:

**Note:** Use the proper size station ground wire as listed in Table A.

- (a) If a power ground rod is not available, install a ground rod for each protector. Bond all protectors together. No more than 3 ground rods need be placed. Place station ground wire from each ground rod as shown in Fig. 29.

- (b) If a power ground rod is available, one telephone ground rod is sufficient. Bond all protectors together and bond telephone ground rod to power ground rod (Fig. 11).

**7.05** Multiple station protectors, such as the 109, 116, or 117 type, may be connected to any of the grounds shown in Fig. 6 through 18 but should not be connected to a single telephone ground rod unless the rod is bonded to the power system ground rod. If a power ground rod is not available, a multiple station protector may be connected to an array of three telephone ground rods, spaced at least 6 feet apart and bonded together with No. 6 station ground wire (Fig. 29).



**Fig. 29—Three Ground Rods**