

GROUNDING

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2. GENERAL

2.1 Scope

2.11 This section covers the methods and requirements for installing a protective grounding system at telephone equipment locations. It also includes information on grounding against inductive and capacitive coupling between circuits (shielding) and grounding of outer protective metal covers as a measure of safety for personnel against accidental contact with hazardous potentials.

2.2 Designating

2.21 Refer to Handbook 39 for supplementing information on designating ground leads. When 145-C numbering plates are used, refer to Section 6A of this handbook for method of tying.

2.22 Special "Do Not Disconnect" designation for "A" Lead is described under "Office Ground - "A" Lead."

2.3 Job Information

2.31 Where unusual or more stringent grounding requirements are given on drawings or in job papers they take precedence over these general instructions.

2.4 Sleeves

2.41 Short lengths of conduits or raceways used as sleeves are exceptions to the general grounding requirements and need not be grounded.

2.5 Definitions

2.51 Grounding is effected by electrically connecting apparatus or equipment to earth either directly or indirectly.

2.52 Bonding in a telephone office is used to assure a low impedance path between two points that are grounded.

2.53 Frames as used herein, refer to all power bays, frames, cabinets, frameworks with or without casings, unless specific types of frameworks or frames are referred to.

3. INSTALLING EQUIPMENT

3.1 Tools

3.11 Tools in the 32 kit, 102 kit or 3 kit, depending on the size of the job, are normally provided and are adequate for use with this section.

3.2 Supplies

<u>Code</u>	<u>Description</u>
R-3163	Abrasive Paper
R-3266	Compound, NO-OX-ID "A"
Obtain Locally	Muslin
Obtain Locally	Paint, Black Asphaltum

4. BONDING - GENERAL

4.1 Bond any power company ac service ground on the premises to the telephone ground if they are different (for example, driven grounds). This may be done by direct connection or by bonding equipments to which the two grounds are connected. To ground by direct connection, connect the bond lead between the telephone ground electrode at one end, and the grounded neutral in the principal power service cabinet at the other end. In the absence of a grounded neutral, connect to the service conduit on the supply side of the cabinet. If the service conduit is to be used, determine that it has been grounded by the power company. Use the same size lead as that specified in Table A for Lead "A".

4.2 A driven pipe or driven rod ground system should be bonded to any local water supply system in the building not suitable as a sole ground for the telephone office. Use a No. 6 lead or a lead the same size as that specified in Table A for Lead "A", whichever is larger.

TABLE A - SIZE OF LEAD "A"
(Pars. 4.1, 4.2, 5.31, 5.45)

Office	Ultimate No. Lines & Trunks	Min Size of Lead "A"	
		If Water Pipe or Tube	If Driven Ground
Telegraph or Repeater	All Sizes	No. 0	No. 0
Central Offices	Above 1500	No. 0	No. 0
Central Offices	201-1500	No. 6	No. 6
Central Offices	0-200	No. 6	★104 loop or No. 6
★The 104 lead is 104 copper line wire (0.104-inch diameter).			

4.3 Prepare surfaces to which the straps or clamps connect by cleaning with a flat file or abrasive paper. Coat with a thin film of NO-OX-ID "A" compound. When making connections to aluminum pipes, rods, conduits, etc., continue the preparation by further abraded the surface using a wire brush without removing the compound.

Determine contact surfaces of clamps and straps are clean and apply a thin film of NO-OX-ID "A" compound. Assemble and tighten securely all connections. Remove excess compound and refinish where necessary to match adjacent metal.

4.31 Preparations of intermediate connections between wire and lug, and lug and clamp, etc., are covered in the seven series of handbook sections.

4.4 Bonding required in connection with the "A" Lead is covered under "Office Ground - "A" Lead.

5. CENTRAL OFFICE GROUND - "A" LEAD

5.1 General

5.11 Lead "A", the principle office ground, carries lightning discharges brought into the building by outside wiring to the office Ground Electrode. Special installing methods are required to accomplish this function. Lightning currents include frequencies high enough to be seriously impeded by inductance caused by iron near Lead "A". Lead "A" is therefore bonded to conduit and cable rack to keep the discharge from arcing to them. The frequencies involved are not so high, however, that they cause arcing at a turn in Lead "A" if it is not less than the minimum bending radius requirement set forth by the National Electrical Code.

5.12 Locate unburied ground connections so that they are accessible for inspection.

5.13 Ground Lead "A" may be insulated or bare.

5.2 Ground Electrodes

5.21 Do not use gas supply pipe for the office ground.

5.22 Use a continuous metallic underground public water system or a private water system with at least 25 feet of buried metallic pipe.

5.23 There is a trend toward the use of nonmetallic (plastic) pipe in the buried connection between the water main or the well and the building. Make sure that metallic pipe has been used before deciding to ground to the water system.

5.24 If the water system is unacceptable use a driven ground provided by the operating company consisting of 3 driven pipes for Central Offices, PBX's and Telegraph or Repeater stations. For Central Offices or PBX's of 200 or less ultimate lines and trunks 3 driven rods are satisfactory.

5.3 Running

5.31 Run Lead "A", which shall be continuous without joints (see Figures 1, 2, or 3) from the principal equipment room ground bar (usually on the

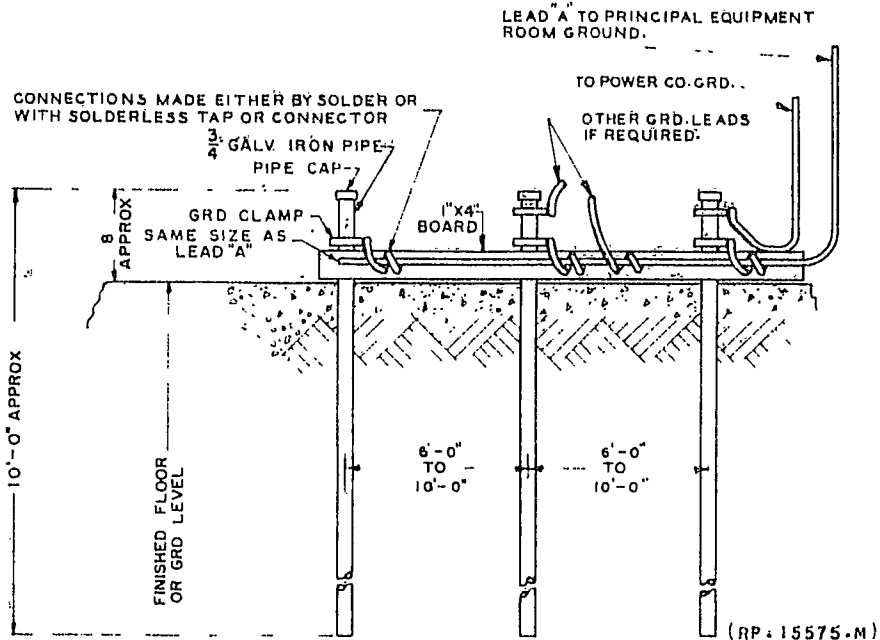


FIG. 1 TYPICAL ARRANGEMENT OF GROUND LEADS TO PIPES DRIVEN IN BASEMENT (PAR. 5.31)

distributing frame mounting the protectors) to the ground electrode as direct as practicable and install in a manner to protect it from mechanical injury. The minimum lead size is shown in Table A. Lead "A" may be either insulated or bare and may be run in conduit, on cable racks, partly in conduit and partly on cable racks, or open.

5.4 Bonding

5.41 Any portion of lead "A" that is run in conduit shall be bonded to each end of the conduit and any portion of lead "A" run on a cable rack shall be bonded to each end of that part of the cable rack so used. See Figure 4. Exceptions are as follows.

5.411 The "A" Lead need not be bonded to the cable rack if the rack is five foot or less in length.

5.412 701-B PBX's are usually provided with piece-parted lengths of over-frame cable rack associated with each bay, the ends of which are not joined with edge clamps. When these lengths of rack support the "A" Lead they do not require bonding one to the other.

5.413 If the cable rack or conduit supporting the "A" Lead is metallically fastened to the ground electrode or framework to be grounded, and the last point of support on the cable rack or end of the conduit is within one foot of the termination of Lead "A", at this location no bond from Lead "A" to cable rack or conduit is required.

5.42 If the length of Lead "A" between the conduit and cable rack is run open, and requires independent support, use

separate parallel connectors as shown in Figure 4 bottom view left and right. In most cases the conduit will terminate near the cable rack and Figure 4 bottom view middle will apply.

5.43 To Lead "A" connect a No. 6 A.W.G. bond wire with a correct KS-5537 parallel connector. Drill the stringer of the cable rack on which Lead "A" is run. Secure the bond wire to a KS-5517 L-R lug and secure the lug to the cable rack with a 1/4 x 20 bolt, nut and washer. Connect to conduit with a GC-104 clamp or by connecting directly using one of the following T & B Condulet Hubs.

Catalogue	Conduit Size	Wire Size
3930	1/2"	8-2
3940	3/4"	8-2
3950	1"	8-000

See Table B.

5.44 Preparation of contact surfaces and connecting information are listed under "Bonding - General".

5.45 Where it is not feasible or economical to connect the "A" Lead to the street side of the water meter provide a bond around the meter and any gauges, valves, unions, etc., as shown in Figure 5. If the water meter has a by-pass arrangement similar to Figure 6 the bond is not required. Install the water meter bond in a manner similar to Lead "A", i.e., lead size, pipe clamps, lugs, etc. See Tables A and B.

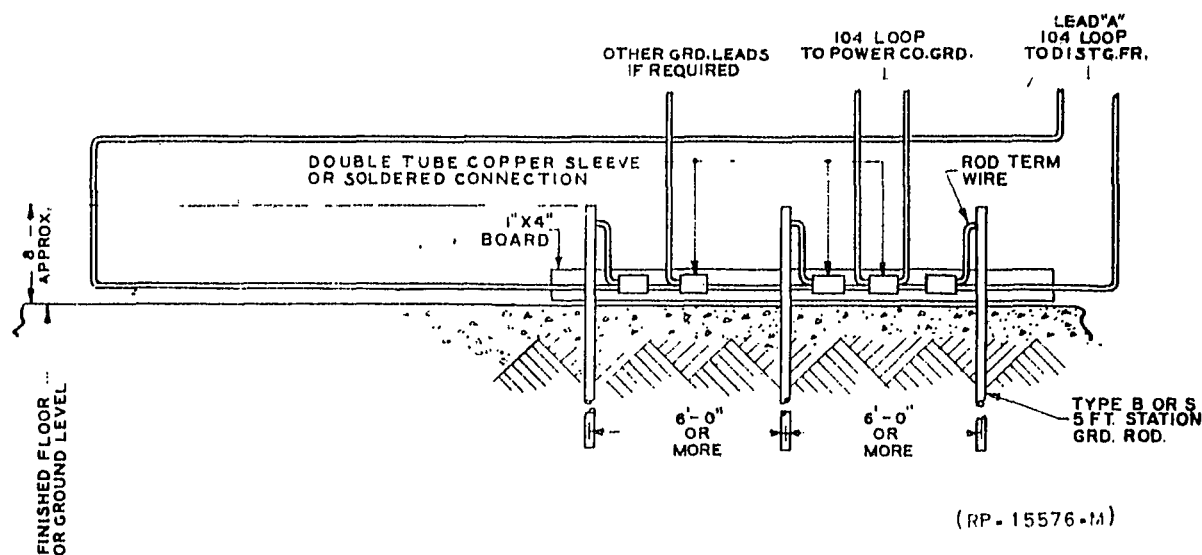


FIG. 2 TYPICAL ARRANGEMENT OF GROUND LEADS TO RODS DRIVEN IN BASEMENT
(Par. 5.31)

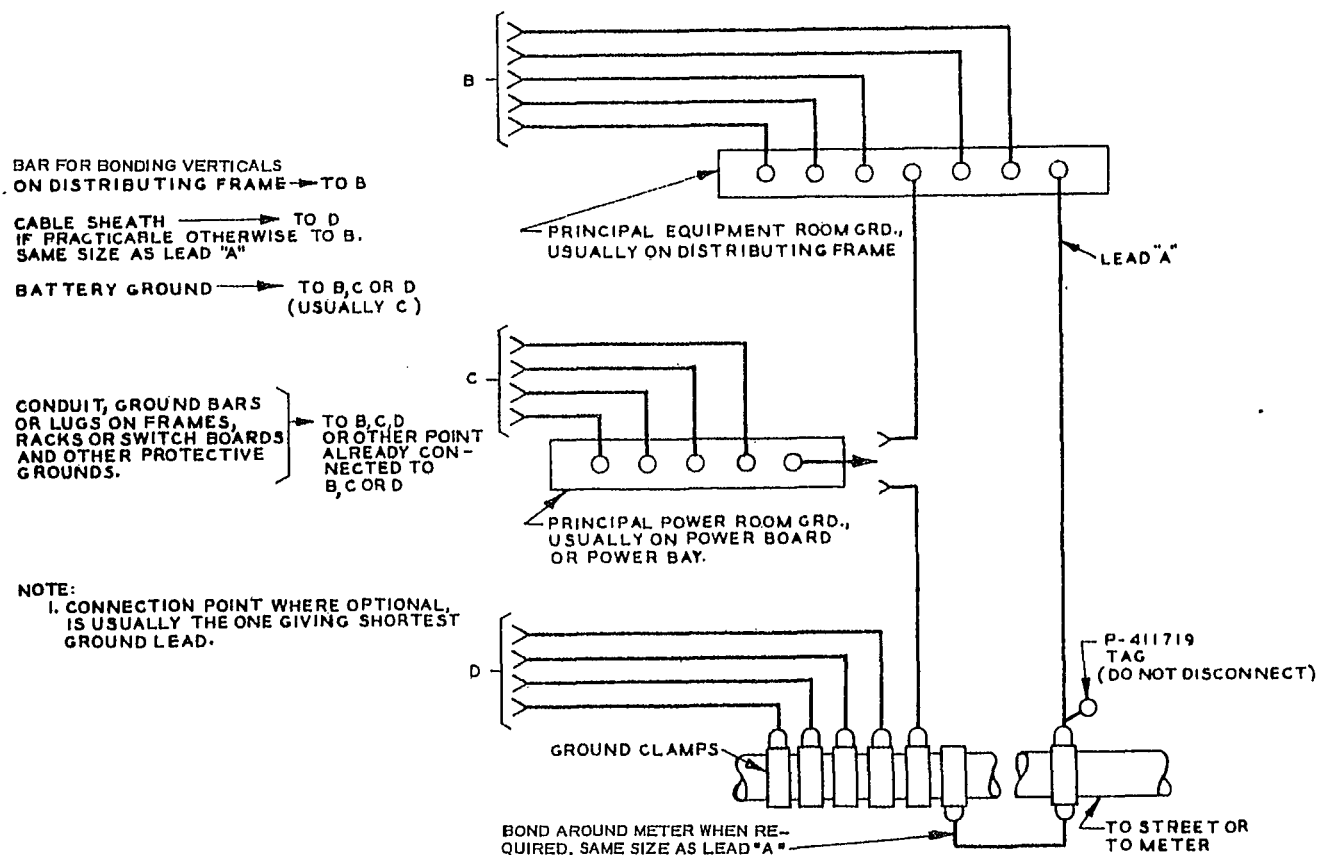
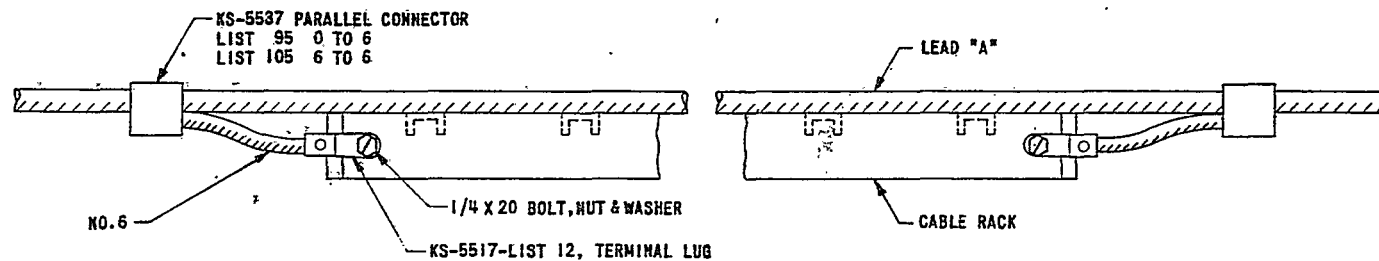
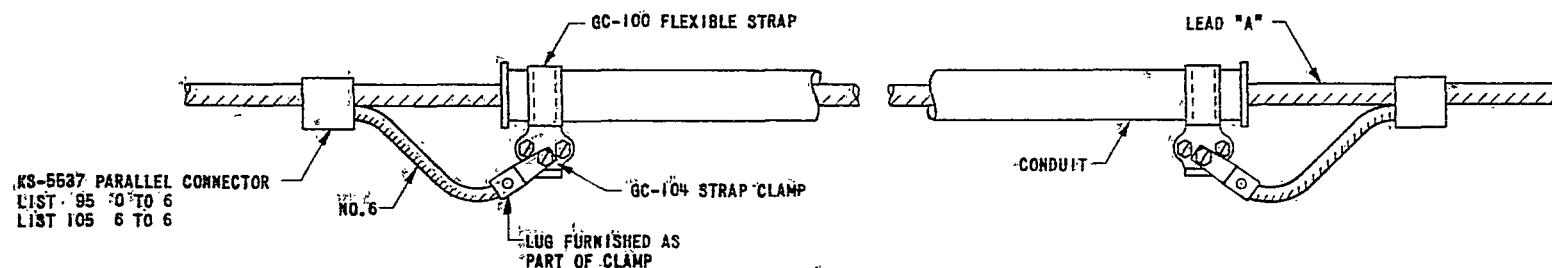


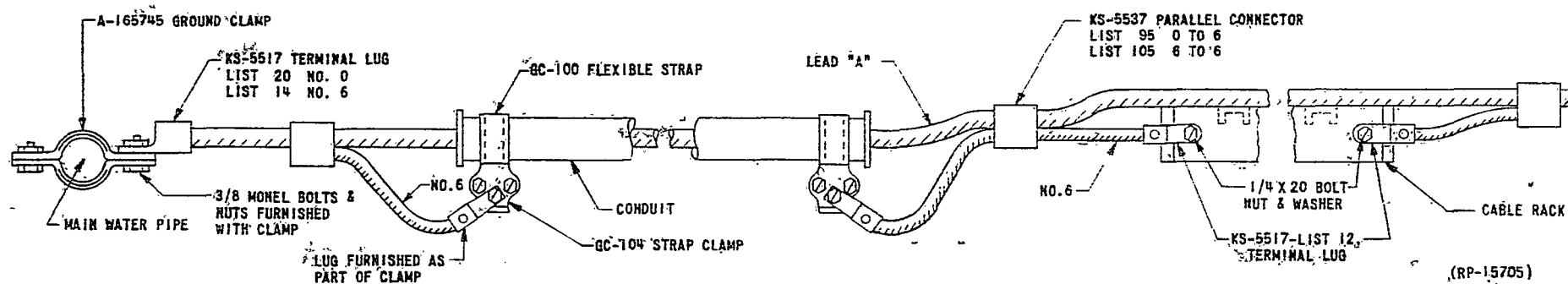
FIG. 3 TYPICAL ARRANGEMENT OF GROUND LEADS TO WATER PIPE (SEE ADDITIONAL FIGURES)
(PARS. 5.31, 5.55, 7.1)



(LEAD "A" ON CABLE RACK)



(LEAD "A" IN CONDUIT)



(LEAD "A" - PARTLY IN CONDUIT, PARTLY ON CABLE RACK)

(RP-15705)

FIG. 4 BONDING OF LEAD "A" WHEN RUN IN CONDUIT, ON CABLE RACK, OR BOTH (PARS. 5.41, 5.42)

TABLE B
CLAMPS, STRAPS AND LUGS FOR DRIVEN GROUND, WATER PIPE AND TUBE, AND CONDUIT GROUND
 (PARS. 5.43, 5.45, 5.52, 9.4, 9.5)

★Clamp (Note 3)	Fig.	Rigid Conduit or Water ID. Pipe Size (in Inches)	Armored Cable & Lead Covered Wire	Copper Water Tube I.D. (size in Inches)	Wire Termination	
					Lead Size	Solderless Lug.
★A-165745 (Note 1)	8	1/2 to 14	-	1/2 to 12	8 to 6 4 to 1 1/0 to 4/0	KS-5517 L-14 KS-5517 L-18 KS-5517 L-20
GCE014 ★GCE014 Everdur	9	1/2 to 4	-	1/2 to 4	8 to 6 4 to 1 1/0 to 4/0	KS-5517 L-13 KS-5517 L-17 KS-5517 L-20
GCH91 ★GCH91 Everdur	7	1/2 to 1	-	1/2 to 1	8 to 4 & 2 solid	None Required
GC104 (Note 2)	10	1/2 and larger	Any number	1/2 and larger	14 to 4 4 to 1	Burndy KPA 4C Lug provided as part of clamp. KS-5517 L-16 with P-65480 H.H.C.S. and P-160739 washer. All ordered separately.

★ All clamps may be used for conventional grounds such as conduit grounding but only those marked with an asterisk may be used on water pipe, water tubing, driven ground rods or ground pipes, when used as an "A" ground.

NOTE 1: When ordering clamps per W. E. Drawing A-165745, specify whether iron pipe or tubing and nominal size (I.D.).

NOTE 2: Clamp used with GC-100 copper strap (length as required).

NOTE 3: GC numbers refer to Crouse Hinds catalogue numbers.

5.5 Terminating

5.51 When using a public water system for ground, connect Lead "A" on the street side of the meter and close to where the pipe enters the building. Where it is not feasible or economical to connect to the street side of the meter, any convenient point on the water main may be used, however, a bond around the meter may be required. See paragraph on "Bonding" and Figure 3.

5.52 Lugs for the "A" lead at the water pipe or driven pipe and rods are listed in Table B and shown in Figures 7 and 8, also Figure 9 when made of "Everdur." At the equipment end of the "A" Lead conventional lugs per KS-5517 are used.

5.53 Preparation of contact surfaces and connecting information for the "A" Lead are listed under "Bonding - General" since the instructions for both are the same.

5.54 Just before treating connections that are to be buried verify all solderless and solder type connectors electrically and mechanically in accordance with applicable handbook sections. Paint the upper part of the pipe or rod, the clamp, and the connection to the ground lead (soldered joint, solderless tap or connector, or double tube sleeve) with asphaltum paint, wrap the connection with several layers of muslin, and saturate with the paint. Allow the paint to dry before it is filled over with soil.

5.55 Brass tag P-411719 is stamped "DO NOT DISCONNECT." Except on buried connection, this tag should be affixed

to the "A" Lead as near to the connection to the grounding electrode as possible. See Figure 3. When more than one "A" Lead terminates on the ground electrode the tags should be further identified as to offices served or the floor on which the "A" Lead terminates. Stamp in appropriate size with black ink on the rear of the tag.

6. GROUND FOR PBX AND CENTRAL OFFICES WITH-OUT OUTSIDE OVERHEAD LINES

6.1 All PBX's and Central offices require a ground. If there are no outside overhead (pole supported) trunk or customer lines connected to the PBX or Central office, an office ground is required, but the special requirements on bonding, bending radius, etc., associated with the "A" Lead are not required.

7. BATTERY GROUNDING

7.1 Unless otherwise covered on job drawings, the lead size for grounding one side of the office battery should be the same as Lead "A". Run either from the battery or from a point on the discharge ground lead or bar, not further from the battery than the battery control board, to the distributing frame, power room ground, or central office ground electrode, whichever is more economical. If run to the water pipe, connect near the meter or water entrance except that if the building is of steel frame construction, the connection may be to any submain of sufficient importance to insure that it will not be cut out of service. (See Figure 3)

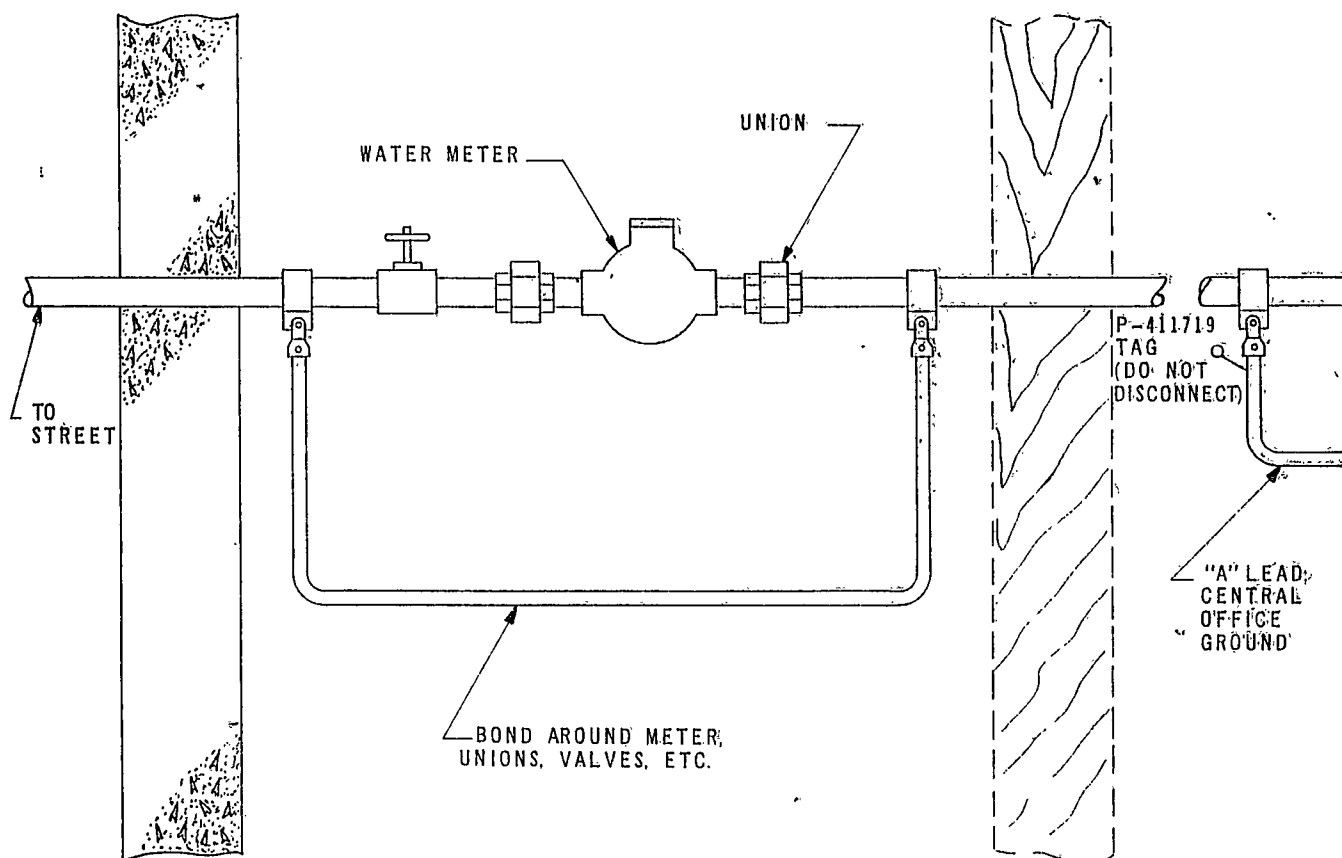


FIG. 5 WATER PIPE GROUND ARRANGEMENT WHERE IT IS NOT FEASIBLE OR ECONOMICAL TO CONNECT "A" LEAD TO STREET SIDE OF METER AND BOND IS REQUIRED (PAR. 5.45)

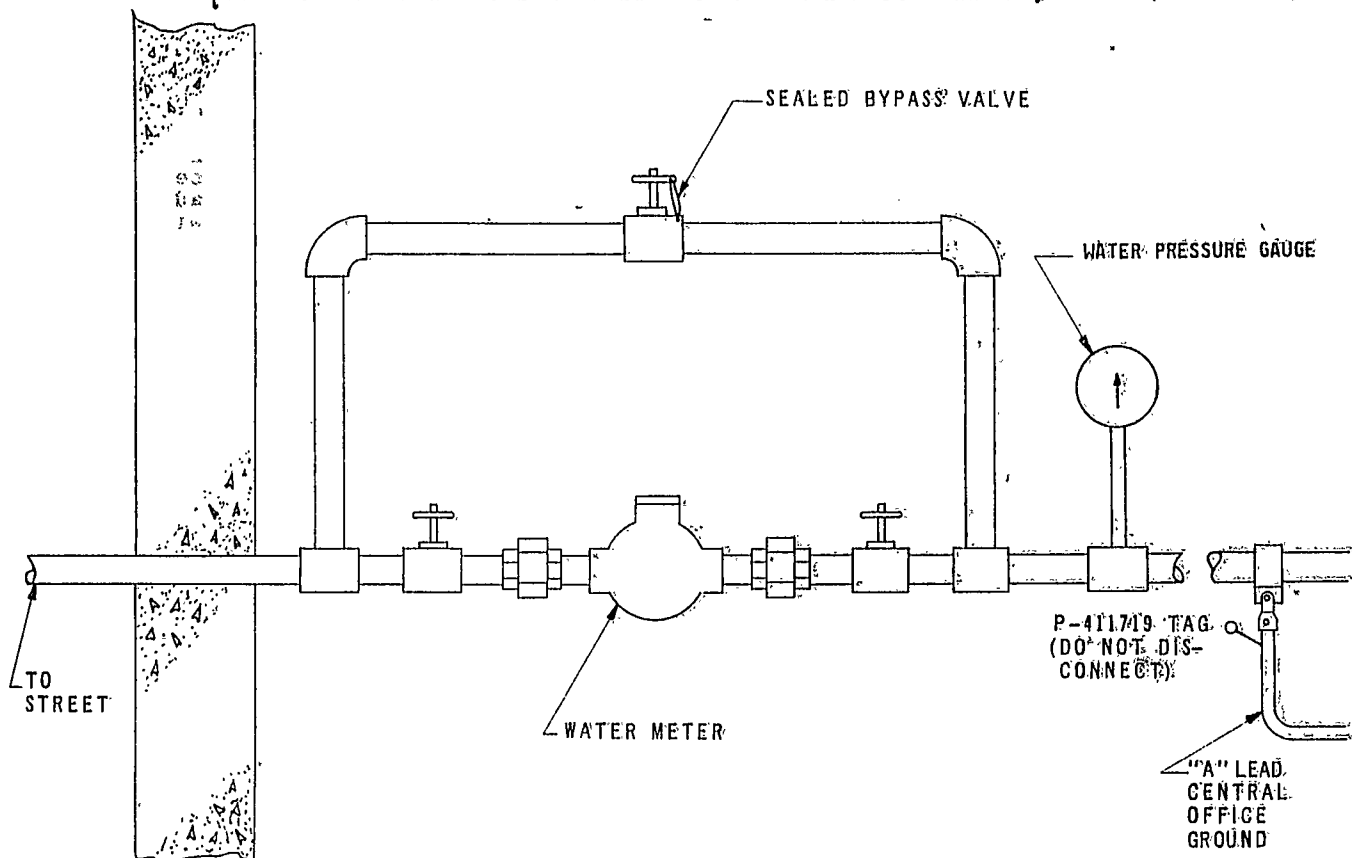


FIG. 6 WATER PIPE WITH BYPASS ARRANGEMENT. GROUND CONNECTION WHERE WATER METER IS OUTSIDE OF BUILDING OR WHERE IT IS NOT ECONOMICAL TO CONNECT "A" LEAD TO STREET SIDE OF METER, AND BOND AROUND METER IS NOT REQUIRED. (PARS. 5.45)

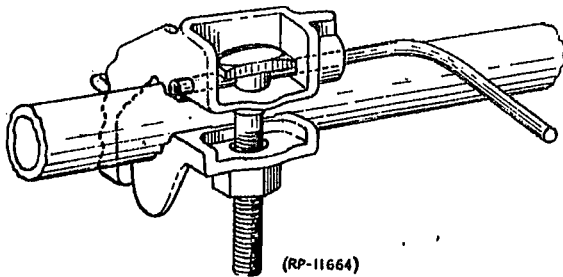


FIG. 7 CAST BRONZE GROUND CLAMP (CROUSE-HINDS CAT. GCH91E) FOR 1/2" TO 1" PIPE. GROUND WIRE AWG 8 TO 4 (PAR. 5.52)

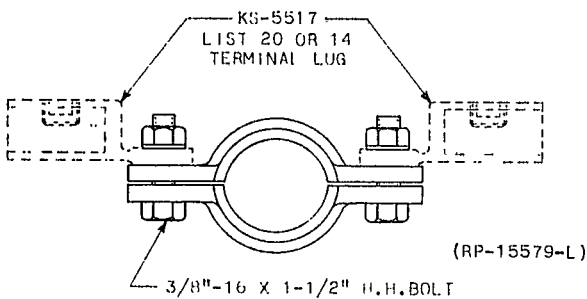


FIG. 8 BRONZE GROUND CLAMPS PER W.E. DRAWING A-165745 FOR WATER PIPE AND DRIVEN GROUNDS (PAR. 5.52)

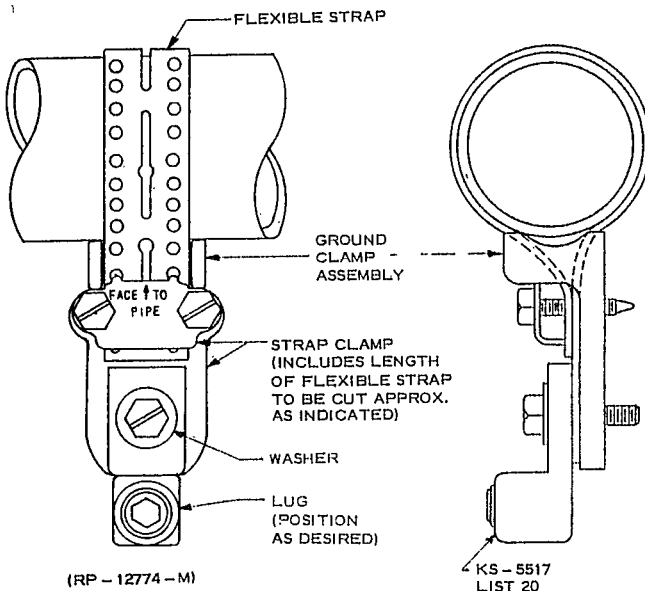


FIG. 9 FLEXIBLE STRAP GROUND CLAMP CROUSE-HINDS NO. (GCE014) FOR USE WITH GROUNDING LEAD SIZES 1/0 TO 4/0 (PAR. 5.52)

8. POWER SERVICE ENCLOSURES

8.1 Protective metallic coverings (such as conduit, armor, lead covering, raceways, boxes, fittings, cabinets and fixtures) shall be grounded. This applies to commercial and emergency service.

8.2 Underwriters' approval of these coverings and devices assures that they will extend ground to one another when mechanical connections are made up tight.

8.3 Ground is provided to the house service cabinet and ground continuity is extended to the power consuming device through these enclosures.

8.4 At locations where there are isolated sections of protective metallic coverings specified, (not bonded or connected through to ground), this condition should be referred to the Equipment Engineers who will specify the lead size and material for grounding.

9. SHIELDING ENCLOSURES

9.1 Conduit, armor, lead covering and shielded wire carrying ringing, tone or interruptions and shielded wire carrying plate supply shall be grounded at each end. Conduit and raceway carrying plate supply normally are grounded by supporting details in which case they do not require special ground connections.

9.2 Refer to Handbook 9 for detailed instruction on preparation of the shielded wire ends.

9.3 Unless otherwise specified, when shielded wires are furnished the shields shall be grounded by connecting the sleeved ground wire to the ground terminal associated with the terminals for the enclosed pair. At locations of wire ends where there are no associated ground terminals any number of sleeved ground wires may be soldered to a single No. 14 AWG ground lead. The No. 14 AWG wire should then be terminated at the ringing ground bar or grounded transformer tap if at all practicable, otherwise at any other ground of comparable or larger size.

9.4 When grounding conduit and armored cable use No. 14 AWG wire with clamping material shown in Table B and Figure 10 and connect to the nearest ringing ground bar or to the grounded ringing transformer tap if at all practicable, otherwise use any other ground of comparable or larger size. Armored cables may be collectively grounded by one clamp. Preparation of cable ends are detailed in Section 7A, however, when armored cable does not terminate in a connector the antishort bushed armor end should be served with friction tape and shellac prior to clamping.

9.5 Lead covered leads encountered in transition work should be grounded in accordance with Table B and Figure 10. Use No. 14 AWG wire for terminating, or bonding when splicing.

9.6 Where additional grounding may be required on some modification jobs, the condition should be referred to the Equipment Engineers who will specify the lead sizes and material for grounding.

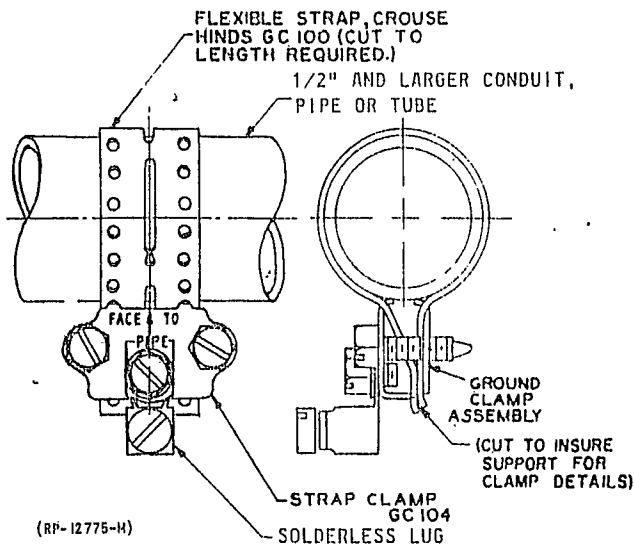


FIG. 10 FLEXIBLE STRAP CROUSE HINDS NO. GC-100 AND GROUND CLAMP CROUSE HINDS NO. GC-104 FOR USE WITH GROUNDING LEAD SIZES AWG 14 TO 1 (PARS. 9.4, 9.5)

10. TELEGRAPH, TOLL AND CARRIER STATIONS

10.1 When a ground potential compensator is not furnished, ground both the repeater filament and metallic telegraph and grounded telegraph batteries to the principal equipment room ground bar or directly to the ground electrode, except that when the telegraph ground is bonded to the filament ground by a bus or short lead (as when both panels are in the same line) the separate telegraph lead to other ground may be omitted. If the lead or leads run to a water pipe, the connection should be near the meter or water service entrance except that if the building is of steel frame construction, the connection may be made to any submain of sufficient importance to insure that it will not be cut out of service.

10.2 The grounding of J carrier auxiliary stations is covered on SD-80850-01.

10.3 The grounding of K carrier auxiliary stations is covered on SD-80852-01.

10.4 The grounding of TD-2 microwave radio relay stations is covered on SD-81094-01. When the TD-2 station derives its 130 volt supply from a power plant supplying common equipment rather than being provided with its own 130 volt plant the equipment engineer will provide a bond between the 130 volt plant ground and the TD-2 ground.

10.5 The grounding of TD-3 microwave stations is shown on SD-81805-01.

10.6 The grounding of TH radio stations is covered on SD-81384-01.

10.7 The grounding of remote TJ radio stations is covered on SD-81366-01.

10.8 Grounds for telephone cable sheaths brought into the terminal room and subject to lightning require special consideration similar to that given to the "A" Lead.

10.9 Unless job information states otherwise on TD-2, TH, TJ and other radio stations in general the No. 2 AWG ground wire around the inside building wall should be located approximately at cable rack height and above door way openings.

11. INSTALLING RING GROUND

11.1 The installation of the ring ground is shown on ED-82070-30 for TD-2 and ED-82138-30 for TD-3.

11.2 To drill the 1/8" "start hole" for the masonry nail in the concrete wall (including hardened concrete) use the R-3773 Spiral Masonry Carbide Drill. Drill this start hole to a depth not exceeding 3/4 inch. Drilling to a depth greater than 3/4 inch will considerably shorten the life of the drill. Use the R-3032 1/2" electric drill. This is a slow speed drill. The R-1285 5/16" electric drill should not be used as its speed is too fast for this application.

12. EQUIPMENT AND FRAMEWORK GROUNDING

12.1 Frames are usually grounded through superstructure, cable rack and conduit. When provided, frames may also be grounded by way of ground bars, lugs, etc., connected to circuit ground conductors. Isolated frames, including rectifiers etc., containing ac service must be grounded. The metallic enclosures containing the ac service or an additional conductor with the ac service provides this ground as does any of the above mentioned framework grounding arrangements. Otherwise, unless called for in job papers, isolated frames need not be grounded.

12.2 Frame ground bars interconnected with junction plates, should be verified for presence and tightness of junction plates. Bonding assemblies where frames are omitted shall be verified for presence and tightness.

13. MISCELLANEOUS GROUNDS - FIXED EQUIPMENT

13.1 Cabinets, rectifiers, frames of emergency alternators, motor generators, motors and other commercial or emergency power consuming devices shall be grounded through the nearest grounded conduit or signaling ground bar.

13.2 If conduit is not conveniently available, a sprinkler system permanently connected through to ground by a water pipe or by steel framework of the building, may be used for equipment grounding. Such equipment may include power boards (use a No. 6 AWG), cases and secondary windings of instrument transformers

(use a No. 12 AWG wire), metal cases of meters and relays for voltages above 150 to ground (use a No. 12 AWG wire).

13.3 Lighting fixtures connected by rubber covered cord must be grounded separately. Refer to Section 9 for verification of this ground.

➔ Arrowed lines indicate new or changed information

Vertical lines at side of paragraphs indicates requirements.

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Superintendent, Installation and
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Reason for Reissue:

- (1) To include method of installing ring ground, Paragraph 11.
- (2) To remove "A" ground requirement for PBX and Central Offices Without Outside Overhead Lines, Paragraph 6.
- (3) Minor changes.

Replaces Section 4 dated 10-19-61.