Installation of Galvanic Anodes

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Appalachian Underground Corrosion Short Course

Installation of Galvanic Anodes

- Brief Review of Fundamentals
- Normal Applications
- General Physical and Electrical Characteristics of Common Underground Galvanic Anodes
- Guidelines for Field Installations

The Galvanic Corrosion Cell

- The Galvanic Corrosion Cell Includes Four Basic Parts:
  1. An Anodes
  2. A Cathode
  3. A Metallic Path between the Anode and the Cathode
  4. A Conducting Electrolyte
- There will be no corrosion unless current flows between the Anode and the Cathode.

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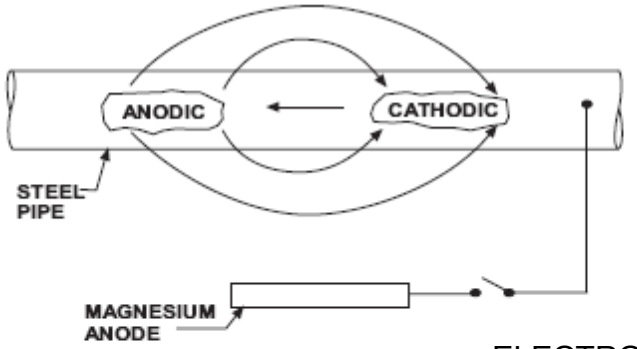
Coatings and Electrical Isolation

- Holidays are Scrapes, Gouges, Pinholes, Rock Penetrations, etc.
- Holidays are expected in any coated pipeline.
- The result of Holidays are that a small area of pipeline becomes exposed and needs to be cathodically protected.
- Galvanic Systems could cathodically protect several hundred feet of a coated structure.

"OPEN CIRCUIT" ANODE IS NOT RECOGNIZED

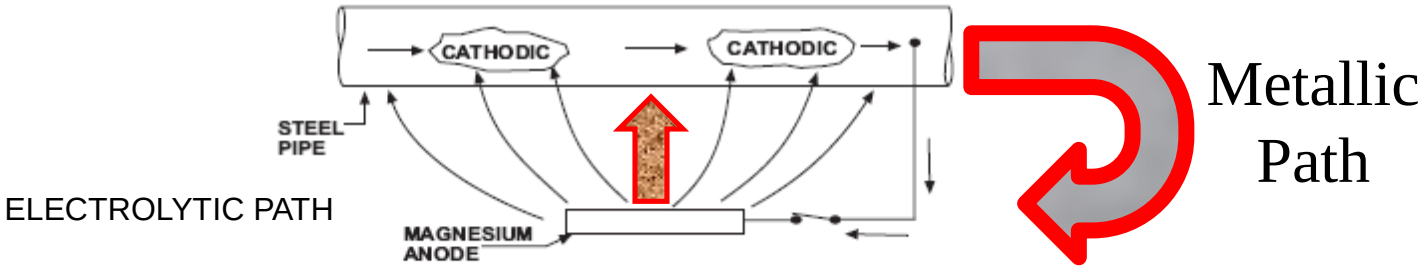


NO CP

ELECTROLYTIC PATH

CONDITION 1:

SWITCH OPEN IN MAGNESIUM ANODE CIRCUIT. NO CATHODIC PROTECTION. CORROSION CURRENT FLOW FROM ANODIC AREA TO CATHODIC AREA OF CORROSION CELL SHOWN BY LINES AND ARROWS. RETURN CIRCUIT THROUGH PIPE.



CONDITION 2:

SWITCH CLOSED IN MAGNESIUM ANODE CIRCUIT. CATHODIC PROTECTION APPLIED. CATHODIC PROTECTION CURRENT FLOW SHOWN BY LINES AND ARROWS. PREVIOUSLY ANODIC AREA HAS BECOME CATHODIC.

CP APPLIED

"CLOSED CIRCUIT" ANODE IS NOW RECOGNIZED

BASIC CONCEPT OF CATHODIC PROTECTION WITH GALVANIC ANODES

FIGURE 2-1

FIGURE 2-1

The Practical Galvanic Series

Material	Potential*
PURE MAGNESIUM	-1.75
MAGNESIUM ALLOY	-1.60
ZINC	-1.10
ALUMINUM ALLOY	-1.00
MILD STEEL (NEW)	-0.70
MILD STEEL (OLD)	-0.50
CAST / DUCTILE IRON	-0.50
STAINLESS STEEL	-0.50 to + 0.10
COPPER, BRASS, BRONZE	-0.20
GOLD	+0.20
CARBON, GRAPHITE, COKE	+0.30

* Potentials with respect to saturated Cu-$CuSO_4$ electrode

Galvanic Anode Applications

- Small amounts of current required.
- Soil resistivity is relatively low.
- Constraints on the use of impressed current.
- ‘Hot Spot’ requirements.
- High voltage dissipation gap (or grounding cell)

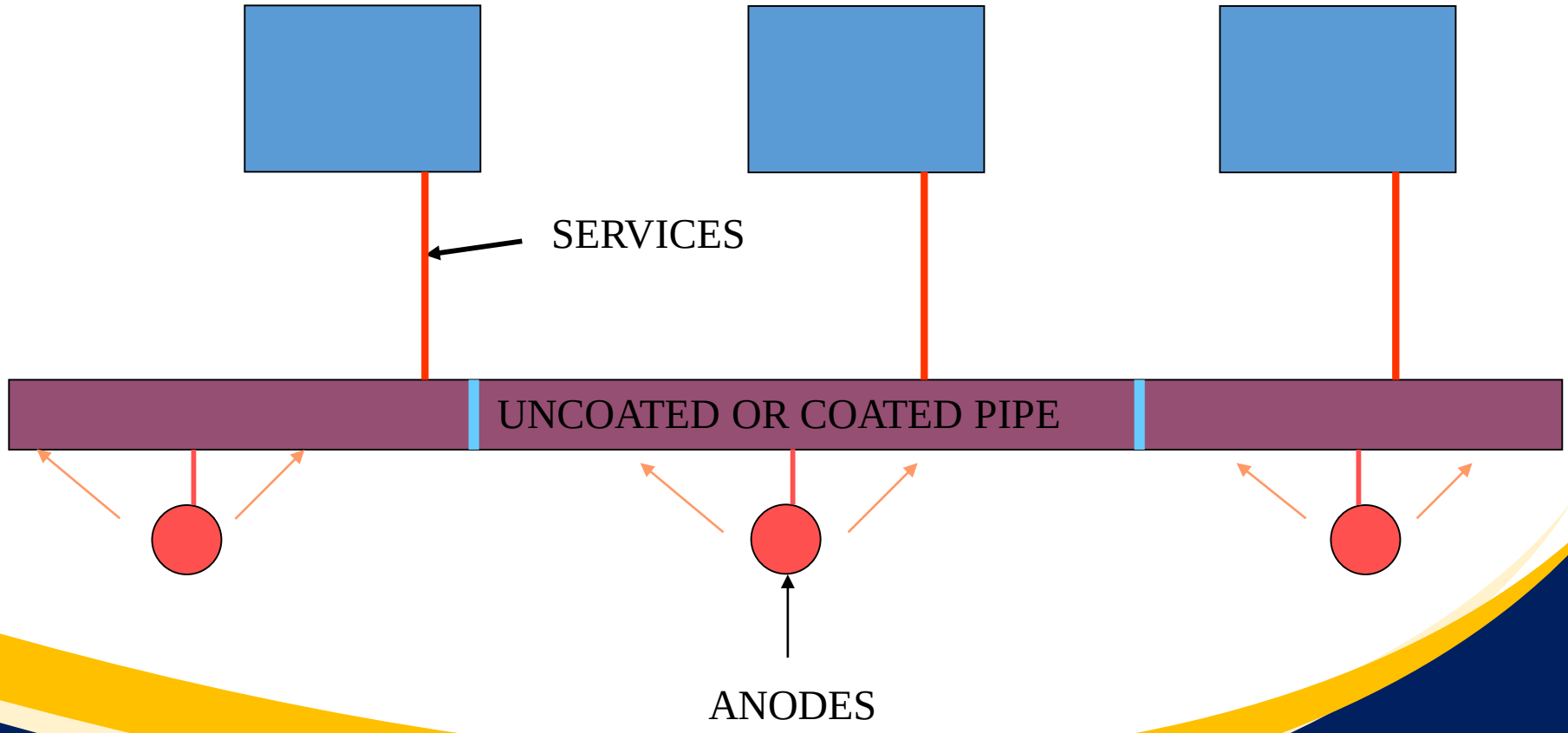
Advantages of Galvanic Anode Systems

- No external power required
- Easy to install
- Maintenance requirements are low
- More economical
- Minimum of anodic interference
- Minimum right of way easement costs
- Anodes can be easily added, as needed

Disadvantages of Galvanic Anode Systems

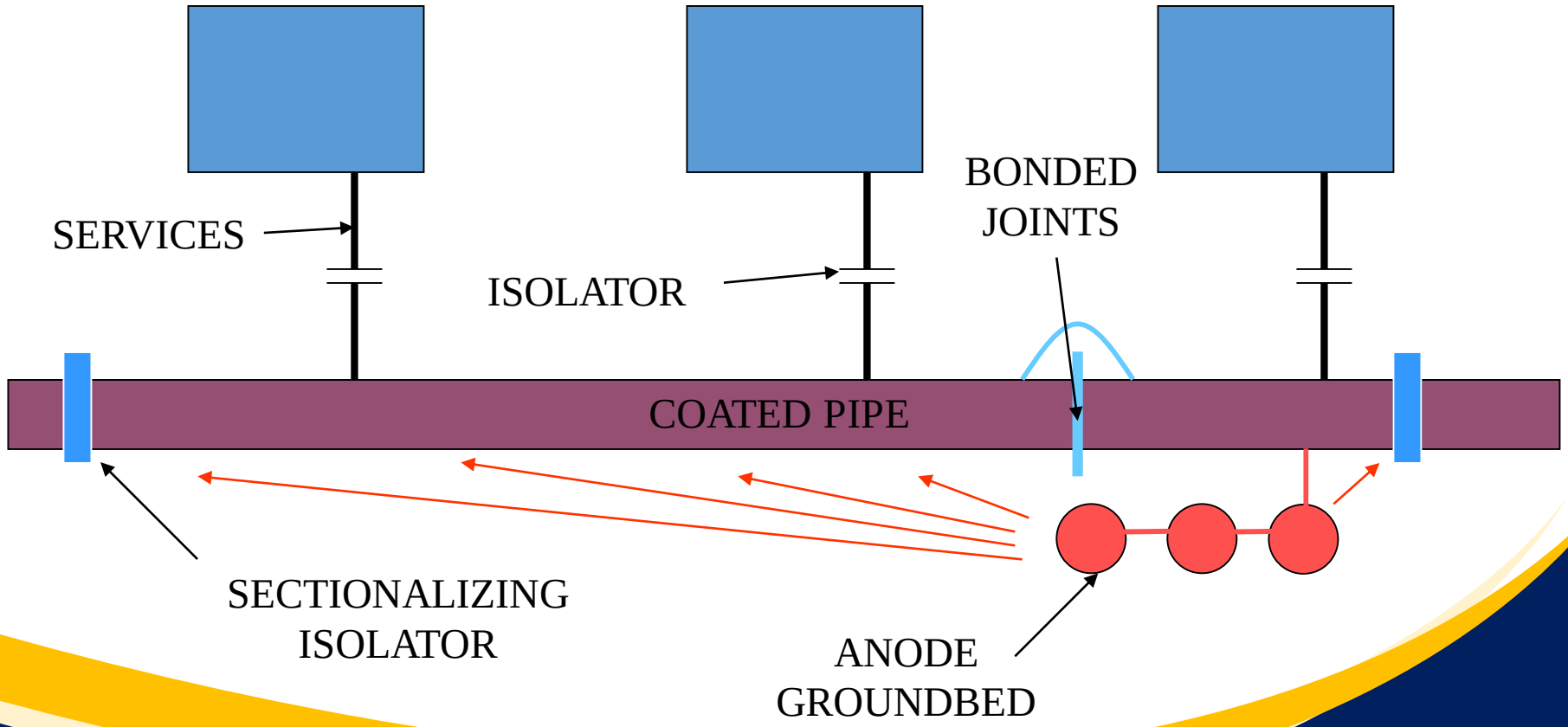
- Limited driving potential
- Lower/limited current output
- Can be ineffective in high-resistivity environments
- Poorly coated structures require many anodes
- Not economical where large currents are required
- May not be effective in dynamic stray current areas

Distributed Galvanic CP System



NOT IN BOOK

Single Groundbed Galvanic CP System



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Galvanic Anode Materials

- There metals are the most common galvanic anode materials:
  - Magnesium
  - Zinc
  - Aluminum

Magnesium Anodes

- Highest driving potential
- Many different shapes and sizes
- Generally used where soil resistivity is between 1,000 and 5,000 ohm-cm

TABLE 2-1

COMMON ALLOY SPECIFICATIONS - MAGNESIUM

Element	High Potential	Grade A	Grade B	Grade C
Al	0.010% max	5.3 to 6.7%	5.3 to 6.7%	5.0 to 7.0%
Mn	0.50 to 1.30%	0.15 to 0.70%	0.15 to 0.70%	0.15 to 0.70%
Zn	0	2.5 to 3.5%	2.5 to 3.5%	2.0 to 4.0%
Si	0.05 % max	0.10% max	0.30% max	0.30% max
Cu	0.02% max	0.02% max	0.05% max	0.10% max
Ni	0.001% max	0.002% max	0.003% max	0.003% max
Fe	0.03 % max	0.003% max	0.003% max	0.003% max
Other	0.05% each or 0.30% max total	0.30 % max	0.30 % max	0.30 % max
Magnesium	Remainder	Remainder	Remainder	Remainder
Solution Potential	-1.80 V	-1.55 V	-1.55 V	-1.55 V

Zinc Anodes

- Many different shapes and sizes
- Perform best in low resistivity environments
  - <2,000 ohm-cm
- Examples of low resistivity environments?
  - Sea Water
  - Salt Marshes

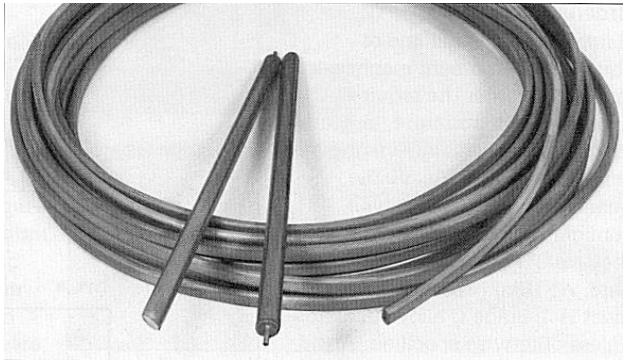
Note: Cadmium is a known carcinogen and thus this alloy should not be used in Underground Applications

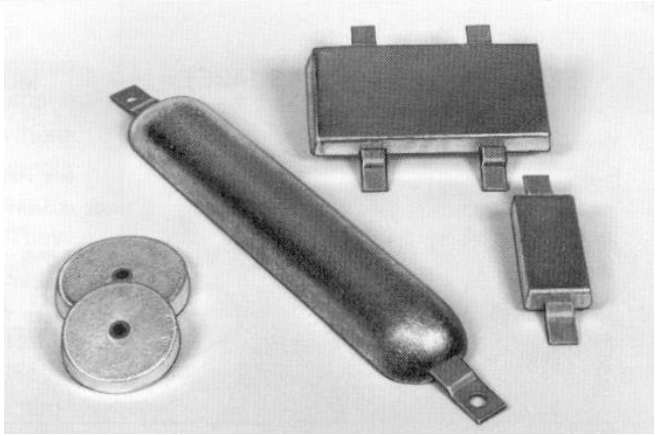
TABLE 2-2

COMMON ALLOY SPECIFICATIONS - ZINC

Zinc (Mil-A 18001)		Zinc (ASTM B418-67 Type II)	
Seawater Use		Underground Use	
Element	Percent	Element	Percent
Aluminum	0.1 to 0.3%	Special high-grade Zinc	99.99% pure
Cadmium	0.025 to 0.06%		
Iron	0.005% max		
Special high-grade zinc	Balance		
Solution potential	-1.10 V	Solution potential	-1.10 V

Zinc Anodes

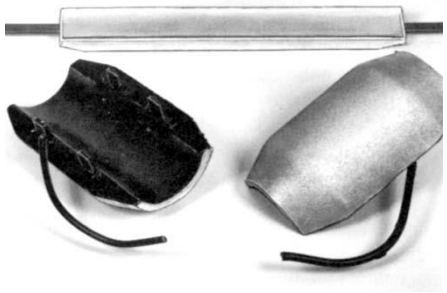





GALVOMAG
HIGH POTENTIAL
2 UNITS TYPE 703
MAGNESIUM
ANODE
WITH BACKFILL
PACKAGED BY
CATHODIC PROTECTION SERVICE
HOUSTON
TULSA - FARMINGTON - LOS ANGELES - MIDLAND
CORPUS CHRISTI - NEW ORLEANS - DENVER

- Gypsum
- Bentonite
- Sodium Sulfate

Note: None of these Aluminum Anode alloys work in Underground Applications – The anode will passivate and not deliver effective CP



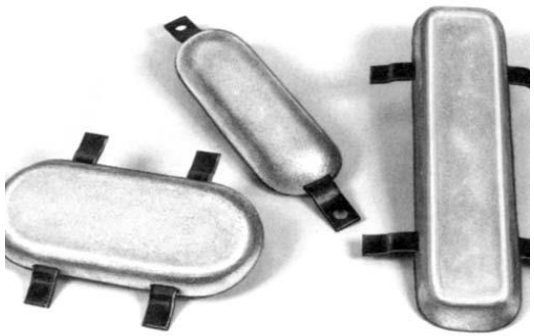
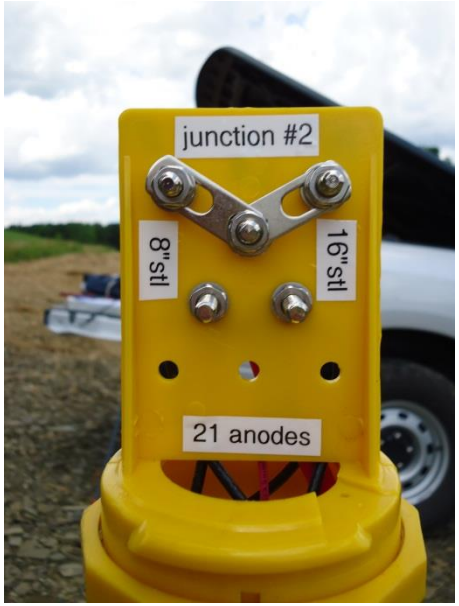


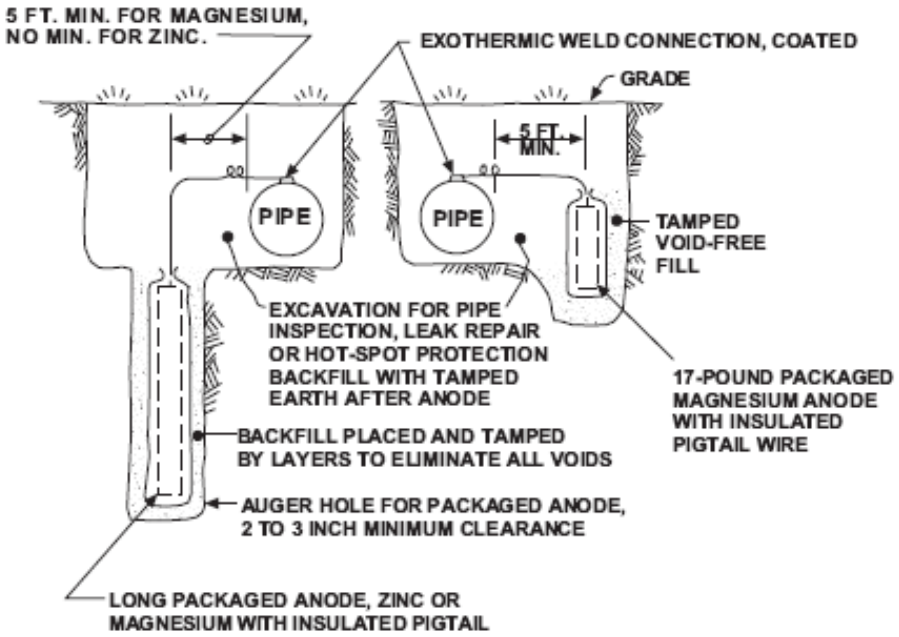
TABLE 2-3

COMMON ALLOY SPECIFICATIONS - ALUMINUM

Element	Seawater Galvalum I	Saline Mud Galvalum II	Seawater Brackish Saline Mud Galvalum III
Zinc	0.35 to 0.50%	3.5 to 5.0%	3.0%
Silicon	0.10% max	-	0.1%
Mercury	0.035 to 0.048%	0.035 to 0.048%	-
Indium	-	-	0.015%
Aluminum	Remainder	Remainder	Remainder
Solution Potential	-1.10 V	-1.10 V	-1.10 V

INSTALLATION

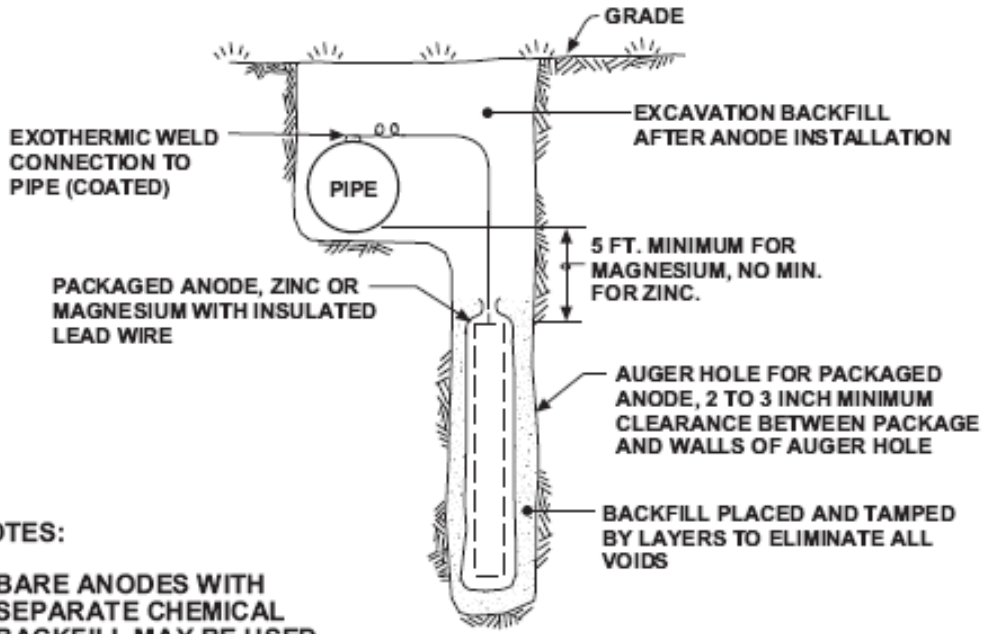




TYPICAL INSTALLATION OF
PROTECTION WITH GALVANIC ANODES

FIGURE 2-2

Although this slide and in your
Book indicate by the drawing
To connect the anode directly
To the pipe, Utilize an approved
test station where you can…This
Will allow the circuit to be
Interrupted for survey & troubleshooting
purposes

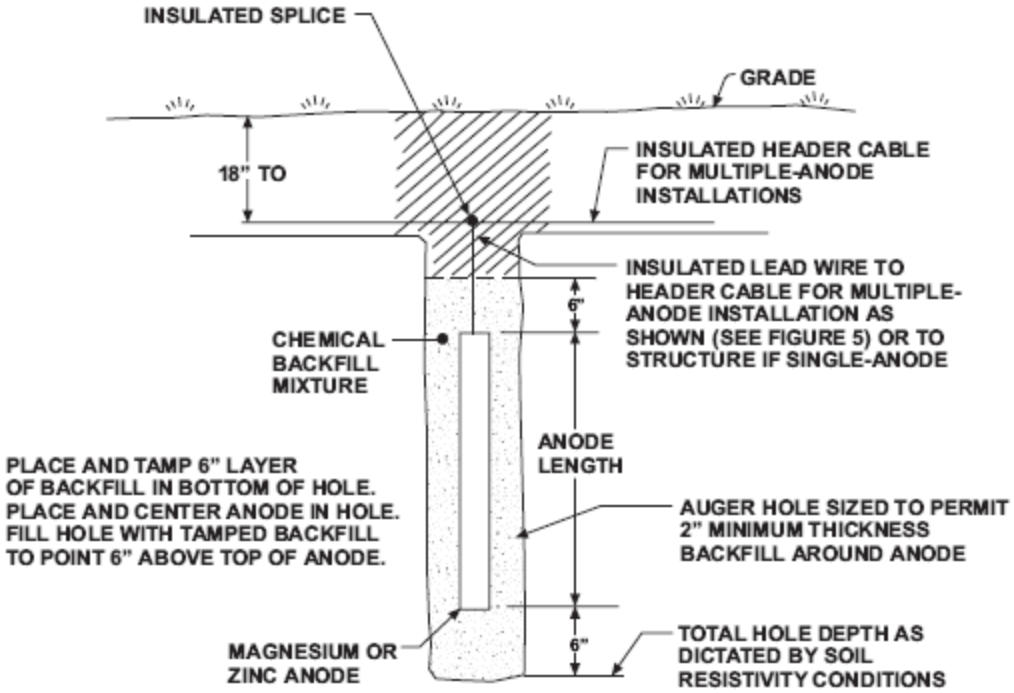


NOTES:

1. BARE ANODES WITH SEPARATE CHEMICAL BACKFILL MAY BE USED PER FIGURE 2-4.
2. MULTIPLE ANODE INSTALLATIONS MAY ALSO BE MADE WITH ALL ANODES BELOW PIPE BUT OTHERWISE IN GENERAL ACCORD WITH FIGURE 2-5.
3. IF NECESSARY, AUGER HOLE MAY BE ANGLED SLIGHTLY

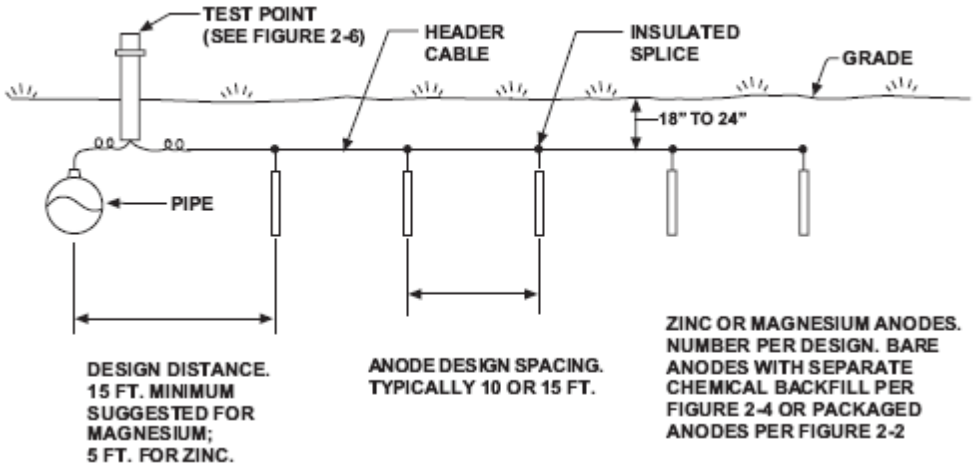
TYPICAL INSTALLATION OF GALVANIC ANODES WHERE LATERAL SPACE IS LIMITED

FIGURE 2-3



TYPICAL INSTALLATION OF BARE GALVANIC ANODES WITH SEPARATE CHEMICAL BACKFILL

FIGURE 2-4

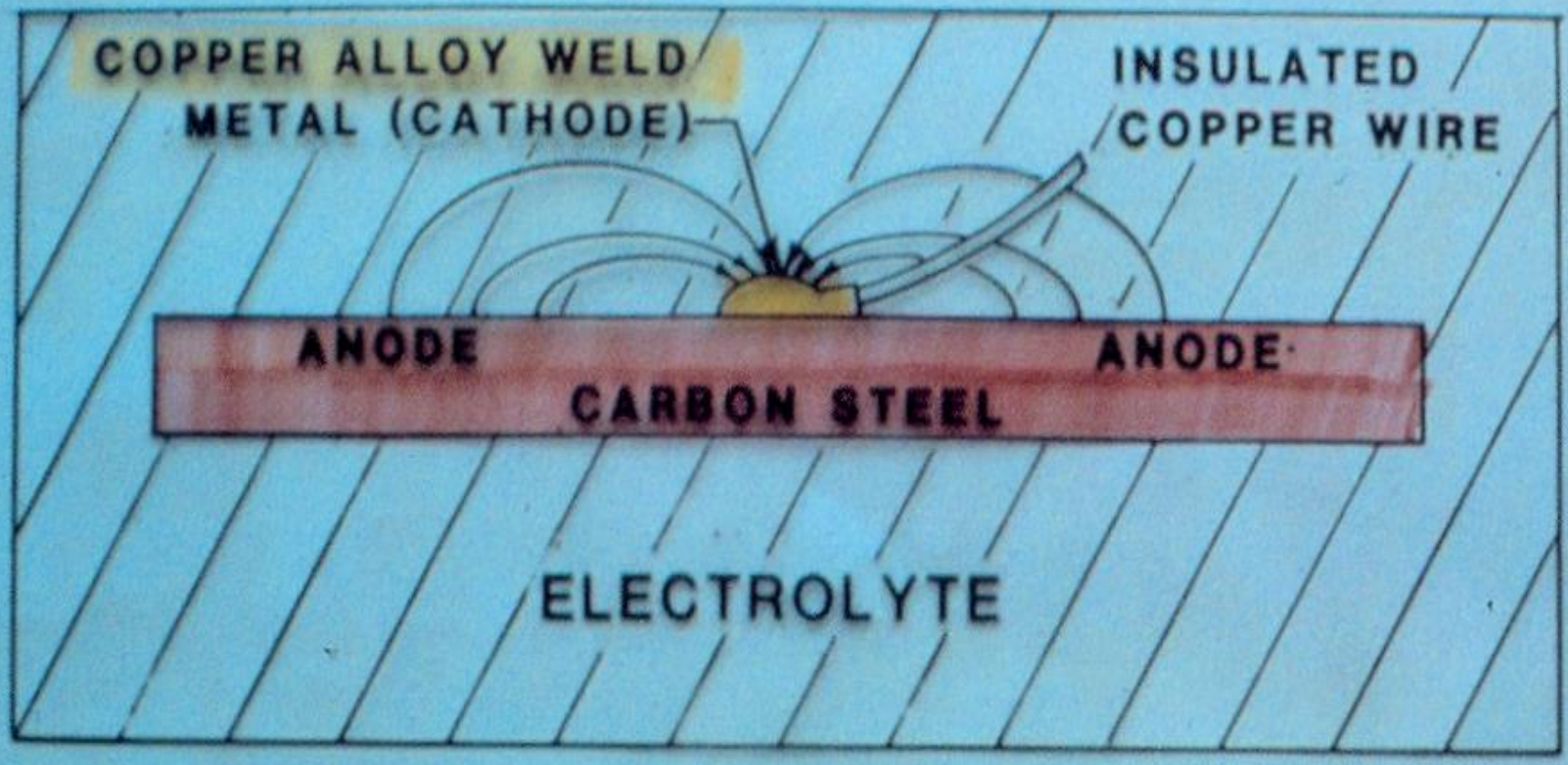


MULTIPLE INSTALLATION OF GALVANIC ANODES

FIGURE 2-5

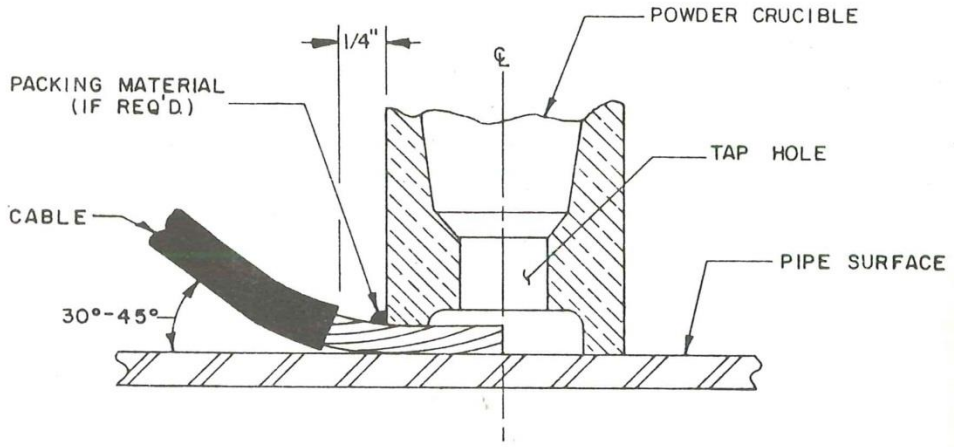
Anode Lead Attachment

- Insulated lead wire from the anode may be connected by some form of an exothermic weld
- Ensures the long-term low resistance in the connection
- The copper metal nub at the point of connection must be thoroughly insulated with suitable coating material



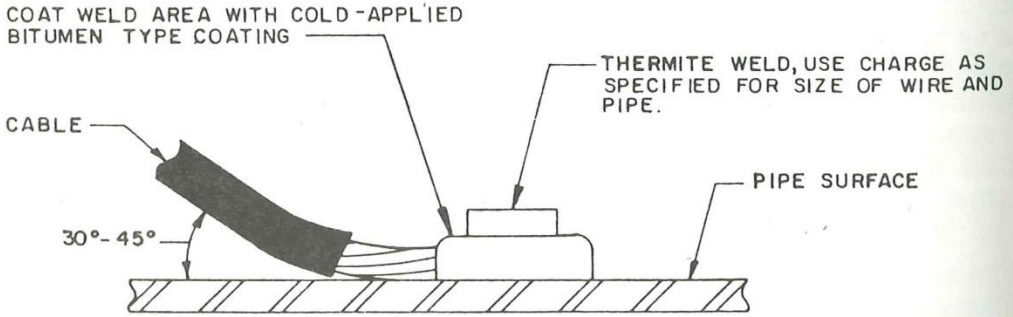
B. EXPOSED THERMIT WELD (COPPER) ON CARBON STEEL: LARGE ANODE VS SMALL CATHODE, SLOW CORROSION RATE

EFFECT OF RELATIVE AREA OF ANODE TO CATHODE



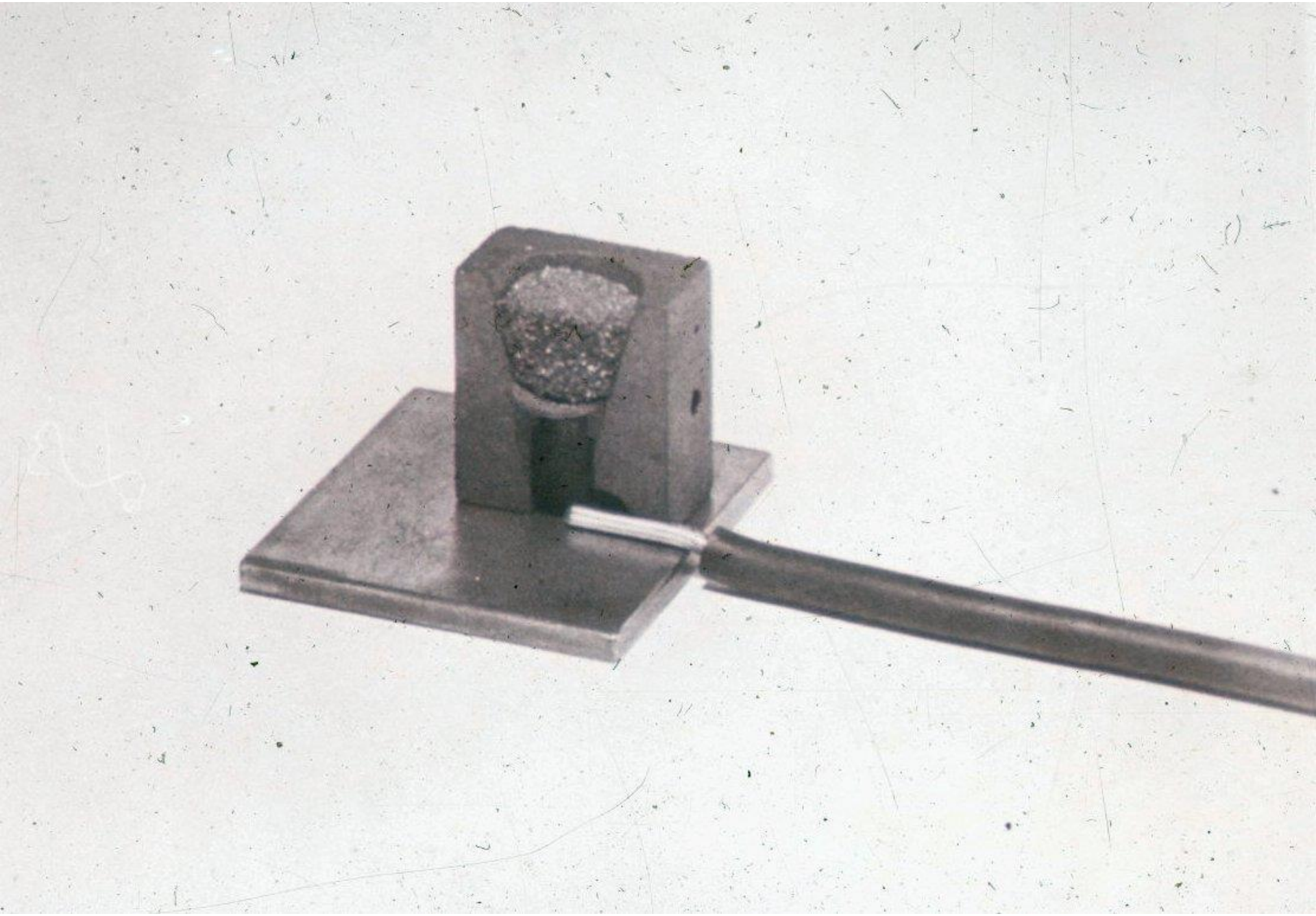
NOTE: END OF CABLE SHOULD NOT PASS CENTER LINE OF MOLD.

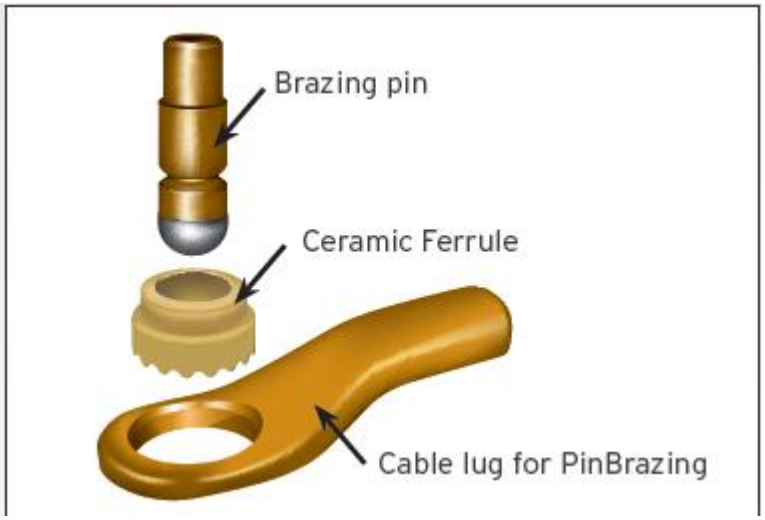
MOLD POSITIONING



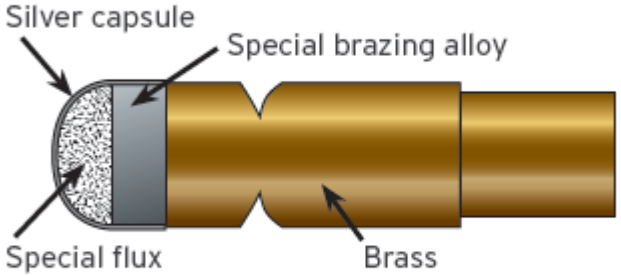
COMPLETED WELD

THERMITE WELD





Brazing pin

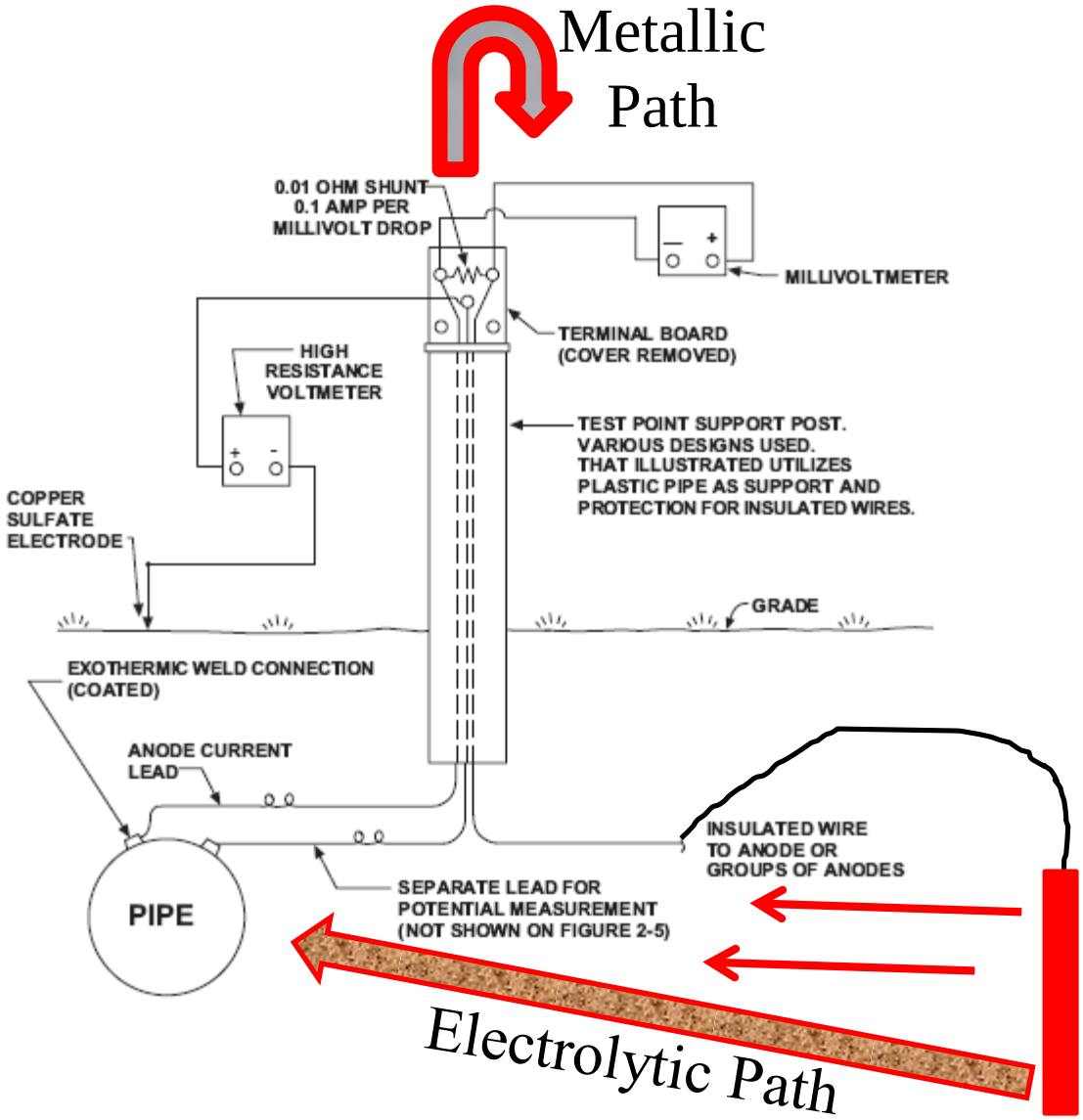


Melting Temperature 1200°F / 650°C
Only 5 microohms/brazed joint


2009/06/25

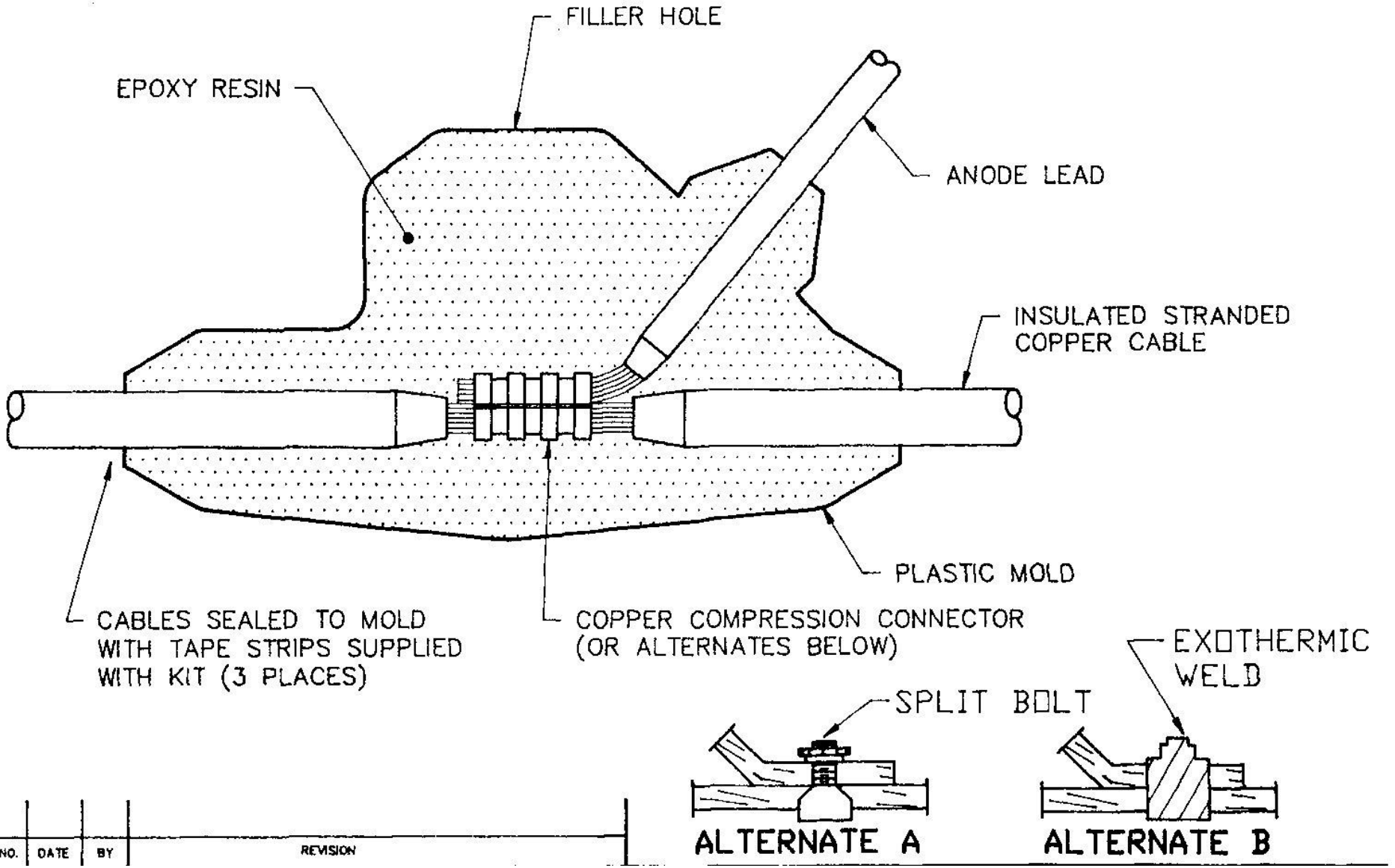
Test Points

- Commonly referred to as test stations
- May be desired and/or required to permit periodic testing of galvanic anode performance

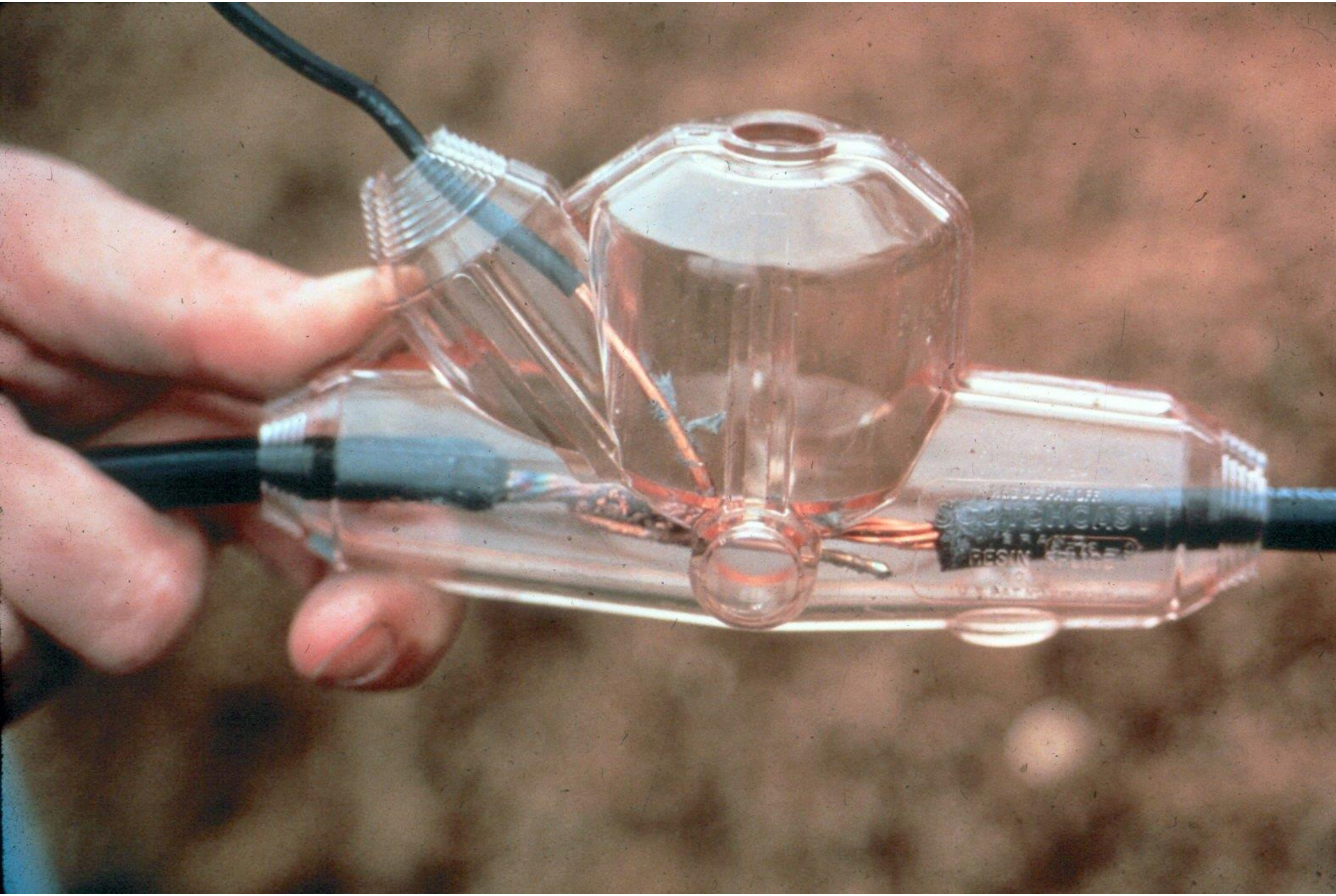


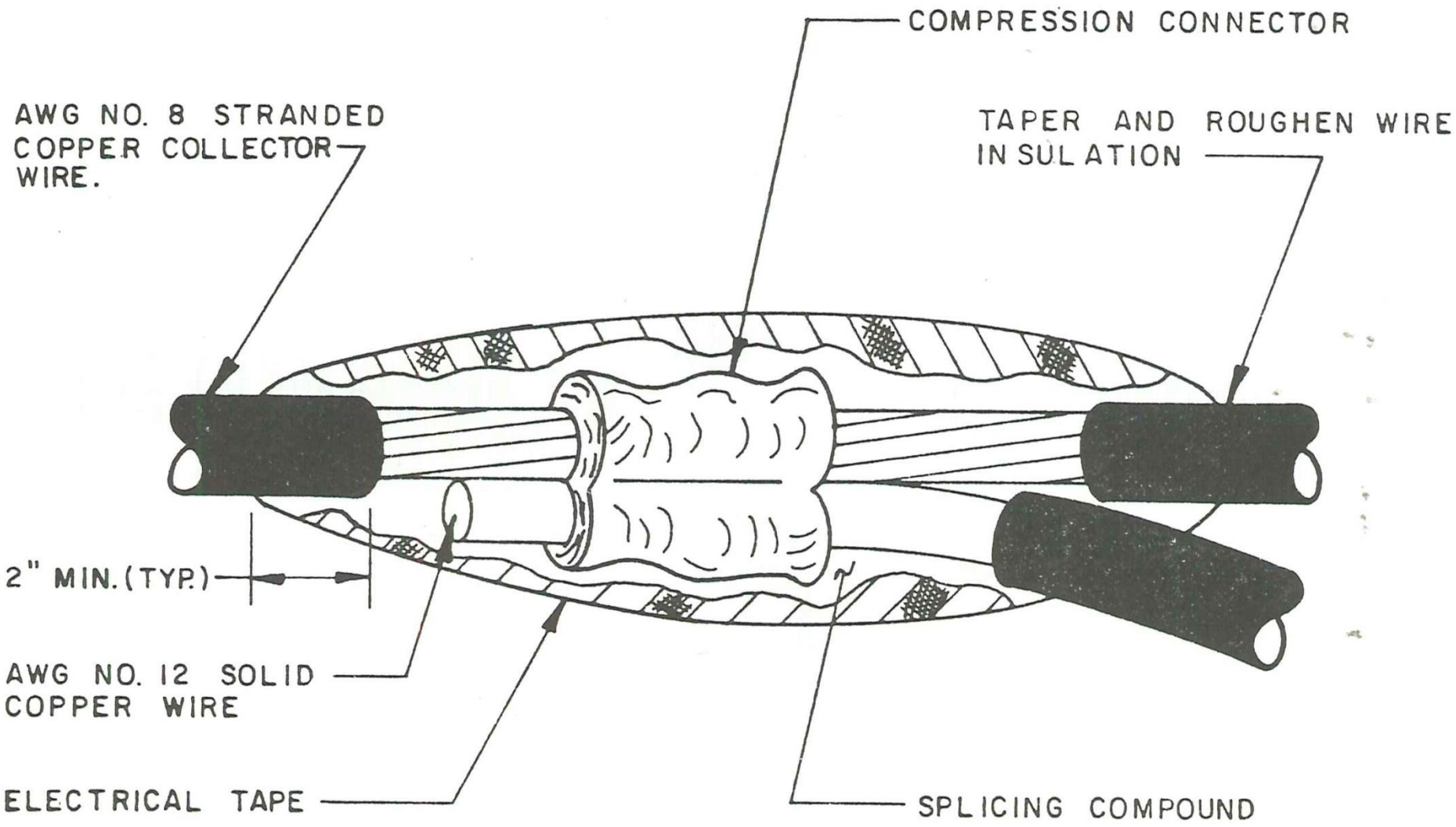
TYPICAL TEST POINT INSTALLATION

FIGURE 2-6

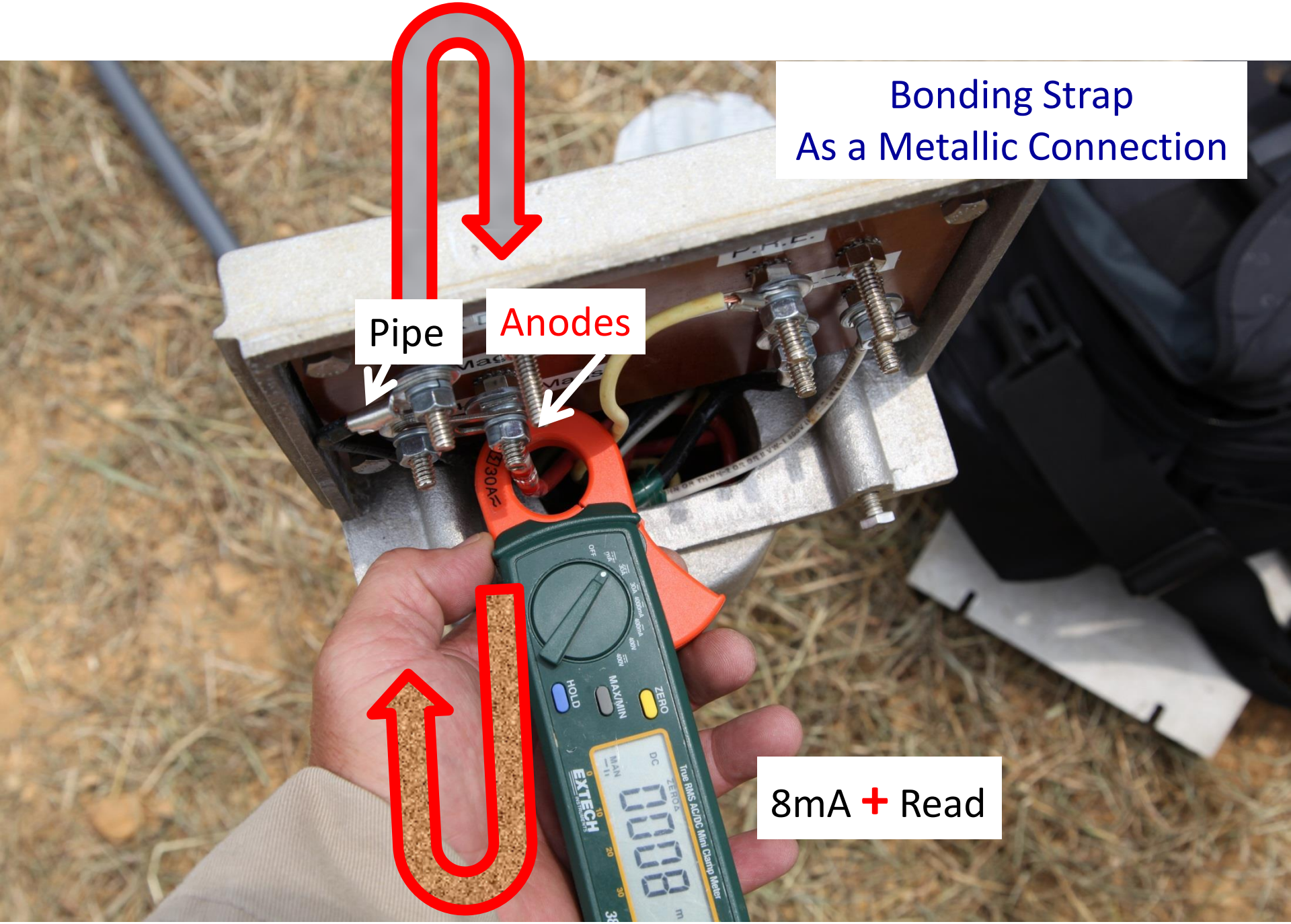


NO.	DATE	BY	REVISION

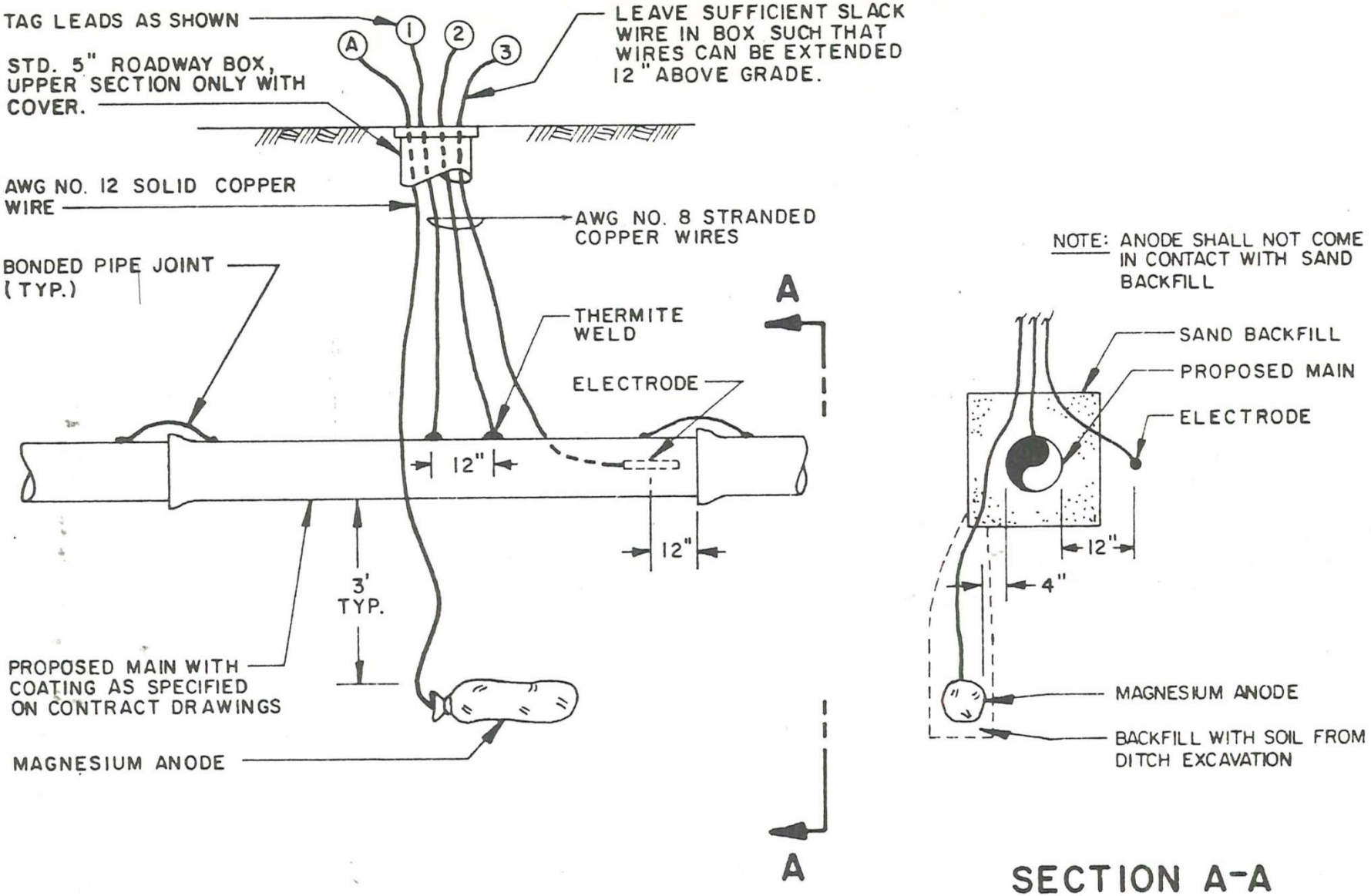




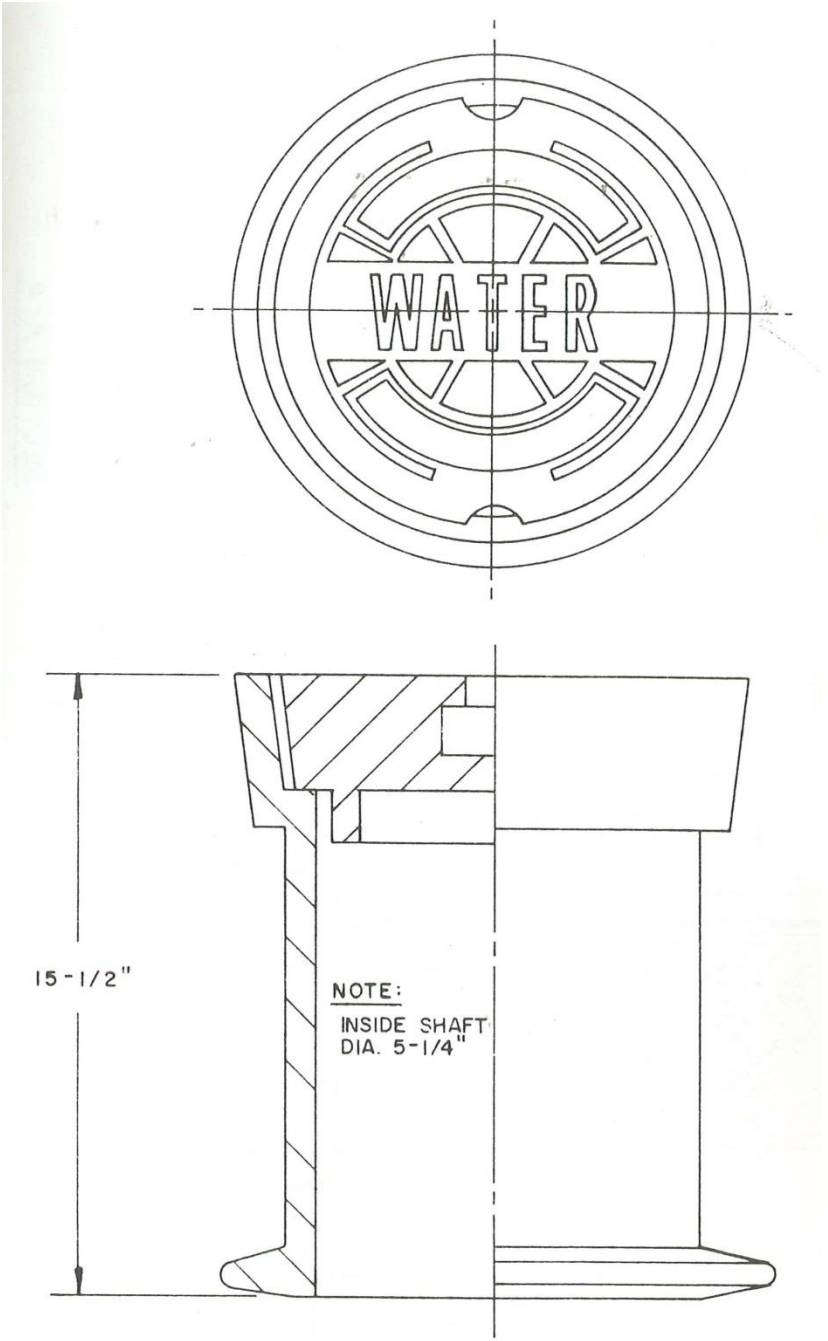
TYPICAL ANODE SPLICE


Bonding Strap
As a Metallic Connection
Pipe
Anodes
8mA + Read

Current Direction Indicated on Amp Clamp

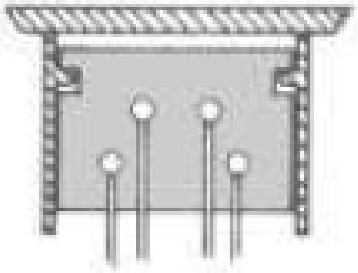


MAGNESIUM ANODE TEST STATION

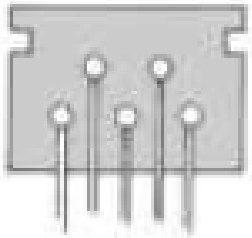


5" ROADWAY BOX

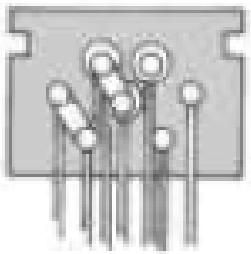
Plastic pipe, 5" I.D., 18" shaft length.



LID SECTION NM-4



NM-5



NM-7

Available with 4, 5 or 7 terminals.

Heavy cast iron lids, both locking and non-locking, available.

One-inch extensions available whenever road resurfacing occurs.

CAUTION: Stay back 50 FEET

CORROSION IN MOTION