ENCLOSURE

Seismic Testing of the Nuclear Instrumentation System Power Range Detector for the Watts Bar Plant

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1.0 INTRODUCTION

A seismic test was performed on a Nuclear Instrumentation System (NIS) Power Range Detector (PRD) mounted in a simulated support assembly to demonstrate the electrical functions/operability of the PRD during and after seismic event. The seismic event simulated during testing exceeds the earthquake requirements at the PRD location specified for the Watts Bar Nuclear Power Plant.

Five tests at four successively higher input levels were performed on the Power Range Detector Assembly. The highest level of input being 2.5 times to 20 times, depending on the frequency, the Watts Bar required level for the NIS Power Range Detector Assembly. Testing was performed at Westinghouse Advanced Energy Systems Division (WAESD) in Large, Pennsylvania, using multi-frequency, tri-axial test inputs developed in accordance with WCAP-8624.(1)

2.0 EQUIPMENT DESCRIPTION

2.1 EQUIPMENT TESTED

The equipment tested consisted of a Nuclear Instrumentation System (NIS) Power Range Detector mounted in a support assembly which conservatively simulated the detector holder. The Power Range Detector consists of an uncompensated ionization chamber with two individual neutron-sensitive sections with a common high voltage electrode, integral mineral insulated cables with tri-axial connectors and eleven ceramic standoff insulators. The WL-23686 detector S/N 771703 was built in accordance with the Westinghouse Industrial and Government Tube Division (WIGTD) Drawing E-2231, Revision 12.

The detector is installed in a mechanical positioning device which allows the detector to be placed in the proper position relative to the reactor vessel. The installation arrangement is shown on Figure 2-1a & b. The normal side entry holder/positioning assembly consists of a 7-1/2" OD x 1/4" thick tube which is supported vertically by a steel wheel assembly. The removable neutron detector (uncompensated ionization chamber) rests on the fixed axle of the wheel assembly. The holder with the detector is positioned at the desired location relative to the by push rods, 2" in diameter, that extend through the shield wall. The push rod assembly is fixed to the shield wall to prevent motion along the axis of the push rods. The attachment of the push rods to the holder is made by a clevis. etween the male and female portion of the clevis, a ± 1/16 clearance exists in both horizontal directions; while a vertical slot in the male clevis provides a ± 1" vertical clearance. The vertical clearance is provided to accommodate construction tolerances. The entire holder assembly fits into a vertical recess in the concrete shield wall. The recess is 9" wide along the length of the holder and is increased to 15" at the holder wheel assembly. The clearance between the holder tube and concrete is ± 3/4" and between the axle of the wheel assembly and wall, the clearance is ± 5/8". When the holder is in the operation position, as shown on Figure 2-1b, the distance of the concrete above the top of the holder tube is limited to a minimum of 9.0" to provide adequate bend radius for the wiring for the detectors.

Details are on the following Drawings.

1184F51 Neutron Detector Positioning Device Assembly

1184F50 Neutron Detector Positioning Device Details

108D582 Neutron Detector Positioning Device Details

2.2 TEST EQUIPMENT AND INSTRUMENTATION

A schematic of the tri-axial test setup is shown in Figure 2-2 and pictures of the test setup are in Figures 2-4 through 2-10. The tri-axial configuration is developed by having the table input motion at an angle of 35 degrees from the horizontal and the equipment positioned so that the horizontal principal axis of the equipment is at a 45 degree angle from the horizontal component of the input. This tri-axial confirguration results in equal and simultaneous inputs to all three principal equipment axis. Two control accelerometers are oriented and mounted to the test table to measure the horizontal ($\sqrt{2}$ times front to back and side to side input) and vertical accelerations.

During seismic test, the detector was energized from a high voltage power supply (500 V DC) and a 10 K Hz AC signal was imposed on the high voltage electrode. This signal, coupled via the interelectrode capacitance, was monitored on each of the signal electrode outputs as well as the leakage current (DC) as shown in Figure 2-3. The AC input signal was recorded along with the two AC output signals and the two DC output signals. The DC output signals were used to identify shorted conditions ((10^{-8}) Amp. full scale) while the AC output signal would identify interelectrode capacitance changes indicative of electrode motion. Table 2.1 provides a list of the instruments used for these tests.

Reference measurements which consisted of DC resistance measurements for each cable-electrode (high voltage, Signal A and Signal B) and leakage current (high voltage to Signal A and Signal B) measurements, were performed before and after each test. All other electrical output signals from the test assembly were cabled to a separate acoustically shielded data acquisition room adjacent to the seismic test area. These signals from the detector assembly consisted of 9 accelerometers and 4 strain gages used to monitor the response of the equipment. A list of the instruments used for the tests is given in Table 2.1.

TABLE 2.1

TEST INSTRUMENTS

NAME	MANUFACTURER/MODEL
High Voltage Power Supply	Keithley 240A
Signal Generator	Hewlett-Packard 200CD
Electrometers	Keithley 600B
0.1 uf 5 KV Capacitor Box	Westinghouse
0.25 uf 2 KV Capacitor Box	Westinghouse
Megohm Meter	General Radio 1864
Conditioners	B&F Model 10-800
Amplifiers	B&F Model 10-800
*Recorders (2)	Honeywell 1612
Recorder	E&I 500
Oscillographs	Bush Mark 200
Shock Spectrum Analyzer	Spectral Dynamics Corporation 13192 and 13231
Magnetic Tape Recorder	CEC GR 2800

*Between tests 3 and 4, the recorder was changed due to a failure of the first recorder.

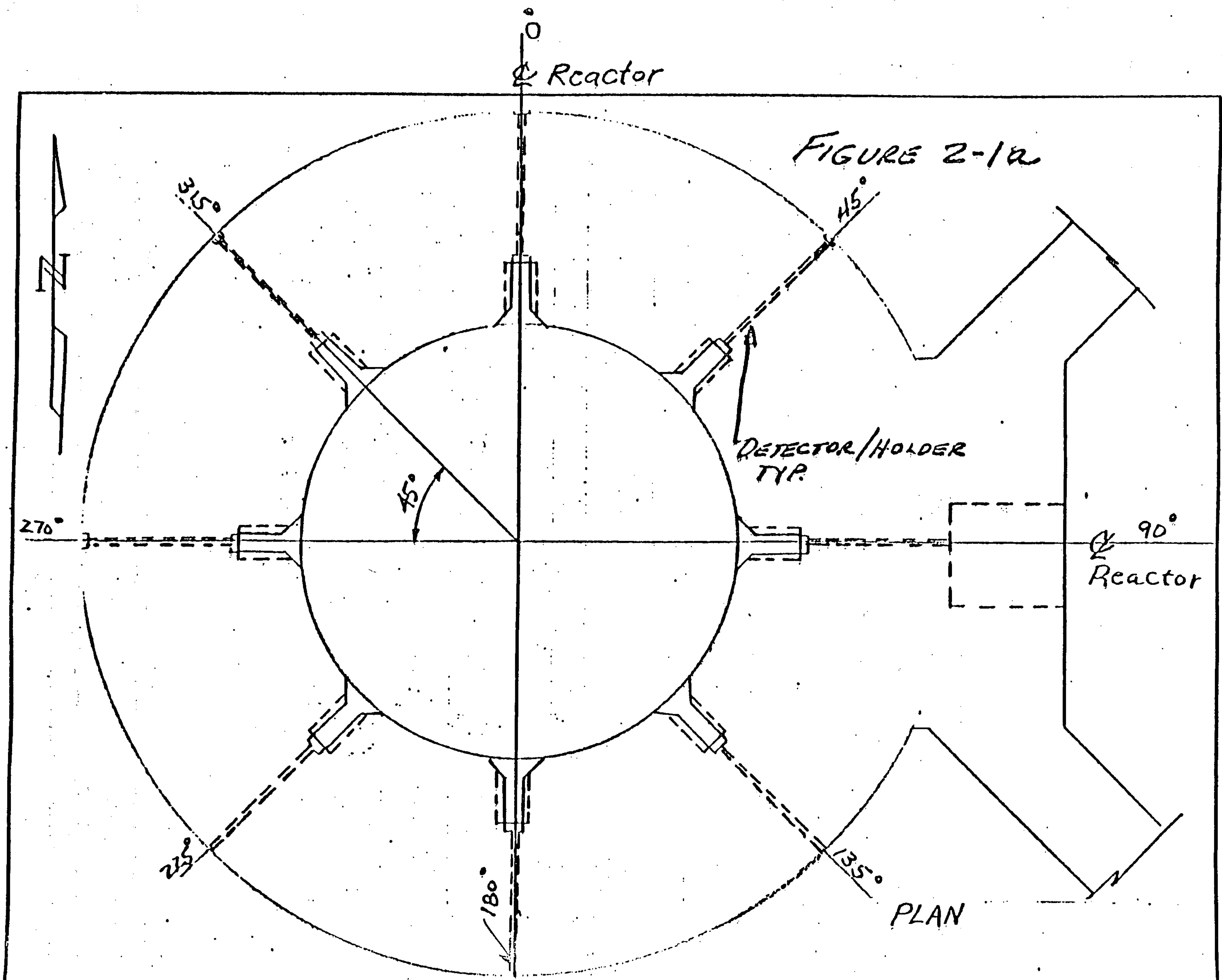

Figure 2-1a Detector Installation Arrangement Plan View

WESTINGHOUSE ELECTRIC CORPORATION

SKETCH SHEET
FORM 28577

WESTINGHOUSE ELECTRIC CORPORATION

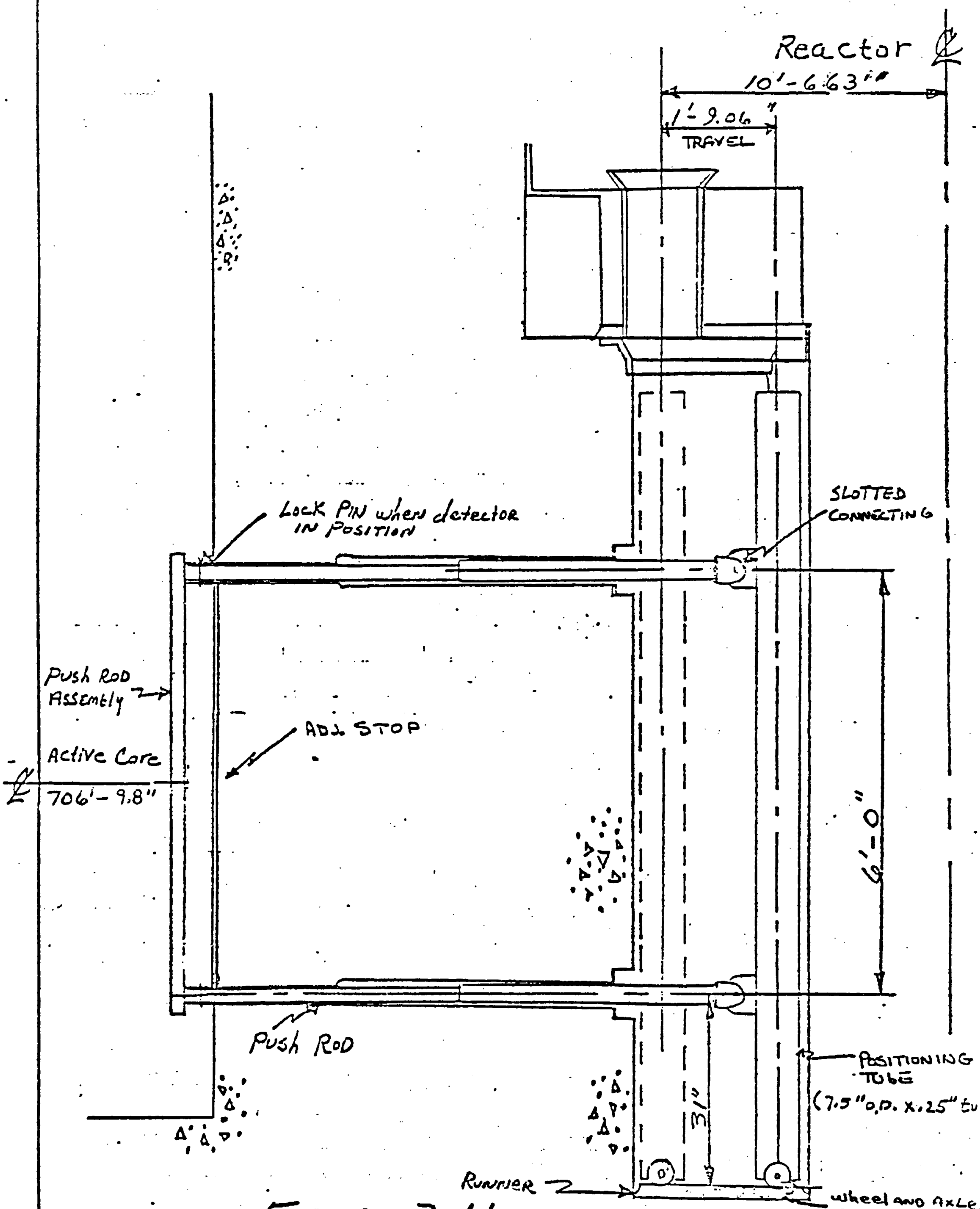

FIGURE 2-16
ELEVATION THRU DETECTOR

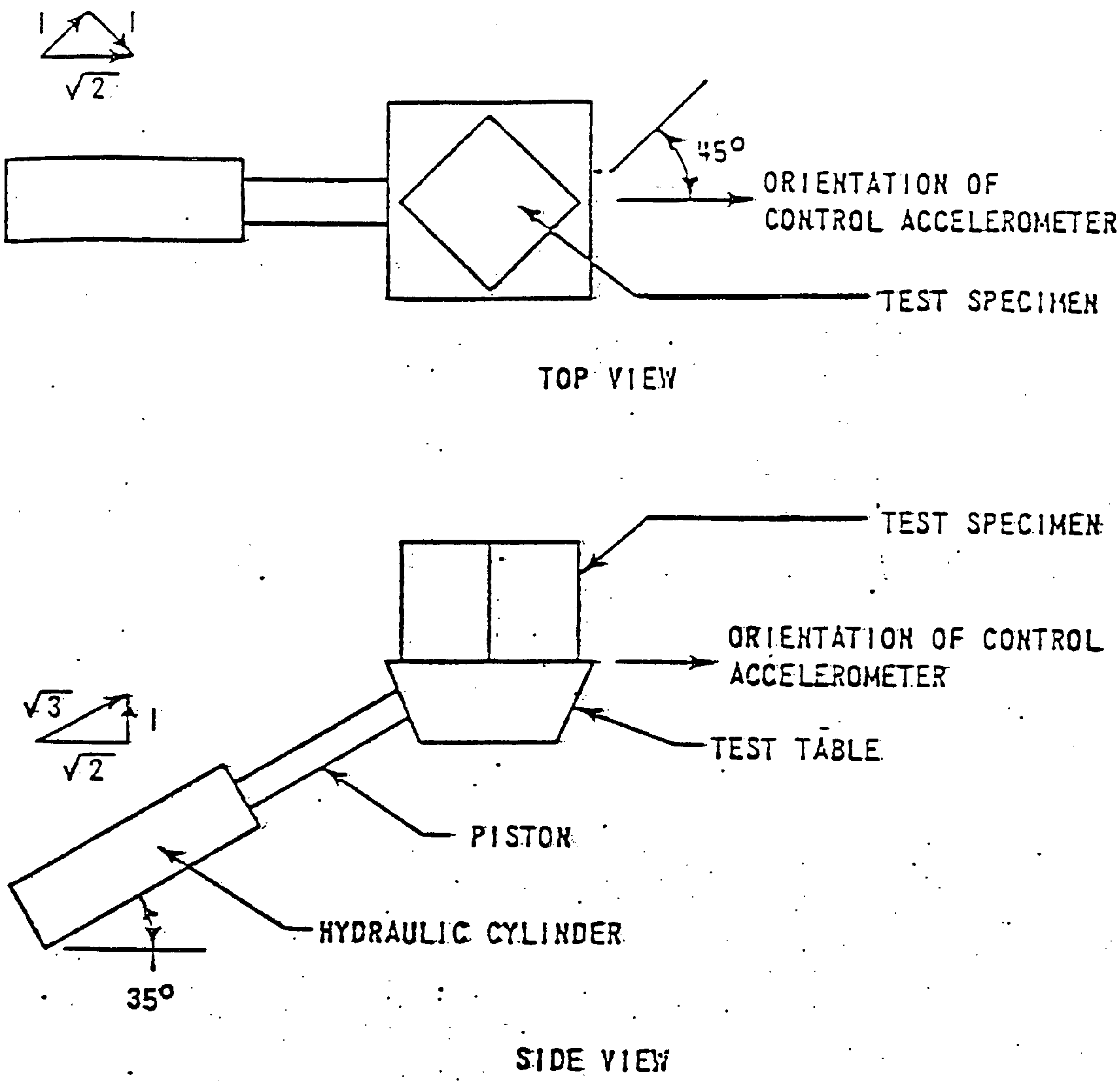

Figure 2-2 **Schematic of Biaxial Test Setup**

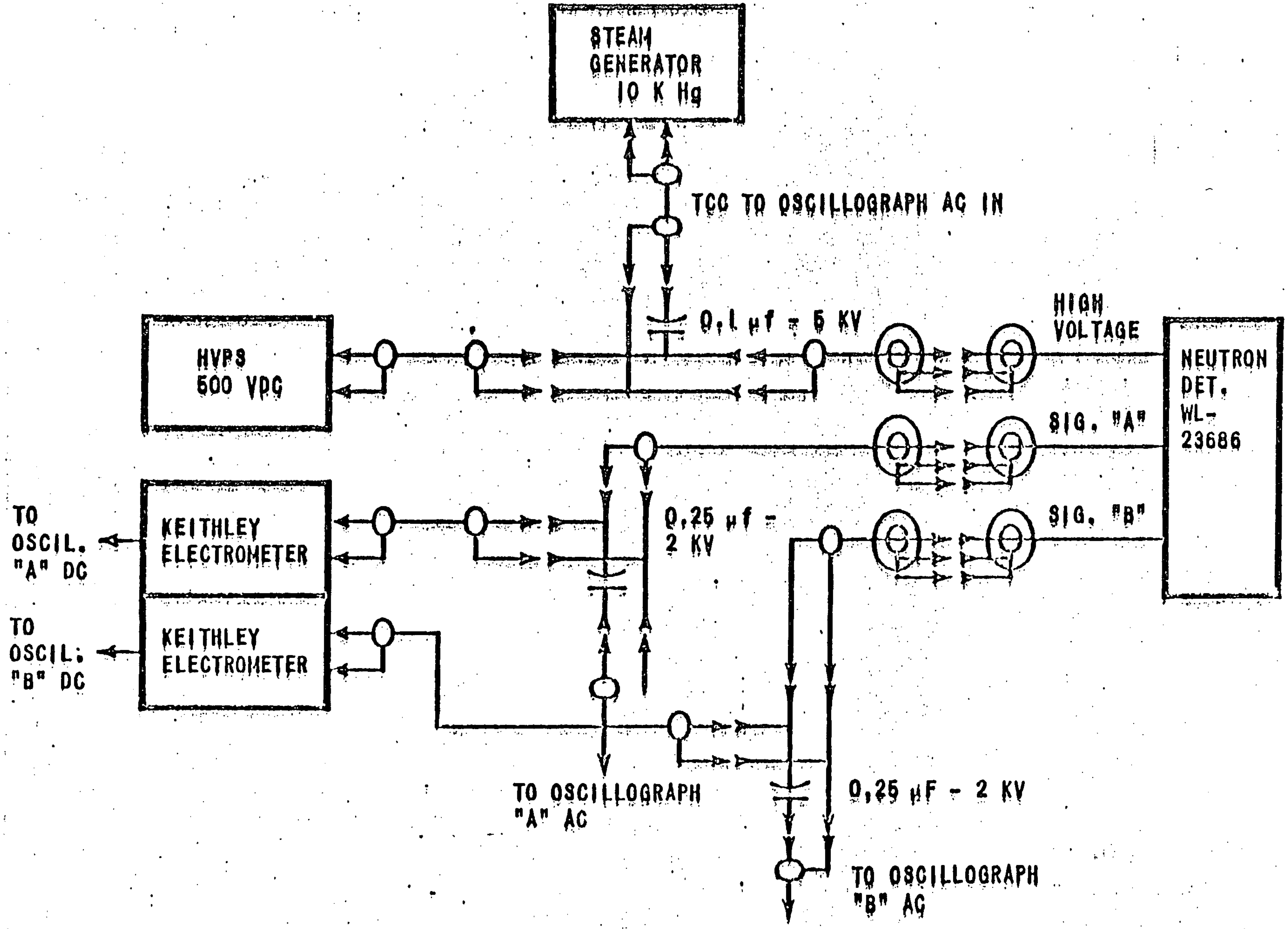

Figure 2-3 Neutron Detector Seismic Test Interconnection Diagram

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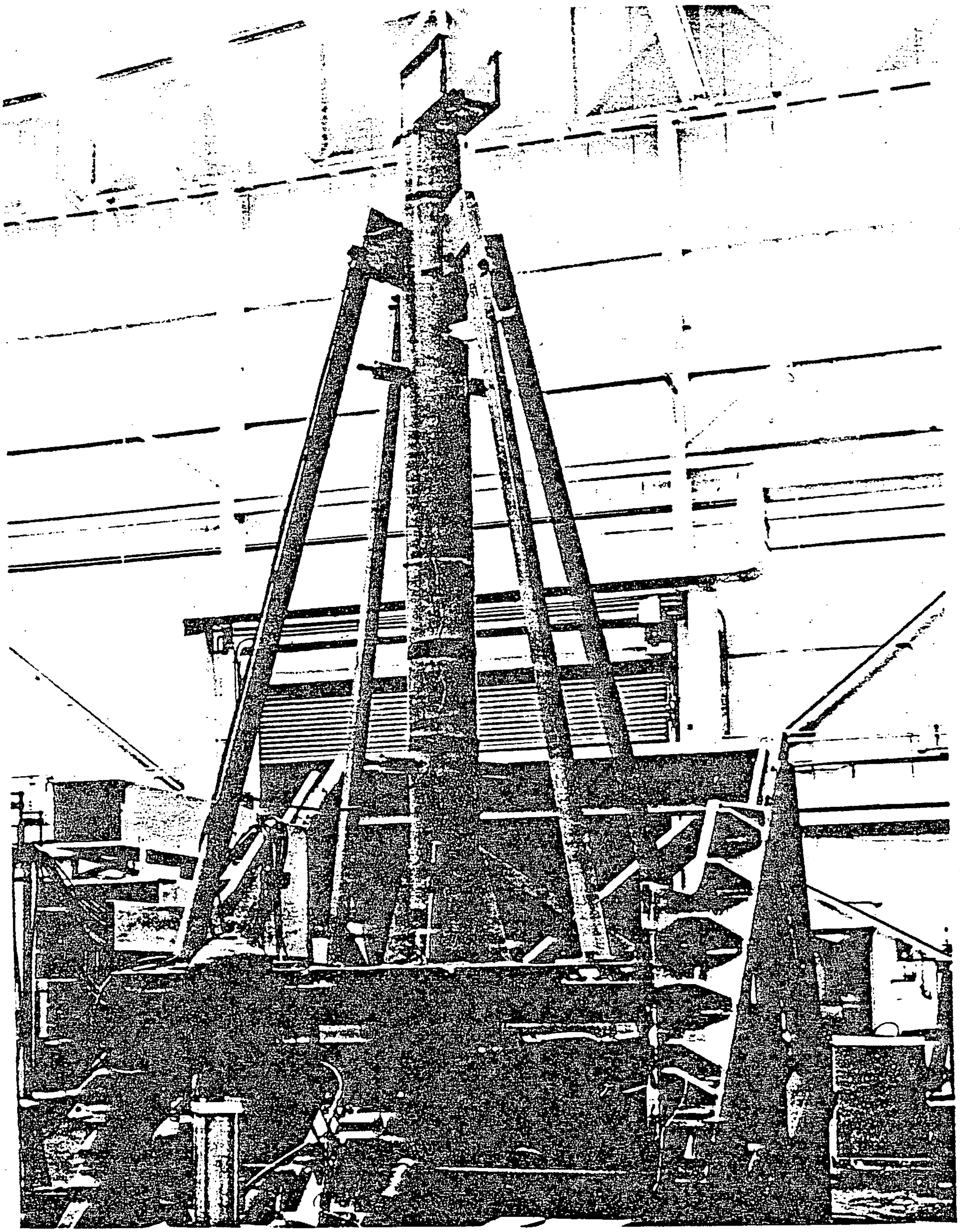

Figure 2-4 Test Fixture on Seismic Table.

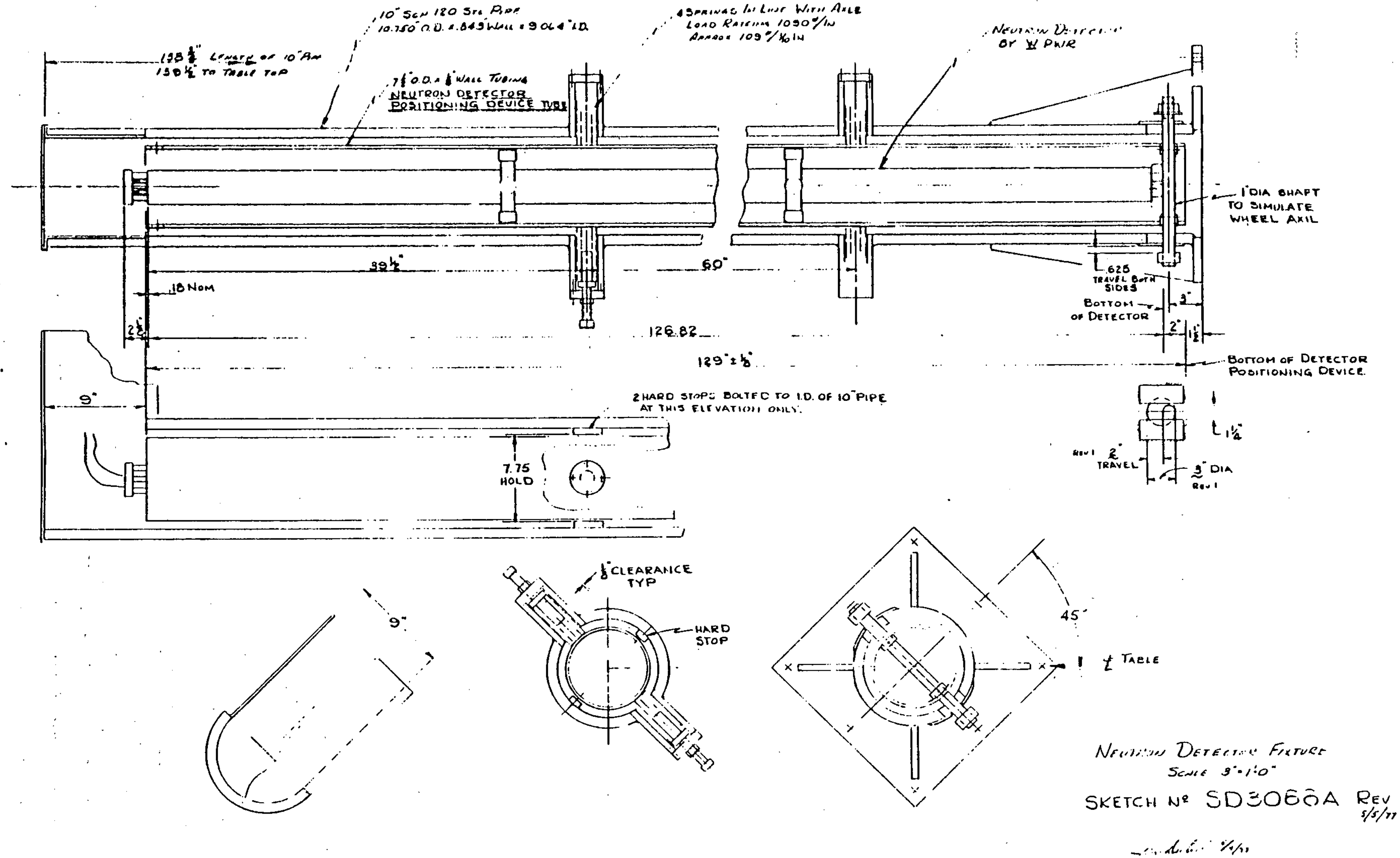

Figure 2-5 Test Fixture Sketch

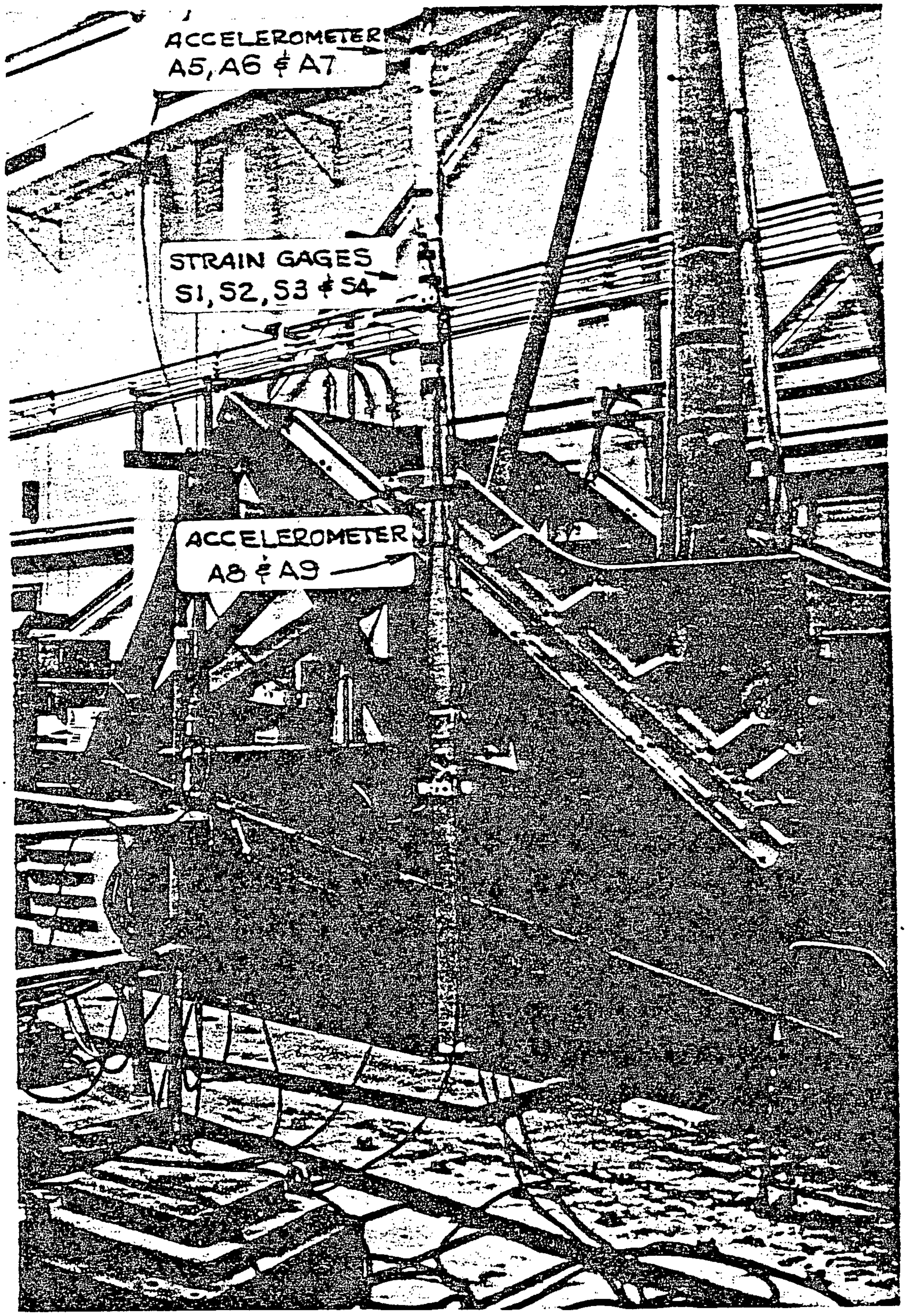

Figure 2-6 Uncompensated Ionization Chamber with Accelerometers and Strain Gages.

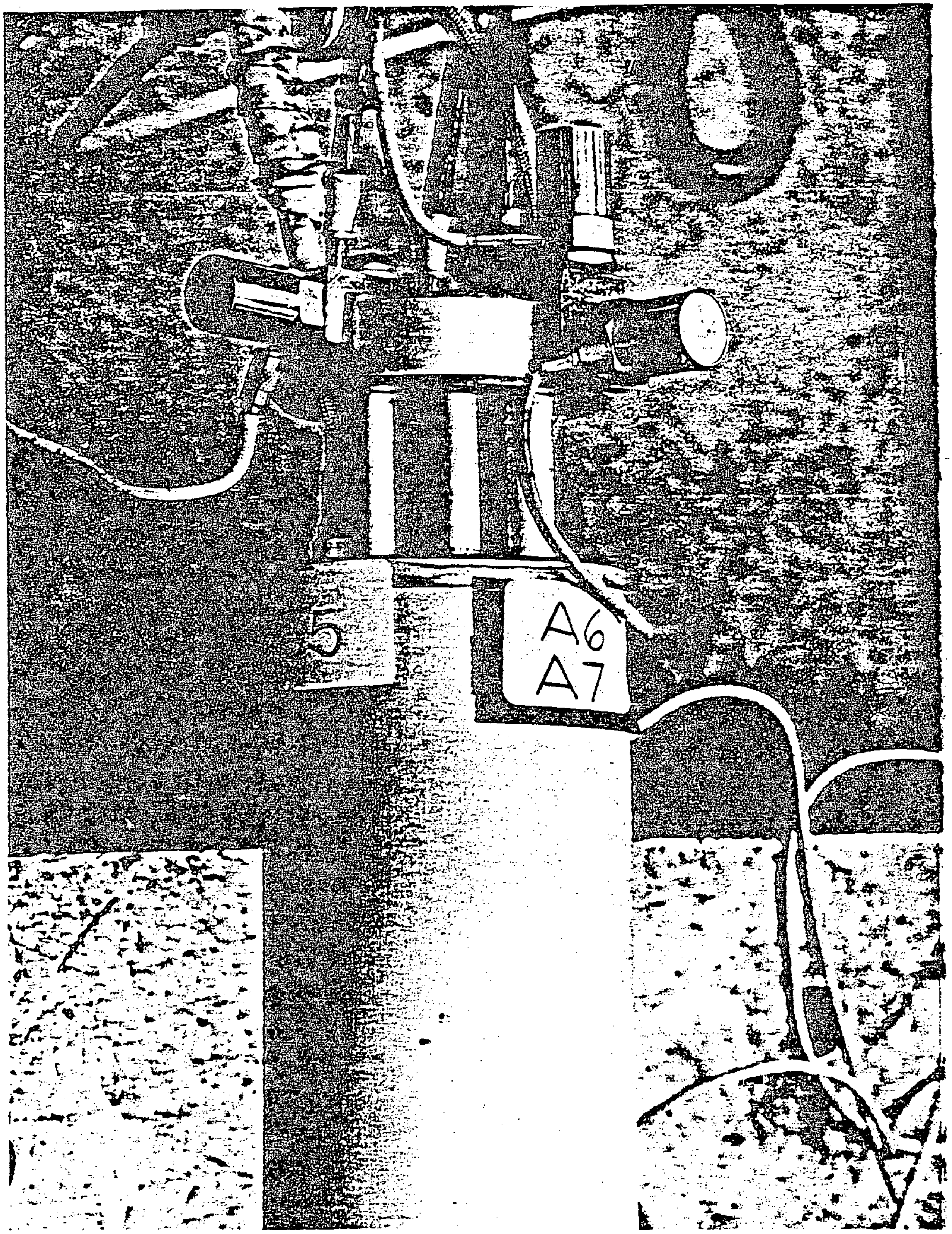

Figure 2-7 Accelerometer on Top of Uncompensated Ionization Chamber.

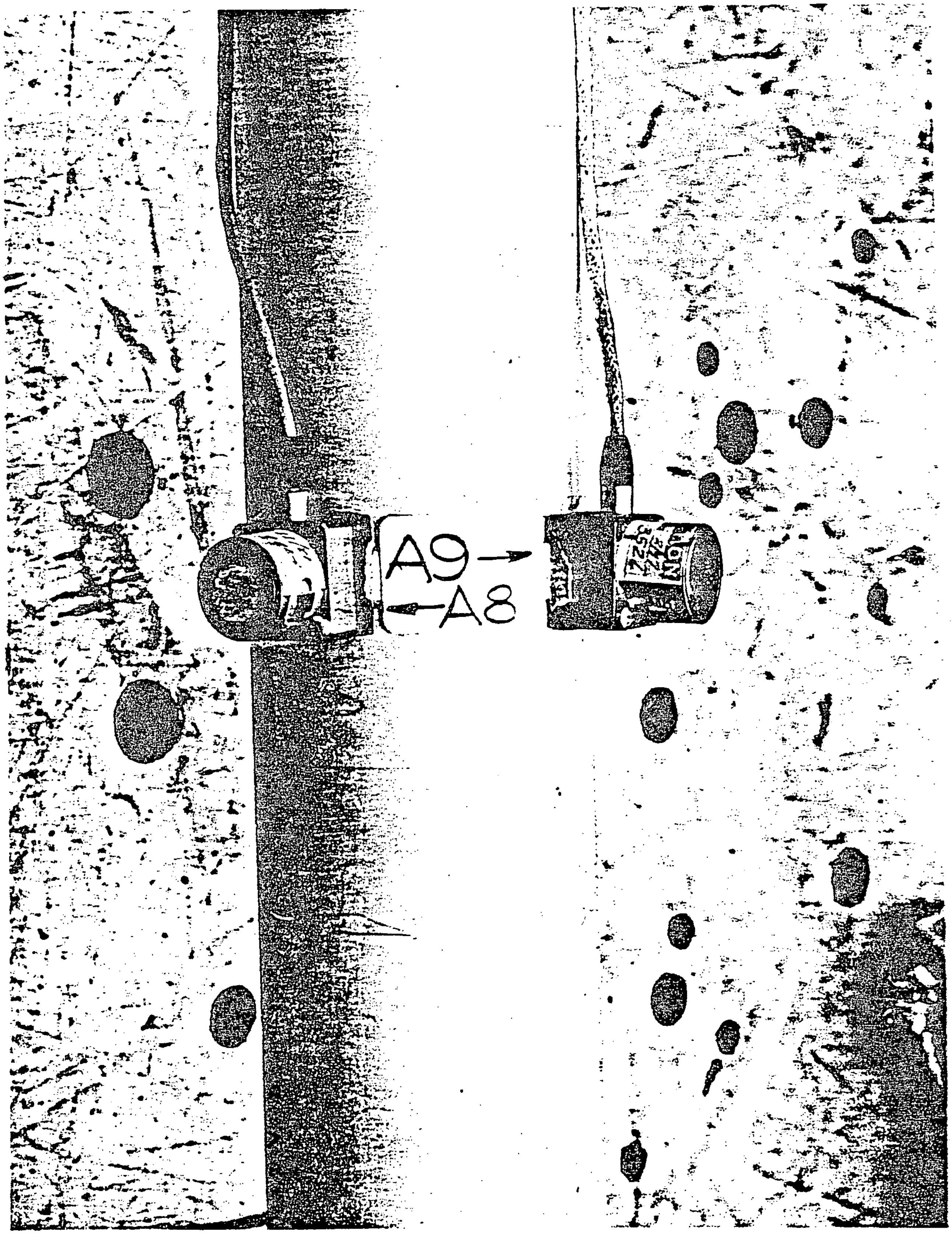

Figure 2-8 Accelerometer on Center Line of Uncompensated Ionization Chamber.

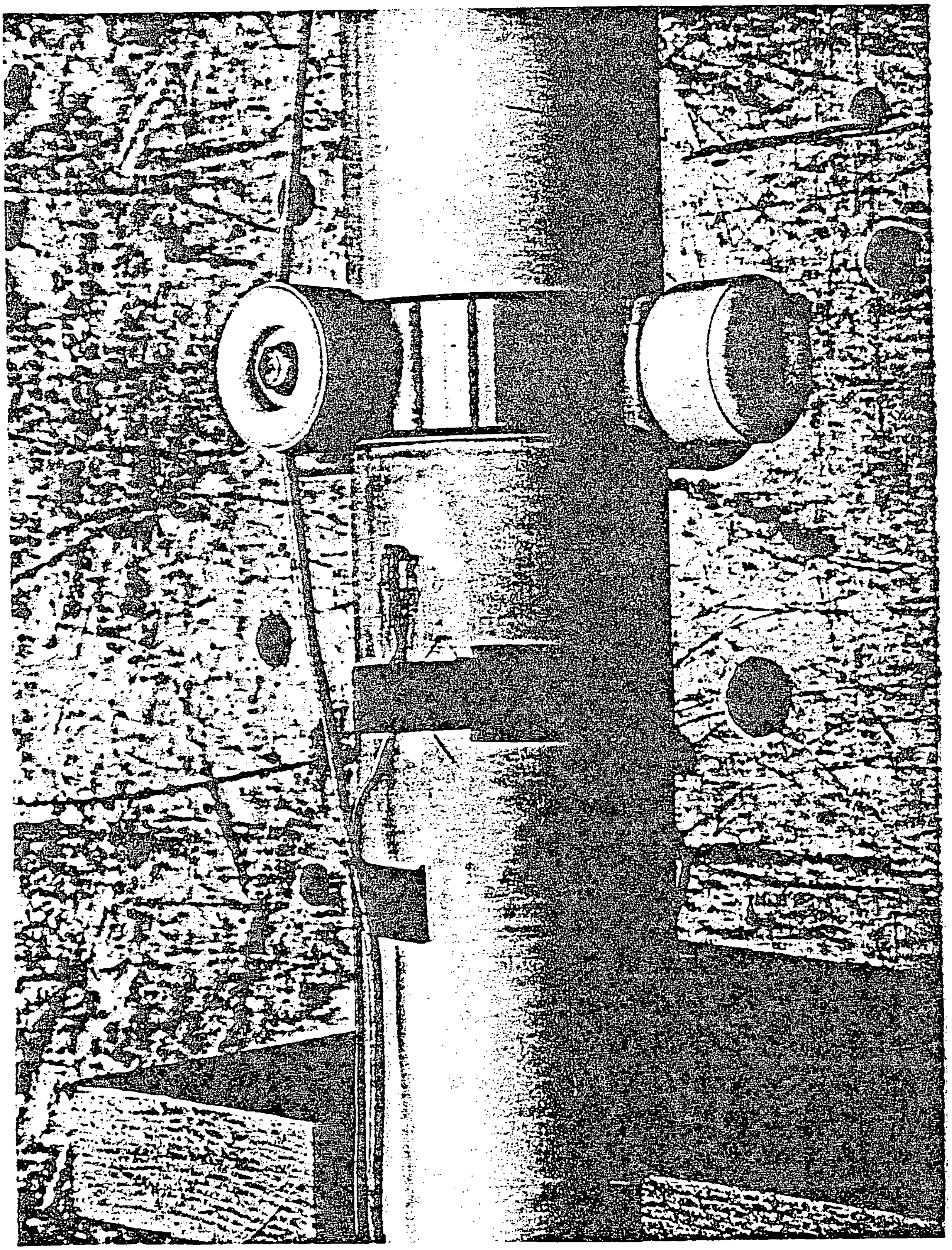

Figure 2-9 Strain Gage on Uncompensated Ionization Chamber & Top Ceramic Bushings Before Testing.

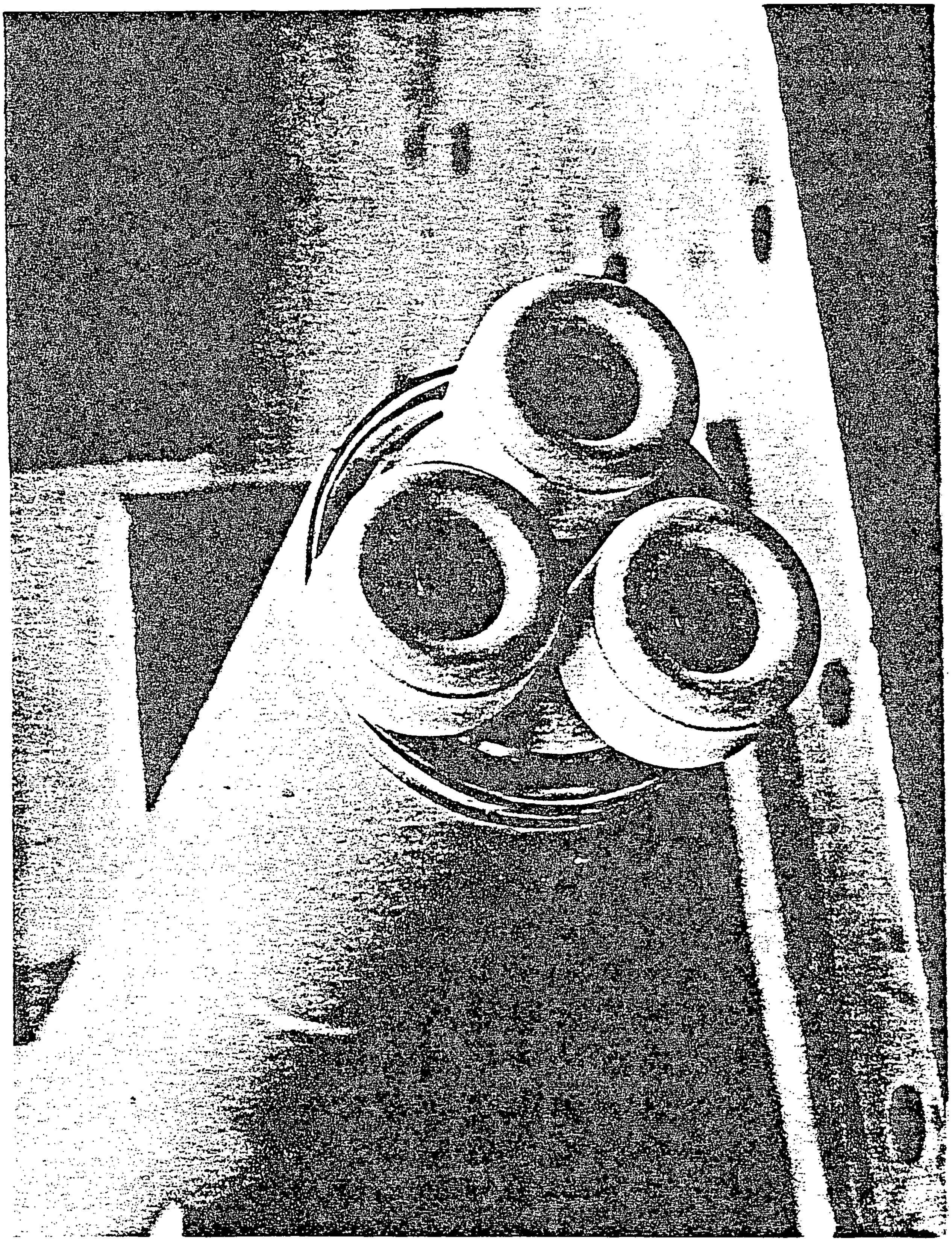

Figure 2-10 **Bottom Ceramic Bushings Before Testing.**