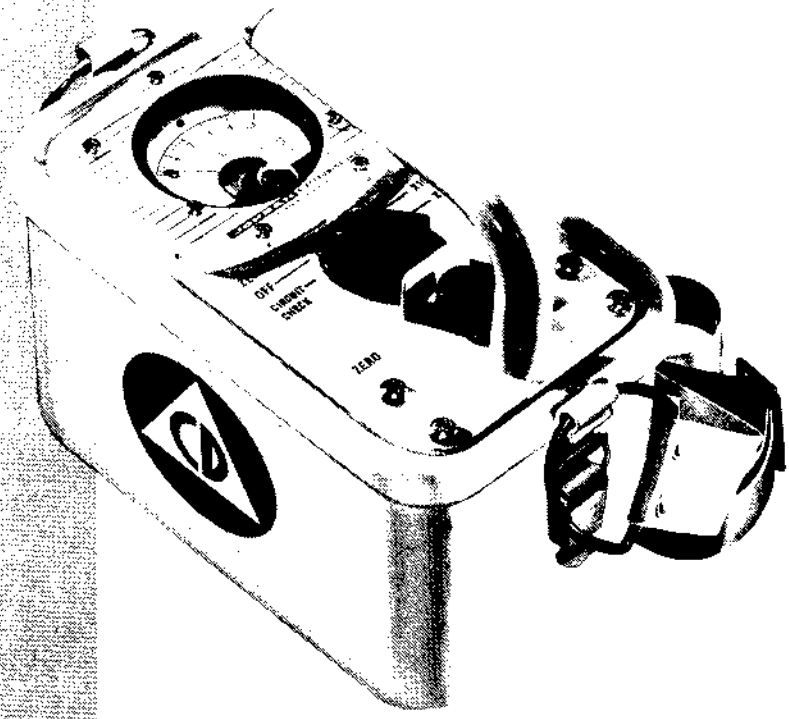
operating
and maintenance
INSTRUCTIONS



Radiation Survey Meter
Jordan Model 710

FCDA Item No. CD V-710 — Model No. 2

Jordan Electronics, Inc.

3025 West Mission Road
Alhambra, California

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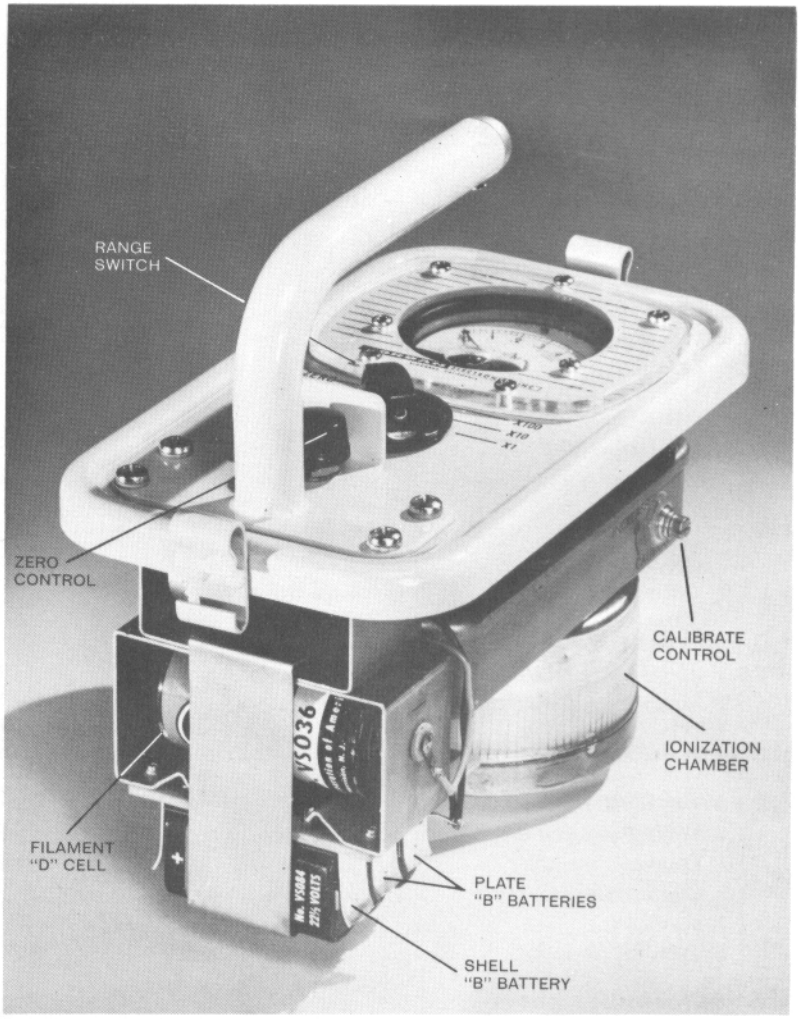

Figure 1 — The Jordan 710 with Case Removed

operating and maintenance instructions

1.0 GENERAL DESCRIPTION

1.1 ranges

The *Jordan 710* measures the intensity of gamma radiation up to 50 roentgens per hour (r/hr). Three ranges are provided, 0-.5, 0-5 and 0-50 r/hr. On the lowest (0-.5 r/hr) range, the smallest division on the scale is .02 r/hr, and, by interpolation, measurements can be made in increments of .01 r/hr. Intensities higher than 50 r/hr are indicated by the meter reading off scale, and the instrument is not harmed.

1.2 ionization chamber

The sensing element in the *Jordan 710* is a plastic air equivalent ionization chamber in an hermetically sealed steel enclosure. All the desirable qualities of the usual plastic chamber are maintained while sealing the chamber minimizes the effects of temperature and eliminates the altitude and moisture effects. These chambers are interchangeable and replaceable without disturbing the calibration of the instrument.

1.3 spectral response

The accuracy of this instrument is not affected by changes in energy level from .08 Mev (Million electron volts) to 1.2 Mev. This is the range required to measure gamma radiation of the various energies encountered in fission products.

1.4 accuracy

The accuracy of this instrument is ± 20% when used in temperatures from −20°F to +125°F. The accuracy is not affected by altitude, and the instrument will not respond to light or radio frequency radiations. The case is watertight to withstand immersion, and the housing containing the critical measuring components is gasketed to prevent any effects of moisture. Under normal operating conditions the accuracy is better than 10%.

1.5 controls

Two controls are provided. (See figure 1.) The RANGE SWITCH is used to turn on the instrument, check its proper functioning, and select the required range. The ZERO CONTROL is used to adjust the circuit to insure correct readings.

1.6 circuit check

The proper functioning of the measuring circuit including the batteries may be checked by setting the range switch to CIRCUIT CHECK and observing the meter reading. The limits of acceptable indication cover the top 40% of the scale, and a reliable indication of the condition of the instrument is available.

1.7 batteries

One "D" size flashlight cell (RCA No. VS-036) and three 22.5V photo flash or hearing-aid type "B" batteries (RCA No. VS-084) are used. The useful operating life is 250 hours for continuous duty and considerably longer for intermittent use.

1.8 meter

The meter in the *Jordan 710* uses the new core magnet type movement that is also used in military ruggedized meters. It will withstand shock and vibration and will provide reliable service under rough field handling.

1.9 physical features

The instrument is approximately 4" wide, 7" long and 5" high and weighs 3½ pounds. It is finished in bright yellow durable baked enamel. The *Jordan 710* will pass a rugged military shock and vibration test (MIL-T-17113) and will withstand considerable abuse without loss of accuracy. The carrying handle is of tubular construction to accept a dial light kit including a lucite lens and pushbutton for illuminating the meter face.

2.0 THEORY OF OPERATION

2.1 ionization chamber

The sensing element of the *Jordan 710* is an hermetically sealed air equivalent ionization chamber. This comprises a cylindrical air container called the **shell** and a disc, centrally located within it, called the **collector**. The collector is insulated from the shell which is operated at a potential of 45 volts positive with respect to the measuring circuit.

Gamma rays passing through the chamber shell cause the air molecules to become charged positively and thus become **ions**. Having a positive charge, the ions are repelled from the positive (+45V) shell, and they go to the collector. The number of ions thus formed is proportional to the intensity of the radiation.

The collection of these positive ions creates a current that flows from the chamber collector to the measuring circuit where it is amplified to operate the meter.

2.2 electrometer tube

The very small ionization current from the chamber collector (.0000025 microampere at .5 r/hr) flows through an extremely high resistor (100,000 megohms) and develops a measurable voltage across this "high-meg"

resistor. This voltage is applied to the grid of a vacuum tube which is called an *electrometer tube* because it is capable of measuring voltages at extremely small current values. The electrometer tube is connected as a triode. Its three elements are the **filament** which when heated by current from the "D" cell emits electrons, the **grid** which controls the flow of these electrons according to the voltage applied to it, and the **plate** which receives the electrons and passes them to the circuit in the form of a measurable current.

2.3 measuring circuit

The tube is connected as one leg of a conventional *bridge* circuit. (See figure 2.) Connected this way, the tube acts as a variable resistor that is controlled by changing the voltage on its grid. When the resistance ratio A:B is the same as C:D, no current flows through the meter, and the bridge is "balanced."

When the "resistance" of the tube (leg D) is changed by radiation the bridge is no longer balanced, and a current proportional to the intensity of radiation flows through the meter thus providing the desired indication.

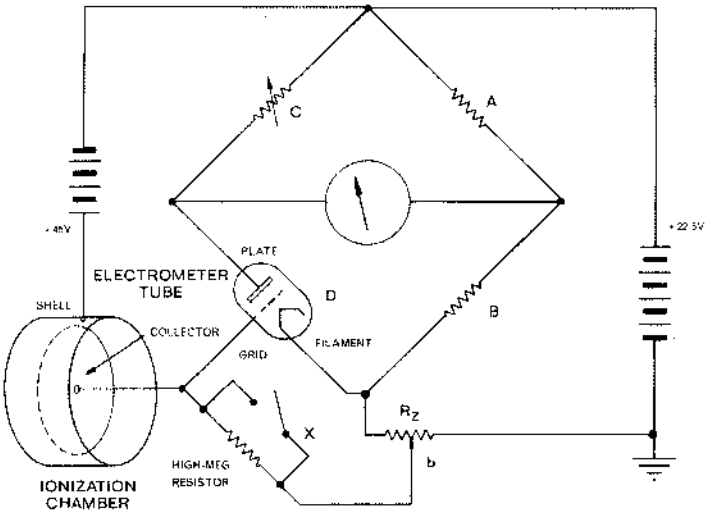

Figure 2 -- The Basic Circuit

2.4 zero control

The current supplied to the bridge by the plate battery flows through the ZERO potentiometer R_Z producing a bias voltage at point b. This voltage is applied to the grid of the electrometer tube through the high-meg resistor and is adjusted by the ZERO control to balance the bridge. This makes the meter read zero when no voltage is being supplied by ion current (radiation = ZERO). When the bridge is balanced, the instrument is *zeroed.*

To enable the operator to *zero* the instrument in the presence of gamma radiation, the range switch is provided with a section X to short out the high-meg resistor and eliminate the voltage developed by the ionization current. This duplicates the zero radiation condition. A COARSE ZERO control (C) is provided to balance the bridge with the zero control in the center of its adjustment. The shell voltage is supplied by adding a 22½ volt battery in series with the plate battery providing a total of 45 volts.

3.0 INSTALLATION

3.1 inspection

The instrument is shipped with the batteries packed separately to prevent damage to the instrument from battery leakage. To install the batteries, remove the instrument from the case by unfastening the clasps on either end and lifting upward by the handle.

Inspect the instrument carefully for any signs of damage in shipment. If any damage is apparent, the batteries should not be installed until an electrical check is made to prevent a short circuit causing further damage.

3.2 batteries

Open the battery clamp by loosening the knurled nut. Remove the clamp and install the batteries. OBSERVE THE POLARITY MARKINGS STAMPED ON THE INSTRUMENT.

Replace the battery clamp being sure that it is hooked in the slot below the "D" cell and tighten the nut.

Place the instrument in the case, be sure the gasket is properly seated and snap the clasps.

* * * *

The shoulder strap is attached by snapping the "D" rings into the catches on the cover.

4.0 OPERATION

4.1 operational checks

Turn the range switch to the ZERO position, wait a minute or two for the electrometer tube to warm up and adjust the ZERO control to make the meter read zero.

Turn the range switch to the CIRCUIT CHECK position. The meter should read within the red band marked CIRCUIT CHECK. If it does not, the batteries may be dead, or trouble may exist in the circuit. See sections 5 and 7 for maintenance procedures. When the batteries are new, the meter should read at the top of the circuit check band. When the reading nears the bottom of the band, the batteries should be replaced.

The CIRCUIT CHECK does not test the chamber, the high-meg resistors, or the shell battery.

4.2 taking readings

Turn the range switch to the X-100, X-10 or X-1 range as required and read the radiation intensity indication on the meter. The meter readings must be multiplied by the factor for the range being used. For example, a meter reading of .35 on the X-10 range indicates 3.5 r/hr. On the X-100 range the intensity would be 35 r/hr.

When several readings will be taken in an hour, or the instrument will be used frequently during a day, it is advisable to leave it turned on during the entire period of use.

The instrument is equally sensitive to radiation from the sides, front and bottom.

5.0 OPERATOR'S MAINTENANCE

5.1 battery replacement

The batteries should be replaced when the CIRCUIT CHECK setting on the range switch makes the meter read near the low end of the CIRCUIT CHECK band.

Remove the instrument from the case, loosen the knurled nut and the battery clamp. Remove the 22.5V "B" batteries. Force the bottom end of the battery clamp up through the slot in the "D" cell holder to pry out the "D" cell. Install new batteries as outlined in section 3.0.

5.2 emergency procedure

If replacement "B" batteries are not available, temporary operation can be obtained by switching the shell battery to the plate circuit. The drain on the shell battery is extremely small, and it will probably be useable after the others are dead. A battery no longer useful in the plate supply will usually operate the shell.

The batteries are switched by removing the shell battery, the one farthest from the battery hold-down nut, removing the plate batteries and replacing one of them in the shell battery position. The shell battery can then be placed in one of the plate battery positions. The plate battery contacts are connected in parallel, so either set can be used. At least one day's satisfactory operation can be obtained by switching the plate and shell batteries.

If the replacement of batteries will not correct the low reading in the circuit check position, or if the meter reads off scale in this position, or if the instrument cannot be *zeroed*, corrective maintenance is required. (See section 7.)

Operator's maintenance should be limited to replacement of batteries.

6.0 PREVENTIVE MAINTENANCE

Preventive maintenance is required once every six months of storage, once every month of occasional use, or prior to any critical period of use.

The batteries should be removed and checked for corrosion and cleaned if necessary. The battery contacts in the instrument should be carefully cleaned if necessary. Any leaking batteries should be discarded and replaced.

Check the ZERO control to be sure that the zero adjustment occurs near the center of its range.

Check the calibration against a standard gamma source and adjust if necessary according to the instructions in section 7.

If the instrument is to be stored for more than a few weeks, the batteries should be removed and stored separately.

7.0 CORRECTIVE MAINTENANCE

7.1 tools required

One screwdriver will usually suffice for servicing this instrument. However, if complete disassembly is necessary, the following tools should be on hand:

1 $\frac{5}{64}$" hex setscrew wrench

1 ¼" blade screwdriver

1 ¼" nut driver

1 ½" box wrench

1 small Phillips screwdriver

1 small soldering iron

1 Multimeter (such as Simpson 260).

7.2 disassembly

The instrument may be partially or completely disassembled in the following steps:

a. Remove the instrument from the case by unfastening the clasps and lifting upward by the handle.

b. Remove batteries as outlined in section 5.

c. Open the high-meg housing by removing the two chamber hold-down screws nearest the batteries. Lift the high-meg housing carefully to disengage the switch shaft from the switch deck inside, then remove the high-meg housing and chamber assembly.

d. For complete disassembly, remove all screws on the cover, the switch and ZERO control nuts and remove the major assemblies from the cover.

7.3 calibration

A calibrated source of radioactive material should be used to calibrate the instrument. Cobalt-60 and Radium sources are most commonly used. If the radiation intensity of the source is unknown, a secondary standard instrument such as a Condenser R Meter can be used to calibrate the source.

The *Jordan 710* can be calibrated on any of its three ranges and the other two will automatically be calibrated. A convenient radiation intensity to use is 0.35 r/hr. A 20 mc. Radium source will produce this intensity at 7.42 inches. All measurements must be made from the center line of the chamber (marked on the case). The source should be no closer than 6 inches from this mark.

Check the calibration with the instrument in the case. Remove and adjust the CALIBRATE control as required. Replace the instrument in the case and check the reading. Repeat this procedure until the correct reading is obtained. If a large source is available, the high ranges should also be checked.

If new batteries are installed at the time of calibration, turn the range switch to CIRCUIT CHECK and adjust the CIRCUIT CHECK control to make the meter read 0.5.

7.4 batteries

The plate "B" batteries and filament "D" cell are tested by the CIRCUIT CHECK. If trouble occurs, however, all the batteries should be tested with a voltmeter. Using a 20,000 ohm per volt meter such as a Simpson 260, the "D" cell should read no less than 1.2v and the "B" batteries no less than 16v.

7.5 trouble shooting

All components with the exception of the high-meg resistors and the electrometer tube are similar to parts used in radio and television sets and most radio servicemen and radio amateurs can test them.

Voltages can be checked with those shown on the circuit diagram. Batteries must be removed before making resistance or continuity checks.

The high-meg resistors cannot be checked with standard radio test equipment but can be assumed to be functioning properly if they are not dirty or damaged.

CAUTION: *Do not handle the high-meg resistors, the ceramic switch deck, or the electrometer tube. Touch them only with clean tools.*

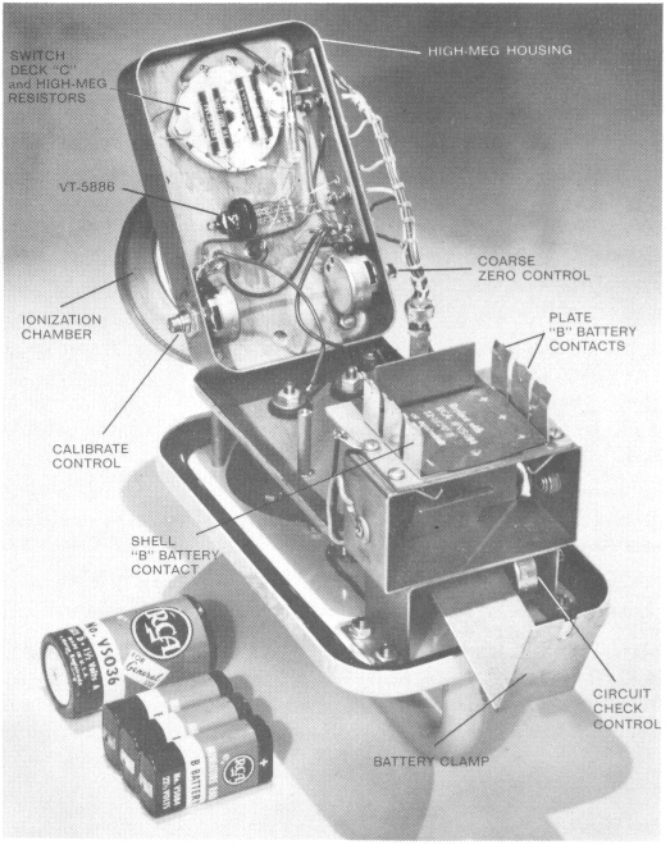

Figure 3 — The Jordan 710 Opened for Servicing

The following symptoms and suggested corrective procedures will be helpful in trouble shooting the *Jordan 710* . . .

will not zero	CORRECTIVE PROCEDURE
Dead batteries	Replace all batteries
Dirty battery contact	Inspect and clean battery contacts
Coarse zero control disturbed	Set ZERO control at center and adjust COARSE ZERO control to make meter read zero
Electrometer tube filament open	Remove "D" cell, set range switch to ZERO, measure resistance between battery contacts. Should be approximately 150 Ω

will not zero	CORRECTIVE PROCEDURE
Open potentiometer	Check potentiometers with ohmmeter
Open resistor	Check resistors with ohmmeter
Open connection	Inspect all solder joints and wiring
Open switch contact	Check switch contacts, clean and, if necessary, adjust contacts
Short circuit	Inspect for mechanical damage
no reading	
Dead batteries	Replace batteries
Dirty battery contact	Inspect and clean battery contacts
Calibration control (shunt) improperly adjusted	Turn calibration control clockwise and use CIRCUIT CHECK position to test
Meter damaged	Replace meter
Chamber damaged	Replace chamber
Open connection	Inspect all solder joints and wiring
reads low	
Calibration control disturbed	Check calibration as outlined in 7.3
Dead electrometer	Replace with new 5886
Dirty high-meg components	Clean the high-meg resistors, ceramic switch deck, electrometer tube, and chamber insulator with pure dry alcohol
Chamber leaks at high altitudes because seal is broken	Locate and repair leak or replace chamber
Meter damaged	Replace meter
reads high	
Calibration control improperly adjusted	Check calibration as outlined in 7.2
If high reading is on only one range, a high-meg resistor may be damaged	Replace suspect high-meg resistor
Calibration control open	Check with ohmmeter and replace if necessary

The two sides of the phenolic switch deck X-B are separated and shown as seen from the top of the instrument. X-b_1 is the top side. Switch decks are shown in the off position.

Voltages shown are measured from chassis ground with 20,000 ohm per volt meter such as a Simpson 260. Set range switch to ZERO position and *ZERO* instrument while taking voltage readings.

Do not make any measurements on high-meg resistors, electrometer tube grid or chamber collector connection. This may damage the electrometer tube. Do not check meter resistance with ohm meter.

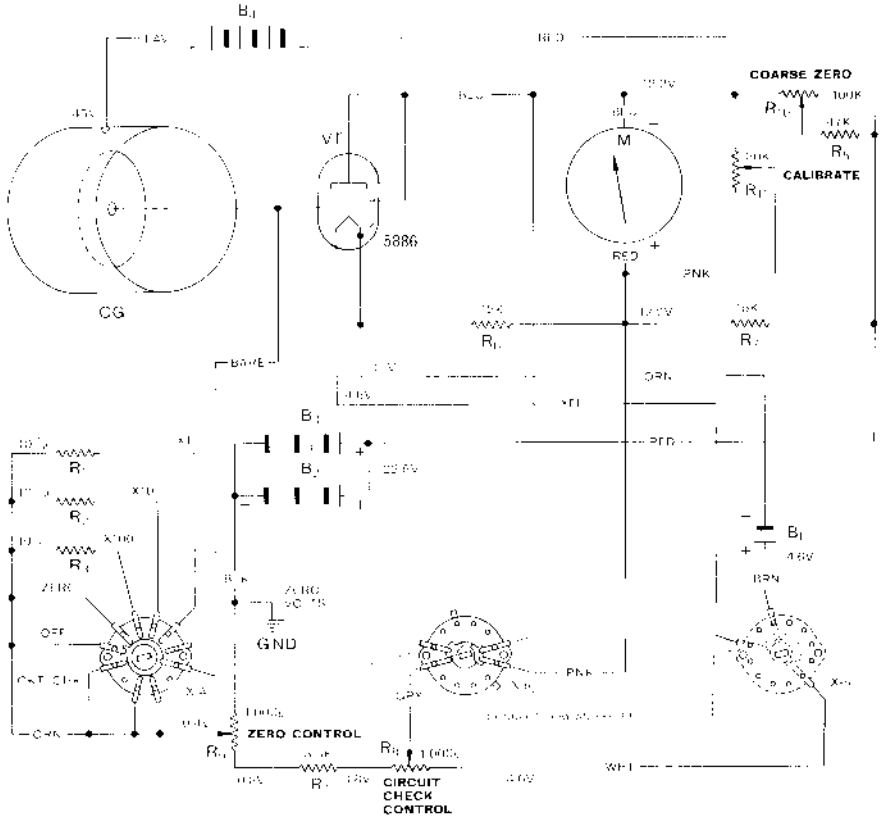

Figure 4 — Circuit Diagram

8.0 REPLACEABLE PARTS

8.1 electrical components

Circuit Symbol	*Description and Function*	*Manufacturer*	*Mfr.'s Part No.*	*Jordan Part No.*
B_1	1.5V "D" cell, filament supply	RCA	VS-036	BA-0005
B_2, B_3	22.5V "B" battery, bridge and plate supply	RCA	VS-084	BA-0006
B_4	22.5V "B" battery, shell supply	RCA	VS-084	BA-0006
R_1	Resistor, high-meg, 100,000 meg. 10% measuring, range X-1	Victoreen	RX-1	RX-0003
R_2	Resistor, high-meg, 10,000 meg. 10% measuring, range X-10	RPC	HBF	RX-0002
R_3	Resistor, high-meg, 1,000 meg. 10% measuring, range X-100	RPC	BBF	RX-0001
R_4	Resistor, carbon 3.3K ½W bias limit	IRC	BTS	RC-0332
R_5	Resistor, carbon 47K ½W coarse zero limit	IRC	BTS	RC-0473
R_6	Resistor, carbon 12K ½W bridge leg B	IRC	BTS	RC-0123
R_7	Resistor, carbon 15K ½W bridge leg A	IRC	BTS	RC-0153
R_8	Potentiometer, carbon 1,000Ω 20% circuit check adjust	IRC	214528	RP-0102
R_9	Potentiometer, carbon 1,000Ω 20% zero control	IRC	214529	RP-0102A
R_{10}	Potentiometer, carbon 100K 20% coarse zero control	IRC	214526	RP-0104
R_{11}	Potentiometer, carbon 30K 20% calibration control	IRC	214523	RP-0303
X-A	Switch deck, ceramic, high-meg switching	Oak	70150HC	SD-0012
X-B	Switch deck, phenolic, bridge switching	Oak	70151H	SD-0011
VT	Vacuum tube, electrometer	Victoreen or Raytheon	5886	VT-5886
M	Meter, indicating, 20μa, 3,000Ω core magnet movement	Simpson	125-E	EI-0007
CG	Ionization chamber, air equivalent gamma	Jordan		AE-0004

8.2 mechanical components

No. Req'd	*Description and Function*	*Mfr. and Catalog No.*	*Jordan Part No.*
1	Cover Assembly	Jordan	AS-0005
1	Case Assembly	Jordan	AS-0006
1	Mtg. Bracket Assembly, "D" Cell	Jordan	AS-0007
1	Battery Clamp	Jordan	MS-0099
1	Handle Assembly	Jordan	AS-0009
1	Meter Cover	Jordan	MP-0001
1	Knob, Zero Control	H. Davies No. 1450	HK-0001
1	Knob, Range Switch	Rogan Bros. No. RB-31	HK-0002
2	Catch, Draw-Pull	Nielsen HC-200-CE	HX-0003
1	Gasket, Cover	Jordan	HG-0025
1	Gasket, Handle	Jordan	HG-0015
1	Gasket, Meter Cover	Jordan	HG-0010

8.3 maintenance supply parts

Suggested supply for five instruments for one year (250 hrs) of operation.

Qty.	*Circuit Symbol*	*Description and Function*	*Jordan Part No.*
5	B_1	"D" Cell, Filament Supply	BA-0005
15	B_2, B_3, B_4	"B" Battery, Plate, Bridge and Shell Supply	BA-0006
1	VT	Vacuum Tube, Electrometer 5886	VT-5886
1	M	Meter, Indicating	EI-0007
1	R_1	Resistor, High-Meg, Range X-1	RX-0003
1	R_2	Resistor, High-Meg, Range X-10	RX-0002
1	R_3	Resistor, High-Meg, Range X-100	RX-0001
1	R_9	Potentiometer, Zero Control	RP-0102A
1	CG	Ionization Chamber Assembly	AE-0004
2		Gasket, Cover	HG-0025
2		Cover, Meter	MP-0001
1		Knob, Zero Control	HK-0001
1		Knob, Range Switch	HK-0002

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INTERNATIONAL RESISTANCE COMPANY
401 North Broad Street
Philadelphia, Pennsylvania

JORDAN ELECTRONICS, INC.
3025 West Mission Road
Alhambra, California

NIELSEN HARDWARE CORPORATION
770 Wethersfield Avenue
Hartford, Connecticut

OAK MANUFACTURING COMPANY
1260 Clybourn Avenue
Chicago 10, Illinois

RADIO CORPORATION OF AMERICA, TUBE DIVISION
Harrison, New Jersey

RAYTHEON MANUFACTURING COMPANY
55 Chapel Street
Newton 58, Massachusetts

ROGAN BROTHERS
8031 Monticello Avenue
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