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TECHNICAL MANUAL

MODEL 263A

NOV. 1947

THE VICTOREEN INSTRUMENT CO.

5806 HOUGH AVE., CLEVELAND, OHIO

Victoreen

TECHNICAL MANUAL

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TECHNICAL MANUAL

I -- INTRODUCTION

A. General Description

The Victoreen Model 263A is a modification of the 263 based on experience gained from its performance over the past four years under a wide variety of rugged military and civilian applications. These two instruments are not to be confused with the model 263 used extensively on Operations Crossroads.

The Model 263A is a portable instrument for measuring the intensity of beta and gamma radiation. The detecting device is a 900 volt counter tube of thin wall glass construction to permit the measurement of beta particles.

A suitable pulse width and amplitude limiting circuit makes the instrument independent of wide variations in Geiger tube pulse amplitudes with battery age. A counting-rate meter smooths out the random pulses with a three second time constant, giving an effective compromise between statistical fluctuations and quick response to changing radiation intensity. Power is supplied by very compact, easily replaceable A, B and high voltage batteries which are commercially available.

The counter tube is a very sensitive device capable of detecting individual ionizing particles producing a pulse of current for each particle. The average repetition rate of these pulses is an indication of the intensity of beta and/or gamma radiation to which the counter is being exposed. In conjunction with suitable power supplies and a counting-rate meter, the counter tube is made the basis of a survey meter for detecting low intensity radiation.

B. Applications

The instrument is used for semi-quantitative work where high sensitivity is required. For example:

1. It is very effective in the search for health hazards from radioactivity in laboratories and industrial plants where such hazards are a possibility.

2. It is used in determining the effectiveness of decontamination procedures after the health hazard is located.

3. In prospecting for radioactive ores, the 263A is used to locate out-croppings and to provide a quick semi-quantitative assay of the carnotite or pitchblend ore.

4. Misplaced or lost radium needles may be located with the 263A.

5. Postal and express inspectors could use the 263A to determine whether or not shipping regulations regarding radioactivity are being observed.

C. Variation From Model 263

1. The probe has been streamlined by bringing the cable out the end and eliminating the side arm connection.

2. Probe clamps have been strengthened.

3. A longer knob is being used on the switch for convenient manipulation of controls with the same hand that is carrying the instrument.

4. Scale multiplying factors are printed on the control panel.

5. The circuit wiring has been cabled and coupling capacitors mounted more rigidly for increased uniformity.

6. A variable capacitor is used for coupling in the 20mr/hr range to provide independent calibration of that range.

7. Three standard 300 volt batteries, Eveready No. 493, have replaced the special 960 volt battery.

8. The weight is decreased by several pounds.

Note: The case size remains the same to permit the use of the old 960 volt batteries when desirable. The new battery bracket can be installed in the old 263 instrument to convert it for use with the new 300 volt batteries.

II -- SPECIFICATIONS

A. Physical Characteristics

Height - 10 inches

Width - 3-1/4 inches

Length - Exclusive of probe, 12 inches

Probe opening - 2 inches by 2-1/2 inches

Beta shield - 1/32 inch brass

Weight - 12 pounds

Finish - Black crackle or grey enamel

Indicating meter - 3 inch scale

Probe - 1-1/2 inches in diameter by 9 inches long. Connected to the instrument through a four foot cable. May be clamped to the front of the instrument case.

Geiger tube wall thickness - 30 mg/cm.^{2}

Components - Supplied complete with tubes, batteries, and headphones

Tropicalization on special request

B. Performance Characteristics

Sensitivity - Radium gamma

Range 0.2, 0 to 0.2 mr/hr.

Range 2.0, 0 to 2 mr/hr.

Range 20, 0 to 20 mr/hr.

Accuracy of calibration - Plus or minus 10%

Time constant - 3 seconds

Battery life - A, 140 hrs.; B, 600 hrs.; HV, shelf

Geiger tube - VG-13

Audio output - High impedance headphones

III -- OPERATING PROCEDURE

A. Gamma Ray Measurement

1. Close the Beta ray shield on the probe.

2. Turn the range switch to 20.

   (0 to 20 mr/hr for hard gamma radiation)

3. Place the instrument with the tube in the location to be measured. (Note the directional characteristics in figures 7 and 8.)

4. If the reading is less than 10% of full scale, switch to 2.0. (0 to 2 mr/hr.)

5. If the reading is still less than 10% of full scale, switch to 0.2. (0 to 0.2 mr/hr.)

6. Watch the meter for about 30 seconds to determine the average reading. (This is particularly important on range 0.2.)

7. Read the meter and record the data.

B. Beta Ray Measurement

1. Remove the probe from its brackets and place it in the desired location (positioning of the tube is much more important than in gamma ray measurements).

2. Repeat gamma ray measurement procedure but with shield open. (Steps 2 through 7.) Record reading.

3. Take gamma ray measurement (probe shield closed) with the tube in the same location. Record reading.

4. Beta intensity is obtained by subtracting reading (3) from reading (2).

C. Background Measurement

1. Turn the selector switch to 0.2. (The intensity is at or near background when the meter reading is less than 20% of full scale.)

2. Plug the high impedance earphones into the jack on the panel.

3. Observe a stop watch or a wristwatch with sweep second hand.

4. Count the number of "clicks" in the phones for a one minute time.

5. Repeat part four several times, allowing a rest period between counts. (The probable error is proportional to the total number of counts.)

6. Average the one minute readings to obtain results in counts per minute.

D. Audio Survey

1. Decide upon the level of intensity above which a careful measurement should be made. An intensity well below the daily tolerance is recommended. For example: 1 mr/hr.

2. Plug in the earphones as in the background measurement.

3. Turn the selector switch to 0.2.

4. Place a radium sample or other source of radiation at a distance to give the level of intensity determined in (1) above.

5. Listen to the signal to become accustomed to the noise level and pulse repetition rate.

6. Move the probe back and forth toward and away from the sample. Notice carefully the difference in the audio signal as the intensity is increased or decreased.

7. Close your eyes and have someone move the sample a short distance.

8. Try to reproduce the distance (4 above) between the sample and the probe, within 10%, using only the audio signal as a guide.

9. When step 8 can be accomplished easily, audio surveys can be made with a degree of confidence and in considerably less time than with most other methods. Attempts have been made to cover a wide range in audio surveying, but this has usually resulted in a sacrifice in accuracy and reliability as compared to the one point comparison method described above.

E. Assay

This instrument will not substitute for chemical assay or the laboratory counter assay but is of considerable assistance to the man in the field for preliminary determination. It has saved months of waiting for information.

1. Prepare the samples in a fine powder or other physical form, uniform and reproduceable in all dimensions.

2. Improvise a means of reproducing the exact position of the sample with respect to the tube.

3. Select a permanent sample as a standard of comparison. This should be of the same order of magnitude, in intensity, as the material to be assayed.

4. Take careful readings, A and/or B above, on the standard before each unknown.

5. If the sample is near background intensity, take background readings and subtract from the readings taken on the standard and on the sample.

F. Recording Data

In most operations involving the measurement of radiation, a large percentage of the information desired has been lost through improper and incomplete methods of recording data. If data sheets are not provided, the operator should make up his own before starting to read the instrument. The following information should be recorded on such a data sheet.

Date, time, place, instrument, model or type number, serial number, identification of source, position of instrument with respect to source, position of beta shield, position of selector switch, meter reading, units of measurement, background reading, comparison standard reading, and identification of standard sample.

Those items which are the same for all measurements can be incorporated in the data sheet heading. The other items can be listed as column headings.

IV -- ELECTRONIC DESCRIPTION

A. No Signal Condition

1. V_1, the VG-13 counter tube is charged to 900 V awaiting an ionizing event.

2. V_2, the first VX-41 tube, is biased by the voltage divider R_2 and R_3, to approximately -4 volts.

3. V_2 is drawing current through the common cathode resistor R_5.

4. V_3 is biased to cut off by the IV through R_5.

5. No current flows through the meter in the plate circuit of V_3.

B. Counter Tube Discharge

1. A Beta or gamma ray enters the sensitive volume of the tube.

2. The incident ray ionizes a molecule of the gas or ejects a photoelectron from the cathode which ionizes the gas.

3. The ion thus produced is accelerated by the electrostatic field between the counter electrodes.

4. With the increased energy the original ion ionizes more molecules of the gas which find their way to the center electrode, producing a negative pulse.

5. A continued spread of ionization throughout the sensitive volume of the tube, called an avalanche, results.

6. Heavy organic molecules forming the "quenching vapor" are also ionized near the center electrode where the electrostatic field intensity is greatest.

7. The heavy ions form a "positive ion sheath" around the center electrode and move to the cathode.

8. The electrostatic field strength in the sensitive volume of the tube is reduced by the "positive ion sheath" to the extent that the tube cannot sustain the ionization process or discharge.

The tube, minus a few molecules of the quench vapor is ready for the next event.

C. Pulse Rise

1. The voltage pulse from the center wire of the counter VG-13 is applied to the grid of V_2, the first VX-41 tube, through a high voltage coupling capacitor, C_1.

2. When this pulse is-3 volts or greater, it drives V_2 to cut off.

3. The plate voltage is increased by approximately 15 volts.

4. This pulse is applied to the grid of V_3, the second VX-41, through C_2.

5. Current will flow through V_3.

D. Duty Cycle

1. The counter tube V_1 has completed its discharge during the rise time of the circuit.

2. V_2 is cut off by the voltage across the cathode resistor R_5 due to the larger plate current in V_3. Paragraph C5 above.

3. C_2 charged by the sudden cut off of V_2 is discharging through R_6 and R_4 with an exponential decay of second time constant.

4. The positive signal applied to the grid of V_3 and the resultant current through it is decreasing with the discharge of C_2.

5. The decreasing current through V_3 decreases the bias on both tubes across R_5.

6. Decreasing bias on V_3 tends to increase the current that is in that tube resulting in a small change in plate current.

7. This unstable condition is terminated when the current in R_5 and the resulting bias on V_2 is reduced sufficiently to allow V_2 to pass current.

E. Circuit Recovery

1. The decreasing current through V_3 and R_5 approaches 200 microamperes, reducing bias on V_2 to 3 volts.

2. V_2 begins to draw current.

3. A negative pulse appears on the plate of V_1 due to iV_1 R_4.

4. The negative pulse is applied to the grid of V_3 through the coupling of C_2, causing V_3 to be cut off.

5. With V_3 effectively out of the circuit, V_2 resumes its 200 microampere current.

6. The 200 microamperes across R_5 will hold V_3 cut off.

7. C_2 will discharge through R_4 and R_6.

8. The circuit has returned to its normal state awaiting another pulse from the counter tube.

F. Metering Circuit

1. The 500 microampere plate current in V_3, during a pulse, charges capacitor C_5.

2. C_5 is discharged through the meter and R_7, with a time constant $(R_m + R_7) \times C_5$.

3. When the time between pulses approaches the time constant of the integrating circuit $(R_m + R_7) \times C_5$, the meter will show individual pulses.

4. When the time constant is much larger than the time interval between pulses, the meter shows an average reading of the pulse repetition rate.

5. Variations or fluctuations still occur in the meter with long time constants. These are caused by the random nature of the particles being measured which result in a statistical variation in the pulse repetition rate.

6. The magnitude, in percentage, of this random variation is proportional to the square root of the average pulse repetition rate and inversely proportional to the square root of the time constant of the circuit.

G. Additions to Simplified Circuit

1. A range switch is provided by switching C_3 or C_4 in place of C_2, the coupling capacitor coupling between V_2 and V_3. This provides a control over the time V_3 is conducting, and thus the average meter current.

2. R_7 is added to the meter resistance to increase the time constant of the integrating circuit.

3. Switches are inserted in the battery circuits.

V -- MAINTENANCE

A. Improvised Volt Meter

1. Disconnect the microammeter from the circuit. (50 microamperes with 0 to 20 scale.)

2. Select a series resistor for the proper full scale voltage range (20,000 ohms per volt).

Full Scale Voltage Sensitivity	2	10	100	400	1000
Resistance	40 K	200 K	2 Meg	8 Meg	20 Meg

B. Battery Voltage Check

After 150 hours of operation, or six months storage period, the battery voltage should be measured.

1. Remove the six screws on the sides of the case and lift the instrument from its case.

2. Use a 20,000 ohm per volt meter.

3. Turn the instrument on and measure directly across the terminals of the 1½ volt A Battery and 67½ volt B Battery. See Figure 6.

4. Turn the instrument off, pull the plugs on the three 300 volt batteries and measure directly across the Battery terminals.

C. Free Point Circuit Check

Use a 20,000 ohm per volt meter to measure voltages and resistances from the octal socket to ground. The proper values are given in the chart below.

Check Point	Meter Range	Voltage	Resistance
1. Ground	-	0	0
2. Counter Anode	1000	880	00
3. B+	250	67	11 meg
4. V2 Plate	50	42	11 meg
5. V3 Plate	250	67	11 meg
6. V3 Grid	-	0	900 K
7. - Filament	10	3.5	24 K
8. + Filament	10	5	24 K

D. Signal Tracing

1. Using a .025 microfarad capacitor in series with an oscilloscope lead, check the wave form of the pulse between the terminal of the octal socket and ground.

2. If an oscilloscope is not available, use the crystal earphones supplied with the instrument. Place a .0025 microfarad capacitor in series with the phones to check the signal between the points on the octal sockets and ground. A signal should be audible from points 2, 4, 6, 7, and 8.

E. Counter Tube Check

1. Place new batteries in the circuit.

2. Adjust a source of radiation at the proper distance from the tube to cause a meter reading of 10 on the 20 scale.

3. Clip a 10 meg. resistor across the counter tube (between pin No. 2 and ground) to reduce the counter tube operating voltage to 875 volts. If a 10 meg. resistor is not available, connect a 22½ volt battery in series with the three 300 volt batteries with opposite polarity to reduce the voltage to 877 volts.)

4. If the meter reading is decreased below 9, the counter tube should be replaced.

F. Symptoms and Diagnosis

1. No response to radiation.

Check batteries, trace signal with phones.

2. Continuous Reading with no Radiation.

Check voltage point 8, cathode bias.

If voltages are correct, replace amplifier.

3. Meter saturates at high intensities before reaching full scale.

If battery voltages are correct, replace amplifier.

4. Calibration too high or too low on all scales.

    If battery voltages are correct, adjust screwdriver calibration control.

5. Calibration does not agree on x1 and x10 scale.

    Adjust trimmer capacitance C_2.

6. Meter fluctuates excessively.

    Add capacitance in parallel with C_5.

7. Meter response is too slow to sudden change in radiation.

    Put jumper across R_7 or replace C_5 with a smaller capacitor.

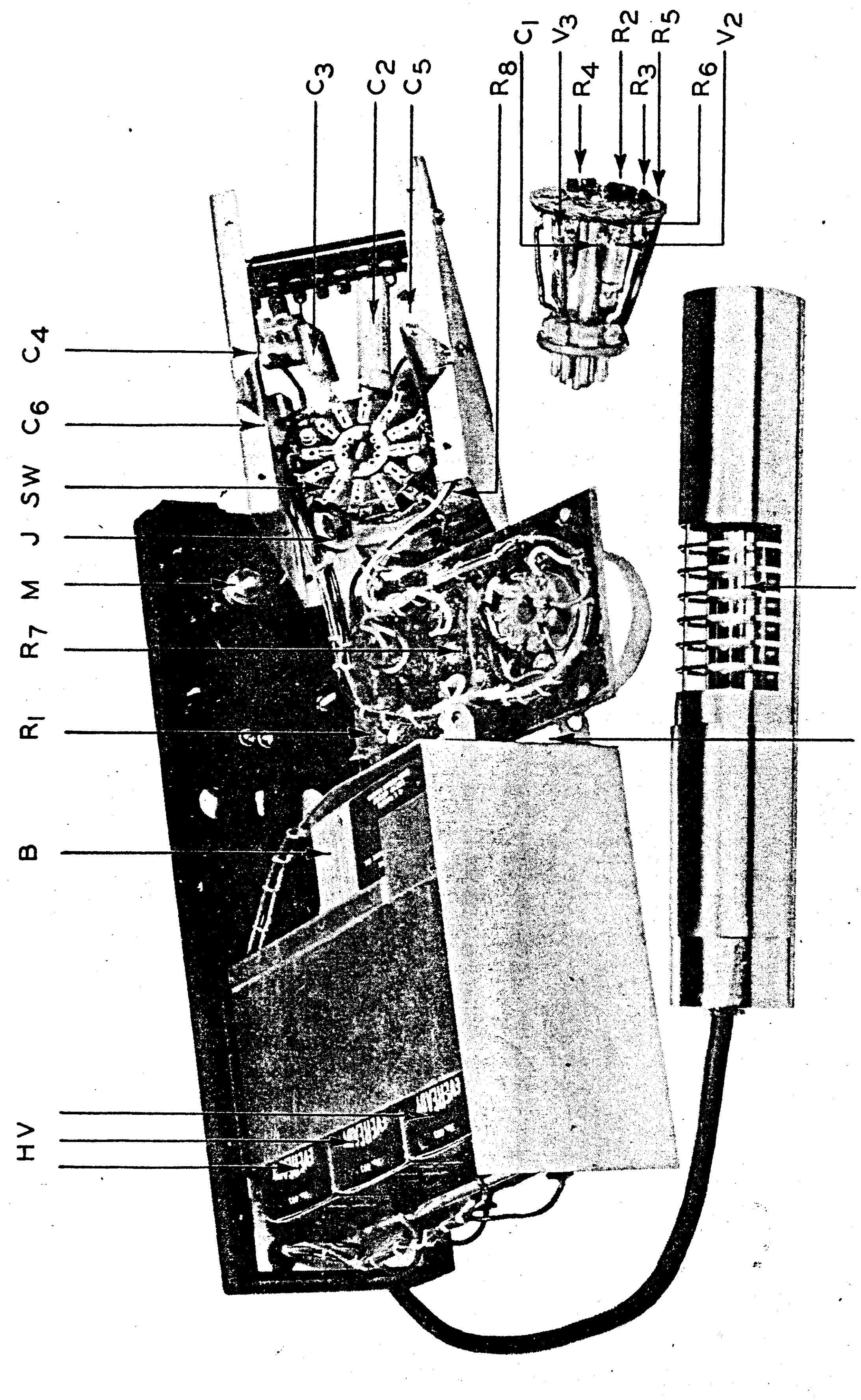

Fig. 1

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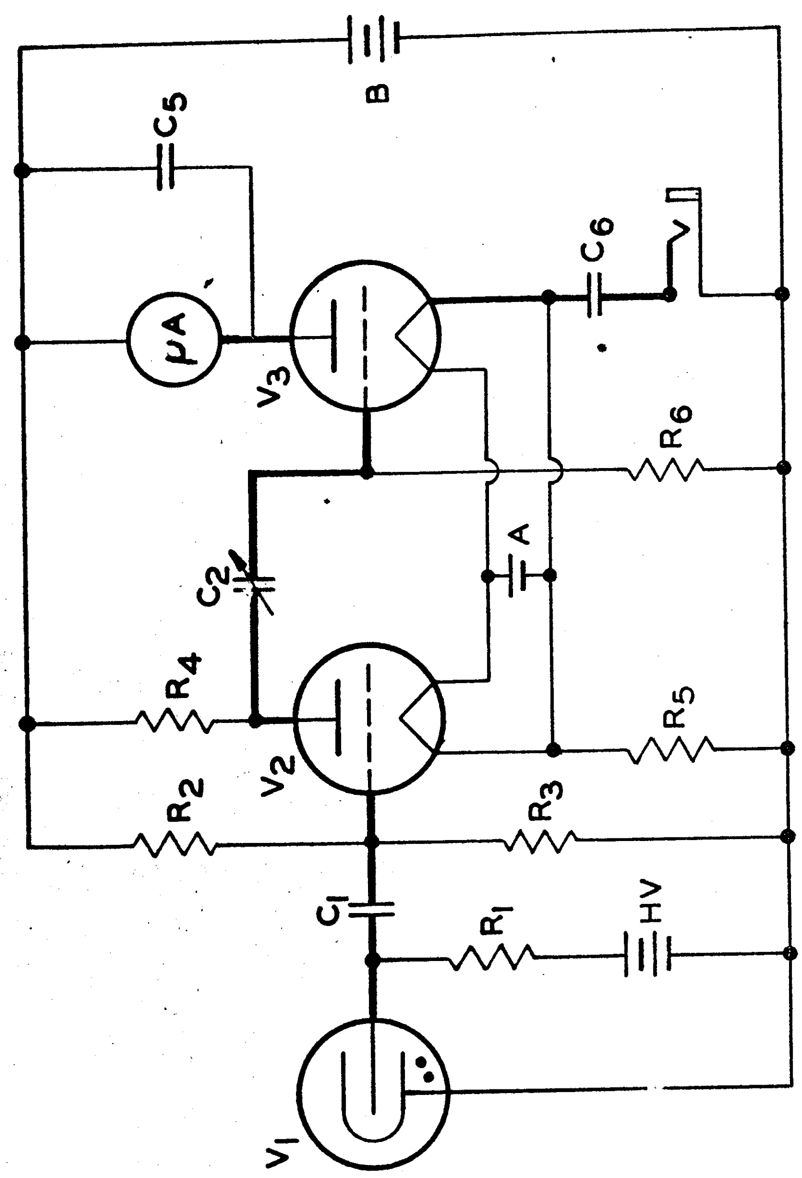
MODEL 263 A
PORTABLE BETA GAMMA RADIATION METER



SIMPLIFIED CIRCUIT DIAGRAM

Fig. 2

263-A

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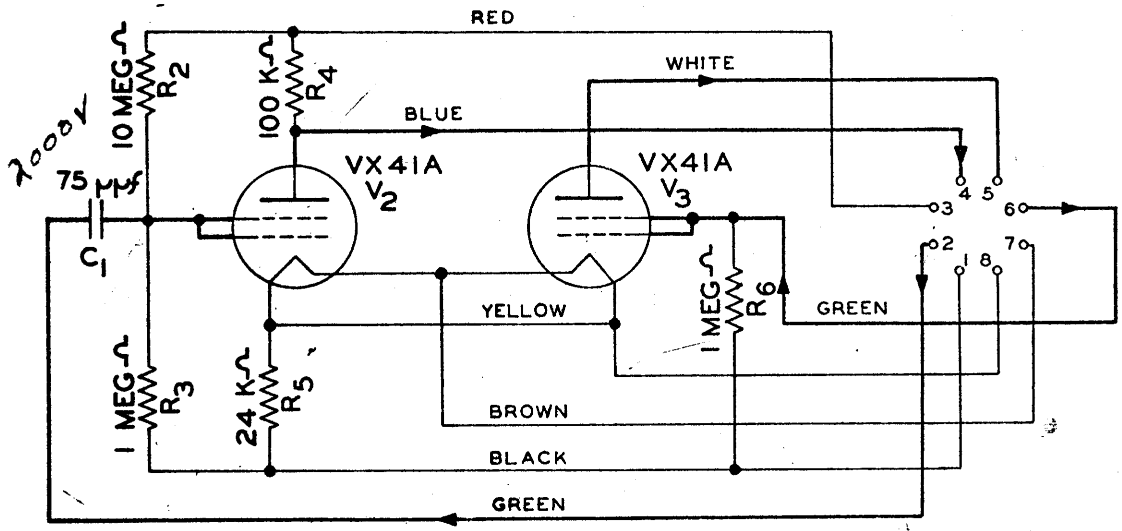
MODEL 263-A
CIRCUIT DIAGRAM



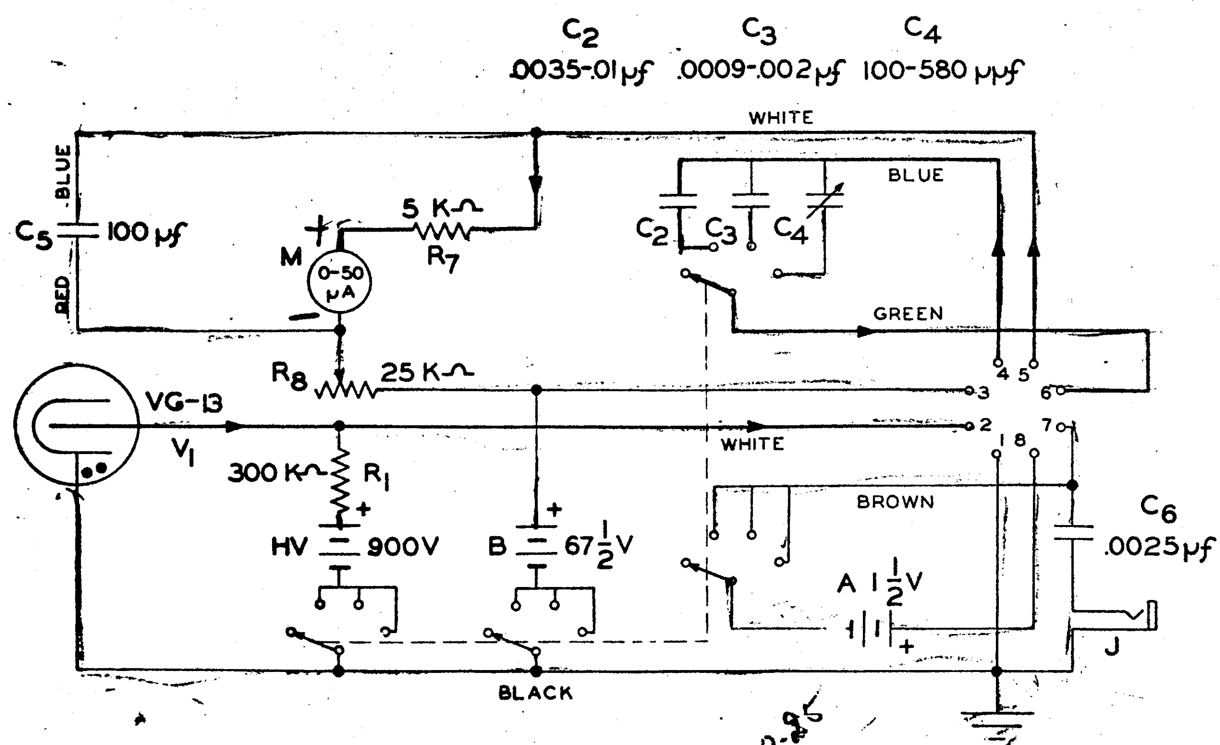


Fig. 3

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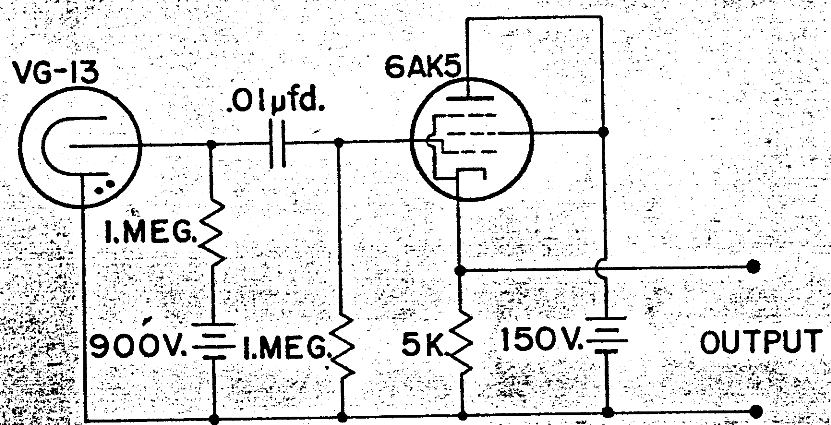
NOV. 1947 | DATA SHEET - 2 | TENTATIVE

VG-13
BETA-GAMMA COUNTER TUBE



TYPICAL CIRCUIT

CHARACTERISTIC CURVE

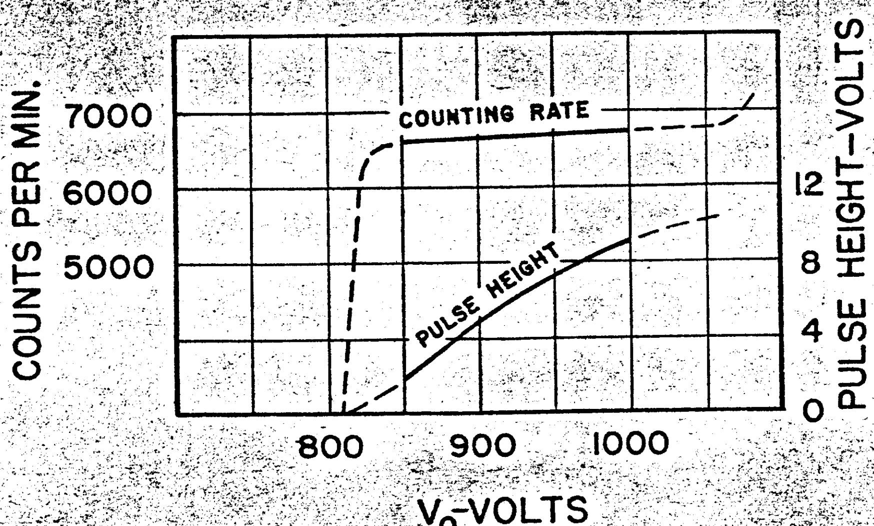
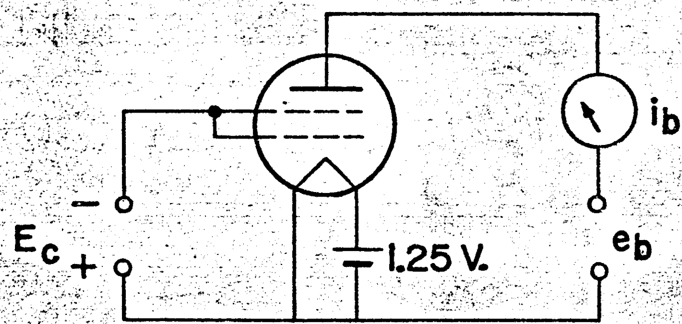


Fig. 4

THE VICTOREEN INSTRUMENT CO.

NOV. 1947 | DATA SHEET - 9 | TENTATIVE

VX-41 A HIGH MU TRIODE CONNECTION



TYPICAL DYNAMIC PLATE CHARACTERISTIC

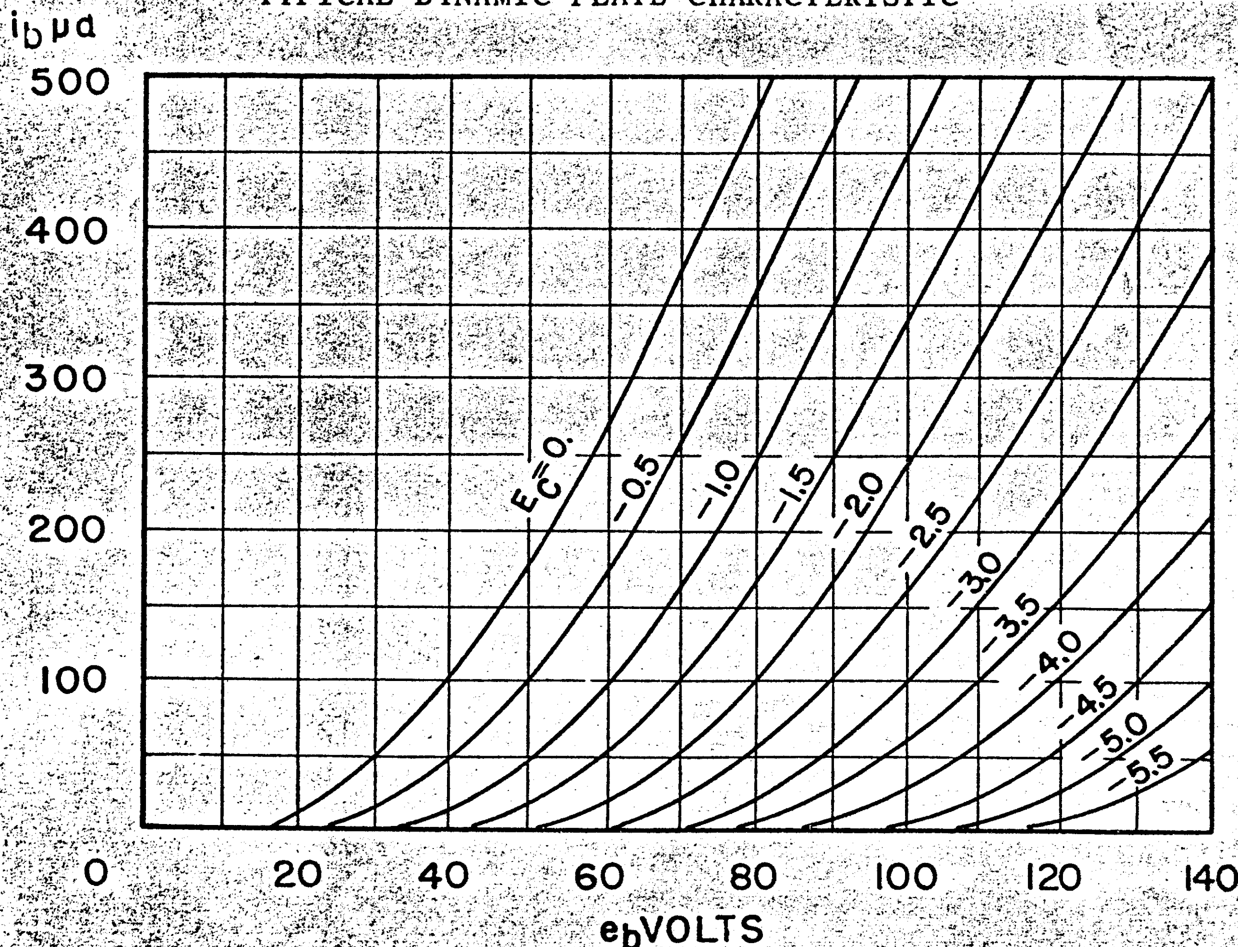


Fig. 5

263 A

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MODEL 263 A
BATTERY DATA

REF.	MFG.	TYPE	VOLTAGE	CURRENT	LIFE	ENDPOINT
A	Ray-O-Vac	#2LP	1.5	20 ma.	140 hr.	1.2 V.
B	Eveready	#467	67.5	200 ma.	600 hr.	60 V.
HV	Eveready	#493	300	Negligible	1 yr.	850 V.

The A battery characteristic is determined by the VX-41A filament characteristic. B battery aging is compensated for by the calibration adjustment. The HV battery characteristic is a reflection of the VG-13 plateau.

EFFECT OF BATTERY VOLTAGE ON CALIBRATION

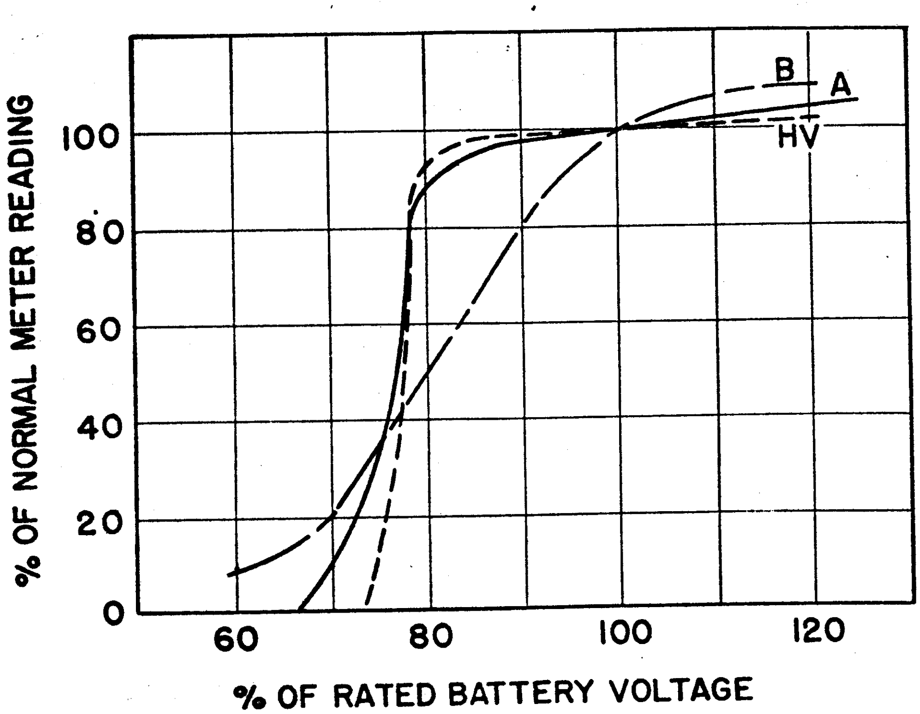

Fig. 6

263 A

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MODEL 263 A

DIRECTIONAL SENSITIVITY-VERTICAL

Meter reading vs. direction in the vertical plane of the instrument. Readings are taken on the x10 scale. A 1 mg. radium source is rotated about the center of the counter tube at a distance of 65 cm.

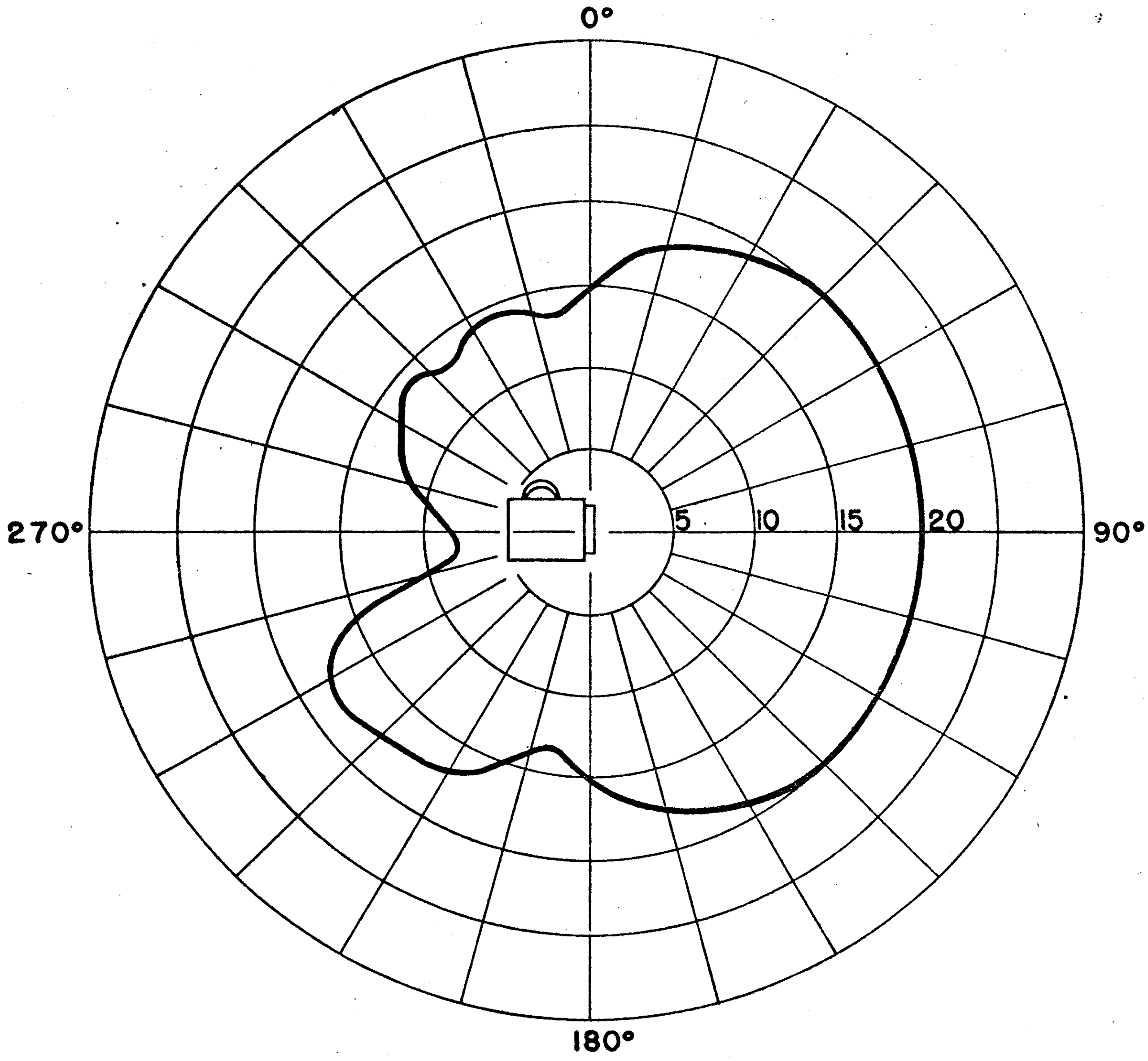

Fig. 7

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MODEL 263 A

DIRECTIONAL SENSITIVITY-HORIZONTAL

Meter reading vs. direction in the horizontal plane of the instrument. Readings are taken on the x10 scale. A 1 mg. radium scouce is rotated about the center of the counter tube at a distance of 65 cm.

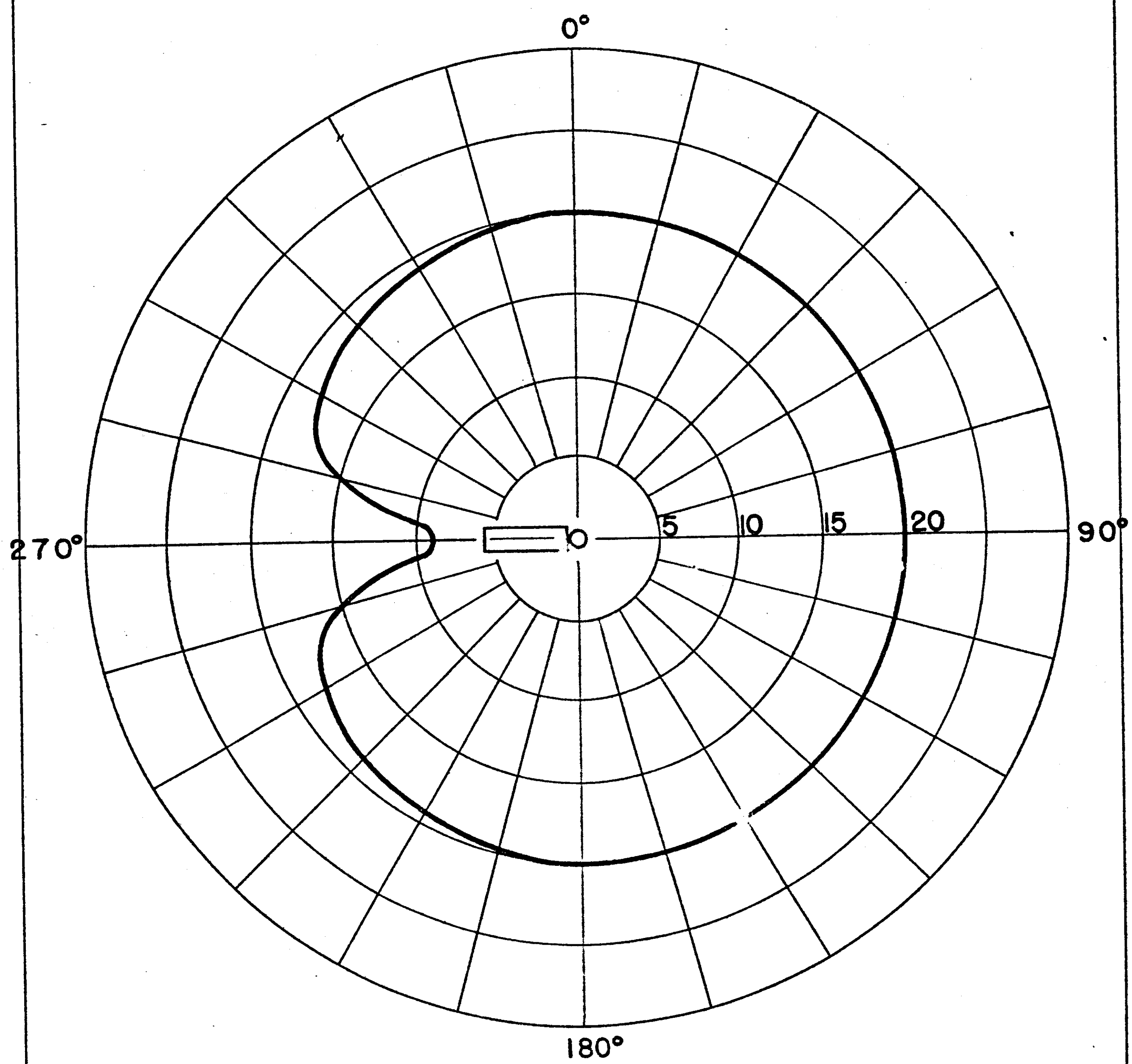

Fig. 8

APPENDIX II

263A SURVEY METER

LIST OF REPLACEABLE PARTS

Ref.	Part No.	Component	Description	Function	Spare Parts Kit *	Manufacturer
A	263-17	Battery	$1\frac{1}{2}$ V.	Filament voltage	50	Ray-O-Vac
B	263-16	Battery	$67\frac{1}{2}$ V.	Plate supply voltage	50	Eveready
C1	263-127	Capacitor	75 uuf. 2000V Silicone	Coupling V1, V2		Condenser Prods.
C2	263-37	Capacitor	.0035-.01 uf. paper	Coupling V2, V3	3	Condenser Prods.
C3	263-136	Capacitor	.0009-.002 uf. mica	Coupling V2, V3	4	Cornell-Dublier
C4	263-126	Capacitor	100-580 uuf. trimmer	Coupling V2, V3	3	Electronic Labs.
C5	263-38	Capacitor	100 uf. Electrolytic	Time constant	3	Sprague
C6	263-39	Capacitor	.0025 uf. mica	Audio coupling	3	Cornell-Dublier
HV	263-101	Battery	3 ea. 300 V.	Counter tube voltage	30	Eveready
J	263-14	Jack	Single circuit	Phones	5	Bud Radio
M	263-6	Meter	50 ua. 0-20 scale	Indicator	1	Hickok
P1	263-49	Plug	Black 71 - 1M	+ HV Battery	15	Amphenol
P2	263-50	Plug	Red 71 - 1L	- HV Battery	15	Amphenol
R1	185-302	Resistor	300 K. ohm $\frac{1}{2}$ W 5%	V1 load	5	Allen-Bradley
R2	185-304	Resistor	10 Megohm $\frac{1}{2}$ W 5%	V2 bias	5	Allen-Bradley
R3	185-36	Resistor	1 Megohm $\frac{1}{2}$ W 5%	V2 bias	5	Allen-Bradley
R4	185-20	Resistor	100 K. ohm $\frac{1}{2}$ W 5%	V2 plate load	5	Allen-Bradley
R5	185-305	Resistor	25 K. ohm $\frac{1}{2}$ W 5%	V2, V3 cathode bias	5	Allen-Bradley
R6	185-36	Resistor	1 Megohm $\frac{1}{2}$ W 5%	V3 grid return	5	Allen-Bradley
R7	185-303	Resistor	5.1 K. ohm $\frac{1}{2}$ W 5%	Time constant	5	Allen-Bradley
R8	263-104	Resistor	25 K. ohm potentiometer	Calibration adjust.	5	Allen-Bradley
SW	263-109	Switch	4 pole, 4 position	Range selector off	1	Centralab

263A SURVEY METER

(Continued)

LIST OF REPLACEABLE PARTS

Ref.	Part No.	Component	Description	Function	Spare Parts Kit	Manufacturer
V1	VG-13	Counter tube	Self quench, 30 mg/cm^2	Detector	15	Victoreen
V2	VX-41A	Vacuum tube	T 3 Tetrode	Multivibrator	15	Victoreen
V3	VX-41A	Vacuum tube	T 3 Tetrode	Multivibrator	15	Victoreen
	110-25	Grommet	Rubber	Cable protection	10	Cont. Rubber
	200-33	Socket	Octal	Amplifier socket	1	Amphenol
	223-29	Rubber feet	5/8" dia. 3/8" high		10	Philpott Rubber
	263-2	Amplifier	Assembly	Pulse shaping	3	Victoreen
	263-18	Handle	Black leather	Carrying	1	L. Lefkowitz
	263-43	Connector	Male	Battery	5	JFD Mfg. Co.
	263-44	Connector	Female	Battery	5	JFD Mfg. Co.
	263-46	Washer	Rubber	Tube supports	2	Victoreen
	263-47	Strip	Sponge rubber 3/16 lg.	Mounting	3	Victoreen
	263-48	Strip	Sponge rubber 3/8 lg.	Mounting	3	Victoreen
	263-68	Shield	Sliding	Beta shield	1	Victoreen
	263-73	Base plate	Sub assembly	Terminal Board	3	Victoreen
	263-76	Phones	Crystal	Audio indicator		Brush Develop.
	263-91	Terminal Strip		Terminal Strip	3	Jones
	263-105	Cap	Screw cap w/chain	Control cover	5	Victoreen
	263-107	Knob	1-5/8 black 2110	Switch	1	Davies Moulding
	263-111	Plate	Bottom	Probe	1	Victoreen
	263-120	Cable	Shielded, single conductor		4 ft.	Alpha
	263-125	Shield	Tube	Probe	1	Victoreen

263A SURVEY METER

LIST OF REPLACEABLE PARTS

(Continued)

Ref.	Part No.	Component	Description	Function	Spare Parts Kit	Manufacturer
	263-131	Lock	Cable	Cable clamp	1	Victoreen
	263-153	Cover	Plastic	Drip proof	40	Giller Prods.
	263-154	Phone plug	2 conductor	Ear phones	5	Brush Develop.
	263-155	Manual	Technical			Victoreen
	337-151	Plug	Octal, mica filled	Sub-assembly		Centralab
		Screws	#6 x $\frac{1}{4}$ lg. type Z		15	
		Screws	#2 - 56 x $\frac{1}{4}$ flat head		4	
		Screws	#6 - 32 x 1/8 rd hd		1	
		Screws	#8 - 32 x 3/8 lg rd hd		10	
		Spaghetti	1/8" dia.		1	
		Spaghetti	3/8" dia.		1	
		Screwdriver	1/8"		6	
		Wrench	End	Volume control	6	Mallory
		Pliers	Needle-nose		6	
		Solder lug			1	
		Tool bag			6	

* NOTE: The spare parts kit is designed to service 10 instruments under field operating conditions in accordance with United States Atomic Energy Commission specifications, and contains parts as listed above.