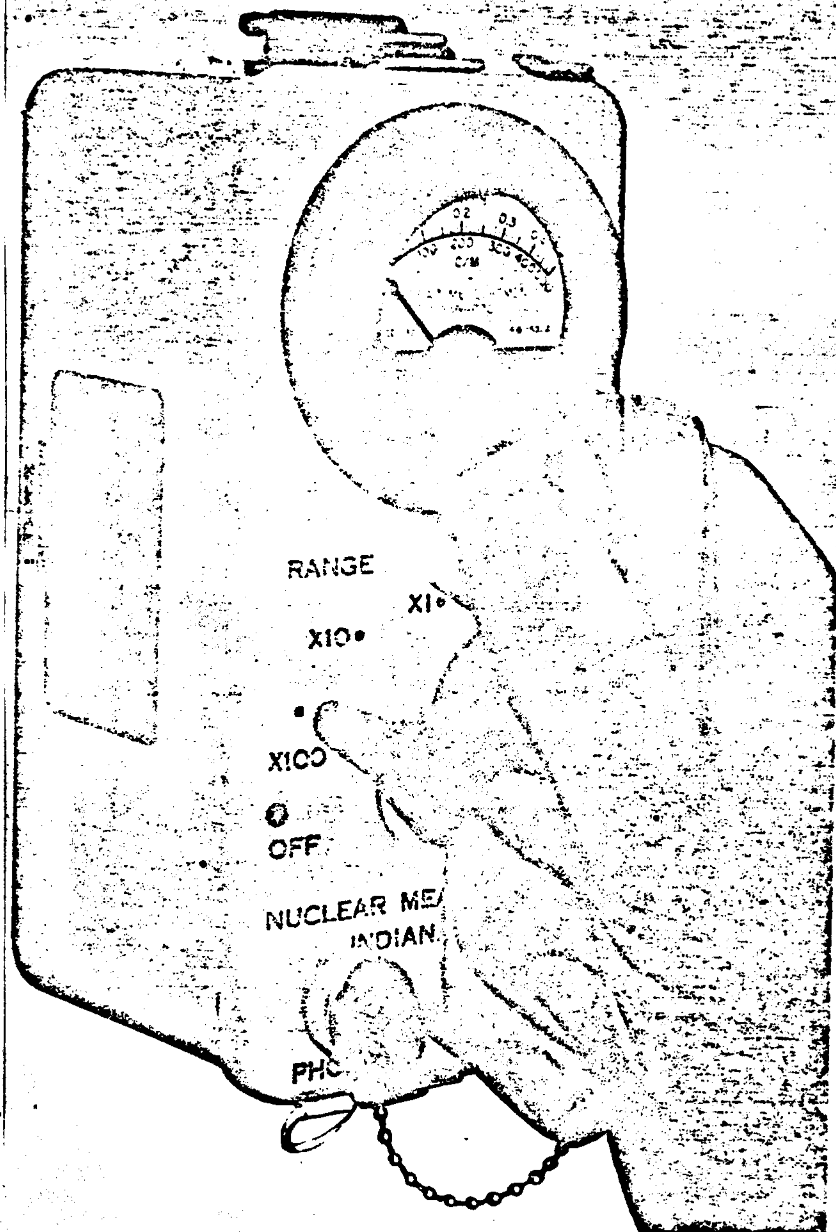
Test Dept

INSTRUCTION MANUAL

GS-3CD

NMC

NUCLEAR MEASUREMENTS CORP.
2460 N. ARLINGTON AVE. · INDIANAPOLIS, IND.


RANGE
X1
X10
X100
OFF
NUCLEAR ME
INDIAN
PH

1. GENERAL DESCRIPTION

1.1 INTRODUCTION

This instrument is a portable survey meter using a Geiger tube as the detector. The Geiger tube is mounted in a probe on the end of a forty inch cable. The entire instrument and its accessories comprise a circuit box, a probe, a headphone and a carrying strap; a radioactive sample is mounted under the instrument nameplate.

1.2 THE PROBE

The probe comprises a chrome-plated brass shield with a window which may be opened in order to admit Beta radiation. Within the probe is mounted a plug-in type Geiger-Mueller tube which is sensitive to moderate and high energy Beta radiation and to Gamma radiation down to low energies. Because the Geiger tube is fragile, rubber padding is included. In addition rubber gasketing is used to seal against moisture. A ring nut at the base of the probe permits easy access for exchange of the Geiger tube. (See Fig. 1)

1.3 THE CIRCUIT BOX

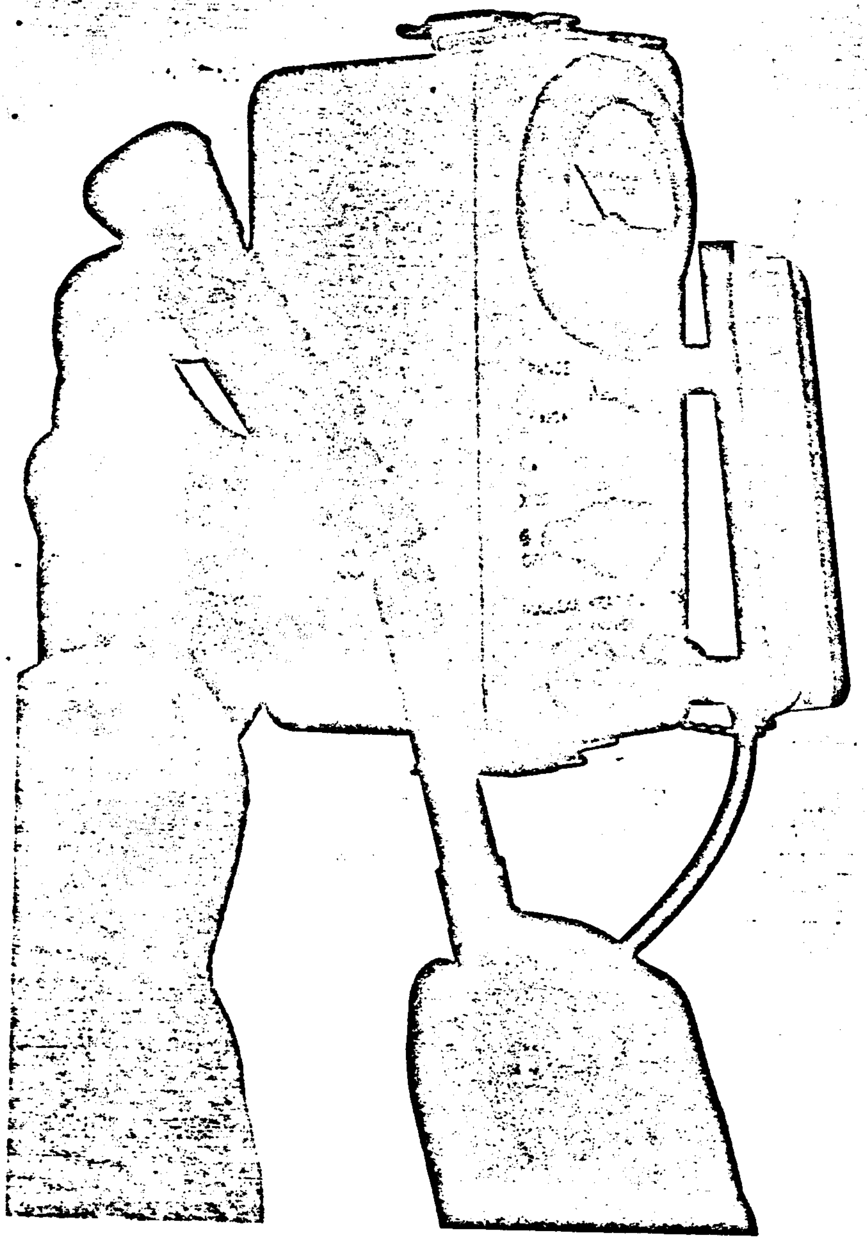
The circuit box comprises the supply batteries, an electronic high voltage supply, an electronic pulse leveling and metering circuit and a radioactive sample. The system is shockproof and waterproof and is secured with rapid take-down clamps in order to make access very simple. The entire battery complement is mounted with press clamps for rapid removal and replacement. The entire electronic circuit is mounted on a single card with connections going to the probe, the phone connector and to the meter.

1.4 THE HEAD PHONE

The head phone is a single piece magnetic-type device with a connector suitable for the sealed jack mounted on the circuit box.

1.5 THE CARRYING STRAP

The carrying strap, made of Polyethelene for easy cleaning, is provided with easily operated spring clips.



(Figure No. 1)

II. THE THEORY OF OPERATION

2.1 INTRODUCTION

Operationally this instrument consists of a Geiger tube radiation detector, a regulated high voltage supply, a pulse leveling and metering circuit, an indicating meter and a headphone for audible detection of activity.

2.2 THE GEIGER TUBE

The Geiger tube is a gas filled device which detects the presence of ionization within its gaseous volume. The ionization results from the passage of ionizing type radiation through the gas. The primary type of ionizing radiation it detects is Beta rays. These are produced as a primary breakdown product of radioactive substances and in addition are produced within the Geiger tube and within the walls of the probe by Gamma radiation which in turn is the result of radioactive decay. A shield is provided which normally stops all external Beta radiation; thus making the detector sensitive to Gamma radiation only, but a window in the probe may be opened to make the system sensitive to Beta radiation also. The Geiger tube operates at 900 volts which is essentially the center of a plateau extending from about 800 volts to about 1000 volts.

2.2 THE HIGH VOLTAGE SUPPLY

The high voltage supply is a relaxation oscillator driven "flyback" type circuit in which pulses are generated by a relaxation oscillator comprising a type NE-7 glow tube, a high valued resistor and a small condenser. The battery supply is 100-135 volts and the main operating voltage of the glow tube is 60-65 volts. The pulse amplitude is of the order of 18 to 25 volts; the pulses are capacitively coupled into the grid of a cut-off pentode-diode type 1AK5. Positive pulses operating the grid of this tube instantaneously cause the tube to draw current through a high impedance, specially designed, high voltage coil. Interruption of the current through the coil produces a field-collapse potential of over 900 volts. This 900 volt pulse is capacitively coupled into the diode of the tube, producing approximately 800 volts DC with a negative potential. This pulsating DC is fed back through a series of resistors to the grid circuit of the tube and to the oscillating glow tube which servies as a standard against which the high voltage is compared. In this way variation in filament and plate voltage of the generating tube are greatly compensated by the grid bias on the generating tube.

2.3 THE PULSE LEVELING AND METERING CIRCUIT

The pulse leveling and metering circuit comprises two type CK548-DX vacuum tubes. These are connected in a one-shot multivibrator cathode coupled circuit with the integrating and metering circuit in the plate of the second tube. Under steady state conditions the first tube draws approximately 250 microamperes, which current passing through the common cathode resistor of 18000 ohms provides a bias of between 4 and 4.5 volts on the second tube, thereby effectively cutting off its conductance. Whenever a negative pulse of greater than 0.2 volt operates the grid of the first tube, the tube current is sufficiently cut off so that the combination of increased plate voltage of the first and decreased cathode voltage on the second tube causes the second tube to start to draw current. Under these conditions the circuit "fires", drawing an instantaneous current of approximately 1½ milliamperes through the second tube, which, in series with the meter and integrating circuit, stores a charge in the integrating circuit. This then discharges through the meter with a time constant of approximately six seconds.

When pulses arrive at the grid of the first tube at a given rate, the average rate is indicated by the amount of current flowing from the charge stored in the integrating condenser in the plate circuit of the second tube.

2.4 SCALE RANGES

Three ranges of operation are provided. The first range, X1, requires 500 pulses per minute for full scale indication; the second range, X10, 5000 pulses per minute; and the third range, X100, 50,000 pulses per minute. These correspond respectively to 0.5 milliroentgens per hour, 5 milliroentgens per hour and 50 milliroentgens per hour of radium-equivalent radiation. Scale-changing is effected by switching condensers, thus changing the "on-time" of the multivibrator.

2.5 THE HEADPHONE

The audio device is a headphone which detects the pulses from the cathode of the trigger circuit. An isolating resistor and condenser are used so that the presence of the headphone has no effect upon the operation of the system.

III. INSTALLATION

3.1 INSTALLING THE BATTERIES

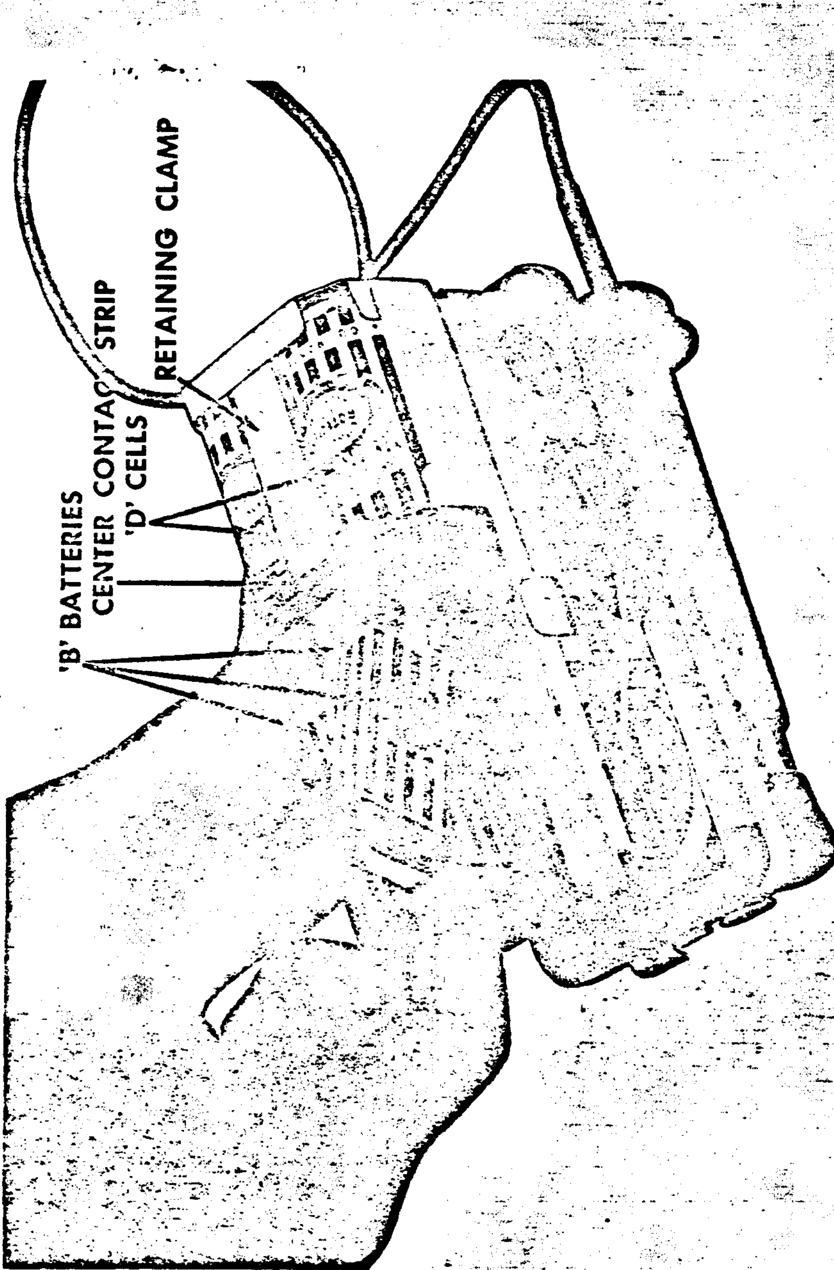
The instruments are shipped with the batteries removed. In order to put the instrument into operation:

1. Open the circuit box by release of the clamp at either end.
2. Remove the batteries from their package, taking care not to short-circuit the terminals of the "B" batteries.
3. Place the "D" cells in position with their center terminals at the center contact strip of their recess. Press the retaining clamp in place, taking care that the negative contact clip is properly centered within the battery shelf.
4. Press the "B" batteries into their terminals. These terminals clamp very tightly and it is difficult to press in both contacts simultaneously. The best method is to tilt the base of the "B" battery up (See figure No. 2), press in the upper contact and then lower the base of the "B" battery and press in the lower contact. After all three "B" batteries are in place the "B" battery clip is introduced into the slot and the clamp pressed into its slot at the edge of the battery shelf. If the instrument is equipped with a replacement Geiger tube, the tube should be removed from its retaining position while the "B" batteries are installed and then carefully returned to its position. Remember that Geiger tubes are very fragile and should not be handled roughly and should not be gripped tightly in the center portion of the glass tube.

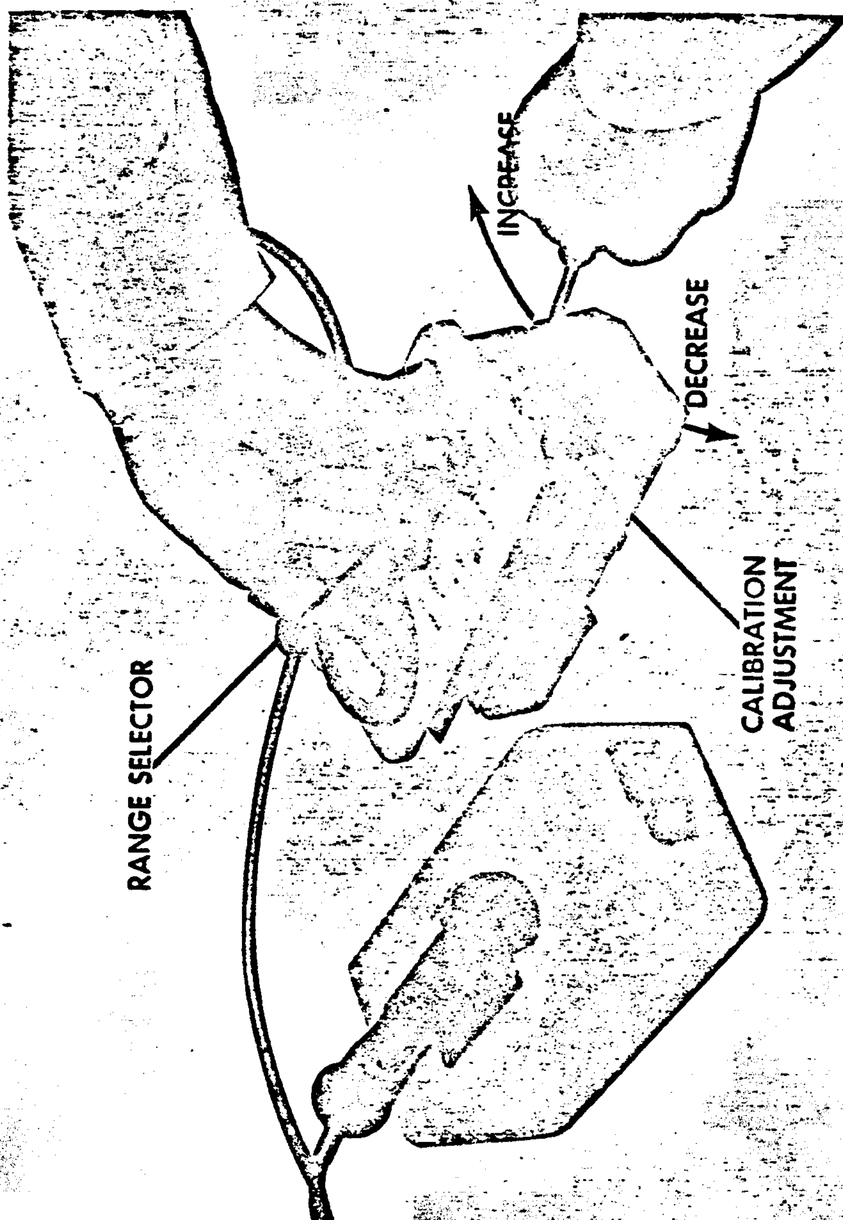
IV. OPERATION

4.1 OPERATING THE CIRCUIT THE FIRST TIME CALIBRATION

Clamp the circuit box back together, turn the instrument to the X10 scale, present the open window of the probe to the center of the nameplate under which is a Beta radiation sample (see figure No. 3). Wait for thirty seconds for the system to reach stability, and the indicator should fall between 2 milliroentgens per hour (mr/hr.) and 3 mr/hr., averaging about 2.5 mr/hr.



(Figure No. 2)


RANGE SELECTOR
INCREASE
DECREASE
CALIBRATION ADJUSTMENT

(Figure No. 3)

If the indication falls above or below this range, it may be corrected by the screw inside the box under the rear pillar of the handle. To gain access to this screw, loosen both clamps, tilt up the rear end of the lid of the box and the screw will be seen through a hole in the inner frame. Advancing the screw clockwise increases the reading, rotating it counter-clockwise decreases the reading.

4.2 SCALE RANGES

There is only one control on this instrument for the operator to use. It is the range control, comprising an "Off" position and three ranges labeled, "X100", "X10", and "X1". These are respectively 100 times, 10 times and 1 time the scale in mr/hr and count per minute shown on the meter. This scale is 0.5 mr/hr and 500 counts per minute respectively with the major divisions all indicated on a 50-division scale.

4.3 USING THE HEADPHONE

If the operator chooses to use a headphone with the instrument, it is screwed into the connector provided immediately to the left of the rear post of the handle. In using the headphone, the operator will note that each pulse arriving at the instrument is indicated by a distinctly audible "click" in the headphones.

4.4 NORMAL BACKGROUND

Since normal background of radioactivity is of the order of 0.01 to 0.02 milliroentgens per hour, little activity will normally be seen. Under background conditions only about 20 per minute of these clicks occur and they are randomly spaced so that one may wait for several seconds before any click is heard and then there may be two or three.

4.5 CHECKING CALIBRATION

The operator should periodically check the calibration of the instrument to verify that it is correct. This operation is described in paragraph 4.1. He may confidently make an adjustment of the sensitivity wherever necessary. This operation is calculated so that any one should be able to adjust the instrument correctly.

4.6 USING THE CARRYING STRAP

The instrument may be carried in the hand or by a strap over the shoulder. The strap anchors are arranged in such a way that the meter is visible when carried over the right shoulder.

V. PREVENTIVE MAINTENANCE

5.1 BATTERY LIFE

CAUTION: MAKE CERTAIN THE INSTRUMENT IS TURNED OFF AT ALL TIMES THAT IT IS SET ASIDE, otherwise the batteries will certainly be depleted and the instrument rendered ineffective. The shortest life battery in the instrument is the "D" cell. This has a normal life of 200 hours of continuous operation or approximately 300 hours at six hours per day. The "B" batteries in the instrument have a continuous life of about 400 hours, or about 600 hours in intermittent duty. There is no indication that the instrument is turned on excepting the position of the control lever, clicks in the headphones and the meter indication. The later two are not obvious at any distance from the instrument so that the operator should be become accustomed to noting that the operating lever is in the correct position when the instrument is set aside.

5.2 STORAGE

The instruments are shipped in a waterproof bag and should be left this way until ready to put into operation. This prevents the accumulation of dirt, moisture and radioactivity which could interfere with proper operation of the instrument. For storage purposes it is best, wherever possible, to keep the instrument in a moderately cool area as this will provide greater shelf life for the batteries. At all times one should attempt to prevent contamination of the instrument and particularly of the probe.

VI. CORRECTIVE MAINTENANCE

6.1 REPLACING THE BATTERIES

Whenever the instrument fails to respond to the Beta sample the condition of the batteries must be checked as indicated above. The "D" cells will deplete first in the instrument and should be replaced about every 200 to 300 hours of operation. Replacing the "D" cells for epening the circuit box, pressing the base of the clamp that holds the "D" cells until it springs open at the center support, (see fig. 2) removing the depleted "D" cells and replacing them with fresh ones.

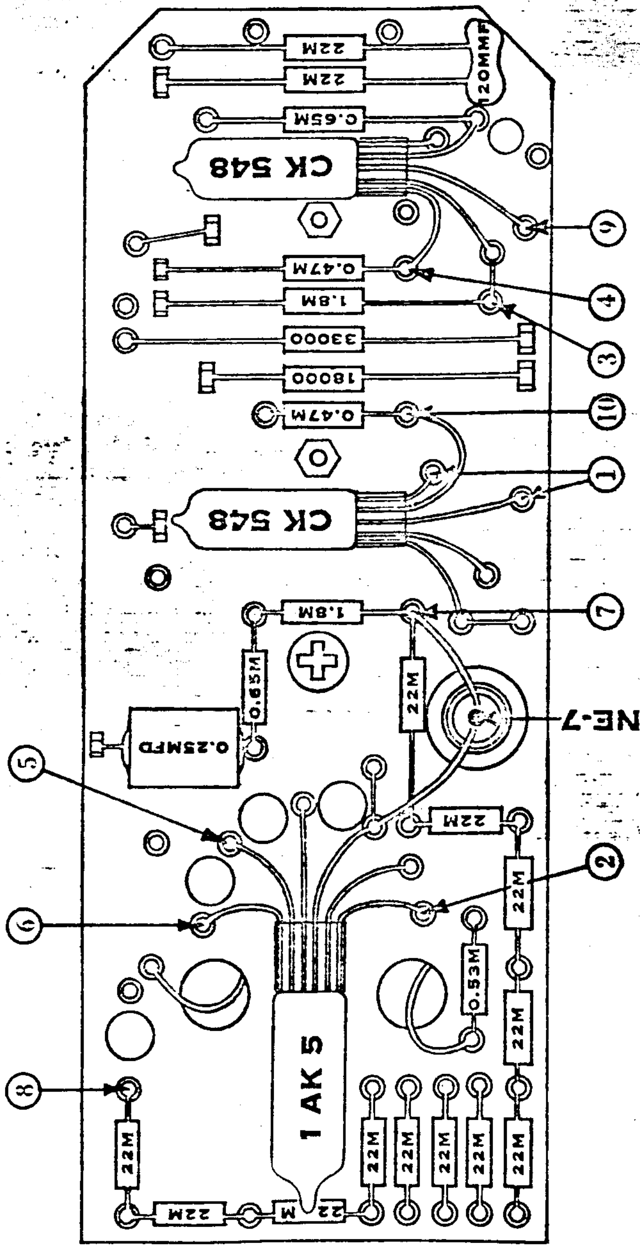
Every second time the "D" cells are replaced, the "B" batteries should probably be replaced. It is recommended that the operator install the "D" cells with the label down the first time they are put in and with the label up the second time they are put in, so that whenever the "D" cells are ready for replacement and the label is up, it is an indication that it is time to replace the "B" batteries also. If a meter is handy, one can check the "D" cells to show that they have reached their useful end point. With the circuit turned on, the end point for "D" cells is approximately 1 volt. They will operate at a lower voltage than this if the "B" batteries are in good condition but if the "B" batteries and the "D" cells both are depleted, one volt is the end point for the "D" cells and 100 volts is the end point for the "B" batteries.

6.2 REPLACING THE GEIGER TUBE

The chief maintenance on this instrument is replacing the battery, (See paragraph 6.1) however, the Geiger tube also expends with use and must be replaced occasionally but one cannot predict precisely the life of a Geiger tube since the total number of counts it has accumulated and the operating conditions of temperature, voltage, and load characteristics are very important. Whenever fresh batteries are installed into the instrument and the instrument does not work correctly, it is wise first to try replacing the Geiger tube before making any further attempts at circuit checking.

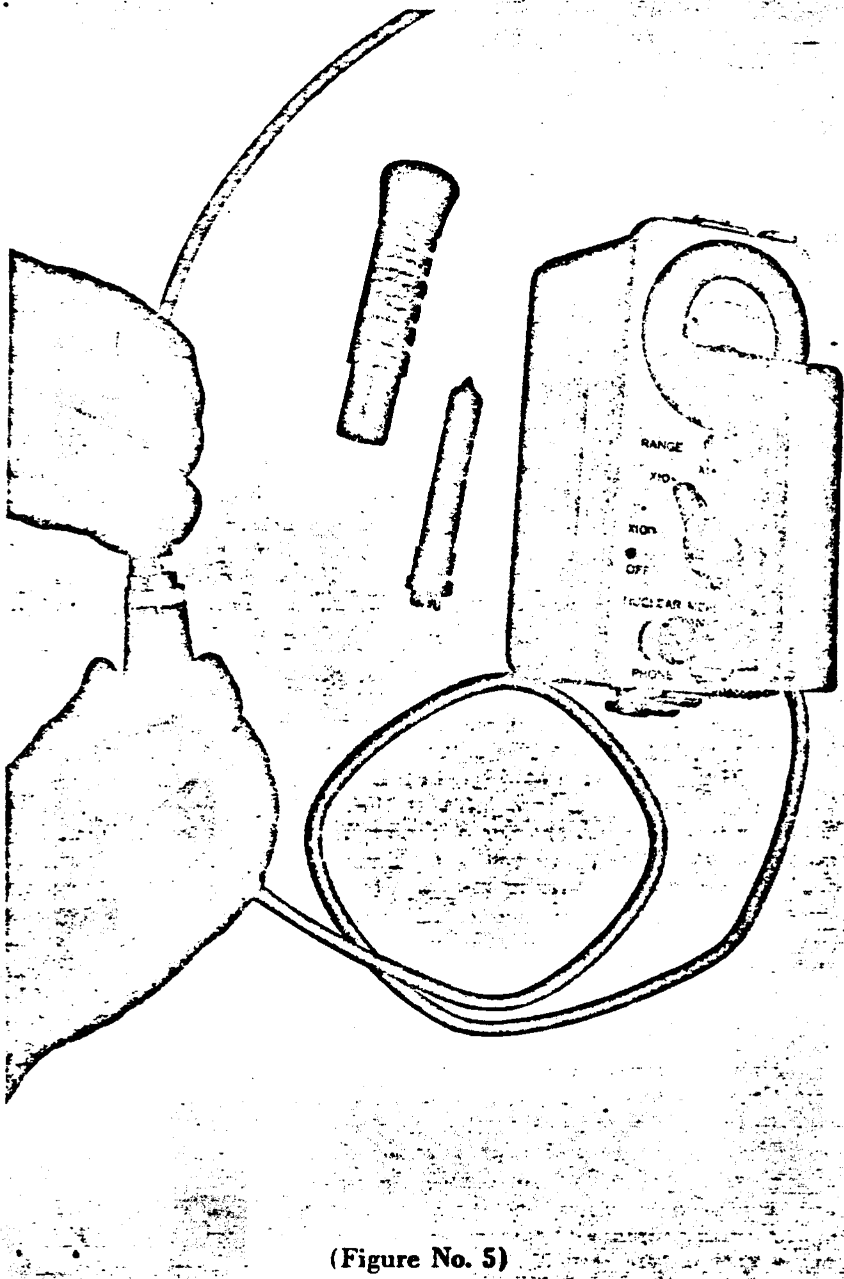
6.3 CHECKING THE HIGH VOLTAGE SUPPLY

In order to check the high voltage supply one should use, where possible, an electrostatic voltmeter operating between the test point indicated in Figure 4 or operating with a special connector into the Geiger tube socket (See Figure No. 5). The normal voltage will be 900 volts plus or minus 20 volts. This voltage may be read only with an electrostatic voltmeter or some other zero-current type voltmeter. As an alternative one may test with a 20,000 ohm per volt meter operating on the 1000 volt scale between the points shown in Figure No. 4. The proper reading will be 600 or 700 volts. Should one have a 100,000 ohm per volt meter such as the Simpson 269, this should read between 700 and 800 volts on the 1600 volt scale. Should the voltage under these conditions read low, check again that the battery supply voltage is correct; if it is, check from screen of the high voltage generating tube to ground (See Figure No. 4). This should read between 55 and 90 volts on the 20,000 ohm per volt meter and from 60 to 100 on the 100,000 ohm per volt meter. If this reads correctly and the high voltage is low it suggests that something is incorrect in the rectifier system and the 1AK5 should be replaced. If, on the other hand, this voltage reads low, it suggests that it may be either a bad 1AK5 tube or a bad NE-7 glow tube. Check the voltage from the NE-7 glow tube to ground, operating on the 250 volt scale of a 20,000 or



(1) Filament Voltage, 548's
All the Following to Ground:
(2) Filament Voltage, 1 AK 5
(3) Screen Voltage, 548's
(4) Plate Voltage, 1st. 548
(5) Screen Voltage, 1 AK 5
(6) Plate Voltage, 1 AK 5
(7) NE-7 Lamp Voltage
(8) High Voltage
(9) Filament to Ground, 548's

(Figure No. 4)



(Figure No. 5)

100,000 ohm per volt meter and the voltage should read between 60 and 65. The most likely causes of failure of the high voltage supply are: 1. A defective 1AK5 tube 2. A defective NE-7 glow lamp, or 3. A defective .01 MF-1500V. high-voltage condenser. When the high voltage reads low, it may be the result of a defect in the probe cable, and accordingly one should remove the black wire going to the terminal shown in Figure No. 4 and recheck the high voltage to verify whether leakage in the cable has reduced the high voltage.

6.4 CHECKING THE PULSE LEVELING AND INTEGRATING CIRCUIT

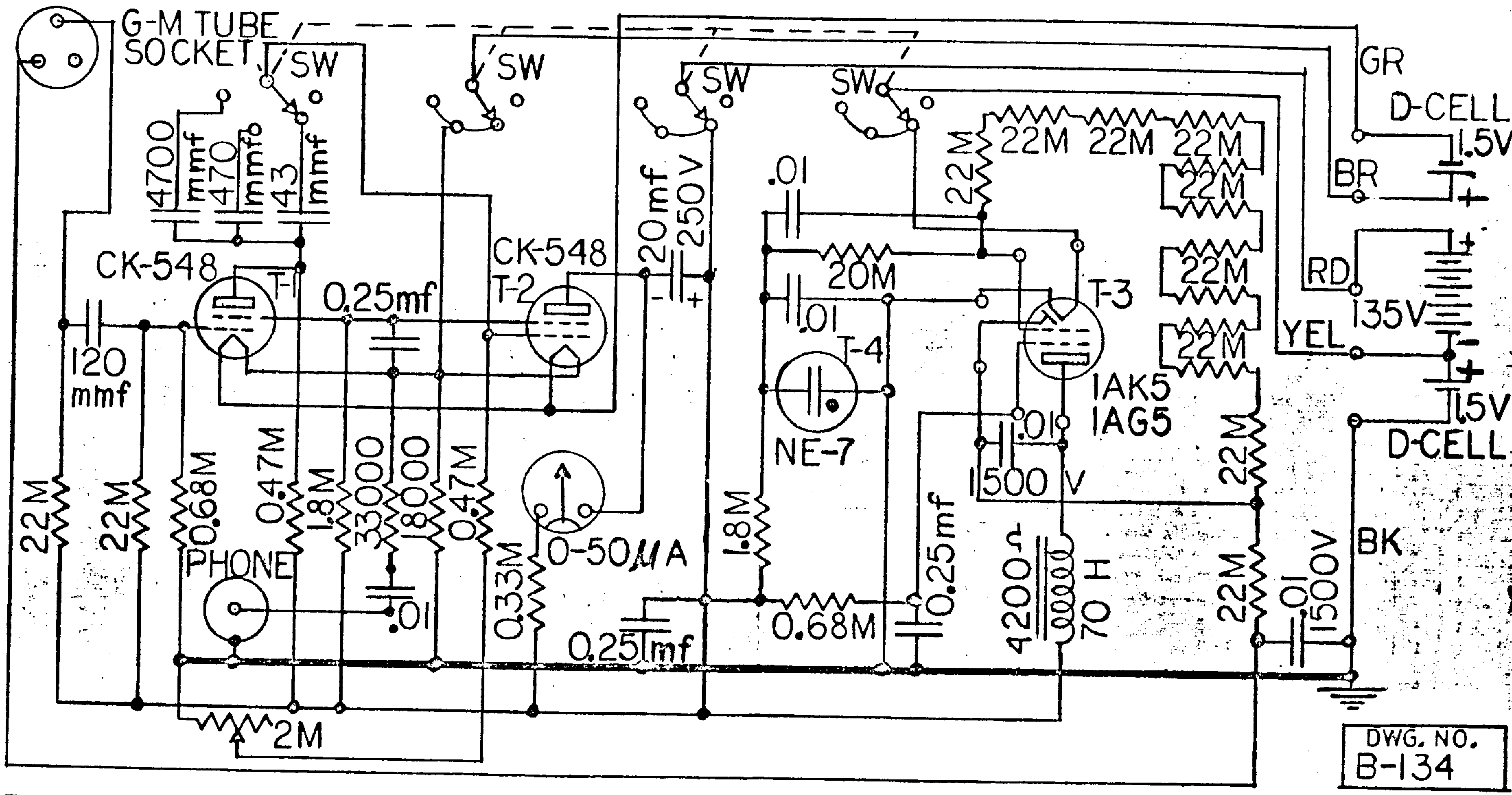
In order to check the pulse leveling and integrating circuit, one should connect the headphone and listen to it while he touches the input circuit (See Figure No. 4) with an insulated screwdriver. This should create sporadic clicking in the headphone and should cause the meter to read when operating on the 1X scale. If this does not occur one should check the filament to ground voltage of the trigger circuit (See Figure No. 4). This voltage should be between 3.8 and 4.2 volts reading on the 10 volt scale of a 20,000 ohm/volt meter depending upon condition of the batteries and tubes. Should the meter read continuously without an input signal, one should short-circuit point 10 to ground, thus preventing pulsing of the multivibrator. If the reading still shows, the defect will probably be a short circuit from filament to ground or a defective CK548-DX tube.

6.5 NORMAL VOLTAGE RANGES

Under normal conditions when read with a 20,000 ohm/volt meter operating on the 250 volt scale, the readings shown in Figure No. 4 will be indicative of the condition of operation of the circuit. If the cathode voltage is low and the plate voltage is high on the first tube, it probably indicates a depleted filament and the tube should be replaced. This same condition can cause continuous running of the trigger circuit producing an off-scale reading of the meter. Grounding the grid of the second half of the circuit as indicated above will correct this. Remember to wait for the comparatively long time constant of the integrating circuit to correct itself to zero.

6.6 CHECKING FOR HIGH VOLTAGE PULSING

Should the indicating meter read off-scale continuously and the first CK548 seems to be good, remove the "D" cell from the high voltage supply in order to eliminate the high voltage and see if this corrects the condition. If it does, it probably indicates a defective cable. If the defect is at the probe end, the entire cable assembly must be replaced in one section, because the entire connector is filled with an epoxy resin which eliminates one of the chief sources of failure of probe type instruments.



NUCLEAR MEASUREMENTS CORP. INDIANAPOLIS	MODEL GS-3CD

CIRCUIT DIAGRAM FOR MODEL GS-3CD

Quantity	Maintenance Quantities	Part No.	DESCRIPTION	Vendor
Electronic Assembly				
1		A-460	Electronic Subassembly	NMC *
1	1	A-460-1	Choke	NMC
13	2	EB-2261	Resistor, 22 Megohm, ½W, 10%	Allen-Bradley Co.
1	1	EB-2065	Resistor, 20 Megohm, ½W, 5%	Allen-Bradley Co.
2	1	EB-4741	Resistor, 0.47 Megohm, ½W, 10%	Allen-Bradley Co.
2	1	EB-6841	Resistor, 0.68 Megohm, ½", 10%	Allen-Bradley Co.
2	1	EB-1851	Risistor, 1.8 Megohm, ½W, 10%	Allen-Bradley Co.
1	1	EB-3341	Resistor, 0.33 Megohm, ½W, 10%	Allen-Bradley Co.
1	1	EB-3331	Resistor, 33,000 Ohms, ½W, 10%	Allen-Bradley Co.
1	1	EB-1831	Resistor, 18,000 Ohms, ½W, 10%	Allen-Bradley Co.
3	1	MP-2P25	Condenser, 0.25mf, 200V, metalized paper	Cornell-Dubilier
2	1	CM-30	Condenser, 4700mmf, 500V, 5% Mica	Electromotive Mfg. Co.
2	2		Condenser, 10,000mmf, 1600V, GMV Ceramic	Centralab Div.
1	1	BR-2025	Condenser, 20mf, 250V, Electrolytic	Cornell-Dubilier
1	1		Condenser, 120mmf, 500V, Ceramic Tubular	Centralab Div.
1	1	NE-7	Lamp, Neon	General Electric Co.
2	4		Tube, CK-548-DX	Raytheon Mfg. Co.
1	2		Tube, 1AK5	Raytheon Mfg. Co.
3	1	A-344	Rubber tube pad	NMC
1	1	B-110	Potentiometer, 2 Megohm, BAS011-046	Centralab Div.
1		A-460-2	Switch Subassembly, complete	NMC
1	1	B-109	Switch, 4 Pole 4 Pos. PA-022-425	Centralab Div.
1	1	CM-15	Condenser, 470 mmf, 500V, 5% Mica	Electromotive Mfg. Co.
1	1	CM-15	Condenser, 47mmf, 500V, 5% Mica	Electromotive Mfg. Co.
1	1	H-1268	Seal Nut	Radio Frequency Lab.
1	1		Knob-2110X Black	Harry Davies Molding
Handle Assembly				
1		A-462	Handle Assembly	NMC
1	1	B-141	Grip	NMC
1	1	A-463	Cap and Chain Assembly	NMC
1	1	A-311	Standoff, ½"x1⅛"	NMC
1	1	A-312	Standoff, ½"x1¾"	NMC
2	2	A-417	Gasket	NMC
Probe and Cable Assy.				
1	2	B-144	Cable Subassembly—Cable and Connector	NMC
1	1	A-464	Probe Shell, complete	NMC
2		A-317	Pad, Rubber	NMC
1	3		GM Tube—Mark 1 Model 22	Radiation Cntr. Labs
1	1	A-310	Gasket, Tube Base	NMC
1	1	A-466	Strain Relief Grommet	NMC
				* See list of Vendors.

Quantity	Maintenance Quantities	Part No.	DESCRIPTION	Vendor
Chassis Assembly				
1	1	C-122	Chassis and Top Assembly	NMC
1	1	A-465	Connector Assembly Headphone	NMC
1	1	A-328	Ring, Aluminum	NMC
1	1	5427-7	"O" Ring	The Parker Appl. Co.
1	1	A-423	Meter Grommet	NMC
1	1	A-303	Meter Ring	NMC
1	1	321	Meter, 50 Microampere	Burlington Instru. Co.
1	1	A-422	Meter Bezel-modified	NMC
1	1	B-114	"B" Battery Clamp	NMC
1	2	A-461	"D" Cell Clamp	NMC
1	1	A-346	Rubber Pad, "D" Cell	NMC
1	1	A-319	Rubber Pad, B Battery, Bottom	NMC
1	1	A-318	Rubber Pad, B Battery, Side	NMC
1	2	B-132	Gasket, Top Seal	NMC
Accessories				
1		A-400	Battery Package	NMC
3	15	U-30	"B" Battery, 45 Volt	Burgess Battery Co.
2	20	#2	"D" Cell, 1½ Volt	Burgess Battery Co.
1	1	A-467	Headphone Assembly	NMC
1	2	A-468	Strap	NMC
1	1	C-124	Can, complete	NMC

VENDORS

Name	Address
Allen-Bradley Company	Milwaukee 4, Wisconsin
Burgess Battery Company	Freeport, Illinois
Burlington Instrument Company	Burlington, Iowa
Centralab, Div. of Globe-Union Co.	900 E. Keefe Street, Milwaukee, Wisconsin
Cornell-Dubilier Electric Corporation	333 Hamilton Blvd., South Plainfield, New Jersey
Electromotive Manufacturing Co., Inc.	Willimantic 1, Connecticut
General Electric Company, Lamp Division	Nela Park, Cleveland, Ohio
Harry Davies Molding Co.	1428 North Wills Street, Chicago, Ill.
Nuclear Measurements Corporation	2460 North Arlington Avenue, Indianapolis 18, Indiana
The Parker Appliance Co.	17325 Euclid Avenue, Cleveland 12, Ohio
Radiation Counter Laboratores, Inc.	5122 West Grove Street, Skokie, Ill.
Radio Frequency Laboratories, Inc.	Boonton, New Jersey
Raytheon Manufacturing Company	55 Chapel Street, Newton, Mass.