Instruction and Maintenance Manual

RADIOLOGICAL SURVEY METER

FCDA ITEM NO. CD V-700, MODEL 4

UAC MODEL V-700

UNIVERSAL ATOMICS®
A DIVISION OF
UNIVERSAL TRANSISTOR PRODUCTS CORP.

Westbury, L. I.
New York

TABLE OF CONTENTS

SECTION 1.
GENERAL DESCRIPTION

SECTION 2.
THEORY OF OPERATION

SECTION 3. INSTALLATION

SECTION 4. OPERATION

SECTION 5.
PREVENTIVE MAINTENANCE

SECTION 6.
OPERATOR'S MAINTENANCE

SECTION 7.
CORRECTIVE MAINTENANCE

SECTION 8.
REPLACEABLE PARTS LIST

LIST OF ILLUSTRATIONS

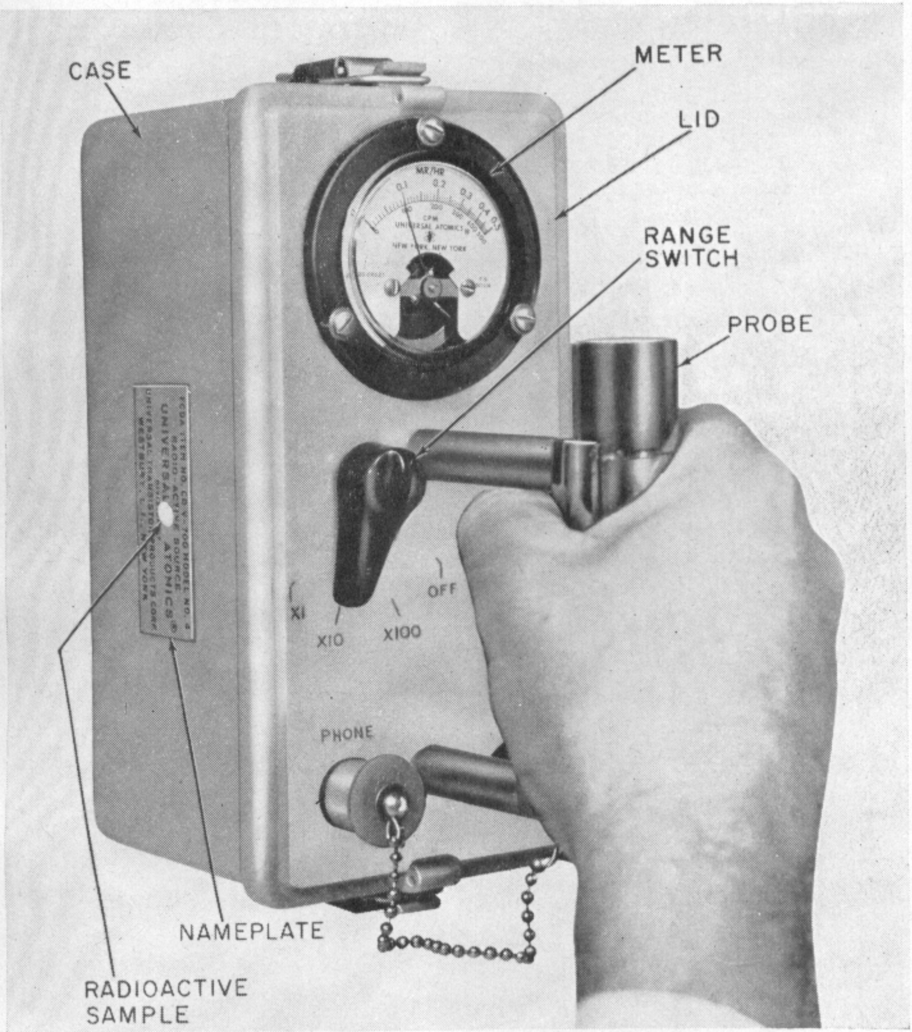


Fig. 1 — Universal Atomics® V-700 Survey Meter

I. GENERAL DESCRIPTION

1.1 INTRODUCTION

The Universal Atomics® V-700 is a portable transistorized survey meter using a Geiger-Mueller tube as the detector. The geiger tube is mounted in a probe on the end of a three foot cable. The entire instrument and its accessories consist of a circuit chassis enclosed in a case, a probe, a headphone, a carrying strap, and a radioactive sample mounted under the instrument name plate. (See Fig. 1)

1.2 THE PROBE

The probe consists of a nickel finished steel shield with a window which may be opened in order to admit beta radiation. Within the probe is mounted a plug-in type geiger 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, potting is used to seal against moisture. The probe screws apart to permit replacement of the geiger tube. (See Fig. 2).

1.3 THE CIRCUIT CHASSIS AND CASE

The circuit chassis and case consists of the supply batteries, a transistorized pulse shaping network, a detecting (metering) circuit, a transistorized high voltage power supply, and a radioactive sample. The system is shock proof and water proof, and is secured with rapid take-down clamps in order to make access very simple. The battery bracket is mounted with press clamps for rapid removal and replacement of batteries. The entire transistorized electronic circuit is mounted on a single board 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 device with a connector suitable for the watertight jack mounted on the lid. The watertight jack is kept covered by a plastic dust cover.

1.5 THE CARRYING STRAP

The carrying strap, made of plastic for easy decontamination, is provided with easily operated spring clips. The strap is adjustable from 30 inches to 60 inches in length.

II. THE THEORY OF OPERATION

2.1 INTRODUCTION

This instrument consists of a geiger tube radiation detector, a transistorized pulse shaping and metering network, an indicating meter, and a head phone for audible monitoring of activity.

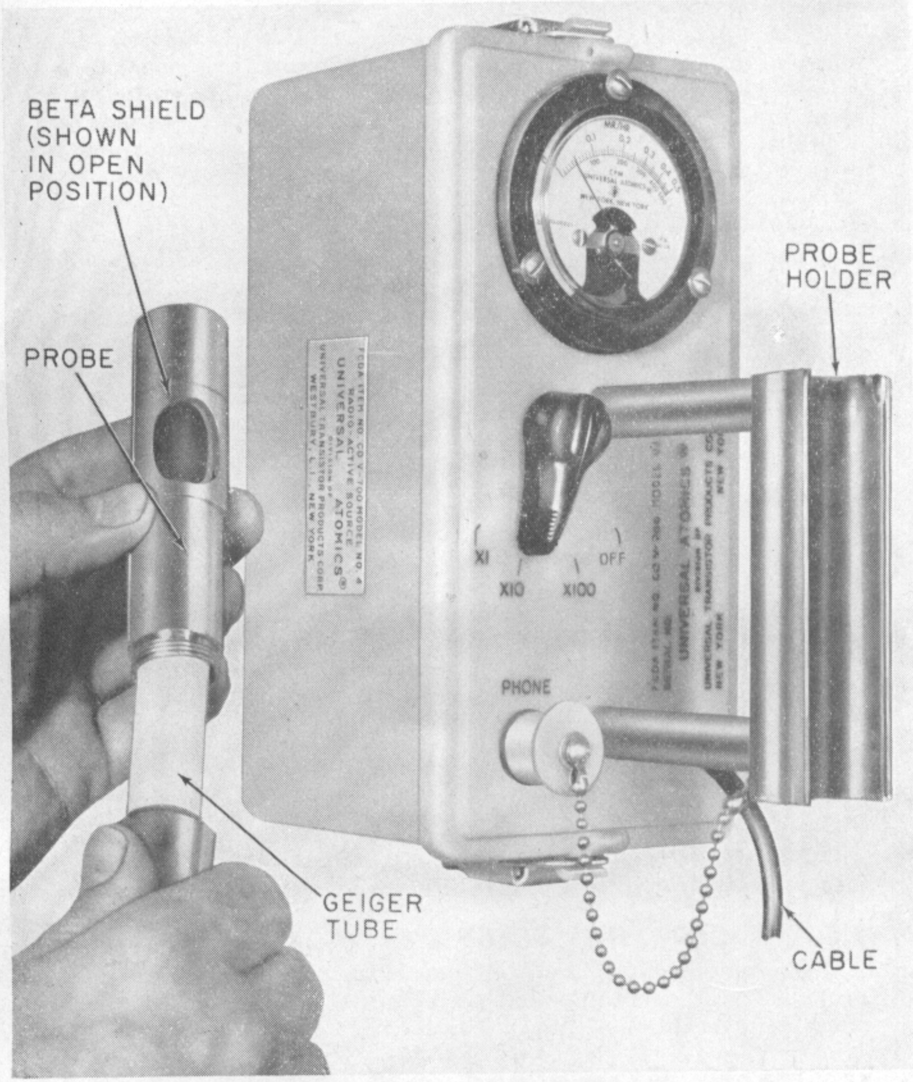


Fig. 2 — V-700 showing Geiger tube

2.2 THE GEIGER TUBE

The geiger tube consists of a thin cylindrical shell which serves as the cathode, a fine wire anode suspended along the longitudinal axis of the shell, and a gas into which a small amount of a halogen gas is inserted to act as a quenching agent. A voltage slightly less than that required to produce a discharge is applied between the anode and cathode. When a radioactive particle impinges upon the tube, some of the particle's kinetic energy is used to ionize a gas molecule. The electrons resulting from this ionization are accelerated toward the anode by the electric field; and in movement toward the anode, cause additional ions to be formed. The creation of additional ions is very rapid thus producing a discharge in the gas. The small amount of halogen gas in the tube serves to help in quenching the discharge and restores the tube to its original condition. This discharge results in a pulse in the external circuit. The frequency of such pulses is proportional to the magnitude of the radiation field.

2.3 THE HIGH VOLTAGE SUPPLY

The high voltage supply consists of a blocking oscillator circuit in which pulses are generated by a transistor, V5, alternately cut-off and saturated. When switch SW1 is closed, collector current in V5 starts to flow, since the emitter is at ground potential. The transformer windings between the base and collector are so phased that when the collector current starts to flow, the voltage at the base goes in the negative direction. By virtue of the base going negative, the collector current will increase still further, causing the base to go more negative. The collector current increases until the transistor saturates, at which point the collector cannot supply the current demanded by the signal at the base. Since there is no rate of change of current in the transformer, there is no signal induced in the base winding. Therefore, the emitter current decreases. If the emitter current decreases, the collector current decreases. The signal induced at the base of the transistor is such as to make this action cumulative, until the transistor cuts off. The collector current stops abruptly, causing a large rate of change of current in the transformer, therefore, inducing a high voltage pulse on the secondary. This makes the base go negative, which, in turn, starts the collector current flowing, and the cycle repeats. In order to keep the input voltage to the collector of V5 constant, it is connected to a source of constant potential at the emitter of V4. The signal on the base of V4 is a constant 3 volts; therefore, the voltage at the emitter of V4 is constant.

A step-up turns ratio between the collector winding and the secondary winding, produces the required high voltage of approximately 900 volts, which is then rectified by the selenium rectifier, CR2, to obtain the required DC voltage.

The fourth winding on the transformer, T1, is used to regulate the high voltage. When the oscillator is generating 900 volts, a pulse of approximately 3 volts appears on this winding. The diode CR3 prevents the signal from rising above this value by clipping the pulse whenever it exceeds 3 volts.

2.4 THE PULSE SHAPING AND METERING CIRCUIT

The pulse shaping and metering circuit is composed of three transistors, a rectifier and a meter. A pulse from the geiger tube is fed into the base of transistor V1, where it is amplified and fed into the base of V2. Transistors V2 and V3 form an emitter-coupled, monostable multivibrator. Since the voltage on the timing capacitor cannot change instantaneously, the signal appears on the base of V2 at the same time it appears on the collector of V3. The signal voltage on the base of V2 causes an amplified signal voltage to appear on the collector of V2. This signal voltage stays on the base until it decays to the turn-on voltage of V2, through the time constant consisting of R6 and the timing capacitor in the circuit. The signal voltage on the collector of V2 is applied to the base of V3 through the voltage divider R7 and R4. The signal voltage on the base of V3 causes an amplified voltage on the collector of V3 and it is this voltage pulse that is rectified in CR1 and fed into the meter M1. The voltage pulses through the meter are integrated by capacitor C7. The average voltage indicated on the meter is proportional to the frequency of the pulses through V3. The pulse frequency is in turn proportional to the frequency of pulses from the geiger tube. Therefore, the meter can be calibrated to read the dose rate directly in milliroentgens per hour. Range switching is accomplished by switching C3, C4 or C5 into the timing circuit.

2.5 SCALE RANGES

Three ranges of operation are provided. The first range, X1, requires approximately 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 equivalent radiation. Scale changing is effected by switching capacitors, thus changing the pulse width of the multivibrator.

2.6 THE HEAD PHONE

The audio device is a head phone which detects the pulses from the base of the trigger circuit. An isolating resistor, R14, is used so that the presence of the head phone has no effect upon the operation of the system.

III. INSTALLATION

3.1 INSTALLING THE BATTERIES

The instruments are shipped with the batteries removed. To put the instrument into operation: (See Fig. 3.)

1. Open the case by releasing the clamps at both ends, and remove the lid assembly.
2. Remove the batteries from their package, taking care not to drop them.
3. Open the battery bracket and remove the battery bracket strap.
4. Place the "D" cell batteries in position. Use care to see that the batteries are installed with the correct polarities. The correct polarities are marked on the bottom of the battery bracket. (The positive terminals of the batteries should be contacting the bronze contact strips). If the batteries are improperly installed, the instrument will not operate, or may operate incorrectly. *NOTE:* The positive terminal is the small center button on the battery.
5. After the batteries are inserted, replace and snap the battery bracket strap into position.
6. Clamp the circuit chassis back together.
7. Replace lid assembly in case.

IV. OPERATION

4.1 OPERATING THE CIRCUIT THE FIRST TIME

Turn the instrument to the times ten (X 10) scale with the beta window closed. Wait five seconds for the system to reach stability. The indicator should remain substantially at zero. Present the open window of the probe to the center of the nameplate under which is a radioactive sample (see Fig. 4), make sure the geiger tube is directly over the dimple on the nameplate. The indicator should fall between 1.5 milliroentgens per hour (mr/hr) and 2.5 mr/hr, averaging about 2.0 mr/hr.

4.2 CALIBRATION

Note: The beta source under the nameplate must constitute the sole source of radiation when calibration is performed. Calibration must not be undertaken when the background is above normal (Sect. 4.5) or in a radiation field other than that produced by the known beta source under the nameplate.

If the indication differs from the above range, it may be corrected by moving the arm of potentiometer, P1, as shown in Fig. 4. To gain access to this potentiometer, loosen both clamps, remove the instrument from the case and tilt the instrument to one side. Use a pencil or orange stick to move the arm of the potentiometer. Advancing the arm clockwise increases the reading; rotating it counter-clockwise decreases the reading.

4.3 SCALE RANGES

The range switch controls an "OFF" position and three ranges labeled, "X100," "X10," and "X1." These are respectively 100 times, 10 times and 1 times the scale reading in mr/hr and counts per minute.

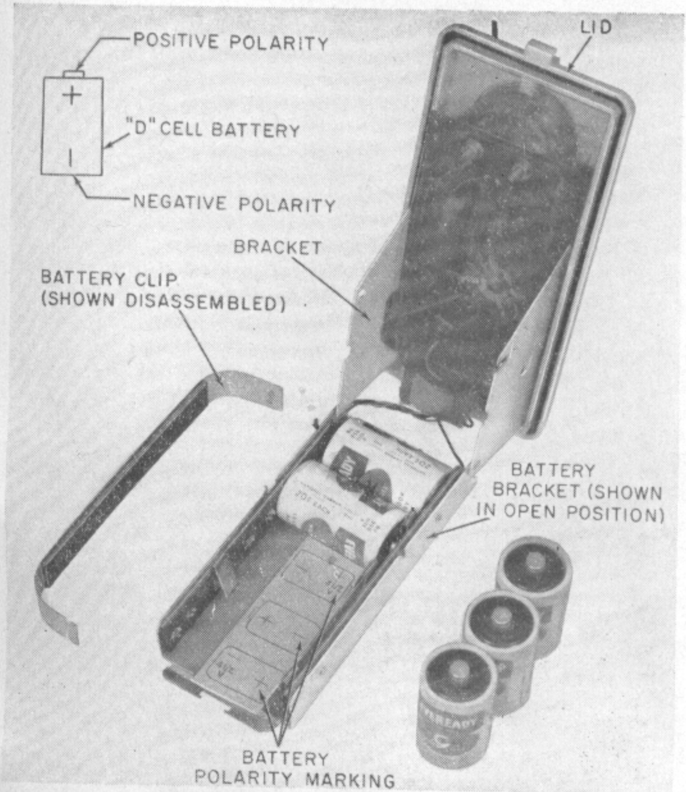
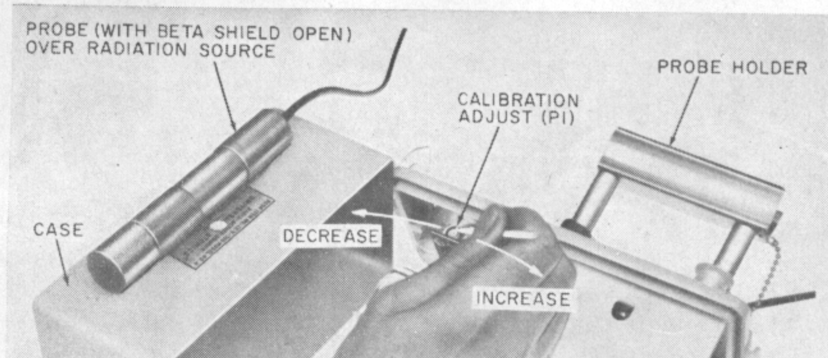


Fig. 3 — V-700 Showing Battery Complement

Fig. 4 Calibration Adjustment



The printed meter scale goes to 0.5 mr/hr and 500 counts per minute respectively.

4.4 USING THE HEAD PHONE

If the operator chooses to use a head phone with the instrument, the phone cable is attached to the connector provided immediately to the left of the rear post of the handle. In using the head phone, the operator will note that each pulse arriving at the instrument is indicated by a distinctly audible "click."

4.5 NORMAL BACKGROUND

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

4.6 CHECKING CALIBRATION

The operator should periodically check the calibration of the instrument to verify that it is correct. This operation is described in paragraph 4.2. He may confidently make an adjustment of the calibration-adjust-potentiometer whenever necessary.

4.7 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 either the left or right shoulder.

V. PREVENTIVE MAINTENANCE

5.1 BATTERY LIFE

Caution: Make Certain the Instrument is Turned OFF Whenever Not in Use; otherwise, the batteries will certainly be depleted, and the instrument rendered ineffective. The life of the batteries is over 100 hours under continuous use; for intermittent use the life is extended. The indications that the instrument is *ON* are: (a) the position of the range switch, (b) clicks in the head phone, (c) the meter reading. The latter two are not obvious at any distance from the instrument. The operator must be sure that the range switch is in the OFF position, when the instrument is not in use.

5.2 STORAGE

The instruments are shipped in a packing container, and should be left this way until ready to be put into operation. This prevents the accumulation of dirt, moisture, and radioactive contamination, which would 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 the probe. The instruments should not be stored with the batteries installed.

VI. OPERATOR'S MAINTENANCE

6.1 REPLACING THE BATTERIES

Whenever the instrument fails to respond to the radiation source, check the batteries. To replace the "D" cells, open the circuit chassis and press down on the end of the battery clip until the battery clip springs open. Remove the old "D" cells and replace them with new ones. Make sure that the proper polarities are observed when replacing the cells. (See Paragraph 3.1) If a voltmeter is available, one can check the "D" cells to determine if they have reached their useful end point. When the circuit is turned on, the end point for the cells is approximately 1 volt.

6.2 REPLACING THE GEIGER TUBE

The chief maintenance required by this instrument is replacing the batteries (see Paragraph 6.1). The geiger tube is halogen quenched so that its operating life is unaffected by use and therefore rarely requires replacement. However, when fresh batteries are installed, and the instrument does not work correctly, it is preferable to replace the geiger tube before making any further attempts at circuit checking.

VII. CORRECTIVE MAINTENANCE

7.1 IN CASE OF DIFFICULTY

Open case and make visual inspection for shorts, broken wires, and obviously damaged or broken components.

7.2 CHECKING THE HIGH VOLTAGE SUPPLY

An electrostatic, or some other high impedance type of voltmeter should be used. A VTVM (vacuum tube voltmeter) with a high voltage probe (1000 megohms or higher) can be employed. The high voltage may be measured between pins 1 and 3 of the geiger tube socket. The probe housing and the geiger tube must be removed to expose the tube socket. The normal voltage will be 920 volts plus or minus 30 volts when measured by an electrostatic voltmeter and approximately 900 volts plus or minus 30 volts when measured with a 1000 megohm VTVM. If neither of these instruments is available, a multimeter or microammeter may be used. The voltage cannot be measured at the geiger tube socket using the latter instrument. It can be measured by placing a microammeter across R10 (test point "G" and ground). This should read 9 plus or minus 2 microamperes (see Fig. 5).

If the voltage falls below 900 volts, the following tests should be made:

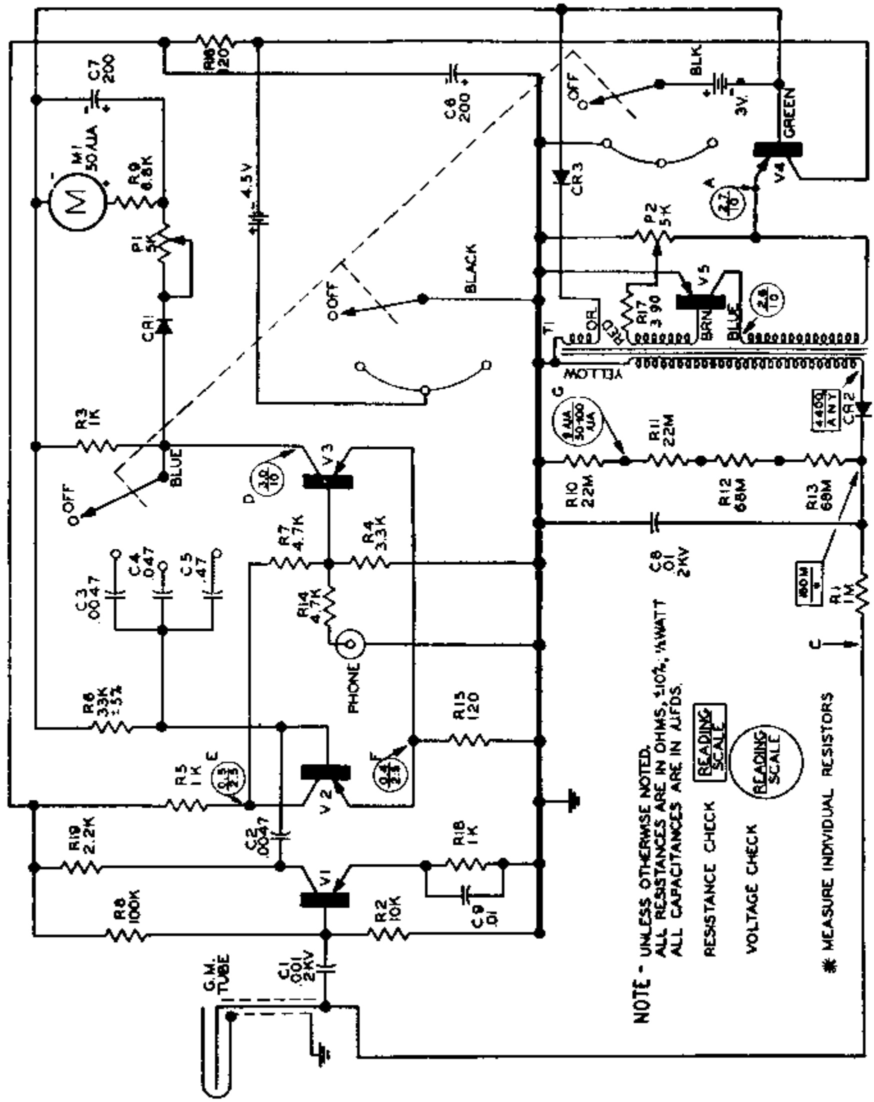


Fig. 5 — Schematic for V-700

a. Check the batteries with the instrument turned on. The two cells nearest the hinge of the battery bracket should read 1.5 volts each. The remaining three cells should read over 1.0 volts. Replace the batteries if weak.

b. If the voltage is still below 900 volts, the high voltage must be adjusted. Use a wooden dowel, pencil, orange stick, or a well-insulated screwdriver to adjust the control P2. (See Fig. 7).

c. If the voltage remains below the limit, check the voltage at test point "A" (see Fig. 7). This voltage should be more than 2.7 volts. If "A" is less, replace V4. If "A" is correct, and some voltage is present at "B", replace V5. If no voltage is present at "B", replace T1. If the voltage remains below the limit, replace CR2. (See Fig. 6).

d. If the voltage is higher than 940 volts, replace CR3.

7.3 CHECKING THE PULSE SHAPING NETWORK AND INTEGRATING CIRCUIT

In order to check the pulse shaping and integrating circuit, connect the head phone and listen while tapping pin 1 of the geiger tube socket with an insulated screwdriver. (CAUTION: Do not touch shaft of screwdriver or allow it to come in contact with the case. To do so may mean an annoying shock, and certainly will damage transistor V1). This should create sporadic clicking in the head phone, and should cause the meter to deflect when the range switch is on the X1 scale. If no clicks are heard when touching the tube socket pin, try the same test at point "C". If clicks are then heard, the cable assembly is defective and must be replaced in its entirety. The probe end of the cable is molded into the socket and repairs on the cable are not possible. If no clicks are heard, check voltages at V1, V2 and V3. (See Figures 5 and 7 for test). If voltages are correct, replace C1. If clicks are heard, but meter does not deflect, replace P1, CR1, and R9 in that order. If the meter deflects and returns too quickly to the zero position, replace C7. If the meter does not deflect, replace meter.

7.4 OHMMETER AND VOLTMETER CHECK

If the instrument is inoperative after the above checks, a resistance check may be made with a 20,000 ohm-volt meter. A voltmeter check with the same instrument will determine if an active element (transistor) or component (resistor, capacitor, etc.) is bad.

Resistance check—The values indicated on the schematic, Fig. 5, should be measured with the switch on the OFF position, that is, with the circuit not energized.

Voltage check—The values indicated on Fig. 5 should be measured with the switch on the X100 position. In this position the instrument will be energized. NOTE: Measurements should not be made in a high count rate area.

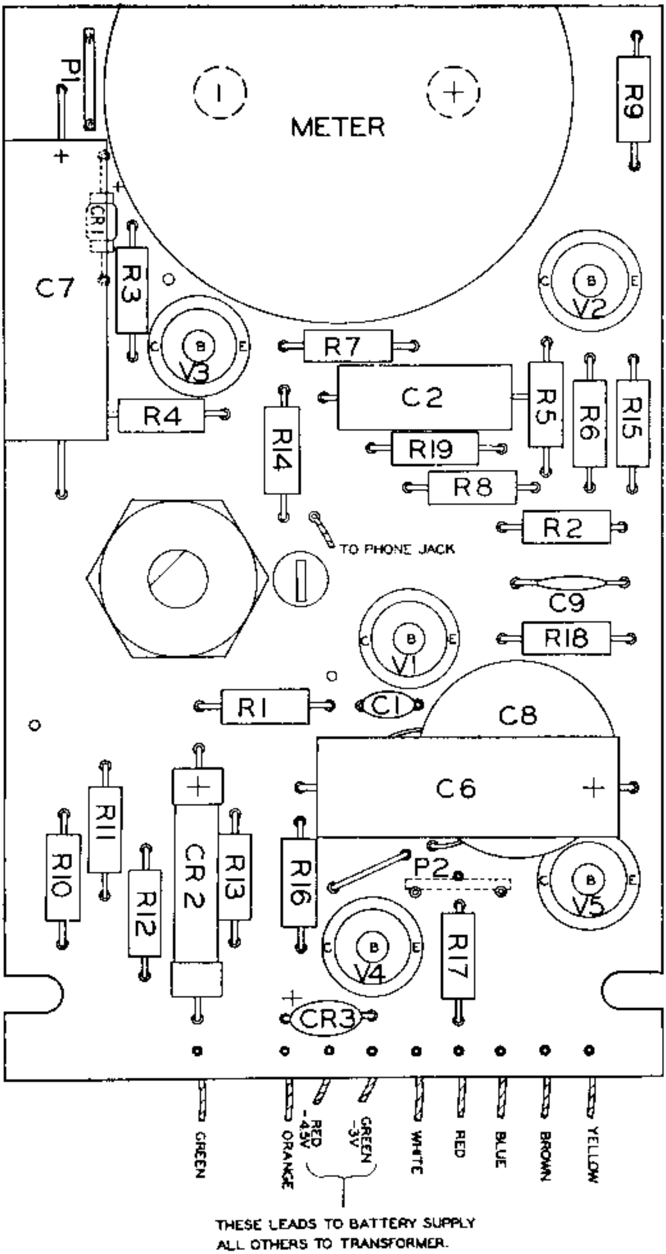


Fig. 6—Printed Circuit Layout Board (Top)

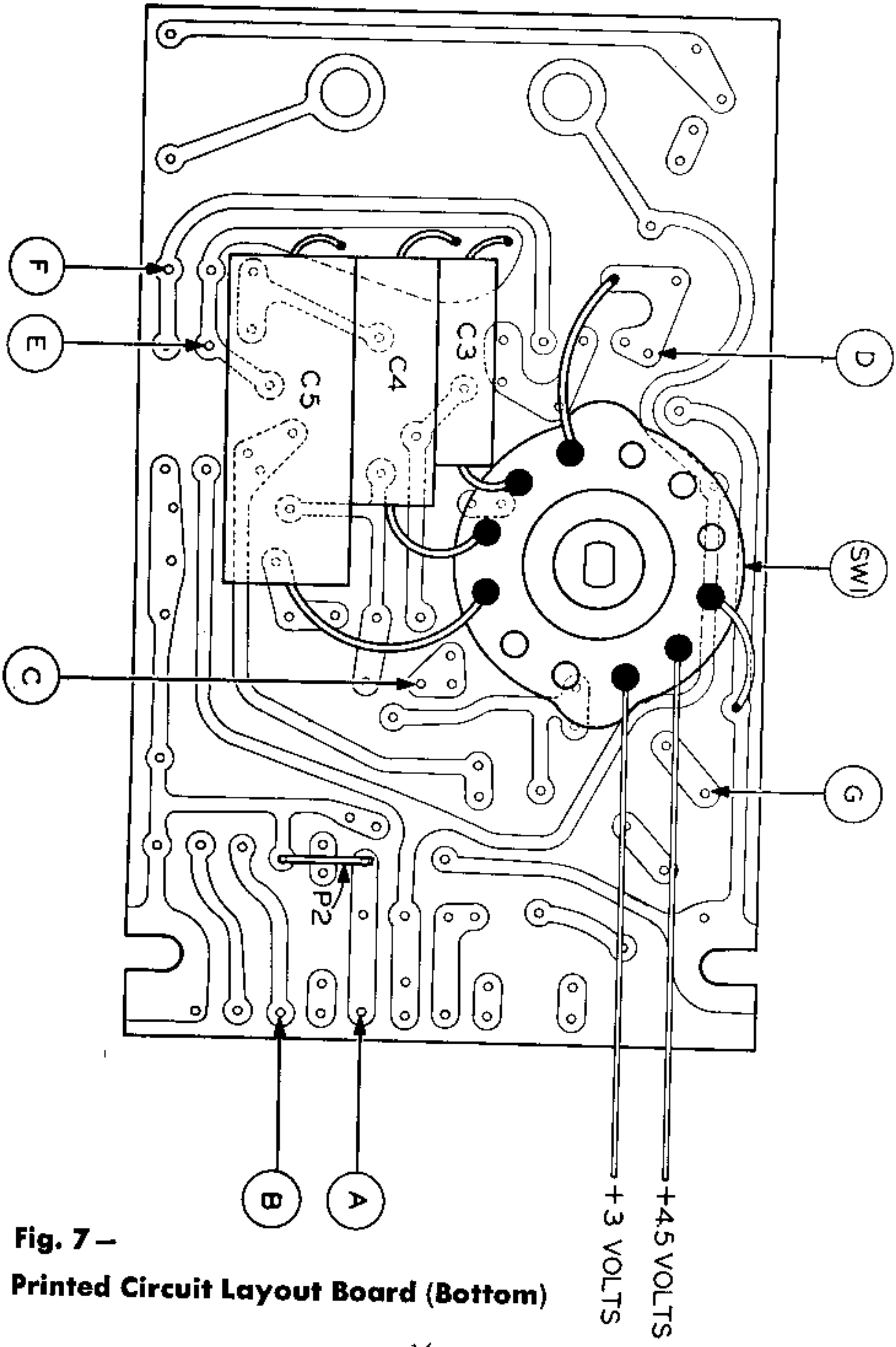


Fig. 7 —

Printed Circuit Layout Board (Bottom)

VIII. REPLACEMENT PARTS

8.1 ELECTRICAL COMPONENTS

Circuit Symbol	Number Required	Description and Function	Manufacturer	Manufacturer Part No.	Universal Atomics® Part No.	Recommended Maintenance Spares
R1	1	Resistor — 1 megohm load for GM tube	S. C. Co.	A-105-K	555-1-3b-1	1
R2	1	Resistor — 10 K ohm — bias for V1	S. C. Co.	A-103-K	555-1-3b-3	1
R3	1	Resistor — 1 K ohm — collector load for V3	S. C. Co.	A-102-K	555-1-3b-2	1
R4	1	Resistor — 3.3 K ohm — bias for V3	S. C. Co.	A-332-K	555-1-3b-9	1
R5	1	Resistor — 1 K ohm — Collector load for V2	S. C. Co.	A-102-K	555-1-3b-2	1
R6	1	Resistor — 33 K ohm ± 5% timing resistor	S. C. Co.	A-333-J	555-1-3b-4	1
R7	1	Resistor — 4.7 K ohm — bias for V3	S. C. Co.	A-472-K	555-1-3b-5	1
R8	1	Resistor — 100 K ohm — bias for V1	S. C. Co.	A-104-K	555-1-3b-8	1
R9	1	Resistor — 6.8 K ohm — damping	S. C. Co.	A-682-K	555-1-3b-12	1
R10	1	Resistor — 22 megohm — bleeder for high voltage	S. C. Co.	A-226-K	555-1-3b-6	1
R11	1	Resistor — 22 megohm — bleeder for high voltage	S. C. Co.	A-226-K	555-1-3b-6	1
R12	1	Resistor — 68 megohm — bleeder for high voltage	S. C. Co.	A-686-K	555-1-3b-10	1
R13	1	Resistor — 68 megohm — bleeder for high voltage	S. C. Co.	A-686-K	555-1-3b-10	1
R14	1	Resistor — 4.7 K ohm — voltage divider for head phone	S. C. Co.	A-472-K	555-1-3b-5	1
R15	1	Resistor — 120 ohm — common emitter resistor for V2 and V3	S. C. Co.	A-121-K	555-1-3b-7	1
R16	1	Resistor — 120 ohm — Filter	S. C. Co.	A-121-K	555-1-3b-7	1
R17	1	Resistor — 3.9 K ohm — bias for V5	S. C. Co.	A-392-K	555-1-3b-11	1
R18	1	Resistor — 1 K ohm — bias for V1	S. C. Co.	A-102-K	555-1-3b-2	1
R19	1	Resistor — 2.2 K ohm — collector load for V1	S. C. Co.	A-222-K	555-1-3b-13	1
C1	1	.001ufd-2kv — blocks high voltage from V1	R. M. C.	.001-1.4kv	555-1-3d-1	1
C2	1	.0047ufd-100 volts ± 10% — couples signal to V2	P. E. C.	490000-9	555-1-3d-6	1
C3	1	.0047ufd-100v ± 10% timing capacitor	P. E. C.	490000-9	555-1-4b	1
C4	1	.047ufd-100v ± 10% timing capacitor	P. E. C.	490000-71	555-1-4c	1
C5	1	.47ufd-100v ± 10% timing capacitor	P. E. C.	490000-33	555-1-4d	1
C6	1	200ufd-6v — filter capacitor	I. E. I.	911-7-35	555-1-3d-3	1
C7	1	200ufd-6v — integrating capacitor	I. E. I.	911-7-35	555-1-3d-3	1
C8	1	.01ufd-2kv — filter capacitor	R. M. C.	.01-1.4KV	555-1-3d-4	1
C9	1	.01ufd-100v — emitter by-pass for V1	R. M. C.	.01-100	555-1-3d-5	1
T1	1	Transformer — to develop high voltage	U. T. P.		555-1-3h-1	1
CR1	1	Rectifier — to rectify meter current	U. T. P.		555-1-3g-1	1
CR2	1	Rectifier — to rectify high voltage	U. T. P.		555-1-3g-2	1
CR3	1	Rectifier — to regulate high voltage	U. T. P.		555-3g-3	1
P1	1	Potentiometer 5K — to adjust calibration	Cent. Inc.	YA 377-011	555-1-3c-1	1
P2	1	Potentiometer 5K — to adjust high voltage	Cent. Inc.	YA 377-012	555-1-3c-2	1
V1	1	Transistor — preamplifier	U. T. P.		555-1-3f-1	1

VIII. REPLACEMENT PARTS cont'd

8.1 ELECTRICAL COMPONENTS (continued)

Circuit Symbol	Number Required	Description and Function	Manufacturer	Manufacturer Part No.	Universal Atomics® Part No.	Recommended Maintenance Spares
V2	1	Transistor — multivibrator	U. T. P.		555-1-3f-2	1
V3	1	Transistor — multivibrator	U. T. P.		555-1-3f-3	1
V4	1	Transistor — voltage regulator	U. T. P.		555-1-3f-4	1
V5	1	Transistor — high voltage oscillator	U. T. P.		555-1-3f-5	1
G-M	1	Geiger tube	A. E. Co.	114	555-1-6e	1
SW 1	1	Switch — change ranges	Cent. Inc.	10713	555-1-4a	1
M1	1	Meter 50 ua — to read radiation	U. T. P.		555-1-1f	1
B	5	Batteries "D" size — to power circuit	N. C. Co.	950	555-1-14	5
TBO1	1	Printed Circuit Board	U. T. P.		555-1-3a	1
H1	1	Head phone	Trimm	#27	555-1-7a	1

(1) All resistors are ± 10% — ½ watt unless noted (2) All capacitors are ± 20% unless noted.

8.2 MECHANICAL COMPONENTS

Number Required	Description and Function	Universal Atomics® Part No.	Recommended Spare Parts
1	Lid — top cover	555-1-1a-1	None
1	Bracket — hold printed circuit board	555-1-1b	None
1	Probe Holder Assembly — holds probe	555-1-1c	One
1	Probe Cable Assembly — connects Geiger tube	555-1-1k	One
1	Case — bottom cover	555-1-2a-1	One
1	Battery Bracket — holds battery	555-1-5	None
1	Probe Housing — holds Geiger tube	555-1-6	One
1	Strap Assembly — carrying strap	555-1-8	One

8.3 VENDORS

Symbol	Name	Address
A. E. Co.	Anton Electronic Laboratories, Inc.	Brooklyn, N. Y.
Cent. Inc.	Centralab, Inc.	Milwaukee, Wisconsin
I. E. I.	International Electronic Industries, Inc.	Nashville, Tenn.
N. C. Co.	National Carbon Co.	New York, N. Y.
P. E. Co.	Pyramid Electric Co.	No. Bergen, N. J.

Symbol	Name	Address
R. M. C.	R. M. C. Associates	New York, N. Y.
S. C. Co.	Stackpole Carbon Co.	St. Mary's, Pa.
Trimm	Trimm, Inc.	Libertyville, Ill.
U. T. P.	Universal Transistor Products Corp.	Westbury, L. I., N. Y.