Instruction and Maintenance Manual

RADIOLOGICAL SURVEY METER

OCDM ITEM NO. CD V-715, MODEL 1

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MANUFACTURED BY
LIONEL ELECTRONIC LABORATORIES, INC.
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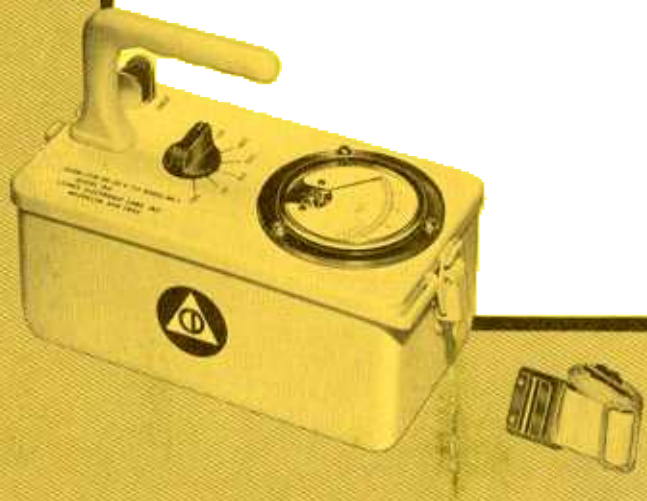

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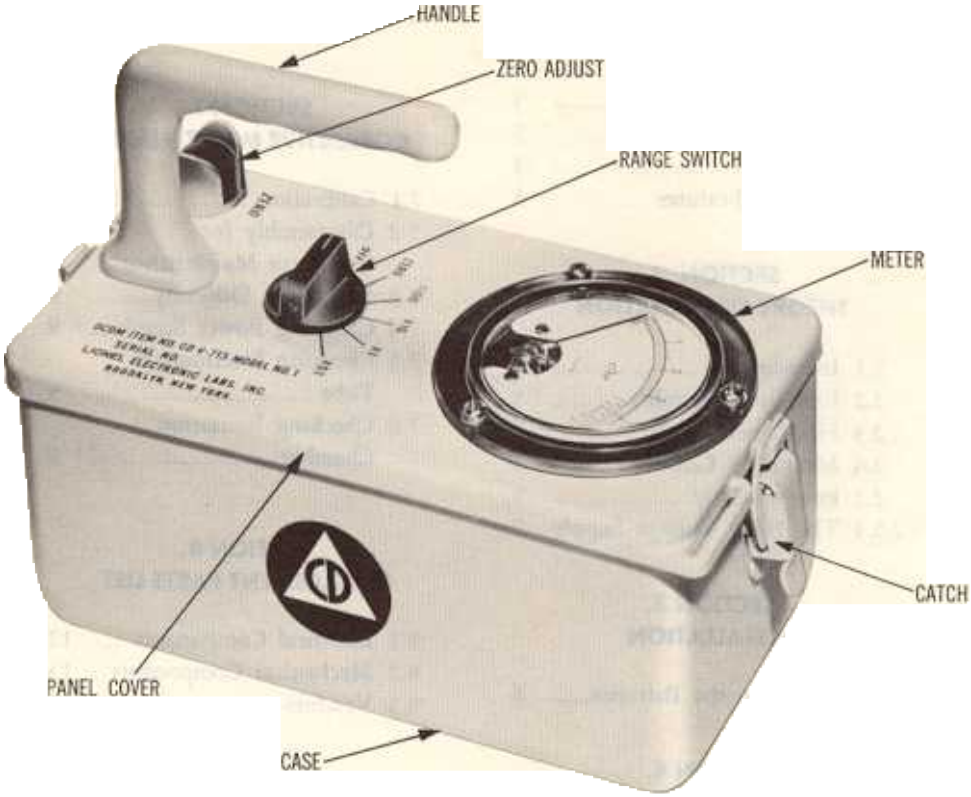

Fig. 1—Lionel CDV-715 Survey Meter

I. GENERAL DESCRIPTION

1.1 INTRODUCTION

The Lionel V-715 is a portable, battery powered, transistorized survey meter using a plated steel, hermetically sealed ionization chamber as the detector. The chamber is mounted inside the case. The instrument and its accessories include a printed circuit board, ionization chamber, carrying strap and strap fastener. The case is watertight to withstand immersion. (See Fig. 1)

1.2 RANGES

Four ranges are provided, 0-.5, 0-5, 0-50 and 0-500 R/RH. On the lowest range, the smallest division on the scale is .01 R/HR. Intensities higher than 500 R/HR are indicated by the meter reading off scale. The instrument is not harmed by this.

1.3 SPECTRAL RESPONSE

The error introduced by changes in energy level from .08 MEV (Million Electron Volts) to 1.2 MEV is less than 15%.

1.4 ACCURACY

The accuracy of this instrument is plus or minus 20 percent of true dose rate in Cobalt 60 and or Cesium 137 gamma radiation fields incident normal to the bottom and normal to the front of the instrument. Accuracy is not affected by altitude and light or radio frequency radiations.

1.5 CONTROLS

Two controls are provided (See Fig. 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 meter to zero each time before use.

1.6 CIRCUIT CHECK

The proper functioning of the measuring circuit including the battery may be checked by setting the range switch to Circuit Check and observing the meter reading. The limits of acceptable indication cover the top 30 percent of the scale. This is a reliable indication of the condition of the instrument.

1.7 BATTERIES

One "D" size flashlight cell is used (NEDA type 13). The useful operating life is a minimum of 150 hour for continuous duty and somewhat longer for intermittent use.

1.8 METER

The meter is a core magnet type of movement, semi ruggedized to withstand shock, vibration and rough field handling.

1.9 PHYSICAL FEATURES

The instrument is approximately 4½ inches wide, 8¼ inches long and 7 inches high including the handle and weighs 4 lbs. It is finished in bright yellow baked enamel. The panel is die cast zinc and the case drawn aluminum. The handle is also die cast zinc contoured to comfortably fit the hand.

2. THEORY OF OPERATION

2.1 INTRODUCTION

This instrument consists of an ionization chamber, electrometer

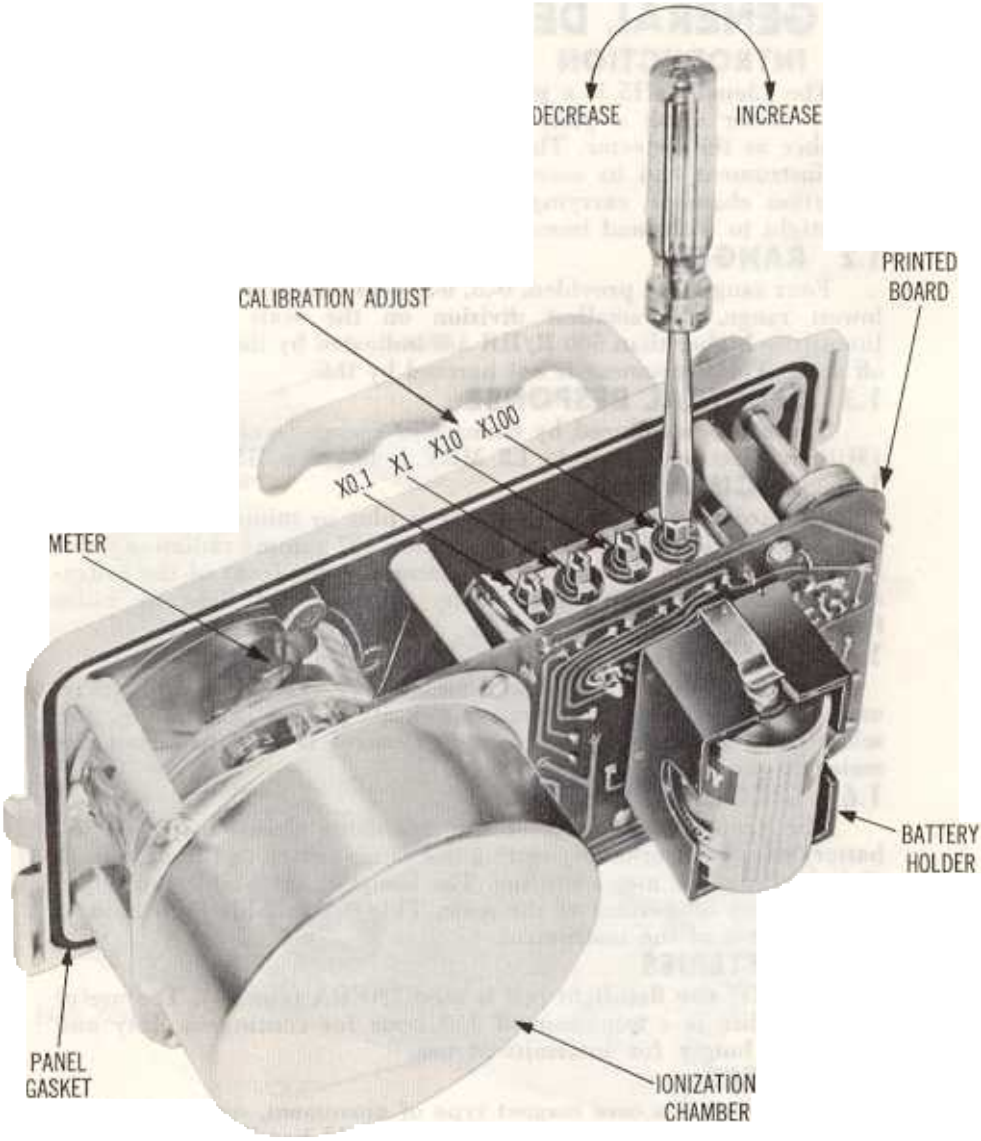

Fig. 2—Calibration Adjustment

tube and a transistorized power supply. Intensity of radiation is indicated on a 3½ inch panel meter. See fig. 2

2.2 IONIZATION CHAMBER

The sensing element is a hermetically sealed air equivalent ionization chamber. This chamber consists of a shell and center collector or electrode. The collector is insulated from the shell by a high resistance feed thru insulator. A voltage is applied between the collector and the shell. This makes the shell 20 volts negative with respect to the collector.

Gamma radiation, in passing through the air contained in the chamber causes air molecules to become charged or ionized. Positive ions or positive charged particles are attracted to the chamber shell which has an opposite charge and vice versa.

The arrival of these ions at the shell of the chamber, causes a flow of current whose magnitude is proportional to the number of ions collected. Since the number of ions collected is proportional to the radiation intensity, the ionization current must be proportional to the radiation intensity at the ionization chamber.

2.3 ELECTROMETER TUBE

The very small ionization current from the chamber collector at .5 R/HR flows through a high ohmage resistor ($2x10^{11}$ ohms) and develops a measurable voltage across the resistor. This voltage is also applied to the grid of V1 5886 Electrometer Tube which is connected as a triode. The filament of this tube is heated by the 1½ volt "D" Cell. The flow of electrons from the heated filament is controlled by the voltage applied to the grid and also the voltage to the plate.

2.4 MEASURING CIRCUIT

A 50 micro ampere meter M 1 is used to measure the change in current through tube V 1. Resistors R 3 and R 4 act as bias resistors to bias V 1. Resistor R 1 the zero adjust control sets the plate voltage so that the tube current is equal to the current flowing in the meter due to the battery and series resistor R 14. The meter M 1 then reads zero. When the ionization chamber is exposed to radiation a negative voltage is developed across R 6. This voltage results in a decrease in tube current and the indicating meter reads up scale by an amount proportional to the Radiation Intensity. Resistors R 10 through R 13 are calibrating potentiometers for the various ranges and they shunt some of the current around the meter. Resistors R 6 through R 9 are in series with the chamber on the various ranges. They act as voltage developing resistors for the four instrument ranges. R 4 is switched out of the circuit in the check position by switch S-1C. This changes the bias on V 1 and serves to make the meter read up scale in the check position.

2.5 POWER SUPPLY

2.5.1 THE HIGH VOLTAGE SUPPLY

The high voltage supply consists of a blocking oscillator circuit in which pulses are generated by a transistor, Q-1 alternately cut-off and saturated. 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 demanded by the signal at the base. At this point, supply the current demanded by the signal at the base. At this point, since there is no rate of change of current in the transformer, there is no signal induced in the base winding. When the signal is removed in the base circuit the collector current decreases and there is a resultant positive signal on the base. The transistor is cut off and a negative pulse is developed at the collector of the transistor. The transistor remains cut off as long as the positive signal on the base is present. When the field in the transformer core has collapsed, the base signal is gone and the transistor starts to conduct again and another full cycle from cut off to saturation to cut off follows.

The step-up turns ratio between the collector winding and the secondary winding produces voltage pulses which are then rectified by rectifiers CR1 and CR2.

Since the transformer is tapped, two voltages of opposite polarity appear. The turns ratio of T 1 is such as make these voltages + 10 volts and —20 volts. The plus 10 volts supplies plate voltage to the electrometer tube and the —20 volts fixes the operating level of the chamber. Capacitors C 1 and C2 serve as capacitive filters for the two voltage supplies.

Potentiometers R 16 is a factory adjustment. It serves to compensate for small drift in the instrument zero on the X-0.1 range.

3. INSTALLATION

3.1 INSTALLING THE BATTERY

The instruments are shipped with the battery packed separately. To put the instrument into operation:

1. Open the case by releasing the clamps at both ends, and remove the lid assembly.
2. Remove the battery from its package, taking care not to drop it.
3. Place the "D" Cell in the battery holder positive end first. The housing is designed to assure correct polarity.

4. OPERATION

4.1 OPERATING THE UNIT THE FIRST TIME

Turn the range switch to the Zero position, wait two minutes for the electrometer tube to warm up and adjust the Zero Control to bring the meter to zero.

Turn the range switch to the Check position. The meter should read within the red markings designated Circuit Check. If it does not, the battery may be dead or trouble may exist in the circuit. See section 5 and 7 for maintenance procedures. When the battery is new, the meter should read within the circuit check band. When the reading nears the bottom of the check band the battery should be replaced. Operators maintenance should be limited to replacement of the battery.

4.2 READING THE INSTRUMENT

Turn the range switch to the X100, X10, X1 or X0.1 range as required and read the radiation intensity on the meter. The meter readings must be multiplied by the factor for the range being used.

Example: A meter reading of 3.5 on the X0.1 range indicates a radiation field of 0.1x 3.5 or 0.35 R/HR. The indicator lines on the sides and front of the unit indicate the center line of the chamber.

5. OPERATORS MAINTENANCE

5.1 BATTERY REPLACEMENT

The battery 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 by opening two catches. Remove battery from holder and install battery as outlined in section 4.

6. PREVENTIVE MAINTENANCE

6.1 BATTERY LIFE

Caution: Make certain the instrument is turned off whenever not in use. The Off Position places the index mark on the range switch perpendicular to the handle. The life of the battery is at least 150 hours under continuous use; for intermittent use the life is somewhat more.

6.2 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 battery. The instruments should not be stored with the battery installed.

6.3 BATTERY INSPECTION

Even under continuous use with leak-proof cells, it is advisable to check the batteries for leakage at least once per month.

7. CORRECTIVE MAINTENANCE

7.1 CALIBRATION

(WARNING: Calibration should only be done by personnel trained in the use of X-Ray generators and radioactive isotopes.)

The CD V-715 is calibrated by being placed in a gamma radiation field of known intensity. Fields of this type may be produced by an X-Ray machine, radium, cobalt 60 or cesium 137. As an example a 100 MC. radium source will produce a radiation intensity of .40 R/HR, at a distance of 18.1 inches. The CD V-715 when set to the X0.1 range and so positioned should read this intensity. If it does not the instrument should be recalibrated. Since each range of the instrument has its own calibration control (See Fig. 2) suitable fields for each range must be available. The X-0.1 range is calibrated by adjusting R 10 similarly R 11 adjusts X-1, R 12 adjusts X-10 and R 18 adjusts X-100. See fig. 2 and 3

The instrument may be calibrated outside of its case if a gamma field such as obtained from Cesium 137 or Cobalt 60 is used. On soft X-Rays, the instrument should be in the case when calibration is checked. Geometry also must be considered. Errors may be introduced

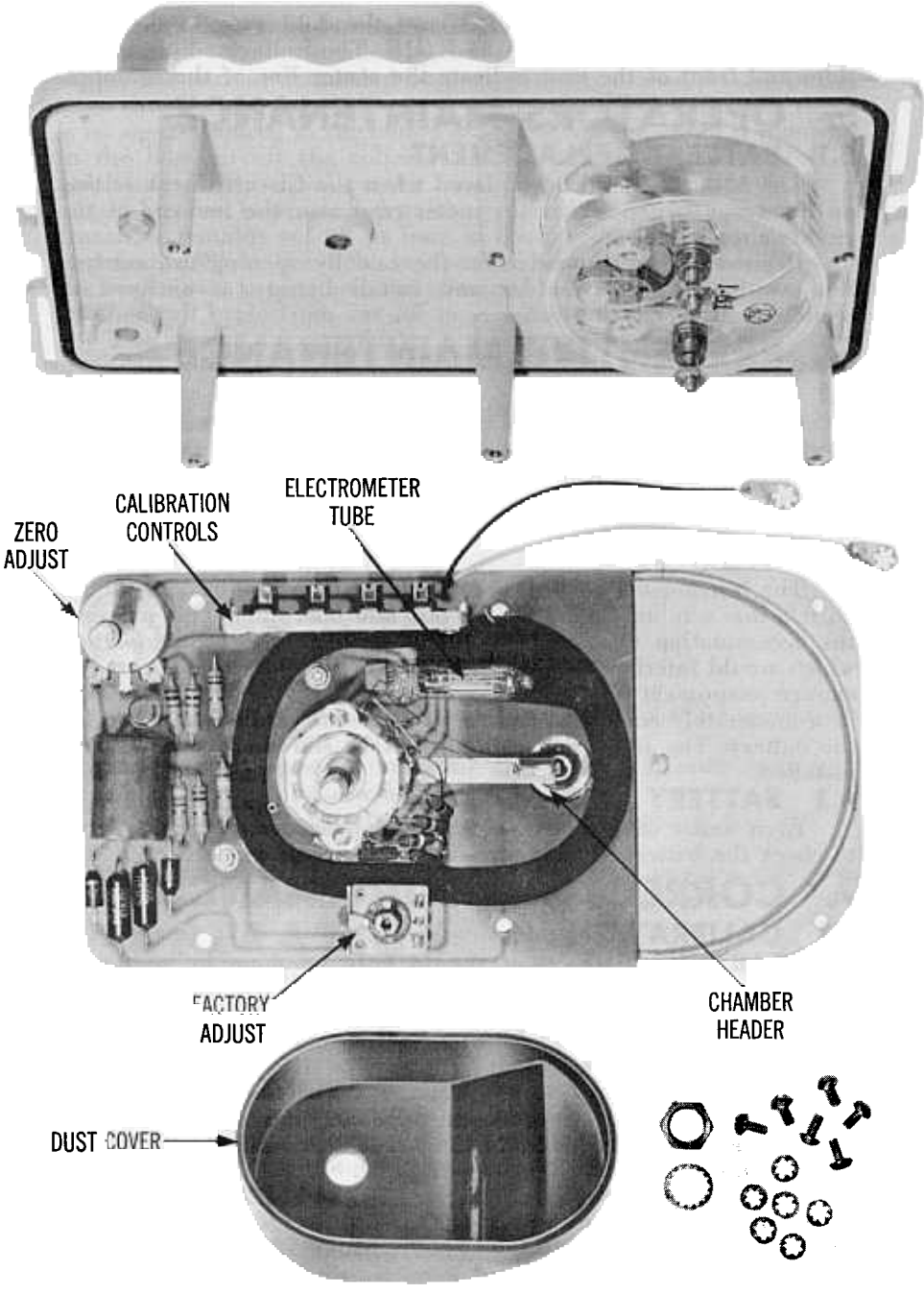

Fig. 3—Interior Details

if the ionization chamber is brought close to the source of radiation so that parts of the chamber are not uniformly exposed to the radiation.

7.2 DISASSEMBLY FOR CORRECTIVE MAINTENANCE

First remove instrument from case and remove battery. Remove the range knob and zero knob by loosening the set screws and pulling the knobs off shafts. Loosen and remove 6 screws holding printed circuit board and chamber to the panel. Pull assembly free from panel being careful not to crack the printed circuit board or damage lead from chamber. The dust cover can be removed by loosening the hexagonal nut on the switch. This exposes all of the electronic components for servicing. Chamber may be separated from the assembly by pulling clip loose. The ionization chamber header, the ceramic switch section, resistors R6, R7, R8, R9 and the electrometer tube require special precautions. These components are all part of a very high resistance circuit. They should not be handled except for replacement. They should be touched only with clean tools and should be cleaned afterward with clean alcohol and a clean soft brush. Solder flux and finger prints should be avoided otherwise surface leakage will result.

Circuit troubles may be traced by reference to the circuit diagram Fig. 5. Voltage measurements are with respect to ground and are obtained with a voltmeter having a sensitivity of 20,000 ohms per volt. Such voltage checks should be made with the range switch set at zero and the Zero Adjust adjusted so that the meter reads zero.

7.3 IN CASE OF DIFFICULTY

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

7.4 CHECKING POWER SUPPLY

Measurements in the voltage supply should be made with a voltmeter having a sensitivity of 20,000 ohms per volt or higher.

1. Check the battery with the instrument turned on. The 1.5 volt supply should read at least 0.9 volt.
2. Check the voltage across C1 and C2, it should read approximately +9 volts and —20 volts respectively. If these voltages are low, check the voltage at the collector of transistor Q-1. This voltages should be at least —0.7 volts with respect to the emitter. If the voltage is low replace Q1. If the collector voltage is sufficiently high replace either or both rectifiers D1 and D2.

7.5 CHECKING ELECTROMETER TUBE

This check can best be accomplished by removing the battery and checking the resistance across the filaments. This should be less than 200 ohms.

7.6 CHECKING IONIZATION CHAMBER

Inspect chamber header for presence of dirt or solder flux. Measure resistance of header to outside of chamber. Resistance as measured on an ohmmeter capable of measuring 1000 megohms should be infinite. If ohmmeter indicates, the chamber is damaged. Care must be exercised in high humidity so as not to be mislead by low resistance readings. The chamber should be checked in a dry environment.

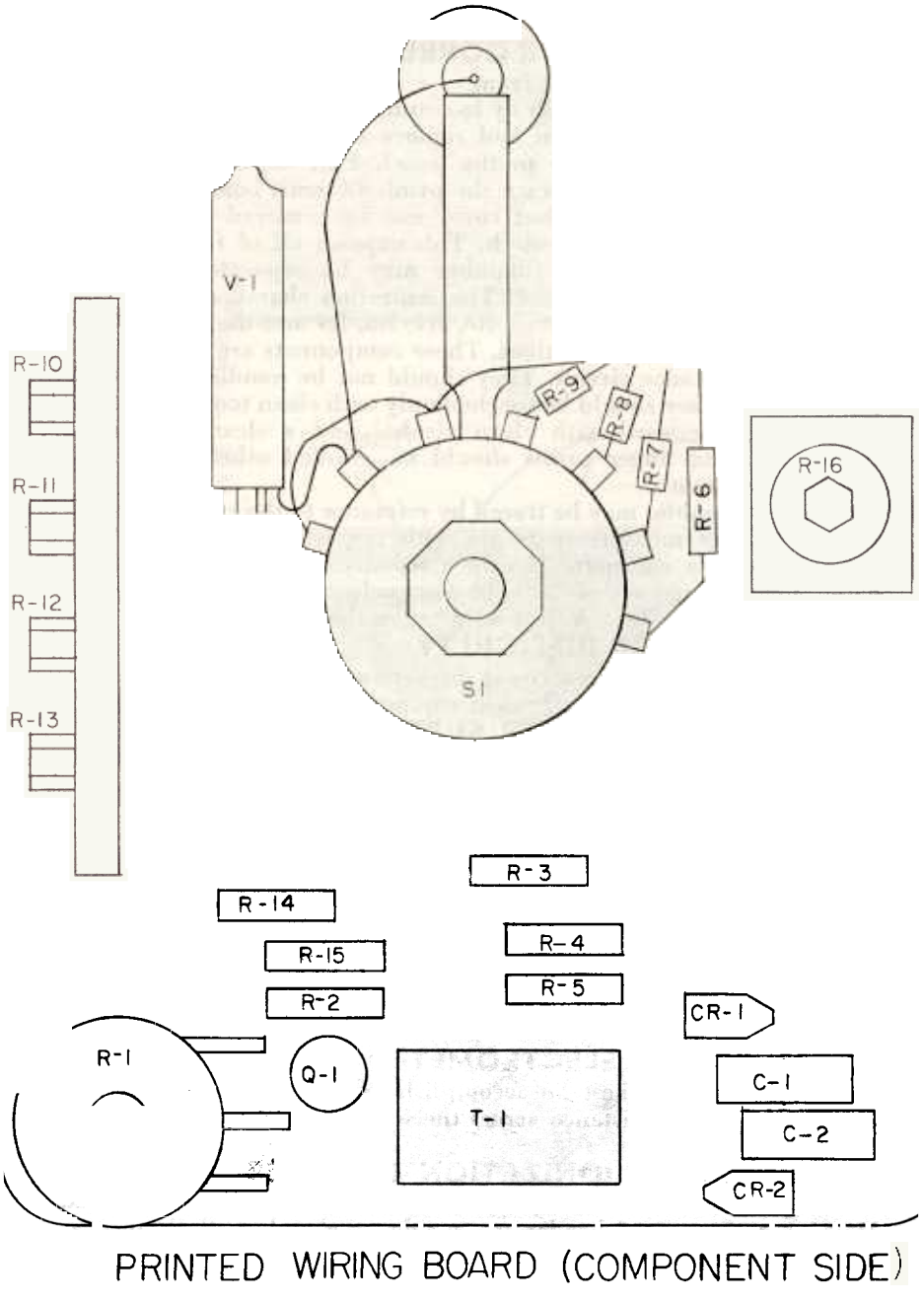

Fig. 4 — Printed Wiring Board and Component Location

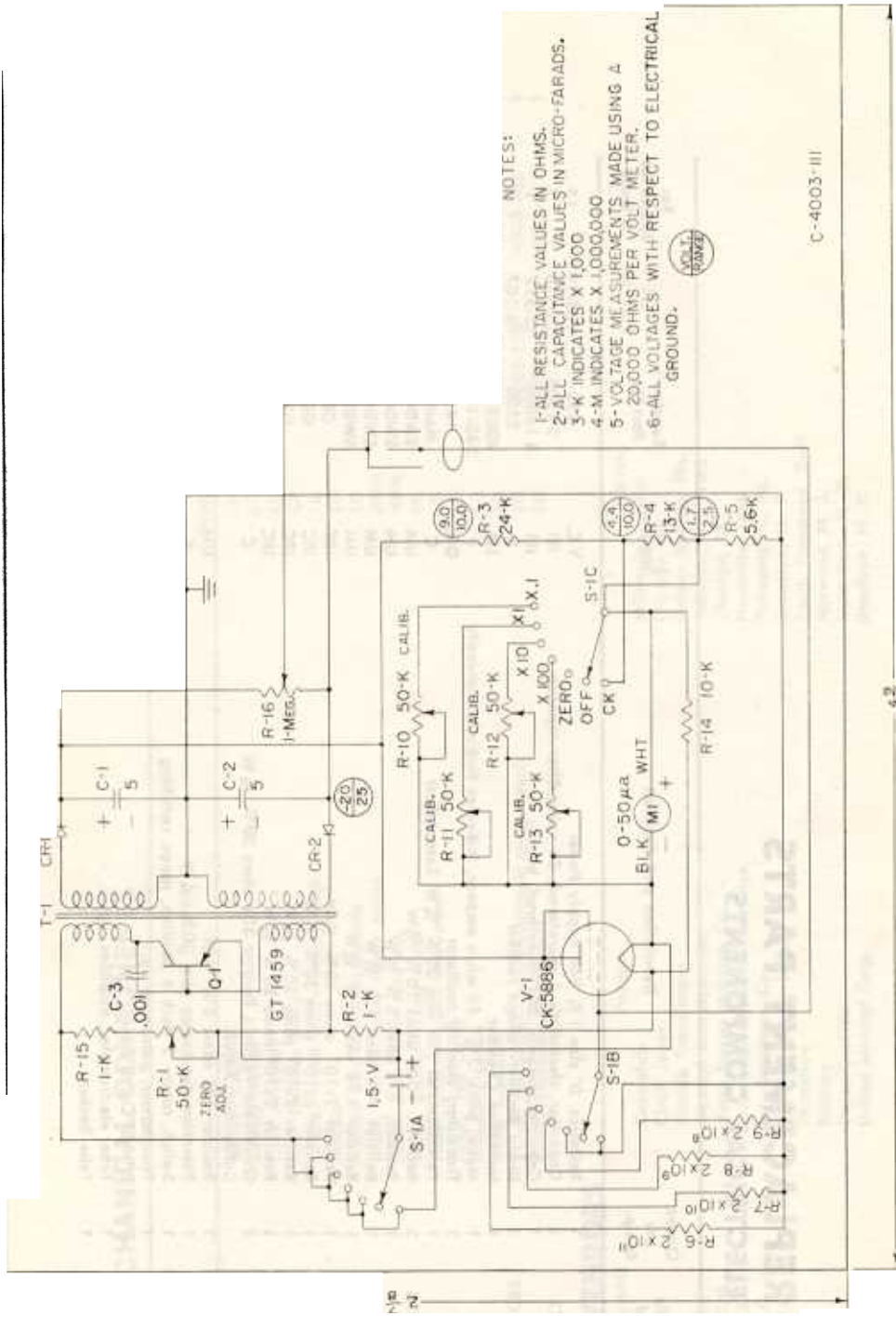

Fig. 5 — Schematic for V-715

8. REPLACEMENT PARTS

8.1 ELECTRICAL COMPONENTS

Schematic Symbol	Quant. per Equip.	Description and Function	Supplier	Supplier's Part No.	LEL Part No.	Rec. Spares for 5 Units
B	1	Batteries 'D' size 1½ Volt Supply Power	V.C.	950	106-198	
C1, C2	2	Capacitor, electrolytic 5 microfarad, 25 volts, filter capacitor	IEI	S 1505	T3-516	
C3		Capacitor, ceramic .001 microfarad, bypass	IEI	S 15005	T3-517	
CR1, CR2	2	Diode Rectifier-voltage rectifier	S	E250	T8-107	
CH	1	Ionization Chamber	LEL	4003-136	4003-136	
M1	1	Meter, panel 3½" 50 micro ampere, Indicates Radiation Intensity	P	340-10087	4003-102	
Q1	1	Transistor, blocking oscillator	GIC	1459	T8-102	
R1	1	Potentiometer 50k ohm 30% ¼W Zero Adjust	C	Model 2	4003-118	
R2, R15	2	Resistor, 1000 ohms 10% ½W	UM	SWD0.33	T10-236	
R3	1	Resistor, 24k ohms 5% ½W	UM	SWD0.33	T10-121	
R4		Resistor 15k ohms 5% ½W	UM	SWD0.33	T10-116	
R5		Resistor 4.7k ohms 5% ½W	UM	SWD0.33	T10-104	
R6		Resistor 2x10" ohms 20% ½W	IRC	GBT	T10-1438	
R7		Resistor $2x10^{10}$ ohms 20% ½W	IRC	GBT	T10-1439	
R8		Resistor $2x10^{9}$ ohms 20% ½W	IRC	GBT	T10-1440	
R9		Ressitor $2x10^{8}$ ohms 20% ½W	IRC	GBT	T10-1441	
R10, R11		Quadruple Variable Resistor 50k ohms 30% ¼W	C	4003-120	4003-120	
R12, R13		Calibration Adjust.				
R14		Resistor 10k ohms 5% ½W	UM	SWD0.33	T10-112	
R16		Potentiometer 1 meg ohm 30% ¼W	C	Model 5	4003-118	
S1		Switch, rotary 2 deck 6 position, range switching	C	PA 083-004	4003-114	
T1		Transformer, pulse step up.	F	4003-16	4003-116	
TB		Printed Circuit Board	LEL	4003-112	4003-122	
V-1		Tube, electrometer, amplifies signal.	LEL	5886	5886	
X1		Tube Socket	C.J.	46A-1-4148	4003-140	

8.2 MECHANICAL COMPONENTS

Quant. per Equip.	Description and Function		Suppliers Part No.	LEL Part No.	Rec. Spares for 5 Units
2	Battery Contacts	LEL	4003-119	4003-119	2
1	Battery Holder	LEL	4003-103	4003-103	1
1	Case Assembly	LEL	4003-110	4003-110	
1	Civil Defense Label	CR	106-123	106-123	
2	Gland, Water Seal—Seals Switch	LEL	106-106	106-106	
1	Handle	LEL	4003-101	4003-101	
1	Handle Gasket—Seals Handle	LEL	107-109	106-109	
1	Knob, Pointer-rotate range switch	HDM	1451	4003-139	
1	Knob, Zero-rotate zero adj.	HDM	1450	4003-138	
1	Meter Gasket—seals meter	LEL	114-104	114-104	
1	Panel Gasket—seals instrument	LEL	114-106	114-106	
1	Panel, Top Cover	LEL	4003-109	4003-109	
1	Schematic Label	LEL	4003-111	4003-111	
1	Strap Assembly	LEL	106-124	106-124	
1	Switch Enclosure—covers electronic components	LEL	4003-105	4003-105	
1	Switch Enclosure Gasket-seal	LEL	4003-117	4003-117	

8.3 VENDORS

Symbol	Vendors	Address
C.	Centralab	Milwaukee, Wisc.
C.J.	Cinch Jones	Chicago, Ill.
F.	Florida Transformer	Deleon Springs, Fla.
G.I.C.	General Instrument Co.	Jamaica, New York
H.D.M.	Harry Davies Molding Co.	Chicago, Ill.
I.E.I.	International Electric Industries	Nashville, Tenn.
I.R.C.	Int. Resistance Co.	Philadelphia, Pa.
L.E.L.	Lionel Electronic Labs.	Brooklyn, N. Y.
P.	Phaostron	South Pasadena, Calif.
S.	Solitron	Norwood, N. J.
U.C.	Union Carbide	New York, N. Y.
U.M.	United Mineral Corp.	Brooklyn, N. Y.