INSTRUCTION BOOK
and
MAINTENANCE MANUAL

FOR

Radiological Survey Meter

OCDM Item No. CD-V-720, Model No. 3

LANDERS, FRARY & CLARK

ELECTRONIC DIVISION

NEW BRITAIN, CONN., U.S.A.

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Illustrations

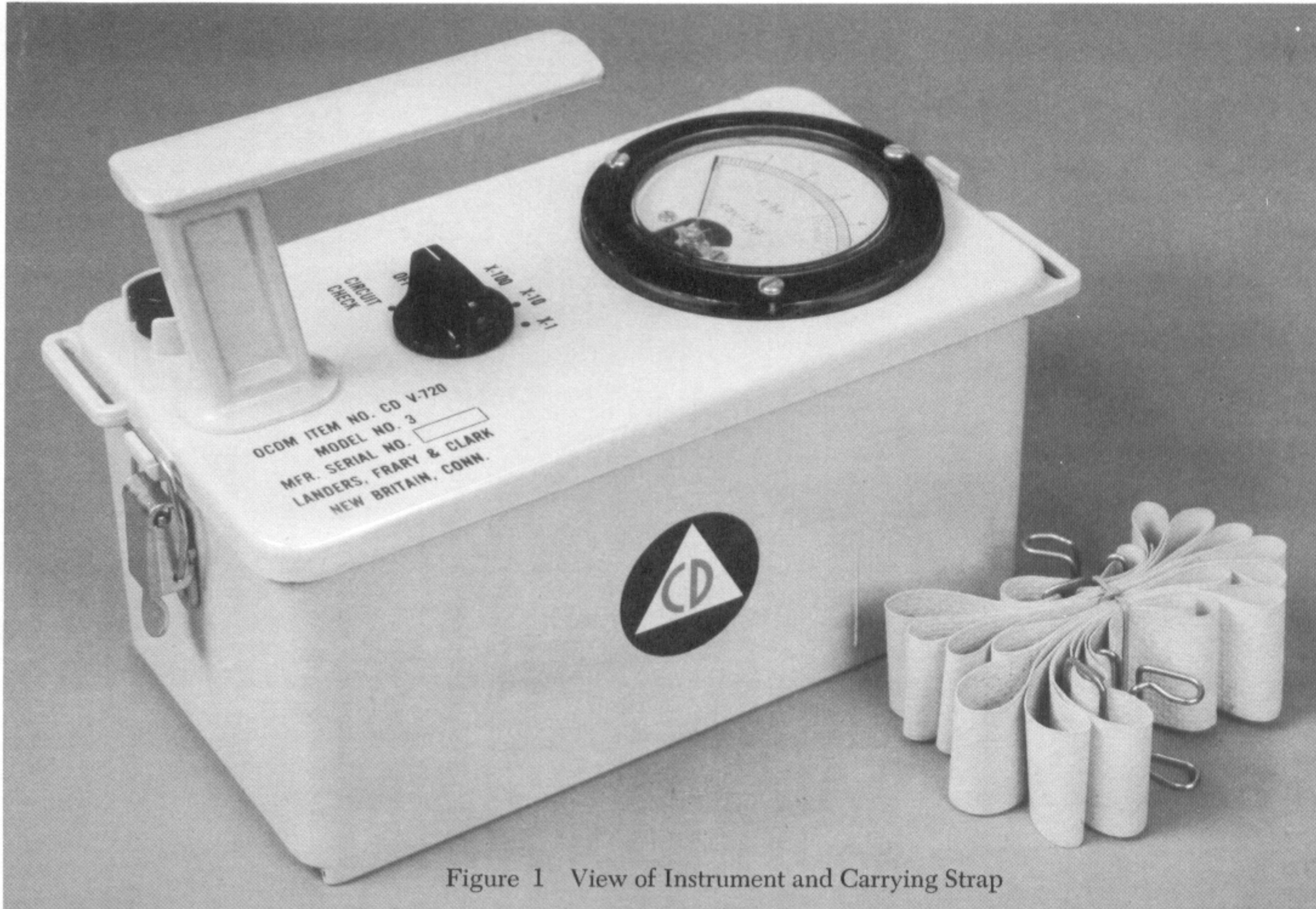


Figure 1 View of Instrument and Carrying Strap

Radiological Survey Meter CD-V-720 Model 3
LF&C Model LF&C 720

INSTRUCTION MANUAL

1.0 GENERAL DESCRIPTION

The LF&C 720 was designed specifically to fulfill the requirements of the Civil Defense High Range Radiological Survey Meter CD-V-720.

Utilizing three ranges of 5, 50 and 500 roentgens per hour full scale, it measures gamma and X-ray radiation fields from 0.5 to 500 roentgens per hour and detects beta particle radiation even in the presence of such fields. An air-filled ionization chamber serves as the radiation detecting element. The chamber has a thin window which permits the transmission of beta particles into the chamber volume, thereby making detection possible. With the window covered by a movable shutter the instrument responds only to gamma or X-radiation. When the shutter is placed in the open position, the beta window is exposed and the unit also responds to beta radiation.

The current produced in the ionization chamber by the action of a radiation field is amplified by a single electrometer-tube circuit and then measured on a meter with an easily read, linear scale, thereby providing a visual indication of the magnitude of radiation field. The power for both the amplifier section and the ionization chamber is obtained from batteries.

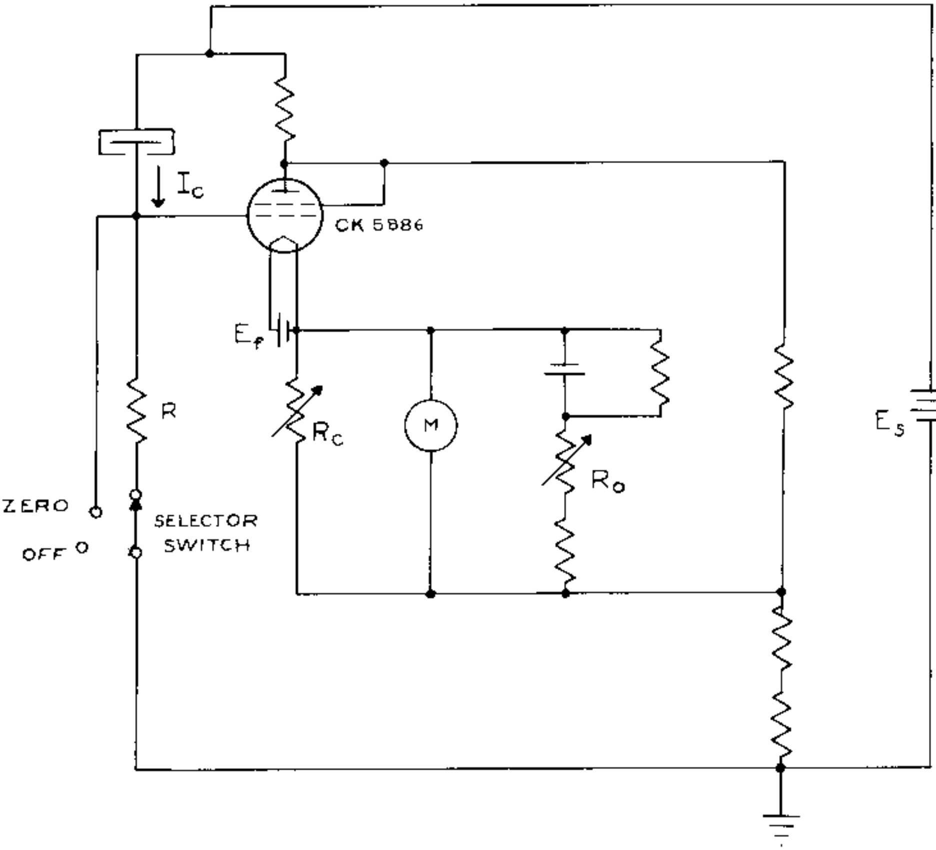
The instrument can be carried easily in one hand by means of the handle or suspended comfortably from the neck or shoulder with the adjustable carrying strap. It is completely ruggedized and designed to operate under adverse field conditions.

The accuracy of the instrument is ± 15% of true dose throughout a temperature range from −20°F to +125°F. It is also within ± 15% for photon energies from 80 KeV to 1.2 Mev with the beta shutter in either the open or closed position. It is unaffected by altitude changes up to 25,000 feet.

2.0 THEORY OF OPERATION

When the instrument is exposed to radiation some of the energy of the radiation field is absorbed within the walls of the ionization chamber. As a result, electrons are ejected from the walls into the air contained within the chamber. As these electrons traverse the chamber, they create a considerable amount of ionization in the air by collision process. Under the influence of the electric field existing between the chamber electrodes the ions move to the electrodes and are collected. Thus, a current which is directly proportional to the magnitude of the radiation field flows in the external circuit connected to the ionization chamber. When the thin beta window of the chamber is exposed, beta particles can penetrate the chamber and initiate the process described above. Since the movable beta shutter is sufficiently thick to stop these particles, the instrument will not respond to this form of radiation with the shutter in the fully closed position. The current from the ionization chamber is amplified by a cathode follower type circuit utilizing a 5886 electrometer tube. *(See figure 2 for simplified Circuit.)*

With the SELECTOR SWITCH in the ZERO position, the Hi-Megohm Resistor R is removed from the grid circuit so that no signal voltage can be developed as a result of any ionization chamber current. The quiescent value of the plate current I_p is then exactly balanced by the bucking current I_f so that the resultant current through the meter is zero. The bucking current is obtained from the filament battery E_f and is adjusted by means of the ZERO ADJUST potentiometer R_o.



SIMPLIFIED CIRCUIT DIAGRAM

Figure 2

When the SELECTOR SWITCH is placed in a range position, the Hi-Megohm Resistor R is reinserted into the grid circuit. Current from the ionization chamber produces a positive signal voltage across this resistor which in turn results in an increase in plate current I_p. Thus the resultant current through the meter is no longer zero and the meter therefore measures the increase in plate current.

Since this change is proportional to the magnitude of the radiation field, the meter scale can be calibrated directly in roentgens per hour.

It should be noted that since the input grid resistor is completely removed from the circuit when the instrument is being zeroed, the zeroing process can be accomplished in the presence of a high intensity radiation field.

3.0 INSTALLATION

3.1 Battery Installation and Replacement

The top cover assembly should be first removed by loosening the two fastenings, one on each side of the case. Grasp top handle firmly, pulling straight up while holding the case. This will allow the ionization chamber to break loose from the "O" ring. The cover assembly should be laid on its side resting on the edge of the handle. The batteries can now be installed in the following manner:

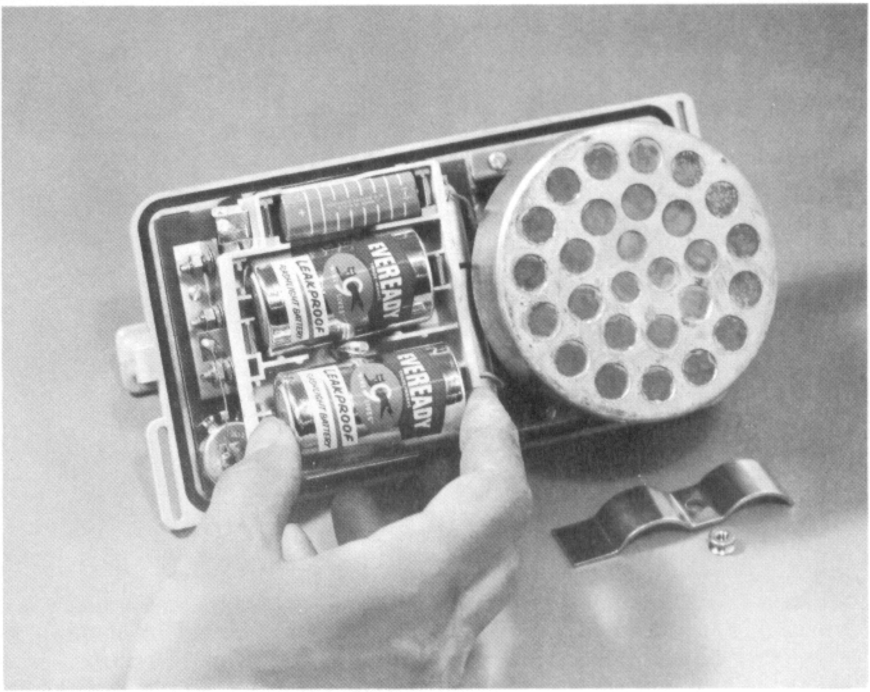


Figure 3

1. Remove the knurl thumb nut, by unscrewing it from the threaded stud.
2. Slip the battery clamp off the threaded stud.
3. Insert the two D-cell batteries in the two slots in the plastic battery case. These two batteries can only fit in one way since the battery case has a fool proof slot for the two D-cells.

4. Insert the 22½ volt battery in the slot provided for as shown in fig. 4. Molded in the plastic battery case is a + symbol and a – symbol. Make sure that the positive (+) mark on the battery coincides with the positive mark molded in the plastic battery case.

All three batteries should be in the battery case as shown in fig. 3.

3.2 Carrying Strap

The carrying strap is attached to the instrument by inserting each end of the strap through the respective slots at the ends of the top cover and then threading the ends through the adjusting slides. The adjusting slides are also used to vary the length of the strap to a suitable carrying position.

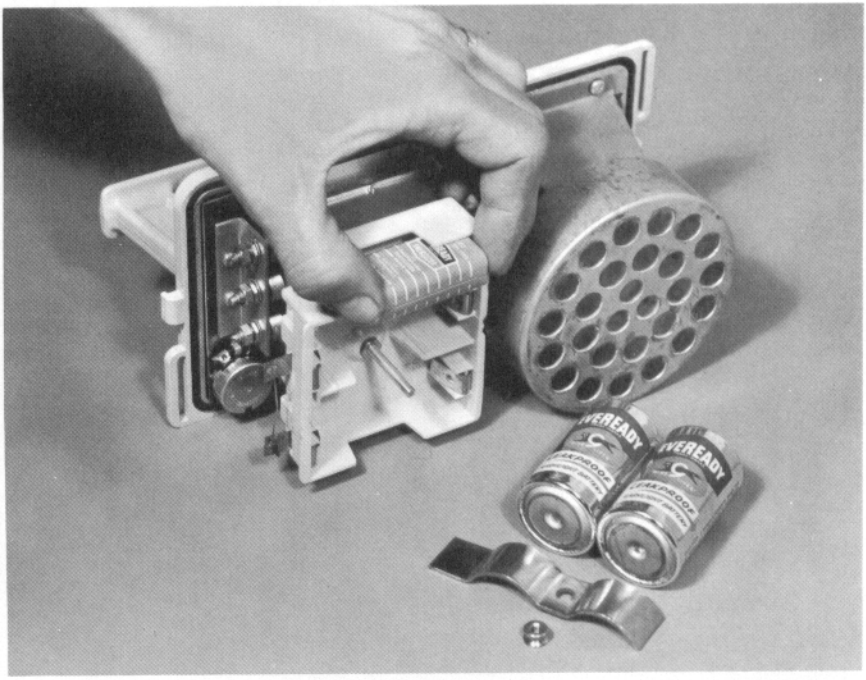


Figure 4

4.0 OPERATION

4.1 General

The instrument has been designed so that a minimum of attention on the part of the operator is required to obtain satisfactory performance. After properly installing the batteries and carrying strap as described in section 3, the unit is set into operation by carrying out procedures described below.

4.2 Zero Adjust

The SELECTOR SWITCH should be rotated clockwise to the ZERO position and the ZERO control located on the top cover adjusted until the meter reads zero. This step can be carried out at any time during the operational life of the instrument and under any conditions of radiation.

4.3 Circuit Check

The SELECTOR SWITCH should now be rotated to the extreme counter-clockwise CHECK position and maintained in that position while the reading is noted. This reading should be above the CIRCUIT CHECK mark on the meter. If at any time during the operation of the unit this reading is below the mark, the batteries should be checked and the defective ones replaced. The operator will notice that upon release, the SELECTOR SWITCH automatically returns to the OFF position so that it is necessary to maintain pressure on the SWITCH to hold it in the CIRCUIT CHECK position.

A fresh set of batteries provide a minimum of 150 hours of continuous service under normal conditions.

4.4 Determination of Radiation Field

The SELECTOR SWITCH should now be rotated to the X-100 range. If no deflection is obtained the X-10 range should be selected. Similarly if no deflection is obtained the SWITCH should be placed on the X-1 range and left on that range until an off-scale reading is obtained. When this occurs, the next highest range should be selected until the deflection can be read on one of the higher ranges. In all cases the magnitude of the radiation field will be given by the product of meter reading and the scale multiplier.

EXAMPLE:

> Assume a reading of 3.5 is obtained on the middle, or X-10 scale. The radiation field will therefore be 3.5 x 10, or 35 roentgens per hour.

5.0 OPERATOR MAINTENANCE

5.1 Batteries

The operator generally should not attempt any maintenance beyond the replacement of batteries, particularly under field conditions. The instrument is designed so that the batteries can be replaced without exposing any critical circuit elements and without requiring the use of special tools. Whenever the instrument is to be stored for prolonged periods of time, the batteries should be removed to prevent any damage due to their deterioration in the equipment.

5.2 Radioactive Contamination

Should the surfaces of the instrument become contaminated with radio active material, they can be cleaned with soap and water or any convenient detergent. However, care should be taken at all times to prevent the accidental rupturing of the Beta window by any sharp object.

6.0 PREVENTATIVE MAINTENANCE

6.1 Monthly Check

If the instrument has been stored with batteries, they should be removed and the contacts carefully cleaned so as to remove all dirt and corrosion. The batteries should be re-inserted in accordance with the instructions given in section 3, with particular care taken to obtain good contacts on all battery connections. The unit should then be checked in accordance with the instructions given in section 4.

6.2 Yearly Check

The monthly check described in paragraph 6.1 should be repeated. Unsatisfactory batteries should be replaced immediately. All gaskets should be inspected for any signs of deterioration. The instrument should then be calibrated in accordance with instructions given in paragraph 7.4.

7.0 CORRECTIVE MAINTENANCE

7.1 Instrument does not zero properly

Most of the difficulties encountered on the Landers 720 will originate either in the battery connections or in the batteries themselves. Therefore, the battery connections should be examined closely and cleaned to

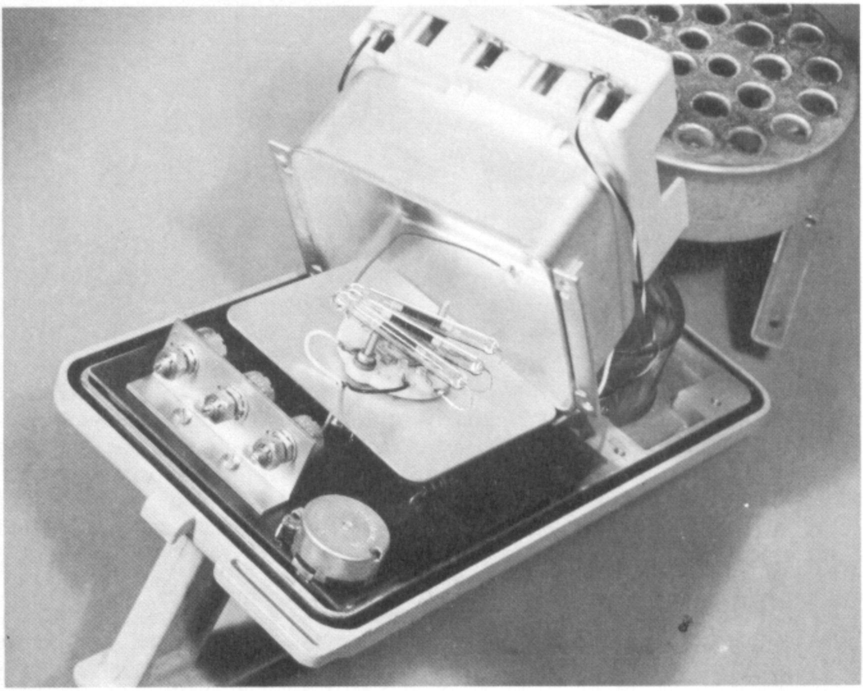


Figure 5

insure that proper contacts are being made. The battery voltages can be measured with a conventional 20,000 Ohms per volt voltmeter. The hearing-aid battery should measure at least 19.5 volts, while the D-cell should measure at least 1.25 volts. These voltages are measured with the range switch of the instrument in the ZERO position.

7.2 Meter Deflection is negative on all ranges

A negative reading on the ZERO, X-100, X-10, and X-1 ranges which appears to be independent of the ZERO potentiometer is indicative of insufficient current in the plate circuit of the electrometer tube. The filaments should therefore be checked. This is most easily done in the following manner:

1. Remove the cover assembly from the case shell.
2. Remove the four screws holding down the cover enclosure and carefully bend back the enclosure cover to allow access to the electrometer tube.
3. Measure the resistance between leads 3 and 4 on the electrometer tube. A resistance of approximately 70 to 100 Ohms indicates the filaments are operating properly. A resistance greater then 100 Ohms indicates the electrometer filaments are open and the tube should be replaced in accordance with instruction given in paragraph 7.3.

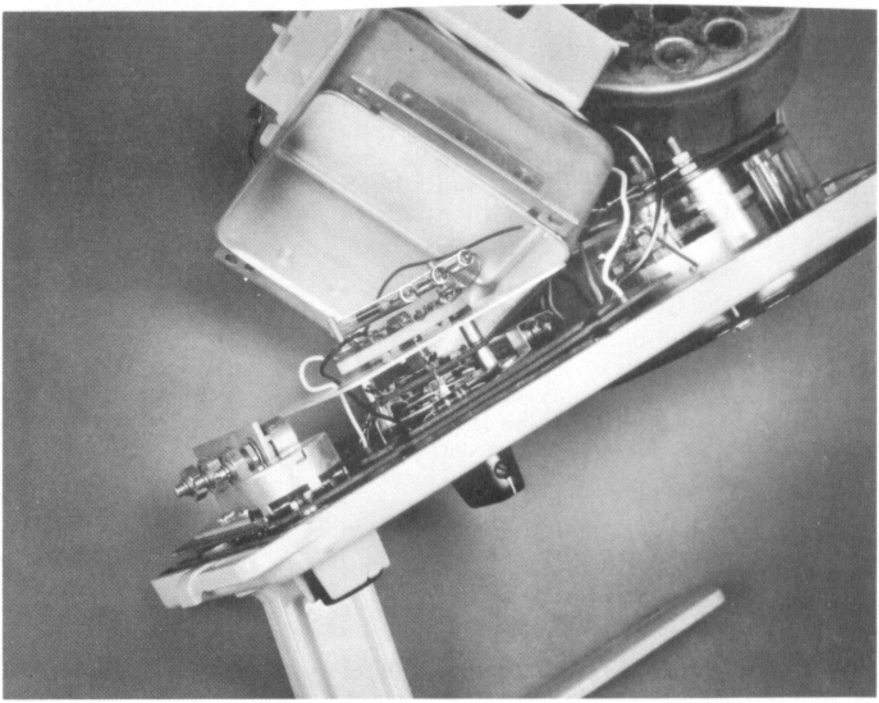


Figure 5A

If the filaments are in working order, the printed circuit board and the ionization chamber assembly can be removed by removing the four hold down screws holding the chamber assembly to the top cover. Remove the selector knob by loosening the two set screws and the zero knob by loosening its set screws. By pushing on the shaft of the SELECTOR SWITCH and ZERO adjust potentiometer, the board assembly will come out of the top cover assembly. Now the complete circuit including the ionization chamber can be checked for correct voltage and continuity checks when the SELECTOR SWITCH is in a ZERO position.

7.3 Replacing Electrometer Tube

The electrometer tube can be replaced without removing the printed circuit assembly in the following way.

Assuming that the cover enclosure is tilted back,

1. Carefully unsolder grid lead from rotary switch.
2. Unscrew tube clamp.
3. Remove tube.
4. Remove sleeving from the grid lead.
5. To replace with new tube cut the leads to the same length as the old electrometer tube, put sleeving over the grid lead, put the leads into the tube socket, put tube clamp on, and solder grid-lead back to rotary switch. Extreme care should be taken to avoid any dirt or grime accumulating near the base of the electrometer tube. Such contamination will interfere with the operation of the instrument. Whenever it becomes necessary to expose or handle any of the high impedance components, the technique used must be flawlessly clean. Fingerprints and similar contamination will result in large errors and improper operation of the unit.

7.4 Calibration

The accurate calibration of the CD-V-720 model 3 or Landers 720 necessitates the use of a high intensity Cobalt-60 source which can provide radiation fields as high as 500 roentgens per hour. In order to obtain "good geometry" the instrument should be located at least 15 inches from the radiation source with the axis of the beam perpendicular to the BETA SHUTTER. At this distance the radiation field must be fairly uniform over an area approximately 5 inches in diameter. The center of the ionization chamber is located 1⅛ inches from the bottom edge of the case shell and directly behind the center of the indentation on the BETA SHUTTER.

The calibration is carried out in the following manner:

1. Move the BETA SHUTTER to a fully closed position.
2. Turn the SELECTOR SWITCH to the ZERO position and set the instrument to zero by means of the ZERO control.

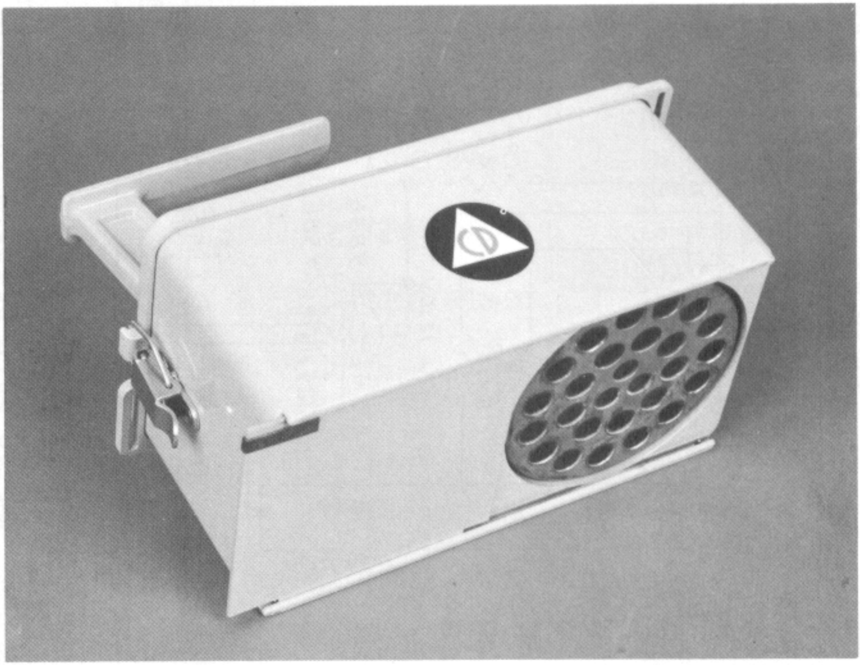
3. Turn SELECTOR SWITCH to the X-100 range and position the unit so that the center of the ionization chamber is in an accurately known field of at least 250 roentgems per hour.

4. If the unit does not read correctly with the known source, remove it from the radiation field. Loosen the two catches on side of the case and tilt the back end of the case until it clears the cover assembly. The calibration potentiometers will now be readily accessible.

5. Loosen only the outermost nut on the X-100 potentiometer and rotate the shaft by means of a screw-driver in the required direction. A clockwise rotation will increase the reading; A counter-clockwise rotation will decrease it.

6. Replace the instrument in the radiation field and repeat this procedure until the reading corresponds with the known value. The locking nut on the potentiometer should be tightened immediately after the scale is calibrated.

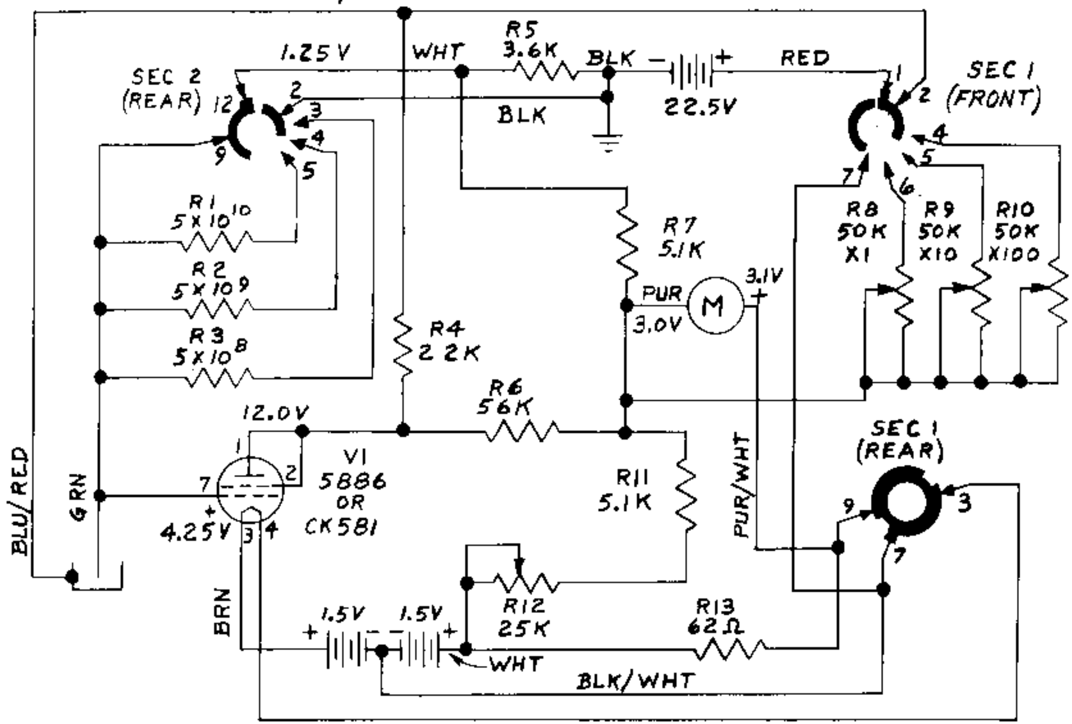
7. The X-10 and X-1 ranges are calibrated in a similar fashion. However, the X-10 ranges should be calibrated in a known field between 25 and 40 roentgens per hour, and the X-1 range in a known field between 2.5 and 4 roentgens per hour.



LF&C 720 with Beta Window of Ionization Chamber Exposed
Figure 6

CD-V-720

RADIOLOGICAL SURVEY METER
LANDERS, FRARY & CLARK MODEL 66-2006



NOTE:

1-SWITCH SHOWN IN CIRCUIT CHECK POSITION

2-ALL RESISTORS IN OHMS

3-ALL VOLTAGE MEASUREMENTS TAKEN WITH A 20,000 OHMS PER VOLT METER WITH RESPECT TO GROUND. SWITCH IN CIRCUIT CHECK POSITION

4-MEASUREMENTS ARE NOT TO BE MADE ON HI-MEG RESISTORS, ELECTROMETER TUBE GRID, OR IONIZATION CHAMBER COLLECTOR ELECTRODE

Figure 7 Schematic

8.0 PARTS LIST

8.1 Electrical Components

PART	TYPE	MANUFACTURER	FUNCTION
B1	Battery 22.5 volts Hearing aid and photo type	Eveready #412 National Carbon Co.	High Voltage Supply
B2, B3	Battery 1.5 volt Flashlight "D" Cell	Eveready #950 National Carbon Co.	Filament Power Supply
M1	Meter 0-50 Micro-Amps	Landers 66-2006-021	Visual Indicator
R1	$5x10^{10}$ Ohm	Victoreen Hi Meg	Chamber Load and VI Grid Leak (X-1 Range)
R2	$5x10^{9}$ Ohm	Victoreen Hi Meg	Chamber Load and VI Grid Leak (X-10) Range
R3	$5x10^{8}$ Ohm	Victoreen Hi Meg	Chamber Load and VI Grid Leak (X-100 Range)
R4	22K Ohm	I.R.C. BTS-20	Plate Dropping
R5	3.6K Ohm	I.R.C. BTS-20	Dropping Resistor
R6	56K Ohm	I.R.C. BTS-20	Dropping Resistor
R7	5.1K Ohm	I.R.C. BTS-20	Dropping Resistor
R8, R9, R10	50K Ohm Potentiometer	Landers 66-2006-064	Calibration for X-1, X-10, & X-100 Ranges
R11	5.1K Ohm	I.R.C. BTS-20	Limiting Resistor
R12	50K Ohm Potentiometer	Landers 66-2006-063	Zero Adjust Potentiometer
R13	62 Ohms	I.R.C. BTS-20	Dropping Resistor
SW1	Switch Selector Assembly	Landers 66-2006-027	Includes Ceramic Wafer for Chamber Load Resistors, Range Section & On-Off Function

8.0 PARTS LIST (Cont.)

8.1 Electrical Components

PART	TYPE	MANUFACTURER	FUNCTION
VI	Tube 5886, electrometer	Raytheon	Amplifier
	Printed Circuit Board	Landers 66-2006-061	
	Ionization Chamber Assembly	Landers 66-2006-080	Beta-Gamma Radiation Detector

8.2 Mechanical Components

Quantity	*Part Description*	*Source*	
1 ea.	Cover Assembly	Landers	66-2006-100
1 ea.	Case Assembly	Landers	66-2006-010
1 ea.	Beta Shield Assembly	Landers	66-2006-120
1 ea.	Knob Selector	Landers	66-2006-013
1 ea.	Knob Zero	Landers	66-2006-014
1 ea.	Bracket	Landers	66-2006-081
1 ea.	Battery Case Assembly	Landers	66-2006-050
1 ea.	Tube Socket	Elco	788BC
1 ea.	Bracket Potentiometer	Landers	66-2006-038
1 ea.	Tube Clamp	Landers	66-2006-033
1 ea.	Shield	Landers	66-2006-066
2 ea.	"O" Ring Shaft	Landers	66-2006-039
1 ea.	Cover Compartment	Landers	66-2006-030
2 ea.	Cover Compartment Gaskets	Landers	66-2006-037
1 ea.	Clamp Battery	Landers	66-2006-053
1 ea.	Knurled Nut	General Cement	#8-32
2 ea.	Instruction Manuals	Landers	66-2006-140
2 ea.	Lugs #8	Zierick	SL-8
1 ea.	Lug #6	Zierick	SL-6
2 ea.	Strap Fasteners	Landers	66-2006-082
2 ea.	Strap Adjusters	Landers	66-2006-083
1 ea.	Strap Carrying	Landers	66-2006-087

8.3 Manufacturers Names and Addresses

Elco Corp.
"M" Street Erie Ave., Philadelphia, Pa.

G. C. Electronics
400 South Wyman St., Rockford, Illinois

National Carbon Company
30 East 42nd St., New York, New York

International Resistance Company
401 North Broad St., Philadelphia, Pa.

Raytheon Company
47 Chapel St., Newton, Mass.

Victoreen Instrument Company
5806 Hough Ave., Cleveland, Ohio

Zierick Manufacturing Company
Beechwood & Rockwell, New Rochelle, N.Y.

8.4 Recommended parts for five units for one year based on 200 hours operation

QTY	ITEM	PARTS DESCRIPTION
12	B1	Battery 22.5 volt #412
25	B2, B3	Battery 1.5 volt #950
1	V1	Tube 5886, Electrometer Pentode
1	M1	Meter, Landers 66-2006-021
1	SW1	Switch, Selector Landers 66-2006-027
1	R3, R9, R10	Potentiometer, Landers 66-2006-064
1	R12	Potentiometer, Landers 66-2006-063
2		Ion Chamber Assembly Landers 66-2006-080
1	Set of 3	High Meg Ohm Resistors X-1, X-10, X-100
10		"O" Rings Landers 66-2006-011
2		Carrying Strap Landers 66-2006-087
4		Strap Fasteners Landers 66-2006-082
1		Battery Case Assembly Landers 66-2006-051
3		Clamp Battery, Landers 66-2006-053