

*Instrument # 1248*

# **instruction manual**

Model 570  
**CONDENSER R- METER**



**THE VICTOREEN INSTRUMENT COMPANY**  
5806 HOUGH AVENUE • CLEVELAND 3, OHIO



MODEL 570 CONDENSER R-METER

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THIS INSTRUMENT IS SOLD TO BE USED ONLY BY, OR ON THE PRESCRIPTION OF A QUALIFIED ROENTGEN RAY THERAPIST. THE RESPONSIBILITY FOR THE APPLICATION OF A SAFE QUANTITY OF X-RADIATION TO A PATIENT RESTS SOLELY WITH THE ROENTGENOLOGIST.



## SECTION I

### GENERAL DESCRIPTION

#### 1. PURPOSE OF THE MODEL 570 CONDENSER R-METER.

The Victoreen Model 570 Condenser R-Meter is an a. c. operated instrument for the rapid and accurate measurement of total X-ray dosage in international roentgens. It may also be used in conjunction with a suitable timing device to determine average X-ray intensity.

#### 2. GENERAL DESCRIPTION.

The Victoreen Model 570 Condenser R-Meter consists of an a. c. operated d. c. power supply, a complete dust-tight electrometer with its viewing microscope system, a lighting system for the microscope and the "On-Off" indicating light, and necessary operating controls. All are contained in a metal case. Projecting from the top of the case are the two operating controls and the viewing microscope.

The Condenser R-Meter is used with interchangeable ionization chambers identical to those used with the previous Model 70 R-Meter. A chamber consists of an ionization chamber connected in parallel with a fixed capacitor. The capacitor is contained in a metal cylinder with a coaxial connector formed at one end, and the ionization chamber at the other. Only the ionization chamber, called a "thimble", is sensitive to X-ray radiation in the normal X-ray therapy ranges. The most accurate chambers use a red nylon, air-equivalent thimble. A protecting metal cap is provided to fit over the connector end of the chamber to prevent ion collection by the contacts, and to keep dust from the insulators. The full scale sensitivity is marked on the barrel of each chamber.

Numerous other chambers, covering a broad range of energy and total dose conditions, may also be used with the Model 570 Condenser R-Meter. For example, measurement of the lower X-ray energies, used in contact therapy, is accomplished by using a chamber with a very thin mylar window. Thick wall chambers are available for accurate measurement of high energy radiation from such sources as Cobalt 60, Radium and super-voltage X-ray machines. The following table provides a summary of the operating specifications for the various chamber types.

The carrying case, in addition to providing a convenient means of safely transporting the instrument, includes a storage space for six extra chambers, spare fuses, lamps, dessicator and instruction manual.

Table 1. Chambers Used With Model 70 and Model 570 Condenser R-Meters.

MODEL NUMBER	RANGE (ROENT)	(R/SEC.) INTENSITY LIMITS <sup>1</sup>		RATED ACCURACY	INTENDED USES (Kev. eff)	WALL MATERIAL	VOLUME (CM <sup>3</sup> ) APPROX.	NOMINAL WALL THICKNESS mg/cm <sup>2</sup>
		MODEL 70*	MODEL 570					
651	250	30	90	± 5%	<b>LOW ENERGY CHAMBERS</b> 6-35	Kodapak	0.20	7
188	0.025	8 x 10 <sup>-5</sup>	24 x 10 <sup>-5</sup>	± 10%	<b>MEDIUM ENERGY CHAMBERS</b> 30-400	Bakelite	1450	220
130	0.25	3 x 10 <sup>-3</sup>	9 x 10 <sup>-3</sup>	± 10%	30-400	Bakelite	177	220
227	1	0.065	0.195	± 10%	30-400	Bakelite	41	220
633	2.5	0.1	0.3	± 10%	30-400	Bakelite	17	220
228	5	1.7	5.1	± 10%	30-400	Bakelite	8	220
326	10	1.7	5.1	± 10%	30-400	Polystyrene	6	80
70-5	25	15	45	± 2%	30-400	Nylon	1.83	67
131	100	25	75	± 2%	30-400	Nylon	.46	89
154	250	40	120	± 2%	30-400	Nylon	.183	89
					<b>HIGH ENERGY CHAMBERS</b>			
552	2.5	0.1	0.3	± 5%	400-1300	Nylon	9.7	450
553	25	15	45	± 5%	400-1300	Nylon	1.83	450
621	100	25	75	± 5%	400-1300	Nylon	0.46	450
					<b>SKIN EQUIVALENT CHAMBER</b>			
576	0.25	0.003	0.009	± 10%	Mixed Beta-Gamma	Kodapak	170	7

\*Discontinued.

<sup>1</sup>These intensity limits are based on full scale reading and may be increased if readings less than one half full scale are taken.

<sup>2</sup>This rated accuracy is based on use with protective plastic sleeve 1/16" thick.

## SECTION II

### THEORY OF OPERATION

#### 1. THE CHAMBER.

The chamber consists of a polystyrene capacitor connected in parallel with an ionization chamber. With the chamber inserted in the bayonet-type socket of the Condenser R-Meter, contact is made to the body and the central electrode of the chamber. The chamber is charged by operation of the charger controls, and the charge is measured by the electrometer.

The principle of operation of the chamber is as follows: The charger-electrometer unit of the Condenser R-Meter charges the ionization chamber to a predetermined voltage as indicated by the "O" position of the electrometer. When the active volume, or thimble portion of the chamber, is placed in an X-ray field, the air in the thimble is ionized in proportion to the X-ray intensity. The ions, or charged particles, are attracted to the oppositely charged electrode of the chamber. Ion migration to the electrodes reduces the charge held by the capacitor, thus reducing the potential difference across its electrodes. The electrometer measures this potential, and by careful calibration, the scale reading for this potential is made equivalent to the X-ray dosage to which the chamber has been subjected. This exposure is read directly on the scale in roentgens.

In order that the chamber will have the same response over a wide range of energies, it has been designed so that the thickness and composition of the wall and electrode materials produce air-equivalent energy response.

#### 2. THE ELECTROMETER.

Figure 1, page 5, is a simple drawing of the string electrometer used in the Model 570 Condenser R-Meter. The charge is applied to the horseshoe shaped string support and the deflecting electrode. This horseshoe type of electrometer construction eliminates the need for any adjustment of the string by the user.

The string is a platinum-coated quartz fiber, and is soldered at each end to the horseshoe support. The deflecting electrode is a long screw which projects from the side of the electrometer housing. This screw is adjusted so that the quartz fiber movement is linear with potential across the scale. Because the charge on the quartz fiber and the deflecting



electrode are opposite in sign, an electrostatic attractive force results. This force moves the quartz loop toward the deflecting electrode against the spring action of the quartz loop itself. The attractive force is proportional to the charge, and the movement of the quartz fiber is proportional to the force. This principle is utilized to form a direct reading voltage indicator, or string electrometer. The movement of the string is optically magnified, and its relative position appears as a fine shadow line on the illuminated scale viewed through the microscope. Calibration is accomplished by varying the magnification of string movement. The scale reads directly in roentgens. Figure 2, page 6, shows the schematic wiring diagram of the Model 570 Condenser R-Meter.

### 3. THE CHARGING CIRCUIT.

NOTE: All symbol designations refer to the schematic diagram on page 6. When the "Zero Set-Off" control is positioned at "Zero-Set", switch (S1) is closed and the d. c. power supply is "On". The potential from the d. c. power supply is connected to the electrometer and chamber socket by turning the "Discharge-Charge" control towards "Charge". This makes an electrical connection between switch (S2) and (O1). With (S2) and (O1) connected, the potential to the electrometer and the chamber socket, can be varied by adjusting the "Zero Set-Off" control. This actuates potentiometer (R 2). When the "Discharge-Charge" control is at rest position switch (S2) and (O1) no longer make contact and the power supply is disconnected from the electrometer and chamber socket.

### 4. THE DISCHARGING CIRCUIT.

To remove the voltage from the electrometer and chamber circuit turn control "Discharge-Charge" towards "Discharge". This connects (O1) to switch (S3) shorting the electrometer and chamber socket.

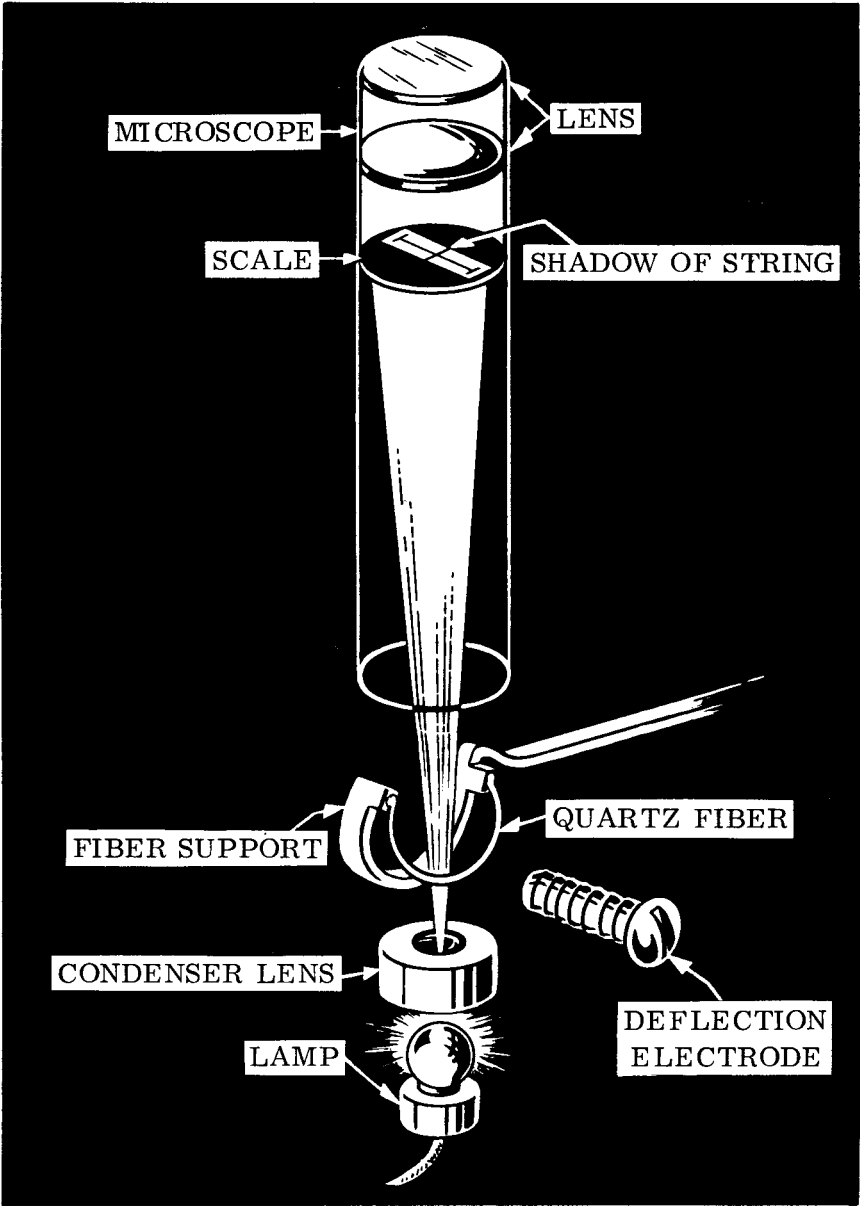


Figure 1. Principle of Electrometer

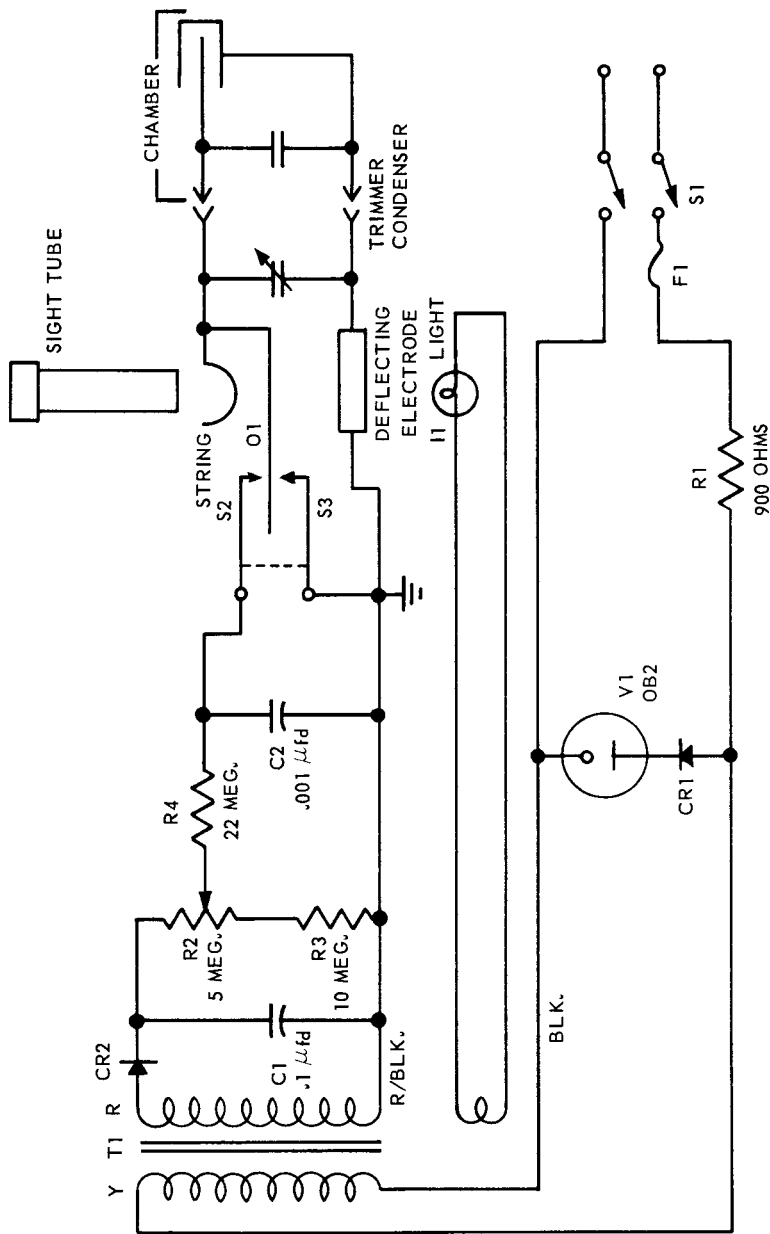


Figure 2. Schematic Wiring Diagram

## SECTION III OPERATION

### 1. OPERATION OF MODEL 570 CONDENSER R-METER.

#### a. CHARGING.

(1) Turn instrument on by turning knurled control (A) toward zero set. Indicating light will glow red.

(2) Remove the black plastic guard from the thimble end of chamber.

(3) Remove the chamber cap from the chamber.

(4) Remove dust cover from the bayonet-type socket of the R-meter.

(5) Insert the chamber in the bayonet-type socket of the instrument in the following manner:

(a) Position chamber in socket so that contact locking pin fits into pin guide.

(b) Press and turn chamber in socket, spring action locking device will hold chamber in place. The chamber is now making contact.

(6) Turn knurled control (B) toward "Charge" against stop.

(7) Hold control (B) toward "Charge" against stop and at the same time look into viewing microscope and rotate control (A) until string reaches the "O" position and then release the charging wheel (B).

(8) Remove the chamber from the socket.

(9) Replace the chamber cap over the connection end of chamber.

(10) Replace dust cover over bayonet-type socket of the instrument.

#### b. EXPOSURE.

The chamber may now be exposed so as to measure the X-ray dosage. The chamber may be operated in any position and inserted into body cavities or phantoms. By the use of a suitable timing device, the average X-ray intensity may be determined.

#### c. READING.

(1) Remove the chamber cap.

(2) Position chamber in bayonet-socket of the R-meter so that contact pin does NOT mate with pin guide, then insert chamber into socket until contact pin stops outside the bayonet-socket of the instrument. With chamber in this position the contact pin functions as a stop and avoids accidental discharge.

(3) Adjust the electrometer to "O" as before (steps 6 and 7) by operation of controls (A) and (B).

(4) Insert chamber completely into bayonet-type socket so that contact is made. (Outlined in a. CHARGING, Step 5).

(5) Read the X-ray dosage directly on the scale corresponding to the value engraved on the chamber.

(6) For greater accuracy, correct the reading for temperature and barometric pressure using the correction chart on page 11.

## 2. NOTES ON OPERATION.

a. It is imperative that the chamber cap be placed over the connection end of the chamber during irradiation. Error in measurement will result if this precaution is not observed.

b. The chamber cap should also be in place over the connection end of the chamber when the instrument is not in use. This keeps dust and dirt off the insulator.

c. The R-meter and chambers should be stored and operated in a dust-free room if possible, and should never be exposed to temperatures below  $0^{\circ}$  F, and over  $100^{\circ}$  F. Chamber caps, thimble guards, and socket dust cover should be tightly in place and removed only when necessary.

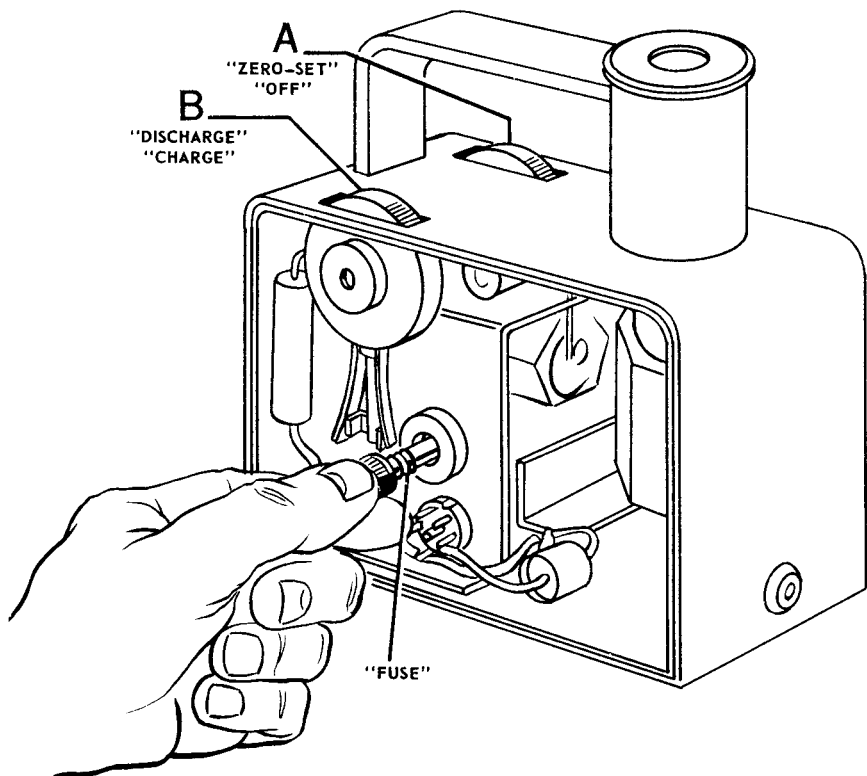


Figure 3. Operating Controls and Fuse Replacement.

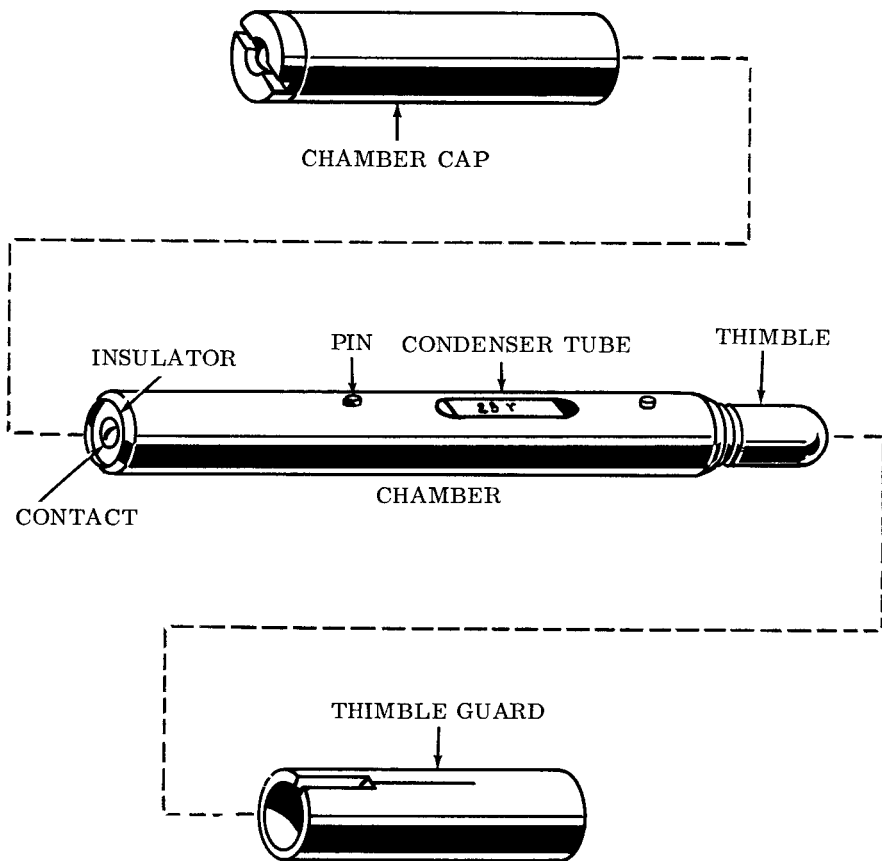


Figure 4. The Chamber

Table 2. Correction Chart.

This instrument is calibrated in International Roentgens corrected to 0° Centigrade when used at 22° Centigrade and 760 mm. mercury (Hg) barometric pressure. For temperatures other than 22° Centigrade and pressures other than 760 mm. Hg., multiply the scale reading by the factor obtained from the following table.

$$\text{Correction Factors} = \left( \frac{273 + t^{\circ}\text{C}}{295} \times \frac{760}{p, \text{mmHg}} \right) \text{Ref. NBS RP424}$$

inches	Mm.	F. 60.8	64.4	68.0	71.6	75.2	78.8	82.4	86.0	89.6	93.2	96.8	100.4	104.0
		20	22	24	26	28	30	32	34	36	38	40		
19.68	500	1.489	1.499	1.509	1.520	1.530	1.541	1.551	1.561	1.571	1.582	1.592	1.602	1.613
20.07	510	1.460	1.469	1.479	1.490	1.499	1.510	1.520	1.530	1.540	1.551	1.561	1.571	1.581
20.48	520	1.431	1.441	1.451	1.461	1.471	1.481	1.491	1.500	1.510	1.520	1.530	1.540	1.550
20.87	530	1.405	1.414	1.424	1.434	1.444	1.453	1.463	1.473	1.482	1.492	1.502	1.512	1.521
21.26	540	1.378	1.388	1.397	1.407	1.416	1.426	1.435	1.445	1.454	1.464	1.474	1.483	1.493
21.65	550	1.354	1.363	1.373	1.382	1.391	1.401	1.410	1.419	1.429	1.438	1.448	1.457	1.466
22.05	560	1.329	1.338	1.348	1.357	1.366	1.375	1.384	1.394	1.403	1.412	1.421	1.431	1.439
22.44	570	1.306	1.315	1.324	1.333	1.342	1.351	1.360	1.369	1.378	1.387	1.396	1.405	1.414
22.83	580	1.283	1.292	1.301	1.310	1.319	1.328	1.337	1.345	1.354	1.363	1.372	1.381	1.389
23.23	590	1.262	1.270	1.279	1.288	1.297	1.305	1.314	1.323	1.331	1.340	1.349	1.358	1.366
23.62	600	1.241	1.249	1.258	1.267	1.275	1.284	1.293	1.301	1.309	1.318	1.327	1.336	1.344
24.02	610	1.220	1.229	1.237	1.246	1.254	1.263	1.271	1.279	1.288	1.297	1.305	1.314	1.322
24.41	620	1.200	1.208	1.217	1.225	1.233	1.242	1.249	1.258	1.266	1.275	1.283	1.292	1.299
24.80	630	1.181	1.189	1.198	1.206	1.214	1.222	1.230	1.239	1.247	1.255	1.263	1.271	1.279
25.20	640	1.164	1.171	1.178	1.186	1.196	1.202	1.212	1.220	1.228	1.236	1.244	1.252	1.260
25.59	650	1.145	1.153	1.161	1.169	1.177	1.185	1.193	1.201	1.208	1.216	1.224	1.232	1.240
25.98	660	1.127	1.135	1.143	1.151	1.159	1.167	1.174	1.182	1.189	1.198	1.206	1.213	1.221
26.38	670	1.111	1.119	1.126	1.134	1.142	1.149	1.157	1.165	1.172	1.180	1.188	1.195	1.203
26.77	680	1.095	1.103	1.111	1.119	1.127	1.135	1.141	1.148	1.156	1.163	1.171	1.179	1.186
27.16	690	1.078	1.086	1.093	1.101	1.108	1.116	1.123	1.131	1.138	1.146	1.153	1.161	1.168
27.56	700	1.064	1.071	1.079	1.086	1.093	1.101	1.108	1.115	1.123	1.130	1.137	1.145	1.152
27.95	710	1.048	1.055	1.063	1.070	1.077	1.084	1.092	1.098	1.106	1.113	1.121	1.128	1.135
28.35	720	1.033	1.041	1.048	1.055	1.062	1.069	1.076	1.083	1.091	1.098	1.105	1.112	1.119
28.74	730	1.027	1.034	1.041	1.048	1.055	1.062	1.069	1.076	1.083	1.091	1.098	1.105	1.112
28.94	735	1.013	1.027	1.034	1.041	1.048	1.055	1.062	1.069	1.076	1.083	1.090	1.097	1.105
29.13	740	1.006	1.013	1.020	1.027	1.034	1.041	1.048	1.055	1.062	1.069	1.076	1.083	1.089
29.33	745	999	1.006	1.013	1.020	1.027	1.034	1.040	1.048	1.054	1.061	1.068	1.075	1.082
29.53	750	992	999	1.006	1.013	1.020	1.027	1.033	1.040	1.047	1.054	1.061	1.068	1.075
29.72	755	986	993	1.000	1.007	1.014	1.021	1.027	1.034	1.041	1.048	1.055	1.062	1.068
29.92	760	980	986	993	1.000	1.007	1.014	1.020	1.027	1.034	1.041	1.047	1.054	1.061
30.12	765	972	979	986	993	999	1.006	1.013	1.020	1.026	1.033	1.040	1.047	1.054
30.31	770	967	974	980	987	994	1.000	1.007	1.014	1.020	1.027	1.034	1.041	1.047
30.51	775	961	968	974	981	987	994	1.001	1.007	1.014	1.021	1.027	1.034	1.041
30.71	780	954	961	967	974	980	987	994	1.000	1.007	1.014	1.020	1.027	1.033
30.90	785	948	955	961	968	974	981	988	994	1.001	1.007	1.014	1.021	1.027
31.10	790	942	949	955	962	968	975	981	988	994	1.001	1.008	1.014	1.021



SECTION IV  
MAINTENANCE

1. MAINTENANCE NOTES ON THE MODEL 570 CONDENSER R-METER.

The line fuse (F1), tube (V1), and the lamp (I1) are the only components likely to become defective. Access to these components may easily be gained by unscrewing the cap located in the middle of each side plate and removing the side plates. The instrument should be unplugged from the a. c. line before removing the sides.

a. FUSE REPLACEMENT.

- (1) Remove side plates.
- (2) Unscrew cap marked fuse, Figure 3, page 9.
- (3) Remove the fuse and replace.
- (4) Reassemble.

b. TUBE REPLACEMENT.

- (1) Remove side plates.
- (2) Remove tube shield.
- (3) Remove tube and replace, Figure 5, page 16.
- (4) Replace tube shield.
- (5) Reassemble.

c. LAMP REPLACEMENT.

- (1) Remove side plates.
- (2) Unscrew the lamp from its socket and replace the lamp.
- (3) Turn instrument on and look into viewing microscope. If the scale is not uniformly illuminated, the lamp position has been moved. While looking into the viewing microscope position lamp and socket until the scale is fully and uniformly illuminated, then tighten nut which holds lamp socket in place.

- (4) Turn instrument off and reassemble.

d. ELECTRICAL INSULATION.

Rapid discharge of the electrometer is the result of electrical leakage.

- (1) Check by charging the electrometer to "O" with the chamber removed. In six hours the discharge should not exceed an indicated 5 r on the 25 r scale.

(2) If the leakage is excessive, remove fibers or lint from inside surface of the bayonet-socket with a clean moisture-free air stream. An ear syringe is suitable for this purpose.

(3) Clean the inside surface of the bayonet-socket by wiping it with absorbent cotton wrapped around a small stick and moistened in pure ethyl alcohol.

(4) Re-check Step 1.

(5) If the leakage is still excessive return the instrument to the manufacturer for repair.

## 2. MAINTENANCE NOTES ON THE CHAMBER.

The most common trouble is electrical leakage, however, most of this trouble can be avoided by keeping the chamber insulator clean and dust-free. Avoid touching the insulator. To check for leakage charge the chamber to "O", remove from the instrument and place chamber in a radiation-free location for 24 hours. Then re-read by following procedure as outlined under Section III, c. READING. The discharge should not exceed one minor division of the scale.

If the leakage exceeds this limit, blow off any dust or lint that may have accumulated on the chamber insulator with a stream of clean, dry air.

If leakage still persists, the chamber should be returned to the manufacturer.

## 3. GENERAL PERFORMANCE CHECK.

A check on calibration is not possible without primary standards of measurement for comparison. However, a rough indication of whether or not the instrument is operating properly may be obtained by the discharge check. This check indicates any gross misalignment of the electrometer and any shift of the electrometer or chamber tube capacitance. An accurate constancy check can be obtained by exposure to a long half-life radioactive source in an accurately reproduceable geometry. The 540B radium standard is designed specifically for this purpose.

### a. DISCHARGE CHECK.

(1) Remove the chamber cap from the chamber.

(2) Insert the chamber in the bayonet-type socket of the R-Meter so that contact is made. As previously explained in Section III, Step 5, under a. CHARGING.

(3) Charge the instrument to the "0" position (extreme left end of the scale) by operation of the charge controls.

(4) Remove the chamber part way so that the contact pin is on the outside of the bayonet-type socket, as for Step 2, under c. READING., Section III.

(5) Discharge the electrometer by turning control (B) towards discharge and then release the knurled control. When the electrometer is completely discharged the quartz fiber is not visible on the scale.

(6) Re-insert chamber so that contact is made. See Step 2 of this Section.

(7) The string moves to a point on the scale that may be used as a reference point to check the constancy of the instrument. This point should correspond to the reading indicated for the particular chamber used, in the Discharge Check Reference Data appearing in the manual supplied with the instrument.

It should be noted again that the discharge check will not necessarily indicate shift of calibration.

#### 4. MANUFACTURER'S ADJUSTMENTS.

Each Condenser R-Meter is carefully calibrated at the Victoreen plant before shipment. Every instrument is also adjusted to have identical capacitance. The screw, focus of the string, and the electrometer housing as well as the thimble on the chamber, should never be moved under any circumstances. Even the smallest altering of these adjustments destroys the accuracy of the instrument.

To preserve the high accuracy of your measurements it is recommended that the instrument be returned to the Victoreen plant once a year for recalibration and preventative maintenance.

### SECTION V LIST OF REPLACEABLE PARTS

SYMBOL DESIG.	DESCRIPTION	PART NO.	QTY.
C1	Capacitor: .1 $\mu$ fd; 600 V	21-283	1
C2	Capacitor: .001 $\mu$ fd; 600 V	21-308	1
E1	Contact Wire	570-68	2
E2	Lamp Socket	570-32	1
E3	Switch Insulator	570-50	1

## LIST OF REPLACEABLE PARTS (Cont'd.)

SYMBOL DESIG.	DESCRIPTION	PART NO.	QTY.
E4	Line Cord and Plug	570-94	1
E5	Insulated Terminal	26-2	2
F1	Fuse: 250 V; 1/4 amp	19-8	1
H1	Sight Tube Nut	570-26	1
H2	Side Connector Cap	570-42	2
I1	Pilot Lamp: 6-8 V	17-17	1
I2	Ocular Lens	187-64	1
I3	Objective Lens	70-34	1
I4	Eye Piece Lens	541-7	1
I5	Quartz Fiber Assembly (Coated)	570-30	1
I6	Ocular Lens	70-65	2
N1	Scale	570-6	1
O1	Sight Tube Cap	570-18	1
O2	Sight Tube Holder	570-89	1
O3	Objective Spacer	70-37	1
O4	Electrometer Housing	570-60	1
O5	Retainer Ring	570-21	1
O6	Electroscope Insulator	570-44	1
O7	Electroscope Locking Plate	570-45	1
O8	Objective Body	570-53	1
O9	Retainer Ring	187-13	2
O10	Green Disc	570-23	1
O11	Scale Ring	70-73	1
O12	Scale Spacer Ring	70-68	1
O13	Paper Washer	44-15	1
O14	Lens Spacer	70-67	1
O15	"O" Ring	46-18	1
O16	Tube Shield	34-4	1
O17	Sight Tube	570-56	1
O18	Case Side	570-57	2
R1	Resistor: 900 $\Omega$ ; 10 W; $\pm 10\%$	185-1103	1
R2	Potentiometer; 5 Meg	22-1009	1
R3	Resistor: 10 Meg; .5 W; $\pm 10\%$	185-34	1
R4	Resistor: 22 Meg; .5 W; $\pm 10\%$	185-275	1
T1	Transformer	14-10	1
V1	Tube: OB 2	35-68	1
CR1	Selenium Rectifier	532-6	1
CR2	Selenium Rectifier	52-38	1

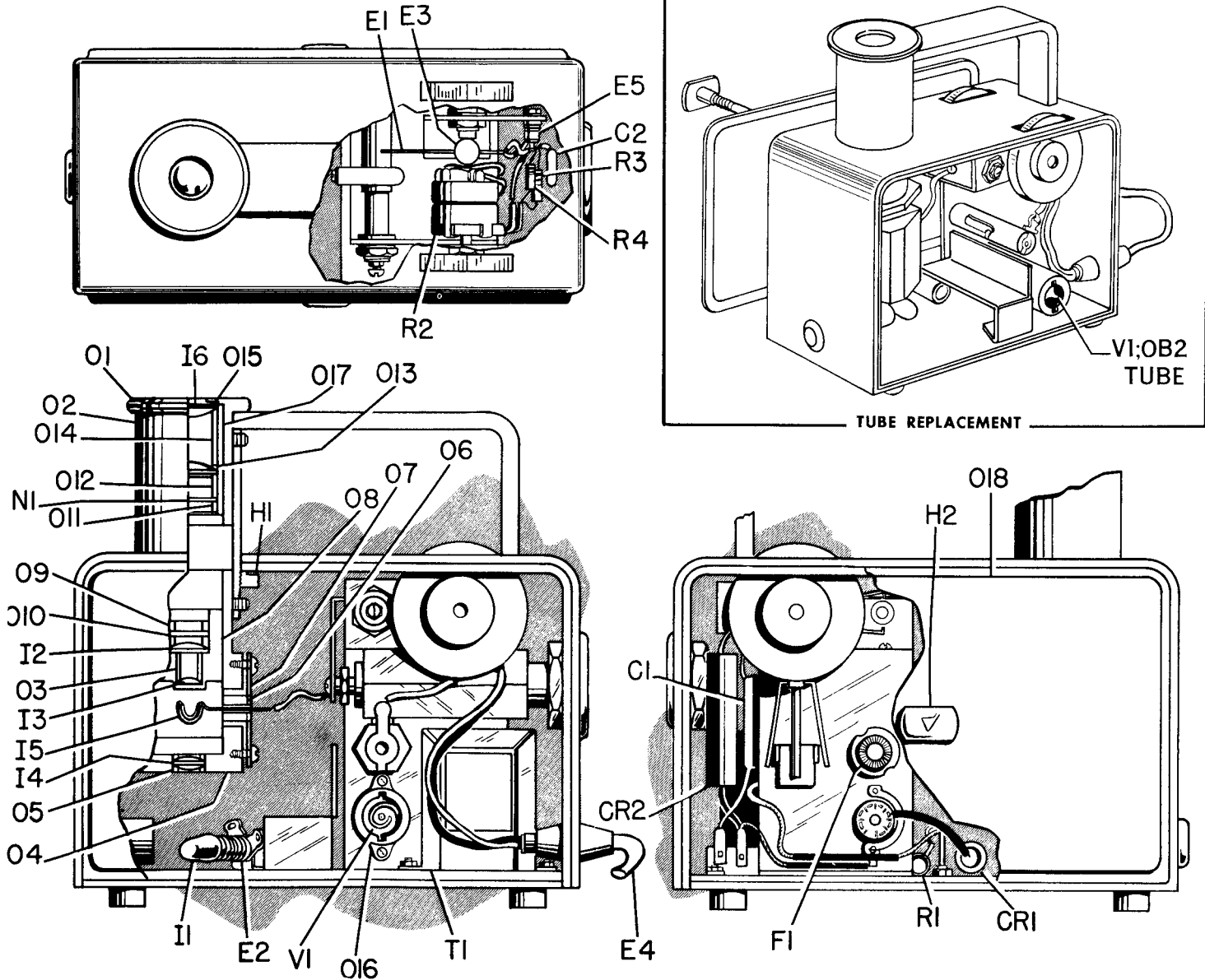


Figure 5. Referenced Illustration and Tube Replacement.

