NAVSHIPS 91856 *(Non-Registered)*

INSTRUCTION BOOK

for

RADIAC SET
AN/PDR-27F

ADMIRAL CORPORATION
CHICAGO, ILLINOIS

BUREAU OF SHIPS NAVY DEPARTMENT

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Contract: NObsr 57163 Approved by Buships: 4 February 1953

LIST OF EFFECTIVE PAGES

Page Numbers	Change in Effect	Page Numbers	Change in Effect
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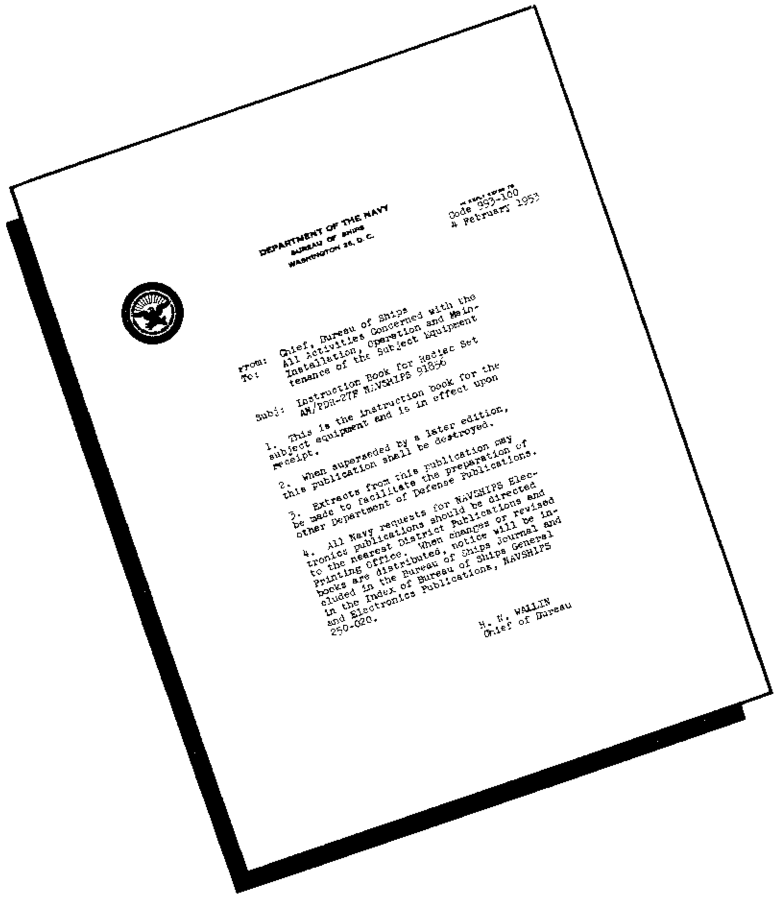

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

Code 993-100
4 February 1953

From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Radiac Set AN/PDR-27F NAVSHIPS 91856

1. This is the instruction book for the subject equipment and is in effect upon receipt.

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.

4. All Navy requests for NAVSHIPS Electronics publications should be directed to the nearest District Publications and Printing Office. When changes or revised books are distributed, notice will be included in the Bureau of Ships Journal and in the Index of Bureau of Ships General and Electronics Publications, NAVSHIPS 250-020.

H. N. WALLIN
Chief of Bureau

RECORD OF CORRECTIONS

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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GUARANTEE

The contract under which the equipment was produced contains the following guarantee:

"Notwithstanding the provisions of Section 5 of these *General Provisions, entitled 'Inspection', the Contractor guarantees that at the time of delivery thereof the supplies provided for under this contract will be free from any defects in material or workmanship and will conform to the requirements of this contract. Notice of any such defect or non-conformance shall be given by the Government to the Contractor within one year of the delivery of the defective or non-conforming item, unless a different period of Guaranty is specified in the **Schedule. If required by the Government within a reasonable time after such notice, the Contractor shall with all possible speed correct or replace the defective or non-conforming item or part thereof. When such correction or replacement requires transportation of the item or part thereof, shipping costs, not exceeding usual charges, from the delivery point to the Contractor's plant and return, shall be borne by the Contractor; the Government shall bear all other shipping costs. This Guaranty shall then continue as to corrected or replacing supplies or, if only parts of such supplies are corrected or replaced, to such corrected or replacing parts, until one year after the date of redelivery, unless a different period of Guaranty is specified in the Schedule. If the Government does not require correction or replacement of a defective or non-conforming item, the Contractor, if required by the Contracting Officer within a reasonable time after the notice of defect or non-conformance, shall repay such portion of the contract price of the item as is equitable in the circumstances."

*Additional General Provisions, Negotiated Supply Contract, BuShips 7-1-50.

**None specified.

INSTALLATION RECORD

Contract Number: NObsr 57163 Date of Contract: Jan. 28, 1952

Serial Number of equipment..........

Date of acceptance by the Navy..........

Date of delivery to contract destination..........

Date of completion of installation..........

Date placed in service..........

Blank spaces on this page shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date of acceptance plate, located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations using form NAVSHIPS NBS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the *Bureau of Ships Manual* or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Standard Navy stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

SAFETY NOTICE

WARNING

The attention of officers and operating personnel is directed to Chapter 67 of the *Bureau of Ships Manual* or superseding instructions on the subject of radio-safety precautions to be observed.

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

RADIOLOGICAL SAFETY WARNING:

All personnel working in high-intensity levels of radioactivity must exercise caution to prevent bodily damage. While the radiation from radioactive substances usually cannot be seen or felt, prolonged or intensive exposure may result in serious damage. Three tenths of a roentgen per week (0.3 r/wk) is considered to be the maximum amount of such radiation which can be absorbed continuously, every day, without serious damage.

When using the radioactive source required for calibration of this equipment, exercise due care in handling it. The safety instructions enclosed herein, and with the source, must be closely followed.

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high-voltage supply on. Under certain conditions, dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties, always remove power and discharge circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

RESUSCITATION

An approved poster illustrating the rules for resuscitation by the prone pressure method shall be prominently displayed in each radio, radar, radiac, or sonar enclosure. Posters may be obtained upon request to the Bureau of Medicine and Surgery.

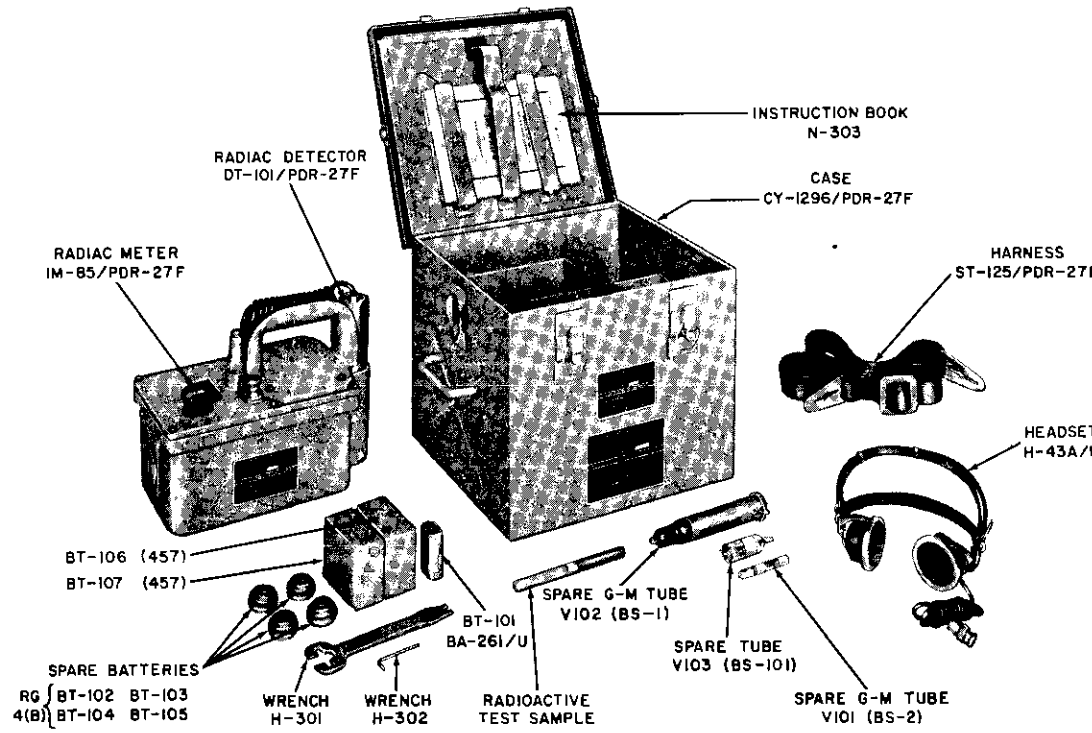


Fig. 1-1. Radiac Set AN/PDR-27F

SECTION 1
GENERAL DESCRIPTION

1. PURPOSE AND BASIC PRINCIPLES.

(See figure 1-1.)

Radiac Set AN/PDR-27F is a portable, watertight, battery-operated radiation detector and indicator. It is capable of detecting and measuring beta and gamma radiations together, or gamma radiations alone. Radiacmeter IM-85/PDR-27F is the main unit of the radiac set; it is equipped with a carrying handle, and also may be carried by an externally connected shoulder harness. Radiac Detector DT-101/PDR-27F is a probe attached externally, by means of a flexible cable, to the radiacmeter. The detector is normally carried in an external well on the radiacmeter and can be easily removed. When measuring gamma radiation, the detector can be used in or out of the well; beta radiations, however, can only be detected when the detector is removed from the well and the beta shield on the probe is moved aside. The radiacmeter also houses an electronic chassis, an indicating meter, and dry batteries. Case CY-1296/PDR-27F is a light-weight carrying case which houses the radiacmeter, Radioactive Test Sample MX-1083B/PDR-27, Headset H-43A/U or H-43/U, Harness ST-125/PDR-27E spare tubes, spare batteries, two wrenches, and two copies of the instruction book.

Geiger-Muller (G-M) tubes are used in the radiac set to detect gamma and beta radiations. When the G-M tubes are exposed to such radiations, they produce short-duration, d-c voltage pulses at an average repetition rate proportional to the average radiation field intensity in the vicinity of the tubes. These pulses, which are of random duration and random amplitude, are converted to pulses of equal duration and constant amplitude and are used to generate visual and aural indications of the average radiation field strength in the vicinity of the G-M tubes. Visual indication is provided by a meter reading proportional to the pulse reception rate; aural indication is provided by headphones in which a click is heard for each received pulse.

The range of field intensities capable of being detected by the radiac set is relatively broad. Therefore, in order to provide an easily observ-

TABLE 1-1. EQUIPMENT SUPPLIED

Quantity per Equipment	Name of Unit	Navy Type Designation	OVER-ALL DIMENSIONS			Volume	Weight
			Height	Width	Length		
1	Case	CY-1296/PDR-27F	9-7/16	10-21/32	11-21/32	1134	8.13
1	Radiacmeter	IM-85/PDR-27F	8	5-13/16	10-9/16	491.84	9.31
1	Radiac Detector	DT-101/PDR-27F	1⅜ diam.	·	7¼	10.47	1.0
1	Headset	H-43/U or H-43A/U	2⅛	7	6⅛	91.3	0.87
1	Harness	ST-125/PDR-27E		....	....	....	1.12
1	Radioactive Test Sample	MX-1083B/PDR-27	⅜ diam.		5	0.55	0.03
1	Wrench - Special		1/16 thick	1	4	0.25	0.11
1	Wrench - Allen		5/64 thick	45/64	61/64	0.60	0.01
2	Instruction Books for Radiac Set AN/PDR-27F	NAVSHIPS 91856	¼ thick	5½	7½	20.6	1.00
1	Tube (spare)	BS-101	¼ diam.		2¾	....	0.04
1	Tube (spare)	BS-1	1¼ diam.		7	....	0.17
1	Tube (spare)	BS-2	⅜ diam.		4	....	0.02
						Total	21.81*
1 set	Equipment Maintenance Repair Parts						6.00
1	Box, Equipment Maintenance Repair Parts, fully packed		9½	10½	13	1296.7	19.00

Dimensions are in inches; volume, cubic inches; weight, pounds. All weights less batteries.
*26.17 lbs. including 2 sets of batteries (1 installed, 1 spare)

able meter deflection for any value of field intensity within the operating range of the set, four ranges of sensitivity are provided. Any one range may be selected by means of a switch on the radiacmeter panel. The two most sensitive ranges utilize a Navy type BS-1 G-M tube, which is contained in the probe. This tube has a mica end-window covered by a removable metal beta shield. The shield can be moved aside to expose the beta window for beta-plus-gamma radiation readings, and is left in place for gamma radiation reading alone. The two less sensitive ranges utilize a Navy type BS-2 G-M tube, which is contained inside the radiacmeter housing. Only gamma radiation field strengths can be measured on these two less sensitive ranges.

2. DESCRIPTION OF UNITS.

(See tables 1-1 and 1-2.)

Radiac Set AN/PDR-27F consists of the components listed in tables 1-1 and 1-2.

a. CASE CY-1296/PDR-27F. *(See figure 1-1.)*—The carrying case houses all other radiac set units. It is completely waterproof and is equipped with carrying handles and hasps. It is fabricated from sheet aluminum and is so constructed that it can be disassembled for decontamination. A spare parts compartment is provided in the case.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

Quantity per Equipment	Name of Unit	Standard Navy and (Signal Corps) Stock No.	Required Use
2	Battery BA-261/U	N17-B-59177-3036	1 operating; 1 spare
8	Battery, Dry; RG-4(B)	N17-B-58733-4980	4 operating; 4 spares
4	Battery National Carbon #457	N17-B-59476-5219	2 operating; 2 spares

b. RADIACMETER IM-85/PDR-27F.—The radiacmeter consists three castings which comprise the handle, the battery compartment, the waterproof enclosure, and space for the electronic chassis. The handle is cast integrally with a plate which serves as a water-tight cover for the battery compartment. The panel casting provides the means for mounting the electronic chassis, meter, range switch, phone jack, and a compartment for the batteries. The remaining casting completes the waterproof enclosure and provides a well at one end to hold the detector probe, the calibration-port cap, and part of the lead shield assembly for Navy type BS-2 tube (figure 1-3). All joints between castings are made watertight by the use of rubber "0" ring gaskets, and screws to draw the joints tight.

Mounted on the panel are an indicating meter, a range switch, a switch actuating sub-assembly, and a headset jack. Mounted to the underside of the panel (figures 1-4 and 1-5) are the electronic elements of the equipment including a plug-in unit (figure 1-4) containing three subminiature tubes and their associated circuit elements, and a push button switch which controls the pilot light.

The plug-in unit contains the circuit elements shown within the dotted box on figure 7-8. Electrical contact to the plug-in unit is made through 11 base pins, the shell, and one spring-clamp connection.

The indicating meter face has a window behind which is placed a meter card with four colored scales (figure 1-2). The meter card is carried on a shaft turned by a sprocket gear. Rotation of the card shaft places the scales, one at a time, within the meter face window; only one scale at a time is visible.

The range switch is a three-wafer, five-section switch with six operating positions selected by switch shaft detents. Mounted on the switch shaft is a sprocket gear O101 (figure 7-4), connected by a spring-loaded chain with the gear on the card shaft. As the range switch is turned to the various operating positions, the card shaft positions the corresponding scales of the meter card in the meter face window.

The battery power is conveyed to the electronic chassis through the wall of the battery compartment by means of a waterproof feedthrough connector which has male contacts on both sides. Female plugs, connected to the battery and electronic chassis cables complete the circuit. Four mercury cells (BT 102, 103, 104, 105) for filament power are placed in a molded styrene holder which in turn fits into the battery holder. The battery holder makes the contact to, and facilitates the changing of the batteries.

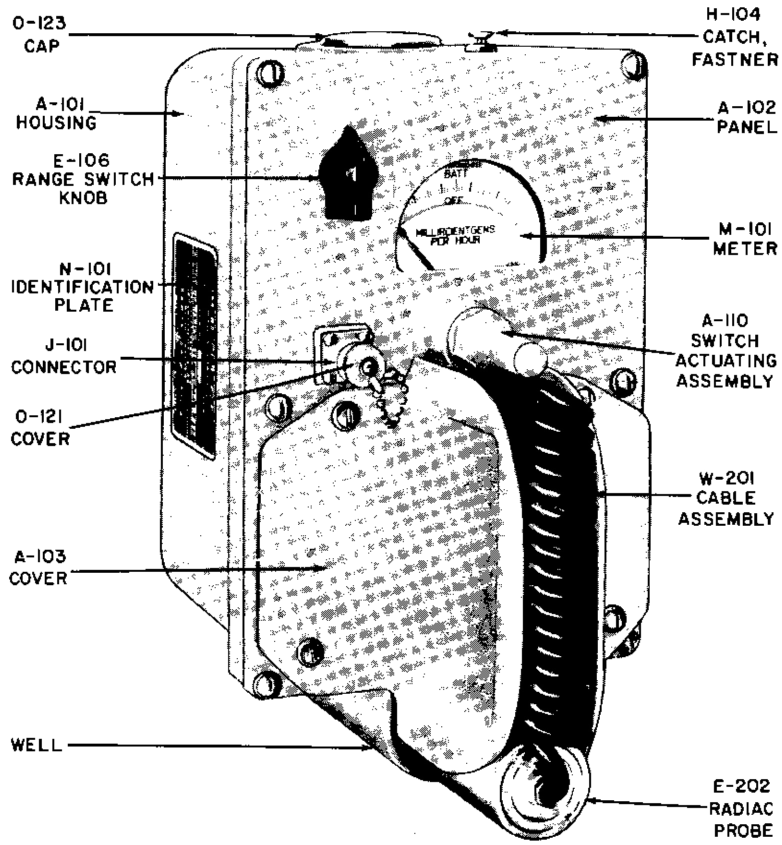


Figure 1-2. Radiacmeter IM-85/PDR-27F, Front View

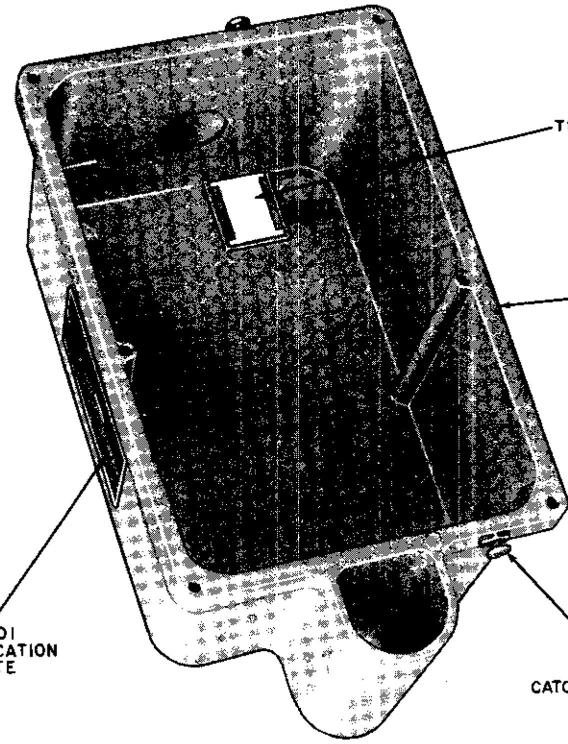


Figure 1-3. Radiacmeter Waterproof Housing

The carrying handle is constructed to allow space for the radiac detector flexible cable when the detector is stowed in its well.

c. RADIAC DETECTOR DT-101/PDR-27F. *(See figure 1-4.)* — The radiac detector is a probe consisting of a Navy type BS-1 G-M tube contained in a cylindrical metal housing. At one end, the housing is closed by a threaded ring and plug; at the other end, a threaded retaining ring bears against the body of the G-M tube but leaves a mica window exposed. The G-M tube is supported by a rubber gasket at one end.

Electrical connection to the tube is made by a kinkproof flexible cable which passes through a waterproof packing gland in the threaded plug at the end of the housing. A spring-retained metal shield covers the mica window of the G-M tube. When the shield is over the window, beta radiations are prevented from entering the tube; the shield can be swung aside when beta-plus-gamma radiations are to be detected. A metal guard is secured directly over the window.

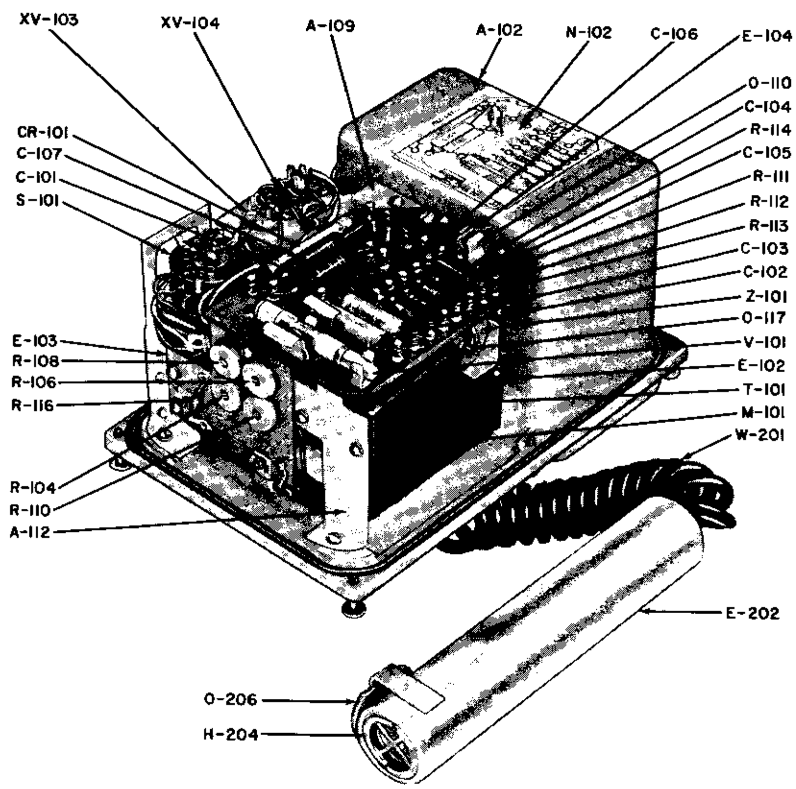


Figure 1-4. Radiacmeter Panel, Right Side and Rear

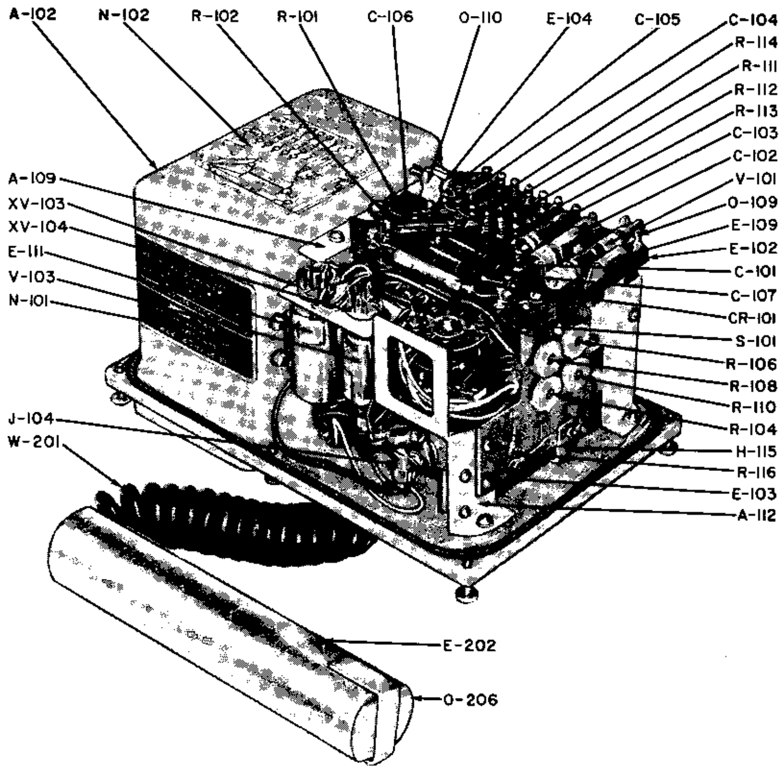


Figure 1-5. Radiacmeter Panel, Left Side and Rear

CAUTION

Since the mica window is only 0.0005-inch thick, it is extremely fragile. Do not touch window under any circumstances, as damage to the tube will result. Do not rely on the guard to protect the mica window; the guard openings are large enough so that sharp objects can pass through and pierce the window.

d. HEADSET H-43A/U or H-43/U. *(See figure 1-1.)* — The headset provides the operator with aural indications of radiation intensity when plugged into the jack on the radiacmeter front panel.

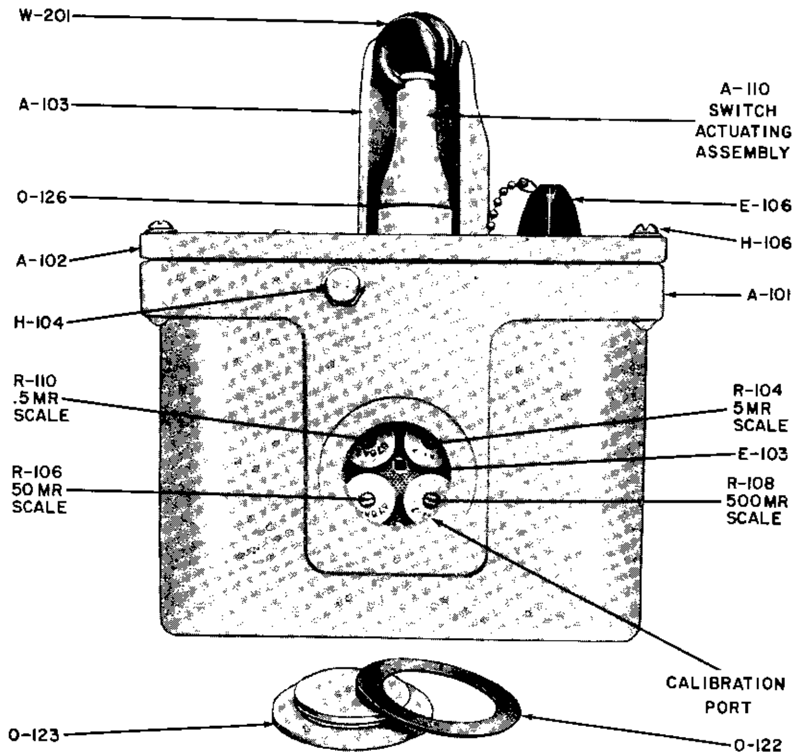


Figure 1-6. Radiacmeter IM-85/PDR-27F, Showing Calibration Port and Switch Actuating Assembly

e. HARNESS ST-125/PDR-27E. *(See figure 1-1.)*—The shoulder harness, an adjustable strap make of a non-absorbent plastic, is used for carrying the radiacmeter and probe during operation. Metal clips on the harness fasten to harness buttons secured to the radiacmeter housing (figure 1-2).

f. RADIOACTIVE TEST SAMPLE MX-1083B/PDR-27. *(See figure 1-1.)*—The radioactive test sample consists of a plastic tube containing 7 micrograms of radium. The tube is flattened at one end to facilitate handling. The radium provides a radiation source that permits the operator to ascertain the operating condition of the radiac set when no known radiation field is available.

WARNING

Because radium is potentially dangerous, serious skin and internal burns may result if the test sample is held close to the skin for prolonged periods. When using the test sample, handle it only long enough to ascertain the operating condition of the radiac set; then replace it in its storage compartment in the carrying case. If the radioactive test sample is broken, notify the officer-in-charge immediately and request disposal instructions.

g. SPARE PARTS.—The field spares, consisting of spare batteries, G-M tubes, and a corona-discharge voltage regulator tube, are carried in the spare parts compartments (figure 1-1) of the carrying case.

3. SUMMARY OF OPERATION.

Step 1. Remove the equipment from the case, attach the shoulder harness, and plug in the headset.

Step 2. Check the battery condition by turning the range switch to BATT COND. The meter pointer should rest at the right of the line, marked BATT, on the meter face.

Step 3. Set the range switch at either 500, 50, 5, or .5, depending on the intensity of the radiation.

Step 4. Check for the presence and the intensity of radiation by observing the meter reading or the frequency of the clicks in the headset.

Step 5. When necessary, illuminate the meter face by tilting the radiacmeter so that the panel is in a 45-degree position, or the meter face may be illuminated by using the push button switch located on the meter panel.

Step 6. When the combined beta and gamma radiation from an object is to be measured, turn the range switch to .5 or 5, remove the radiac detector from the well of the radiacmeter, move aside the beta shield on the probe, point the probe at the object to be investigated, and move the probe close enough to the object to obtain a meter indication.

Step 7. Stop the equipment by turning the range selector switch to OFF. Remove the harness and headset from the radiacmeter, replace the radiac detector in the well of the radiacmeter, and stow all items in the carrying case.

CAUTION

The batteries should be removed from the radiacmeter and from the case if the equipment is not to be used for a prolonged period (approximately three months).

4. REFERENCE DATA.

Reference data applicable to the radiac set is as follows:

a. NOMENCLATURE: Radiac Set AN/PDR-27F.

b. CONTRACT NUMBER AND DATE: NObsr 57163 January 28, 1952.

c. CONTRACTOR: Admiral Corporation

d. COGNIZANT NAVAL INSPECTOR: Inspector of Naval Material, Chicago, Illinois

e. PACKAGES PER SHIPMENT: One

f. CUBICAL CONTENTS: 4.53 cubic feet (including eqpt spares)

g. WEIGHT:
- crated, without batteries, 66.8 pounds
- uncrated, without batteries, 40.8 pounds
- uncrated, with batteries, 43.6 pounds.

Above weights include equipment spares.

h. RANGES: Four sensitivity ranges: 0.5, 5, 50, and 500 milliroentgens per hour.

i. TYPE OF DETECTION: Field intensity of gamma radiations alone, or gamma and beta radiations together.

j. TYPE OF DETECTORS: Geiger-Muller tubes, Navy types BS-1 and BS-2.

k. POWER SUPPLY: Dry batteries:

Number Req.	*Type*	*D-C Voltage (volts)*	*Standard Navy and (Signal Corps) Stock No.*
1	BA-261/U	22.5	N17-B-59177-3036
4	Battery, Dry RG-4(B)	1.345	N17-B-58733-4980
2	Battery, Dry 457	67.5	N17-B-59476-5219

l. HEAT DISSIPATION: Negligible

TABLE 1-3. SHIPPING DATA

Shipping Box No.	CONTENTS		OVER-ALL DIMENSIONS			Volume	Weight
	Name	Designation	Height	Width	Length		
1	Radiac Set AN/PDR-27F (including eqpt spares)		15¾"	17⅝"	28⅛"	4.53	66

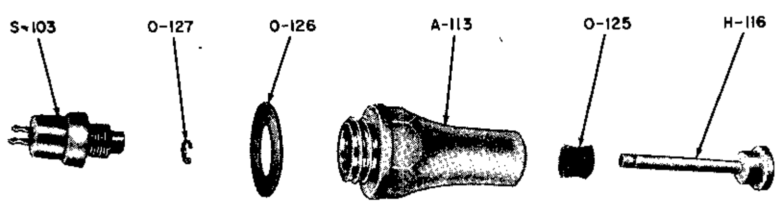


Figure 1-7. Switch Actuating Assembly, Exploded View

SECTION 2

THEORY OF OPERATION

1. RADIOACTIVITY AND ITS DETECTION

a. INTRODUCTION.—With the arrival of atomic energy as an important factor in national defense, naval personnel are called upon to take part in the handling, measurement, and detection of radioactive materials. The following paragraphs will acquaint naval personnel with the nature of atomic radiations, the necessity for detecting them, and methods of detection.

b. ATOMIC RADIATION.—Many chemical elements, such as radium and uranium, and materials exposed to powerful radioactive disintegrations have the property of expelling radiations, which are invisible to the eye. Some of these can penetrate the human body and, if they are of sufficient intensity or duration, can cause serious injury and death. To prevent exposure to damaging concentrations of radioactive materials and to prevent exposure to damaging radiation fields, equipment is provided which detects the presence of these radiations and measures their intensity.

Emissions by radioactive substances are generally composed of alpha, beta, and gamma radiations. Certain characteristics of these radiations are important aids in their detection and measurement. The alpha radiation carries a positive charge; it ionizes gases strongly, but it possesses weak penetrating power. The beta radiation carries a negative charge; it does not ionize gases as readily as the alpha radiation, but its penetrating power is much greater. The gamma radiation carries no charge; it ionizes gas molecules by reaction with them, and its penetrating power is much stronger than that of the alpha and beta radiations.

c. DETECTION OF RADIATION.—The ability of alpha, beta, and gamma radiation to ionize gases is the characteristic most frequently used to detect the presence of radiation. A simple device for such detections is a G-M tube (figure 2-1). The tube is filled with a gas mixture at low pressure. A thin wire, the anode of the tube, is oriented axially to a cylinder and insulated from it. A voltage is impressed across the tube so that the wire is positive with respect to the cylinder. The

TABLE 1-4. EQUIPMENT SIMILARITIES.

Equipment Nomenclature	Batteries Required	Trigger Amplifier	Dial Lamp	Calibration Port	High Voltage Power Supply	Energy Independence	Radiac Detector Size, Weight	Carrying Case (filled) Size, Weight	Radio Active Test Sample	Wrench
AN/PDR-27E	Same as AN/PDR-27A	Ref Symbol Z101 Admiral part/dwg GC-329 Standard Navy Stock Number F16-A-35201-1024 This unit interchangeable between 27A, C, and E.	Turned on by tilting Radiacmeter and by using panel push button	Has port	Uses auto-transformer	Has lead shields over geiger tubes to assist in energy independence	Cable entrance on end, has internal shock mount for tube 7 13/32"x1 3/8" diam; 1 lb.	CY-963B/PDR-27A Waterproof 9 21/32"x11 1/2"x16 3/16"; 8.62 lbs.	MX-1083B/PDR-27	Ref Symbol H301 Admiral part Dwg No. 515A174
AN/PDR-27F	1. JAN Type BA-261/U 4. General Dry Batteries Type RG-4(B) 2. National Carbon Batteries No. 457	Same as AN/PDR-27E	Turned on by tilting Radiacmeter and by using panel push button	Has port	Uses auto-transformer	Has lead shields over geiger tubes to assist in energy independence	DT-101/PDR-27F 7 1/4"x1 3/8" diam; 1 lb.	CY-1296/PDR-27F Waterproof 9 7/16"x10 1/2"x11 1/2"; 8.13 lbs.	MX-1083B/PDR-27	Ref Symbol H301 Admiral part Dwg No. 515A174

Notes

1. The equipments in the AN/PDR-27 series are basically electrically interchangeable. The major difference being in the battery complement. Mechanically the equipments are basically interchangeable with the exception of the AN/PDR-27F which has been made shorter and lighter.
2. The lead and phosphor bronze shields tend to make the equipment energy independent.
3. In the AN/PDR-27E and AN/PDR-27F, a calibration port is incorporated to simplify calibration of the unit, and a push button switch to illuminate the meter face is conveniently located. See figure 1-6. Figure 1-7 is an exploded view of switch actuator, A110.

magnitude of the impressed voltage is just below that necessary to ionize the gas molecules and cause conduction. Therefore, in the dormant condition, no current flows. When radiation is present in the vicinity of the tube, an incoming radiation usually ionizes some molecules of the gas within the tube. The ionized gas particles are attracted toward either the cylinder or the wire, depending on their charge. On their way through the gas, these ionized gas particles collide with non-ionized gas molecules and ionize them. As a result of this action, a large portion of the gas becomes ionized, thus producing a large current flow. This current flow is quenched quickly, either by a small amount of organic vapor which is included in the gas mixture or by the use of external circuits which reduce the potential between the tube elements after conduction. As soon as tube conduction stops, the voltage across the tube is returned to the original pre-ignition value, and the tube awaits the next ionizing event. The duration of tube conduction is short compared to the average time between ionizing events and, therefore, the tube output is in the form of a series of pulses. Because of the fluctuating intensity of the ionizing radiations, the random time interval between ionizing events, and the chance arrangement of the gas molecules in the G-M tube, the pulses produced by the tube vary in amplitude (½ volt to 50 volts) and duration (50 to 100 microseconds), and occur at random time intervals. These pulses are generally used to activate various indicating devices.

d. MEASUREMENT OF RADIATION.—The unit of measurement of radiation is called the "roentgen," or "r," and is defined as *the amount of gamma radiation that will produce one electrostatic unit of charge in one cubic centimeter of air that is surrounded by an infinite mass of air at standard conditions.* Radiation values are usually expressed as

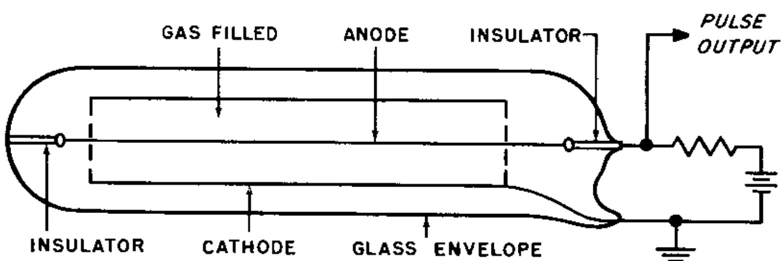


Fig. 2-1. Typical Geiger-Muller Tube

milliroentgens per hour, or mr/hr. Human tolerance to radiation is usually defined in terms of these units. Radiation intensity (in mr/hr) decreases rapidly as the square of the distance from the radioactive object is increased.

2. GENERAL CIRCUIT DESCRIPTION.

(See figure 2-2.)

Dry batteries supply +135-volt d-c power to the high-voltage power supply and the shunt voltage regulator circuits, 1.5-volt d-c filament power to the high-voltage power supply, the shunt voltage regulator, and the pulse shaper and amplifier circuits, and a 22½-volt d-c bias voltage to the shunt voltage regulator circuit. The batteries are the source of all power for the equipment and, at 25°C. (77° F.), can power it for approximately 40 hours of continuous operation.

The high-voltage power supply circuit converts the +135-volt d-c power from the batteries into regulated +700-volt d-c power that is fed to the G-M tubes in the detector circuit. The power supply circuit operates on the "fly-back" principle, and utilizes a corona-discharge regulator tube to maintain the output voltage relatively constant.

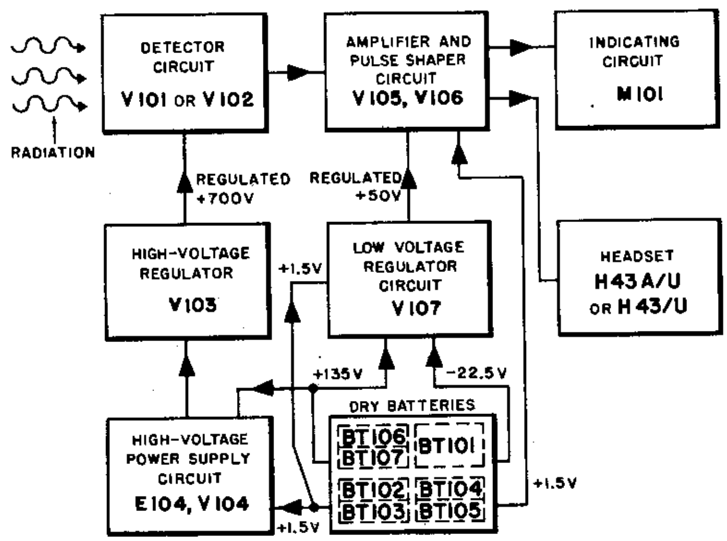


Fig. 2-2. Radiac Set AN/PDR-27F. Block Diagram

The G-M tubes generate voltage pulses when exposed to radioactivity. The average repetition rate of these pulses is proportional to the average radiation field intensity in the vicinity of the tubes, and this rate is used in the radiac set to measure the radiation intensity. The pulses generated in the G-M tubes are of random amplitude and random duration and are fed to the amplifier and pulse shaper circuit. This circuit is a one-shot multivibrator which converts the G-M pulses into pulses of constant area and feeds them to the indicating circuit. The duration of these pulses is different for each sensitivity range.

The indicating circuit converts the pulses fed from the pulse shaper and amplifier circuit to a meter reading proportional to the pulse reception rate. The factor of proportionality depends on the sensitivity range selected by means of the range switch. The meter scales are changed automatically when the sensitivity range of the radiac set is changed by operation of the range switch. Consequently, the meter is always direct-reading.

The shunt voltage regulator circuit maintains the plate voltage of the pulse shaper and amplifier circuit at a relatively constant value as the battery voltage decreases with age.

3. CIRCUIT ANALYSIS.

a. DETECTOR CIRCUIT. *(See figure 2-3.)*—The detector circuit consists of G-M tubes V101 and V102, anode load resistor R101, coupling capacitors C113, and section S101A of range switch S101.

The two G-M tubes are used as radiation detectors. Tube V102, a Navy type BS-1 tube, is the more sensitive of the two and is used in the probe. When S101A is in either the .5 or 5 position, V102 is connected to the radiacmeter and V101 is disconnected. When S101A is in either the 50 or 500 position, V101, a Navy type BS-2 tube, is connected to the radiacmeter, and V102 is disconnected.

When S101A is turned to one of the range positions, regulated +700-volt d-c power is applied through anode load resistor R101 to the anode of the selected G-M tube. When the G-M tube conducts under the influence of an ionizing event, a voltage pulse is developed across resistor R101. This pulse is capacitively coupled through C113 to the input grid of V105 in the pulse shaper and amplifier circuit. The output of the G-M tube is a series of negative-going pulses, one for each ionizing

NOTE:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUE ARE IN MICROMICROFARADS
   MEG = 1,000,000 OHMS
2. SWITCH SHOWN AS VIEWED FROM END OPPOSITE CONTROL KNOB.

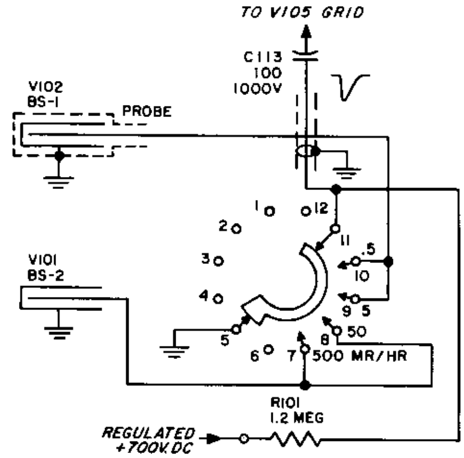


Fig. 2-3. Detector Circuit

event that occurs within the tube. The approximate average duration of these pulses is 80 microseconds, and their average amplitude is approximately 5 volts, although pulse amplitudes of 50 volts occur occasionally.

b. PULSE SHAPER AND AMPLIFIER CIRCUIT. *(See figure 2-4.)* —The pulse shaper and amplifier circuit consists of tubes V105 and V106, section S101B (front) of range switch S101, and associated resistors and capacitors. This circuit converts the random-amplitude, random-duration pulses from the detector circuit into pulses of constant amplitude and constant duration and feeds them to the indicating circuit. The amplitude and duration of the output pulses are seriously affected by changes in the plate supply voltage of V105 and V106. To eliminate this effect, the plate supply voltage for both tubes is regulated.

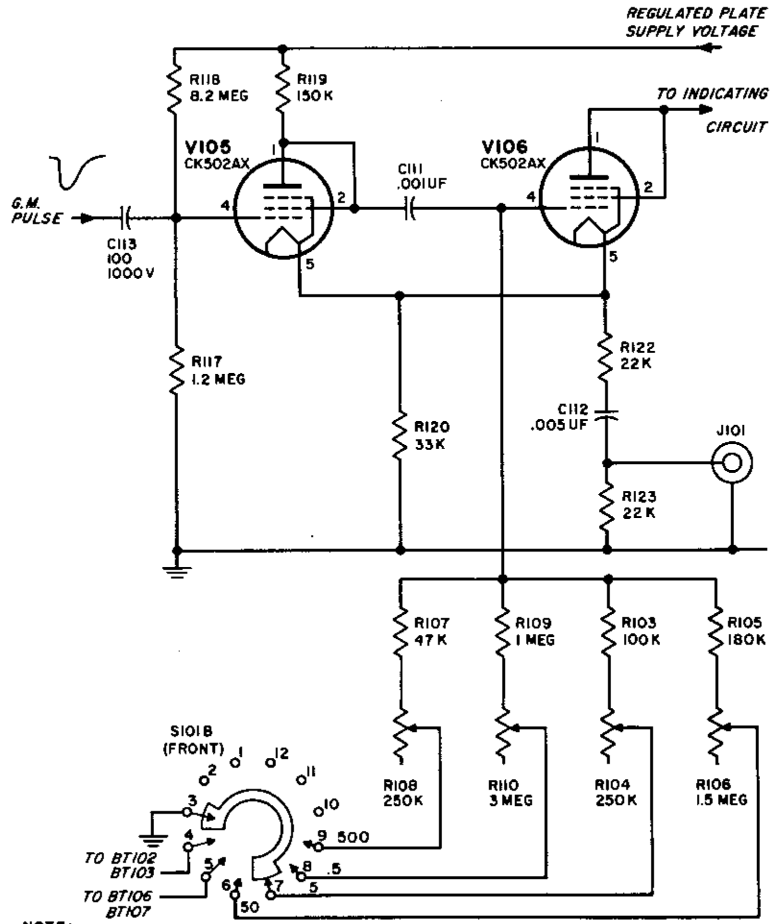
Tubes V105 and V106 (connected as triodes) comprise a single-shot multivibrator. In the dormant state—that is, when no pulses are received from the detector circuit—V105 is conducting and V106 is cut off. Resistor R119 is the plate load for V105 which is made to operate as a triode by connection of its screen grid to its plate. Resistors R117 and R118 comprise a voltage divider; these resistors, in conjunction with common cathode resistor R120, establish the steady-state grid bias for V105. As a result of this bias, V105 conducts in the dormant state. Tube V106 is also connected as a triode amplifier. The control grid of V106 is connected, via one of the resistance paths, through S101B (front) to ground. The cathode of V106 is connected to the cathode of V105 and is, therefore, held positive by the steady-state current through V105; thus, V106 is held in the cut-off condition during the dormant state.

The negative going pulses from the detector circuit are applied to the control grid of V105. These pulses drive the grid of V105 more negative. The resulting rise in the plate potential of V105 is coupled through capacitor C111 to the control grid of V106, causing V106 to conduct heavily. Plate voltage for V106 is applied through components of the indicating circuit. As long as V106 conducts, V105 is held at cut-off by the rise in cathode potential caused by the plate current flow of V106 through common cathode resistor R120. Capacitor C111 now discharges to ground through the selected resistance path and S101B (front). Tube V106 conducts until the discharge of C111 has lowered its control grid voltage to cut-off. The length of time that V106 conducts is determined by the R-C time constant of C111 and the selected resistance path to ground. Four separate resistance paths to ground from the V106 grid are provided by R103 and R104, R105 and R106, R107 and R108, and R109 and R110. Potentiometers R104, R106, R108, and R110 are provided for calibration of the equipment.

When V106 reverts to cut-off, the corresponding drop in its cathode potential, directly coupled to the cathode of V105, permits V105 to conduct its steady-state current again. Since the average time between successive pulses from the detector circuit is considerably longer than the duration of the conduction of V106, the entire circuit reverts to its steady-state condition after each input pulse.

The output of V106, a series of current pulses, is fed to the indicating circuit. The duration of the V106 output pulses is determined primarily by the constant of the selected coupling circuit, and is thus constant for any particular range; each range has a different time constant because the grid to ground resistance of V106 is changed by S101B whenever ranges are changed. Consequently, the duration of the output pulse changes when ranges are changed.

The pulsed fluctuations of the V105 and V106 cathodes are applied to a voltage divider circuit consisting of R122, C112, and R123. The a-c component of the cathode fluctuations generates a voltage across



NOTE:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   K = 1,000 OHMS
   MEG = 1,000,000 OHMS
   UF = MICROFARADS
2. SWITCH SHOWN AS VIEWED FROM END OPPOSITE CONTROL KNOB

Figure 2-4. Pulse Shaper and Amplifier Circuit

R123, and this voltage is applied to jack J101. A headset may be connected to J101 for aural monitoring of the radiation intensity.

c. INDICATING CIRCUIT. *(See figure 2-5.)*—The indicating circuit consists of capacitor C103, resistor R121, and meter M101. Capacitor C103 is connected in parallel with M101. The complete circuit is connected between the plate of V106, in the pulse shaper and amplifier circuit, and the V106 plate supply. When V106 conducts, the current pulse charges C103 and causes a meter deflection. During the interpulse interval, V106 is cut off, causing C103 to discharge through M101 and thus maintains the meter deflection nearly constant.

The function of the indicating circuit is to convert the output pulses of V106 into a relatively steady meter deflection proportional to the radiation intensity. The pulsed output of V106 is smoothed and averaged by C103 to form a fluctuating average meter current; because of the inertia of the meter movement, the fluctuations do not appreciably affect the pointer deflection. The average current through M101 depends on the following factors:

1. The number of pulses per second received from V106.

2. The amplitude and duration of each pulse.

Since the number of pulses per second is proportional to the radiation intensity, the average meter current will be proportional to the radiation intensity as long as the amplitude and duration of each pulse remain the same—i.e. at any one position of range switch S101. When ranges are changed, the amplitude and duration of the pulses from V106 change; consequently, the meter current per pulse per second also changes.

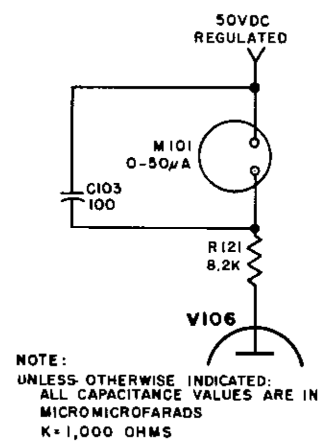


Figure 2-5. Indicating Circuit

The meter deflection is proportional to the average meter current; this current is proportional to the number of pulses per second, and the number of pulses per second is, in turn, proportional to the radiation intensity for a given type of radiation. Consequently, the meter scale can be calibrated to indicate mr/hr (milliroentgens per hour) directly.

d. RANGE SWITCH CIRCUITS.—The functions performed by each of the five range switch S101 sections are shown in figure 2-6.

e. FILAMENT POWER SUPPLY CIRCUIT.—Batteries BT104 and BT105 in parallel provide 1.5 volts for the filaments of V105 and V106, and are connected to these filaments in all positions, except OFF, of range switch S101B (rear). These batteries "float" with respect to the chassis, thus permitting a potential difference to exist between the filaments and chassis.

Batteries BT102 and BT103 in parallel provide 1.5 volts for the filaments of V104 and V107; these batteries are connected to these filaments in all positions, except OFF, of S101B (front). In the BATT COND position of S101C (rear), M101 is connected across the battery to provide an indication of battery condition. A center line, marked BATT, on the meter face indicates the minimum operating voltage of the battery.

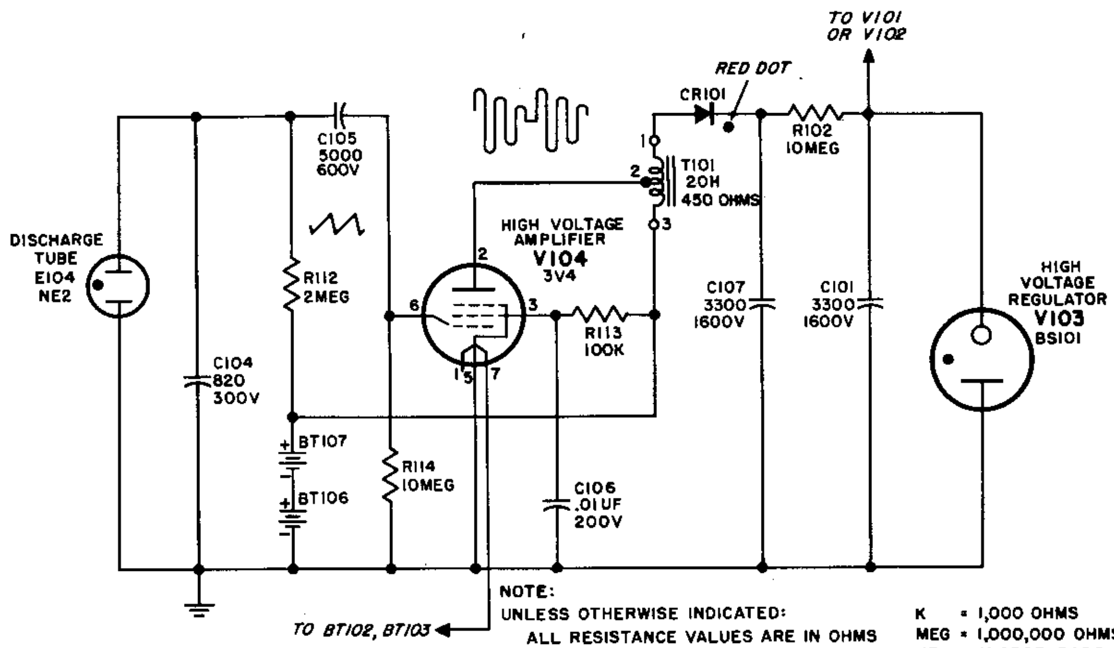
f. HIGH-VOLTAGE POWER SUPPLY CIRCUIT. *(See figure 2-7.)* —The high-voltage power supply circuit consists of a relaxation oscillator circuit, a power amplifier circuit, a rectifying and filtering circuit, and a regulating circuit.

(1) RELAXATION OSCILLATOR CIRCUIT. *(See figure 2-7.)* In this circuit, +135-volt d-c power from the series combination of BT106 and BT107 is applied through resistor R112 to capacitor C104. Tube E104, a cold-cathode glow-discharge tube, is connected across C104. Capacitor C104 charges slowly until it reaches a value equal to the striking voltage, approximately 90 volts, of E104. As soon as 90 volts is reached, E104 conducts heavily and discharges C104 almost instantaneously. Capacitor C104 then starts to charge again, and the cycle is repeated as long as the equipment is operating. The sawtooth voltage across C104 is coupled through capacitor C105 to the control grid of V104 in the high voltage amplifier circuit.

(2) HIGH VOLTAGE AMPLIFIER CIRCUIT. *(See figure 2-7.)* —In the high voltage amplifier circuit, +135-volt d-c power is fed to

Switch Position	Section S101A front	Section S101B rear	Section S101B front	Section S101C front	Section S101C rear
OFF	Grounds output side of high voltage power supply filter through R101.	Disconnects BT104, BT105 from V105 and V106 filaments.	Grounds V106 control grid circuit.	Applies direct short circuit to M101 terminals.	Grounds negative of M101
BATT COND	Nooe.	Connects BT104, BT105 to V105 and V106 filaments.	Grounds negative of BT103 and BT102; grounds V106 control grid circuit.	Connects positive of BT103 and BT102 to positive of M101	Connects negative of BT103 and BT102, through R111, to negative of M101.
500	Connects cap of Z101 and high voltage power supply output to V101.	Connects BT104, BT105 to V105 and V106 filaments.	Grounds negative of BT102, BT103 and BT106; grounds V106 control grid through R107 and R108.	Connects positive of M101 to regulated voltage output of voltage regulator V107.	Connects negative of M101 to output of pulse shaper V106 through R121.
50	Same as 500 position.	Same as 500 position.	Grounds negative of BT102, BT103 and BT106; grounds V106 control grid throngh R105 and R106.	Same as 500 position.	Same as 500 position.
5	Connects cap of Z101 and high voltage power supply output to V102	Same as 500 position.	Grounds negative of BT102, BT103 and BT106; grounds V106 control grid through R103 and R104.	Same as 500 position.	Same as 500 position.
5	Same as 5 position.	Same as 500 position.	Grounds negative of BT102, BT103 and BT106; grounds V106 control grid through R109 and R110.	Same as 500 position.	Same as 500 position.

Figure 2-6. Circuit Connections for Different Positions of S101



NOTE:
UNLESS OTHERWISE INDICATED:
ALL RESISTANCE VALUES ARE IN OHMS
ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
ALL INDUCTANCE VALUES ARE IN HENRIES

K = 1,000 OHMS
MEG = 1,000,000 OHMS
UF = MICROFARADS

Figure 2-7. High-Voltage Power Supply Circuit the high voltage amplifier tube V104 through the center tap of auto-transformer T101. Resistor R113 and capacitor C106 provide the screen grid voltage of V104. The positive-going part of the sawtooth voltage applied to the grid of V104 causes the V104 plate current to build up gradually, then the negative-going portion of the saw-tooth voltage drives the grid rapidly beyond cut-off. When the plate current of V104 increases during the slow rise of its grid voltage, energy is stored in the magnetic field of T101. As soon as the plate current of V104 is cut off by the sharp fall of grid voltage, the collapse of the magnetic field of T101 causes a damped oscillating voltage to exist on the V104 plate. The amplitude of the oscillations is large because of the large inductance of T101 and the sudden current change. This voltage is stepped up by auto-transformer action and applied to the rectifying and filtering circuit.

(3) RECTIFYING AND FILTERING CIRCUIT. *(See figure 2-7.)*—In the rectifying and filtering circuit, the oscillations of T101 are rectified. Half-wave rectification is provided by selenium rectifier CR101; the rectified voltage is filtered in a network consisting of resistor R102 and capacitors C107 and C101. The rectified oscillations provide approximately 900-volt d-c power at the junction of R102 and C101. This output is applied to the regulating circuit.

(4) REGULATING CIRCUIT. *(See figure 2-7.)*—The regulating circuit consists of resistor R102 in series with corona-discharge tube V103. Tube V103 functions in a manner similar to the standard gaseous discharge voltage regulator tubes, except that it regulates at 700 volts. Resistor R102 limits the current through V103. Capacitor C101, in parallel with V103, bypasses noise and stray voltages induced in the wires. Regulated 700-volt d-c power is fed from the junction of R102 and V103, through R101 in the detector circuit, to either V101 or V102. Note that R102 serves a dual function. It is common to the filter circuit and to the regulating circuit.

g. REGULATED PLATE VOLTAGE POWER SUPPLY CIRCUIT. *(See figure 2-8.)*—The regulated plate voltage power supply circuit consists of batteries BT106 and BT107 in series, a shunt voltage regulator circuit, and capacitor C102. Battery power is applied through resistor R127 to a voltage divider consisting of resistors R124 and R125. The control grid of shunt voltage regulator V107 is held at a potential 22½ volts below the potential existing at the junction of R124 and R125 by means of battery BT101. Tube V107 is connected as a triode. The voltage existing on the plate of V107 depends on the potential drop caused by

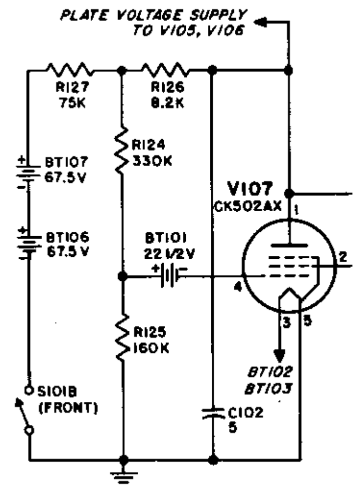


Figure 2-8. Regulated Plate Voltage Power Supply Circuit

the V107 plate current through R127 and R126. The plate current of V107 is, in turn, governed by the potential on the control grid.

As the batteries age, their output voltage decreases, causing a corresponding decrease in the potential applied to the V107 grid. The resulting decrease in V107 plate current causes a corresponding decrease in the potential drop across R127 and R125. Thus, as the battery voltage decreases, the potential drop across R127 and R125 decreases; this action tends to maintain the voltage at the plate of V107 at a constant value throughout the usable life of the batteries.

The load of this power supply consists of a series of short-duration, high-current pulses, separated by relatively long periods of zero current. The shunt voltage regulator and batteries alone are not capable of supplying the pulse current requirements without serious decreases in voltage. However, the supply voltage must remain constant during the pulse. Therefore, C102, connected across V107, is used to maintain the voltage at constant level. During each current pulse, C102 acts as a low-impedance source of power; during the interpulse interval, the charge on C102 is replenished. Capacitor C102 is sufficiently large to prevent a substantial decrease in voltage during the load-current pulse.

h. METER ILLUMINATION CIRCUIT. *(See figure 7-8.)*—The meter illumination circuit consists of mercury switch S102, push button switch S103, Glow discharge lamp E105, and resistor R116. S102 and S103 are connected in shunt with each other, and in series with R116 and E105 across S101B (front) and series combination of BT106 and BT107. Switch S102 is open when the radiacmeter panel is horizontal; however, when the radiacmeter is held so that the panel is almost vertical, S102 closes automatically, causing E105 to illuminate the face of meter M101, if S101B (front) is turned to one of the four operating ranges. Resistor R116 limits the current through E105 to its operating value. Switch S103 closes the meter illuminating circuit in any one of the four operating ranges regardless of the position of the radiacmeter panel.

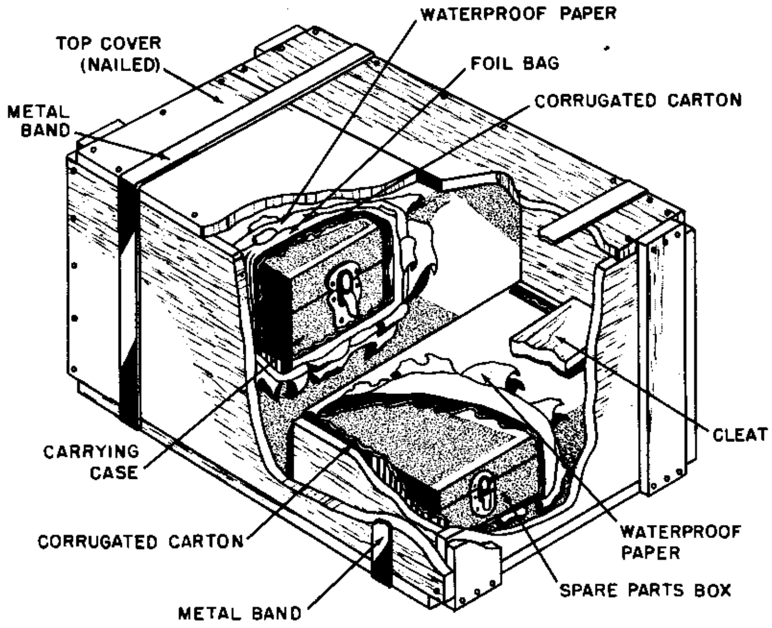


Figure 3-1. Shipping Crate, Cutaway View

SECTION 3
INSTALLATION

1. UNPACKING.

(See figure 3-1.)

The radiac set is shipped in a wooden crate. When unpacking the equipment, perform the following steps:

Step 1. Cut the two metal bands from the wooden shipping crate, and discard them.

Step 2. Pull out the nails securing the top cover, and remove it.

Step 3. Pull out the nails securing the cleat, and remove the cleat.

Step 4. Lift out the two inner packages.

Step 5. Cut open the waterproof paper, the foil bag, and the corrugated paper.

Step 6. Lift out the carrying case and the spare parts box. Remove and discard the supports protecting the handles.

Step 7. Open the carrying case, and remove and discard its corrugated filler and wadding.

Step 8. Remove the cloth bag containing the dessicant from the spare battery compartment, and discard it.

2. INSTALLATION.

Batteries must be installed in the radiac set before the set can be operated. In addition, one set of spare batteries should be placed in the carrying case; these batteries are to be used as field spares. When installing batteries, perform the following steps:

Step 1. Obtain batteries listed in Table 1-2 from Supply Department.

Step 2. Place spare batteries in the spare battery compartment of the carrying case.

Step 3. Remove the radiacmeter from the carrying case. Remove the four screws securing the handle and cover of the battery compartment. Remove the cover.

Step 4. Place the batteries in the battery compartment.

Step 5. Replace the cover.

Step 6. Replace the screws securing the cover and tighten. Screws must be tightened equally on all sides, or rubber gasket may be damaged.

CAUTION

Do not use excessive force in tightening screws. Breakage may result.

3. INITIAL TESTING.

(See figure 3-3.)

Test the radiac set before placing the unit in operation by performing the following steps:

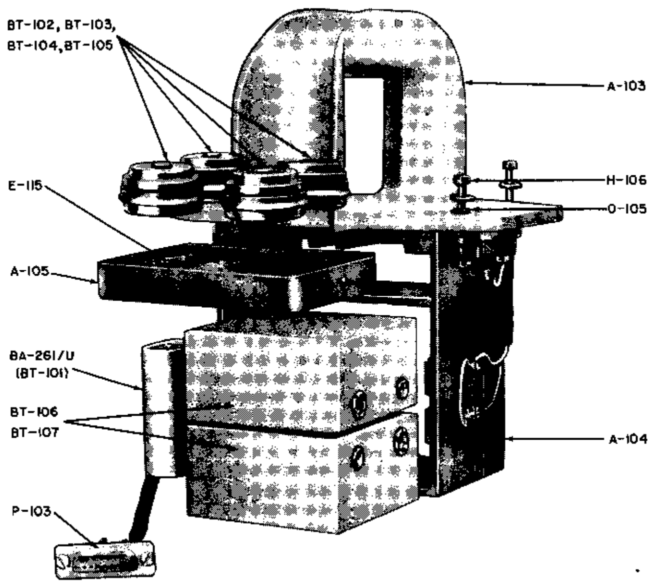


Figure 3-2. Radiacmeter Cover with Battery Mountings.

WARNING

Steps 4 through 9, below, involve handling of the radioactive test sample containing radium. Exercise the utmost caution in handling the test sample. Obey all safety regulations. Perform steps 4 through 9 as rapidly as possible to avoid prolonged exposure to the radiation.

Step 1. Remove the radiacmeter from the carrying case.

Step 2. Turn the range switch to BATT COND. The indicating meter pointer should now rest to the right of the center line marked BATT.

Step 3. Turn the range switch to 500. The meter reading should be zero.

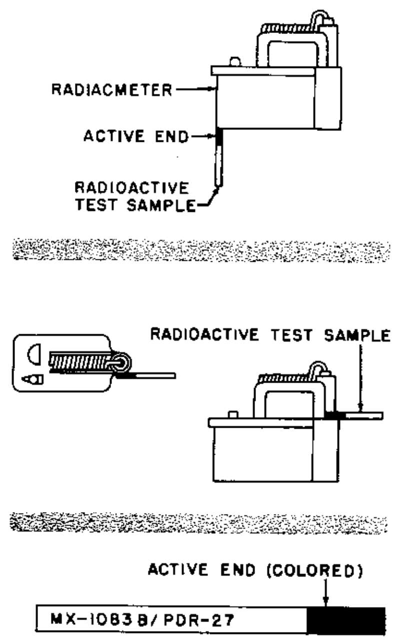


Figure 3-3. Radiac Set Test Setup.

Step 4. Remove the radioactive test sample from the carrying case.

Note

A dimple is provided on the bottom surface of the radiacmeter housing. When the active end of the radioactive test sample is placed in this dimple, maximum meter deflection is obtained.

Step 5. Place the test sample in the dimple under the radiacmeter housing as shown in figure 3-3. The meter reading should be 10 to 30 mr/hr.

Step 6. Turn the range switch to 50. Place the test sample in the dimple under the radiacmeter housing as shown in figure 3-3A. The meter reading should be 5 to 15 mr/hr.

Step 7. Turn the range switch to 5. Hold the active end of the test sample near the radiacmeter probe as shown in figure 3-3B. The meter reading should be 1 to 3 mr/hr.

Step 8. Turn the range switch to .5. Hold the test sample near the radiacmeter probe, as shown in figure 3-3B, with the active end of the sample pointing away from the probe. The meter reading should be 0.10 to 0.30 mr/hr.

Step 9. Replace the test sample in the carrying case.

Step 10. Turn the range switch to OFF.

When the meter readings specified in steps 2, 3, 5, 6, 7, and 8 are obtained, the radiac set is in proper operating condition. If any of the meter readings are incorrect, trouble shoot the radiac set as instructed in Section 7.

Note

To obtain more exact readings of the meter when performing steps 5, 6, 7, and 8, above, refer to the calibration procedure in Section 7-6a and Section 7-6b.