MANUAL OF OPERATION
JUNO RADIATION SURVEY METER

MODELS SRJ-7 AND HRJ-7

TECHNICAL ASSOCIATES

INSTRUMENTATION FOR NUCLEAR RESEARCH

140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA

DENNISON MFG. CO. U.S.A. 7GC

Juno Inspection Tag

Serial No. 2830

1. Subchassis assembly and test with source M.B.
2. Install and check screens and slides E.V.
3. Case finish and engraving E.V.
4. Install case and recheck slides E.V.
5. Install battery pack and set zero [illegible]
6. Calibration: X1 [illegible] X10 [illegible] X100 [illegible]
7. Install back plate and level feet E.V.
8. Final Inspection
9. Completion Date

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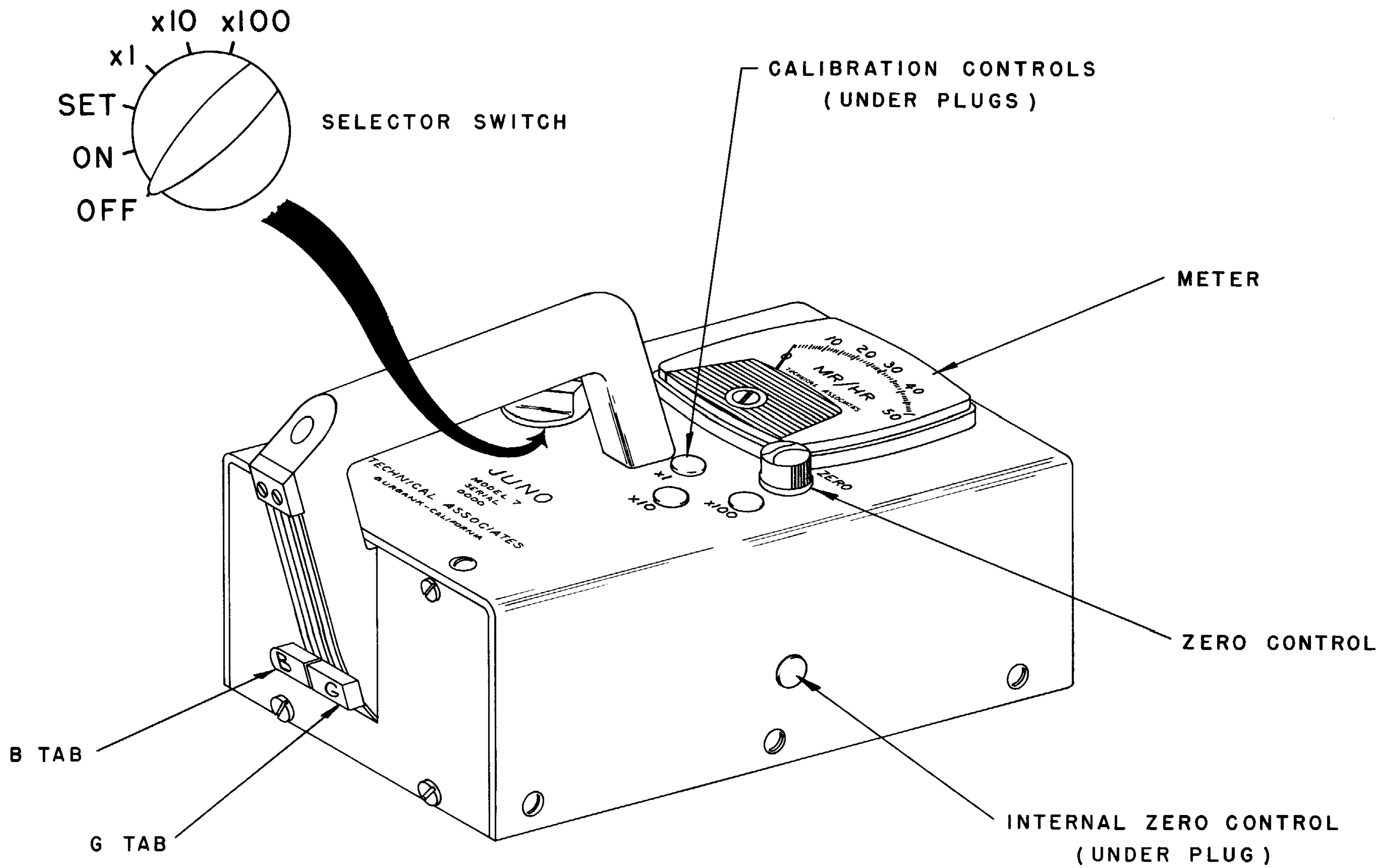
(Rev. 10/60)



JUNO MODEL 7

TECHNICAL ASSOCIATES

MANUAL OF OPERATION

JUNO RADIATION SURVEY METER

MODELS SRJ-7 AND HRJ-7

I. GENERAL DESCRIPTION

THE JUNO SURVEY METER IS A PORTABLE, BATTERY OPERATED INSTRUMENT FOR MEASURING THE INTENSITY OF, AND DISTINGUISHING BETWEEN ALPHA, BETA AND GAMMA RADIATION. THIS INSTRUMENT IS NORMALLY SUPPLIED IN TWO MODELS: SRJ-7 (STANDARD RANGE) WHICH HAS A SENSITIVITY RANGE SUITABLE FOR ALL ROUTINE APPLICATIONS; AND HRJ-7 (HIGH RANGE) FOR USE WHERE EXCEPTIONALLY HIGH RADIATION LEVELS ARE LIKELY TO BE ENCOUNTERED. TO EASILY IDENTIFY THE HIGH RANGE JUNO (HRJ-7), THE RANGE SELECTOR SWITCH KNOB AND THE METER FACE ARE RED IN COLOR. BOTH MODELS MEET A.E.C. SPECIFICATIONS.

THE INSTRUMENT COMPRISES AN IONIZATION CHAMBER, AN ELECTROMETER CIRCUIT, AN INDICATING METER CALIBRATED DIRECTLY IN MR/HR, A REMOVABLE PLUG-IN BATTERY PACK, AND TWO ABSORPTION FILTERS FOR THE REJECTION OF ALPHA AND BETA PARTICLES. THE JUNO IS SELF-CONTAINED IN A HARD-CHROME PLATED ALUMINUM CASE WHICH CAN BE EASILY DECONTAMINATED WHEN NECESSARY.

THE MODEL 7 JUNO IS DESIGNED TO PERMIT OPERATION UNDER HIGH HUMIDITY CONDITIONS. THE SWITCH BOX, WHICH CONTAINS THE HI-MEG GRID RESISTORS (R-1, R-2, AND R-3) AND THE ELECTROMETER TUBE (V-1), IS SEALED BY MEANS OF GASKETS. A REPLACEABLE DESICCANT CARTRIDGE IS USED TO TAKE CARE OF ANY LEAKAGE OF MOISTURE INTO THE BOX.

II. SPECIFICATIONS

RANGES:	MODEL SRJ-7 JUNO (STANDARD RANGE): 50, 500, 5000 MR/HR FULL-SCALE (IMPROVED A.E.C. MODEL S1C-17B). WHITE METER FACE.
	MODEL HRJ-7 JUNO (HIGH RANGE): 250, 2500, 25,000 MR/HR FULL-SCALE. (IMPROVED A.E.C. MODEL S1C-17D). RED METER FACE.
IONIZATION CHAMBER:	VOLUME: 27 CUBIC INCHES
	WINDOW OPENING: 3" x 4 5/8"
	ALPHA SCREEN: 0.3 MIL RUBBER HYDROCHLORIDE (0.45 MG/CM^2).
	ALPHA REJECTION ABSORBER: 0.01" CELLULOSE ACETATE SHEET (36 MG/CM^2).
	BETA REJECTION: 0.102" ALUMINUM (720 MG/CM^2)
	DISTANCE FROM BOTTOM OF FEET TO THE ALPHA SCREEN 1.7 CM.
ACCURACY:	+10% TO -5% OF GAMMA RADIATION INTENSITY WHEN AIR DENSITY CORRECTIONS ARE MADE.

Operating Temperature Range:	35°F. to 135°F.
Case:	Hard-chrome plated aluminum with engraved markings on top of case; gasketed, dust and moisture resistant. Dimensions: 11 1/2" L. x 5 3/4" W. x 6 1/2" H.
Handle:	Aluminum especially cast low-porosity, smoothly polished.
Weight:	6 lbs. 11 oz. net.

III. THEORY OF OPERATION

A. Ionization Chamber.

The ionization chamber is a rectangular aluminum case, (the inside of which is coated with aquadag) located in the forward end, bottom of the Juno case. Air at atmospheric pressure is the ionization medium. The collector, an aluminum rod coated with aquadag, is extremely well insulated by means of a teflon support bushing. Alpha, beta and/or gamma radiation, when passing through the chamber, collides with individual molecules of air. A collision causes an electron to be displaced from its normal energy level. Once removed sufficiently far from its normal energy level it is subjected to static electric force. This force pulls the free electron to the collector which is 90 volts positive with respect to the chamber walls. The molecule, or atom, after losing an electron assumes a positive potential (such a charged atom is called an ion) and is attracted by the negatively charged walls. Since the collector is well insulated the electrons which land on its surface build up a charge, resulting in a more negative potential. This negative shift in the collector is what is detected by the electrometer circuit. The reason for choosing aluminum coated with aquadag is to duplicate the performance of a hypothetical air wall chamber as nearly as possible. In order to give a relatively correct reading on all types of radiation and all energies, the solid material of which a chamber is made must nearly duplicate the ionizing properties of air and therefore have approximately the same atomic weight. Aquadag approaches this very closely and aluminum is the most acceptable of those metals which have satisfactory structural properties.

B. Electrometer Tube and Grid Resistors.

The electrometer tube is a specially constructed, high vacuum pentode which is operated as a triode. It requires a very low power signal on its grid to control its plate current. The low power input permits the use of an extremely high grid resistor, (R-1, R-2, or R-3). Hence, a very small current through the grid resistor will make a readily observed change in the plate current. In turn, the plate current is conducted through a 20 microampere meter which provides the visual indication of the level of radiation in the chamber. The CK 5886 electrometer tube filament operates on 10 ma., 1.25 volts. The plate voltage is 6.5V and the plate current (with no radiation) is 80 microamps. The tube is

SUPPORTED BY AN ANTI-VIBRATION TUBE CLAMP WITHIN THE SWITCH BOX. THE BASE IS SPECIALLY TREATED FOR HIGH INSULATION VALUE IN HIGH HUMIDITIES AND WILL PROBABLY BE PERMANENTLY DAMAGED IF TOUCHED WITH FINGERS. THE THREE GRID RESISTORS ARE ALSO SPECIALLY TREATED. THE HOUSING FOR THE SWITCH AND ELECTROMETER IS AT BIAS POTENTIAL SO THAT THE IONIZATION OF AIR IN THE TUBE COMPARTMENT WILL NOT AFFECT THE VOLTAGE OF THE ELECTROMETER GRID.

THIS SWITCH BOX HAS BEEN SEALED, BY MEANS OF GASKETS, TO PREVENT MOISTURE FROM AFFECTING THE OPERATION OF THE INSTRUMENT UNDER HIGH HUMIDITY CONDITIONS. A REPLACEABLE DESICCANT CARTRIDGE IS USED TO TAKE CARE OF ANY LEAKAGE OF MOISTURE INTO THE BOX. THIS CARTRIDGE IS EASILY REACHED, FOR INSPECTION AND REPLACEMENT, BY REMOVING THE INSTRUMENT BACK-PLATE (WHICH ALSO GIVES ACCESS TO THE BATTERY PACK). THE DESICCANT MATERIAL IS EFFECTIVE WHEN IT IS BLUE IN COLOR. WHEN THE MATERIAL BECOMES PINK, THE CARTRIDGE SHOULD BE REPLACED. A SPECIAL WRENCH IS SUPPLIED WITH EACH JUNO TO FACILITATE THE REMOVAL OF THE CARTRIDGE IF THIS EVER BECOMES NECESSARY.

CAUTION

IT IS NEITHER NECESSARY NOR DESIRABLE TO USE THE WRENCH WHEN INSTALLING THE CARTRIDGE. FINGER TIGHTNESS IS ADEQUATE AND POSSIBLE THREAD DAMAGE IS AVOIDED.

C. JUNO CIRCUIT.

B-3 IS IN SERIES WITH 82,000 OHMS AND SUPPLIES 80 MICROAMPS TO THE METER. THE ELECTROMETER TUBE WITH A PLATE VOLTAGE OF 6.5 VOLTS, AND FILAMENT VOLTAGE OF APPROXIMATELY 1.25 VOLTS, HAS A PLATE CURRENT OF 80 MICROAMPS ALSO. THESE TWO CURRENTS EXACTLY CANCEL IN THE METER, PROVIDING THE INSTRUMENT IS PROPERLY ZEROED. ON INCREASING THE RADIATION SUFFICIENTLY TO GO FROM ZERO TO FULL SCALE, THE CURRENT THROUGH THE ELECTROMETER TUBE CHANGES FROM 80 MICROAMPS TO 60 MICROAMPS. IT IS THIS DIFFERENCE THAT IS INDICATED ON THE METER. THE METER IS SHORTED IN THE OFF AND ON POSITIONS SO AS TO LESSEN THE CHANCE OF DAMAGE FROM SHOCK AND VIBRATION. WITH THE SELECTOR SWITCH IN THE ON POSITION THE FILAMENT OF THE ELECTROMETER IS ALLOWED TO WARM UP. THIS INCREASES THE LIFE OF THE TUBE AND REDUCES ZERO DRIFT. WITH THE SELECTOR SWITCH IN THE SET POSITION, THE BIAS VOLTAGE, FILAMENT VOLTAGE, PLATE VOLTAGE, AND BUCKING VOLTAGE ARE APPLIED. IN ADDITION THE GRID RESISTANCE IS SHORTED OUT. THIS PERMITS ACCURATE ZEROING OF THE INSTRUMENT IN THE PRESENCE OF RADIATION. WHEN THE SELECTOR SWITCH IS TURNED TO THE X1, X10 OR X100 POSITION, THE IONIZATION CURRENT GENERATED IN THE CHAMBER CAUSES VOLTAGE DROP ACROSS R-1, R-2, OR R-3, RESPECTIVELY. SLIGHT VARIATIONS IN THESE RESISTANCES ARE COMPENSATED FOR BY THE CALIBRATION ADJUSTMENTS R-10, R-11 AND R-12, RESPECTIVELY. ZEROING IS ACCOMPLISHED BY CHANGING THE FILAMENT VOLTAGE AND THE TUBE BIAS VOLTAGE.

IV. OPERATION

A. To measure radiation intensities:

1. Turn the Selector Switch to the ON position and wait five seconds for the electrometer tube filament to warm up.

2. Turn the Selector Switch to the SET position and adjust the ZERO control until the meter reads exactly zero.

3. Turn the Selector Switch to the "X1" position. If the meter reads off scale, the radiation present is greater than 50 MR/HR in the case of the SRJ-7 (standard range), and the Selector Switch should be turned to either the "X10" or "X100" position.

4. The instrument is now ready for reading gamma radiation intensity. To read gamma and beta simultaneously, slide back the aluminum screen by pulling up right hand tab "G" in the handle. To read alpha, beta and gamma simultaneously, slide back both the aluminum and acetate filters by pulling up both tabs in the handle.

CAUTION

WITH BOTH FILTERS BACK, THE ALPHA SCREEN IS EXPOSED AND CAN BE VERY EASILY DAMAGED. A VERY DELICATE TOUCH MAY CAUSE IT TO RIP.

5. These instruments are calibrated in International Roentgens corrected to Standard Temperature and Pressure (32°F. and 29.92 inches Hg.) when used at 71.6°F. (22°C) and 29.92 inches Hg. (760 mm. Hg.) For temperature other than 71.6°F. and pressures other than 29.92" Hg., a correction factor must be applied to the meter reading to compensate for ionization chamber air density changes.

$$\text{Correction Factor} = \frac{459.7 + T^{\circ}F.}{531.3} \times \frac{29.92}{P.\ \text{inches Hg.}}$$

Example: A radiation measurement is taken and the meter reading is 25 MR/HR on the X10 range = 250 MR/HR. The air temperature is 90°F. and the barometric pressure is 29.13" Hg.

$$\frac{459.7 + 90^{\circ}}{531.3} = \frac{549.7}{531.3} = 1.035$$

$$\frac{29.92}{29.13} = 1.027$$

Correction Factor = 1.035 x 1.027 = 1.063

Corrected Reading = 250 MR/HR x 1.063 = 266 MR/HR.

The effects of air temperature and pressure must be taken into

CONSIDERATION WHEN THESE INSTRUMENTS ARE RECALIBRATED OR WHEN THE CALIBRATION IS CHECKED.

V. CALIBRATION

A. Internal Adjustments.

Calibration. There are three internal calibration controls; one for each range. These controls are accessible, through holes in the top of case, by removing the cover plugs labeled X1, X10, and X100. These controls should not be changed unless there are calibrated radium or Co^{60} sources available for accurate recalibration. The proper procedure for calibrating the Model SRJ-7 (Standard Range) is as follows:

1. Turn the instrument ON and allow several minutes warm-up.

2. Turn to SET position and zero the meter with the Zero Control.

3. Place the instrument in a radiation field of 15 MR/HR and turn the switch to the X1 position.

4. Measure air temperature and barometric pressure. Adjust meter readings shown below to compensate for air density in ionization chamber. (Refer to Section IV., Paragraph 5).

5. Remove the cover plug labeled X1 on the top of the case and adjust the internal control until the meter reads 15 MR/HR.

6. Place the instrument in a radiation field of 45 MR/HR and check the meter reading. Readjust the calibration control if necessary. Accuracy of the calibration on all three ranges should be such that indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed if air density corrections are made.

7. Place the instrument in radiation fields of 150, 450, 1500 and 4500 MR/HR. With the range selector switch in the appropriate positions, and using the corresponding calibration controls, calibrate the X10 and X100 ranges using the procedure given above.

8. To calibrate the Model HRJ-7 (High Range), use the above procedures and increase the radiation intensities by a factor of five.

B. Internal Zero Adjustment.

If the external Zero control will not zero the meter, it is an indication that the 1.35 volt filament cells (B-2)have dropped slightly in voltage. To compensate for this, an internal Zero adjustment is provided which is accessible through a hole in the side of the case as mentioned in Section VI, paragraph A. This control should be adjusted in the following manner:

1. Turn the Selector Switch to the SET position.

2. Turn the external Zero control to approximately 3/4 of a revolution from the extreme counter-clockwise position.

3. Adjust the internal Zero adjustment until the meter reads zero.

VI. MAINTENANCE

A. Battery Replacement.

All batteries are contained in a removable plug-in battery pack. To gain access to the pack, remove the four screws from the back-plate (not the bottom plate). Move the filter control tabs to the up position and remove the end plate. Special attention should be given to placing the batteries in their proper positions. The instrument will not function properly if polarity is reversed. Refer to Battery Pack sketch for battery types, location and polarity.

The 1.35 volt mercury cells (B-2) which supply the tube filament current, will need to be replaced more frequently than the other batteries. These cells must be replaced when it becomes impossible to zero the instrument by means of both the external zero control and the Internal Zero control (accessible through a hole in the side of the case).

B. Alpha Screen Replacement.

The Alpha screen, which covers the bottom of the chamber, is very delicate. If this screen is touched, or allowed to touch a surface being measured, it may be perforated or torn.

Replacement screens are available from Technical Associates and may be easily replaced by following the procedure given below:

1. Remove the four nuts which form the feet of the instrument.

2. Remove the bottom plate and slide the two filters back to expose the Alpha screen.

3. Remove the two small screws on either side of the metal frame of the Alpha screen.

4. Slide the frame towards the filters, then tilt it up and remove by sliding towards the front of the instrument.

5. The new Alpha screen can now be installed by reversing the above procedure.

JUNO MODEL 7

Parts List

	Standard Range Juno SRJ-7	High Range Juno HRJ-7
R 1	4×10^{11} Ohms	8×10^{10} Ohms
R 2	4×10^{10} Ohms	8×10^{9} Ohms
R 3	4×10^{9} Ohms	8×10^{8} Ohms

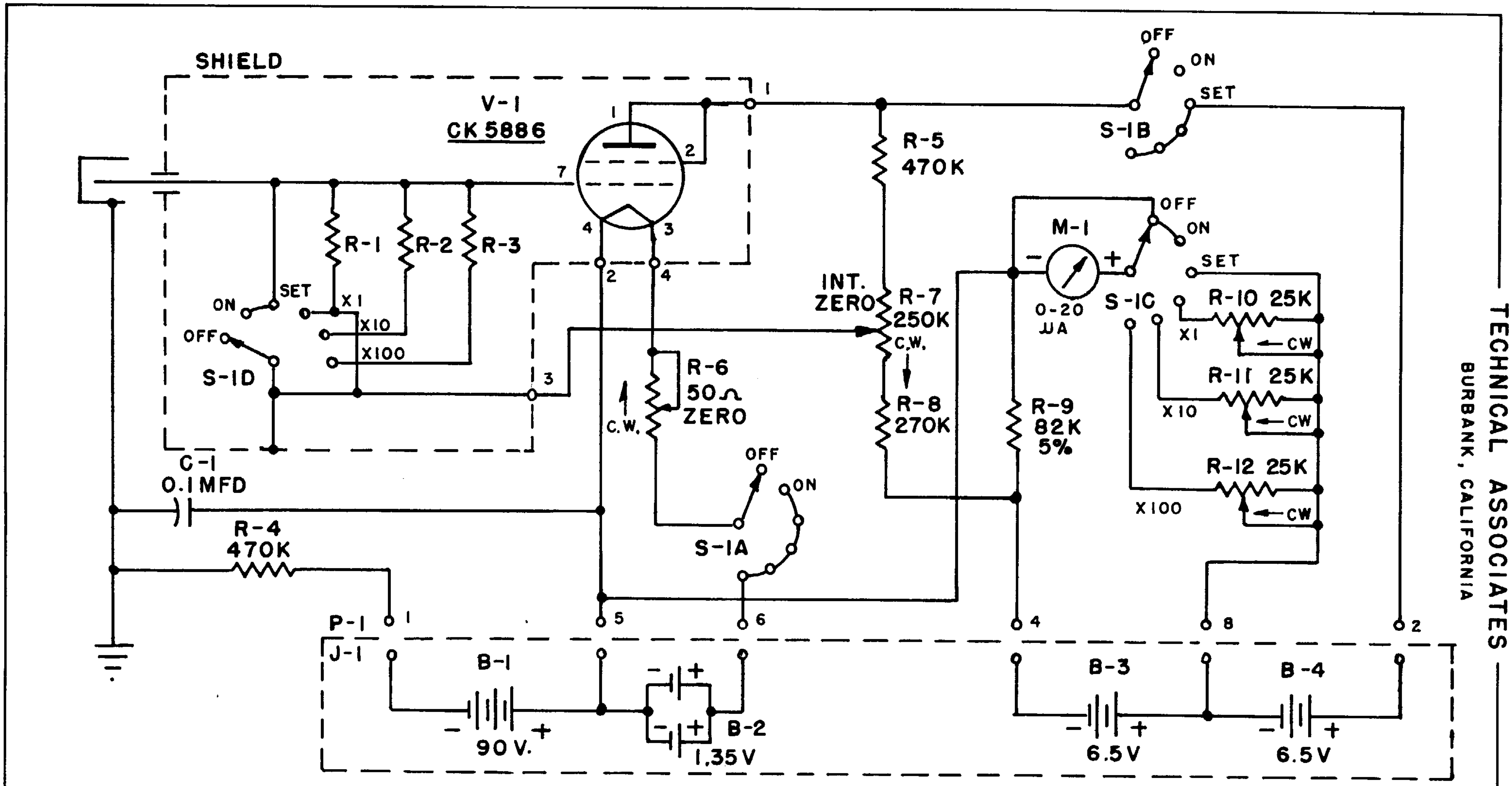
R 4 Resistor	470K, 1/2 watt, 10% - Allen Bradley Type EB 4741
R 5 Resistor	470K, 1/2 watt, 5% - Stemag Type SLAD
R 6 Zero Control	50 Ohms, 2 watts - Clarostat Type CM 10042
R 7 Internal Zero	250K, 2 watts - Allen Bradley Type JU 2541
R 8 Resistor	270K, 1/2 watt, 5% - Stemag Type SLAD
R 9 Resistor	82K, 1/2 watt, 5% - Stemag Type SLAD
R 10, R 11, R 12	Calibration Controls - 25K Ohms, 2 watts - Clarostat Type CM 10040
C 1 Capacitor	0.1 MFD, 400 volts - Sprague Type 4 TM-P1, or equal
J 1 Receptacle	Amphenol Type 26-183
P 1 Plug	Amphenol Type 26-182
V 1 Tube	Raytheon Electrometer Type CK 5886
M 1 Meter	0-20 microamperes - General Electric Type DO-91 (special) (SRJ-7 Scale calibration 0-50 MR/HR, White face) (HRJ-7 Scale calibration 0-250 MR/HR, Red face)
S 1A,B,C Switch	Grigsby Allison Type 12260-4MLW-1 (special)
S 1D Switch	Technical Associates Type SW-5
B 1 Battery	22 1/2 volts (4 required) - Eveready No. 412, or RCA No. VS084, or equal
B 2 Battery	1.35 volts (2 required) - Eveready No. E-12, or Mallory No. RM-12R, or equal
B3, B4 Battery	6.5 volts (2 required) - Mallory No. TR-115, or equal.
Alpha Screen	Technical Associates Type A-19204-B
Handle Assembly	Technical Associates Type C-19222
Beta Filter	Technical Associates Type A-1111-A

PARTS LIST (CONTINUED)

DESICCANT CARTRIDGE	TECHNICAL ASSOCIATES TYPE 6248
DESICCANT CARTRIDGE WRENCH	TECHNICAL ASSOCIATES TYPE A-23227
O-RING	LINEAR, INC. PART NO. 1820-11

RECOMMENDED SPARE PARTS LIST
(BASED ON YEARLY PERIODS)

	QUANTITY
B 1 BATTERIES	4 EACH
B 2 BATTERIES	QUANTITY DEPENDS ON INSTRUMENT USAGE - NORMAL LIFE OF THESE BATTERIES IS APPROXIMATELY 800 HOURS.
B 3, B 4 BATTERIES	DEPENDS ON INSTRUMENT USAGE - NORMAL LIFE IS APPROXIMATELY 3000 HOURS.
V 1 TUBE	1 EACH
ALPHA SCREEN	2 EACH
DESICCANT CARTRIDGE	1 EACH



TECHNICAL ASSOCIATES
BURBANK, CALIFORNIA

SRJ-7

R-1 = $4 \times 10^{11}\,\Omega$

R-2 = $4 \times 10^{10}\,\Omega$

R-3 = $4 \times 10^{9}\,\Omega$

HRJ-7

R-1 = $8 \times 10^{10}\,\Omega$

R-2 = $8 \times 10^{9}\,\Omega$

R-3 = $8 \times 10^{8}\,\Omega$

LETTER	REVISION	BY	CHEK'D	DATE

NEXT ASSEM.	NO. REQ'D	MATERIAL

SCALE

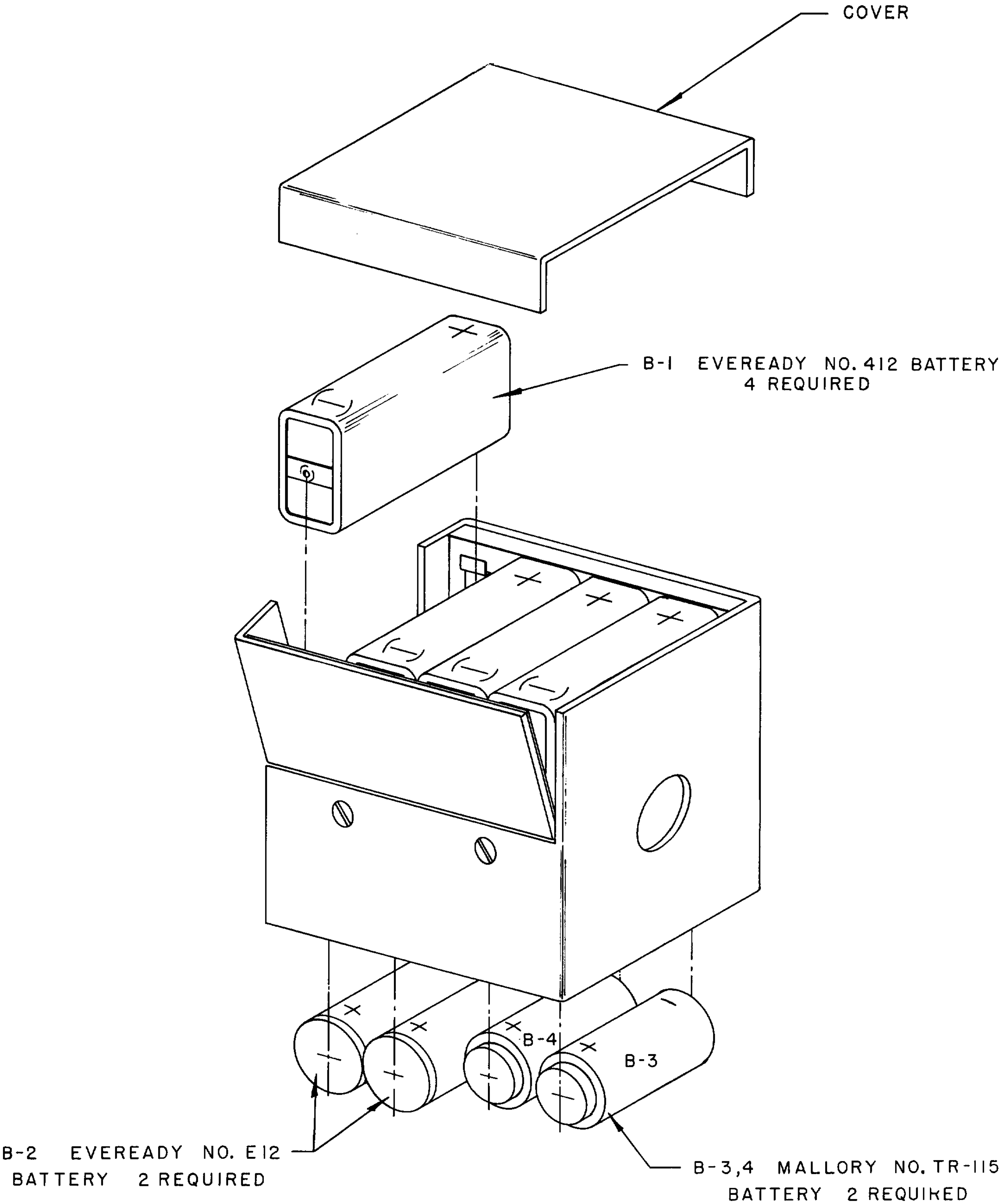
JUNO MODEL 7

CIRCUIT DIAGRAM

DRAWN	DATE
ELR.	4-26-60
CHEK'D	DATE
Glen	4-27-60

TOLERANCES UNLESS OTHERWISE NOTED
FRACTIONS ± 1/64
DECIMALS 2 PLACES ±.01 3 PLACES ±.005

A-23201



JUNO MODEL 7 BATTERY PACK

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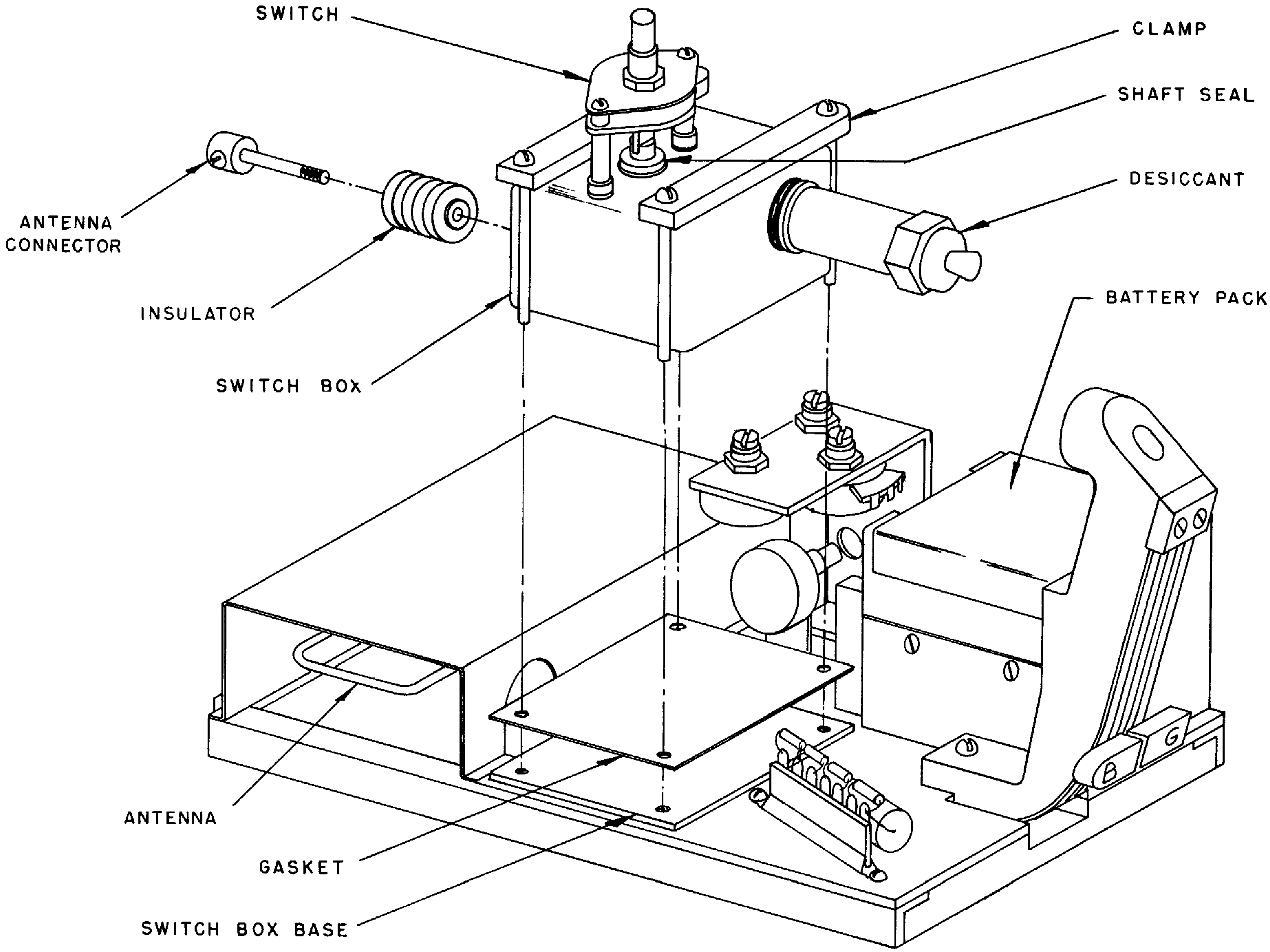

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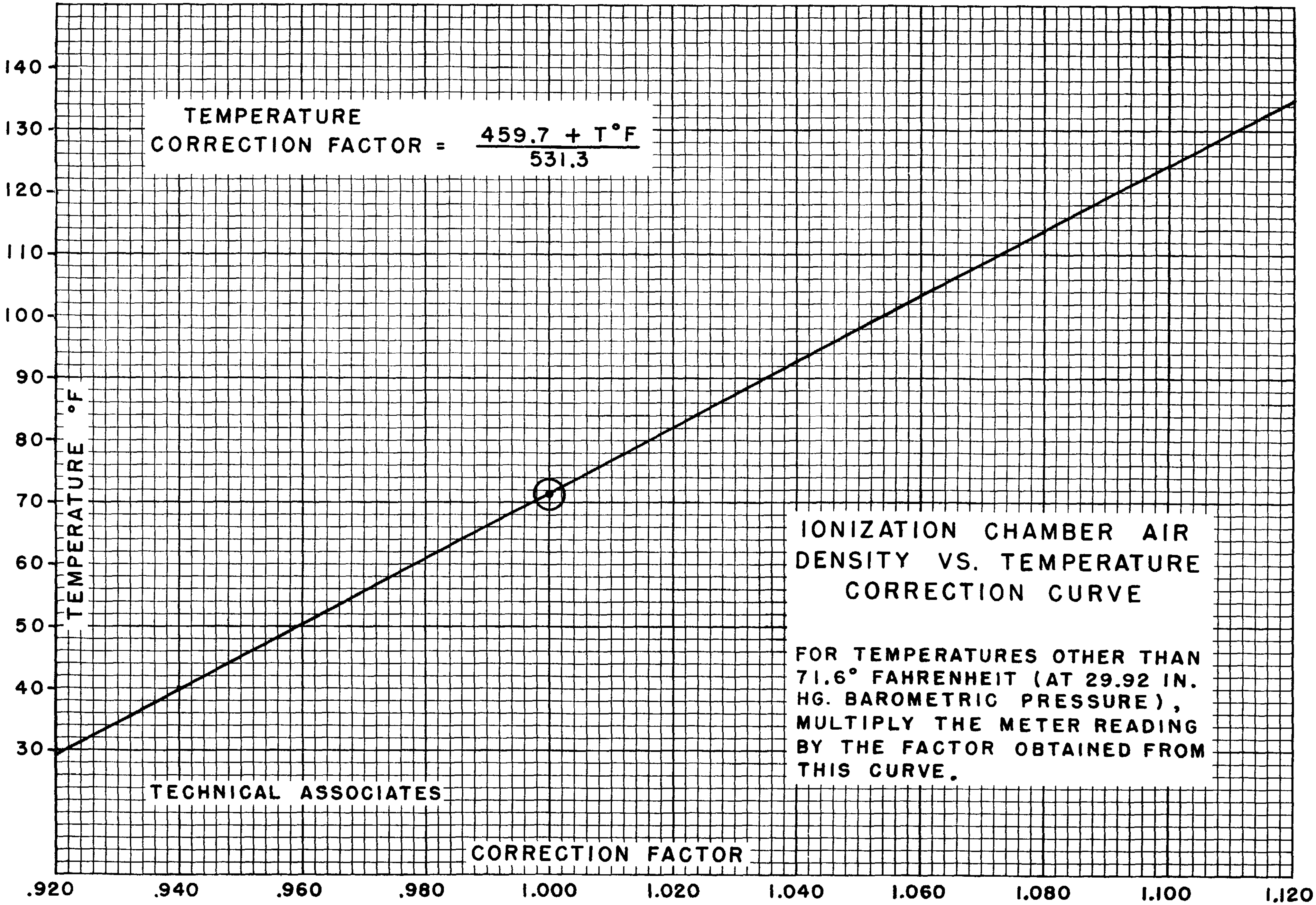
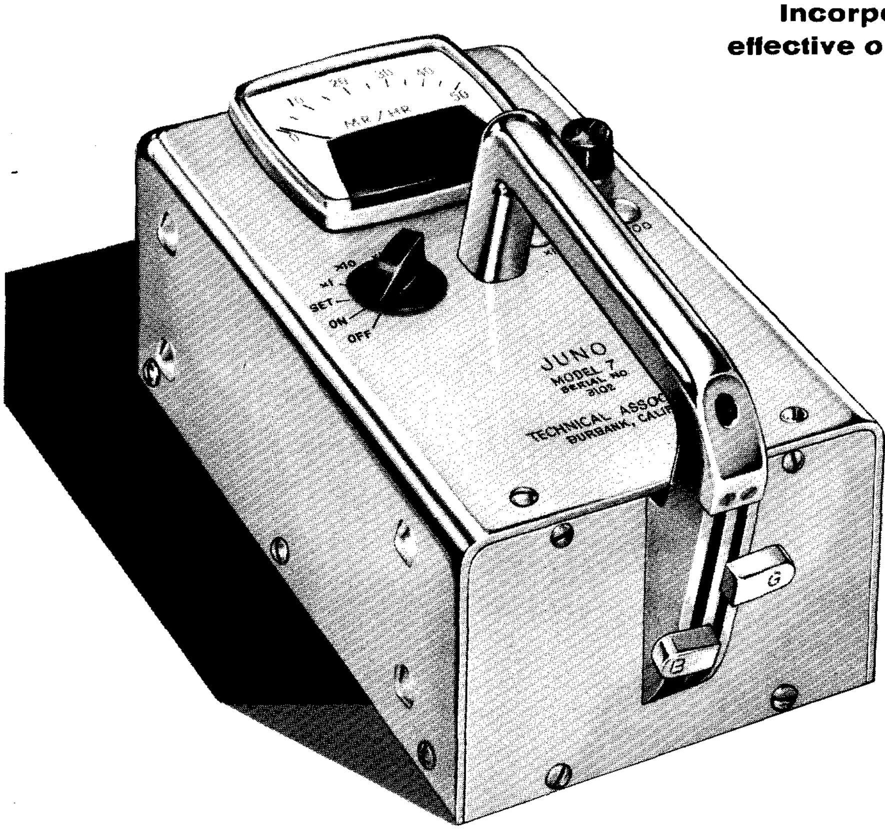
JUNO MODEL 7


TEMPERATURE
CORRECTION FACTOR = $\frac{459.7 + T°F}{531.3}$
IONIZATION CHAMBER AIR DENSITY VS. TEMPERATURE CORRECTION CURVE
FOR TEMPERATURES OTHER THAN 71.6° FAHRENHEIT (AT 29.92 IN. HG. BAROMETRIC PRESSURE), MULTIPLY THE METER READING BY THE FACTOR OBTAINED FROM THIS CURVE.
TECHNICAL ASSOCIATES
TEMPERATURE °F
CORRECTION FACTOR
140
130
120
110
100
90
80
70
60
50
40
30
.920
.940
.960
.980
1.000
1.020
1.040
1.060
1.080
1.100
1.120

INSTRUMENTATION FOR NUCLEAR RESEARCH

JUNO SURVEY METER, Models SRJ-7 and HRJ-7

Incorporating design features which permit effective operation under high humidity conditions



APPLICATION. The Juno Survey Meter is a portable instrument for measuring the intensity of, and discriminating between alpha, beta, and gamma radiation. It is used to protect personnel from the danger of over-exposure to radiation from radioactive materials or X-rays. While primarily intended for inspection of flat surfaces, the instrument is suitable for most uses where a high degree of accuracy is desired.

The T/A Juno is available in two models: SRJ-7 (standard range) for all normal applications; and HRJ-7 (high range) for use where exceptionally high intensity radiation is likely to be encountered. Both models meet A.E.C. specifications.

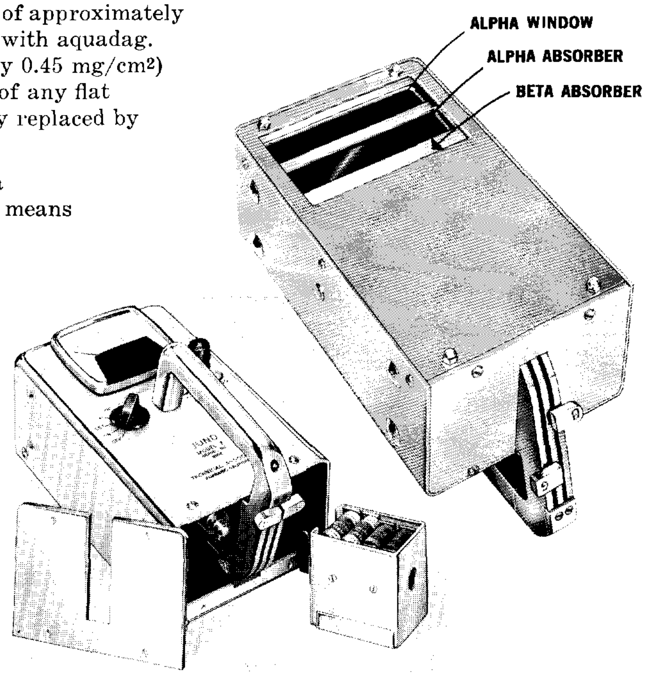
Models SRJ-7 and HRJ-7 are improved versions of the original Hanford instrument. The high impedance circuit switch box includes a desiccant cartridge and is sealed with gaskets. These design improvements insure high efficiency performance under adverse humidity conditions.

DESCRIPTION: The instrument comprises an ionization chamber, an electrometer circuit, absorption filters for the rejection of either alpha or beta particles, suitable batteries mounted in a removable power pack, and an indicating meter. The unit is battery operated and is self-contained. To easily identify the High Range Juno, its knobs and meter dials are finished in brilliant red.

The ionization chamber has a volume of approximately 27 cubic inches. All surfaces within the chamber are coated with aquadag. The chamber is covered by a screen of .0003″ (approximately 0.45 mg/cm^2) rubber hydrochloride film. The alpha screen is within 7/16″ of any flat surface on which the instrument may be placed, and is easily replaced by simply removing the bottom plate and two retaining screws.

Two absorbers are provided to reject either alpha or beta radiation. These are readily moved in and out of position by means of sliding tabs fitted in rails which form part of the handle. The tab marked "G," with a square end, operates the absorber which rejects alpha and beta, thus permitting a reading of gamma only. The tab marked "B," with a rounded end, operates the absorber which rejects alpha, permitting a reading of beta and gamma. The total of all three types of radiation is read, when both tabs are in "open" position.

The high quality microammeter, which is calibrated in milliroentgens per hour for gamma radiation, has a large easy-to-read face and is mounted in position to permit excellent visibility. Battery life is approximately 800 hours in normal intermittent use. An easily removable battery pack, with simple positive contacts, assures trouble-free operation over long periods of service.



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3M-4/61 (Rev.)

Printed in U.S.A.

Models SRJ-7 and HRJ-7 have similar circuits, the principal difference being the value of grid resistances used.

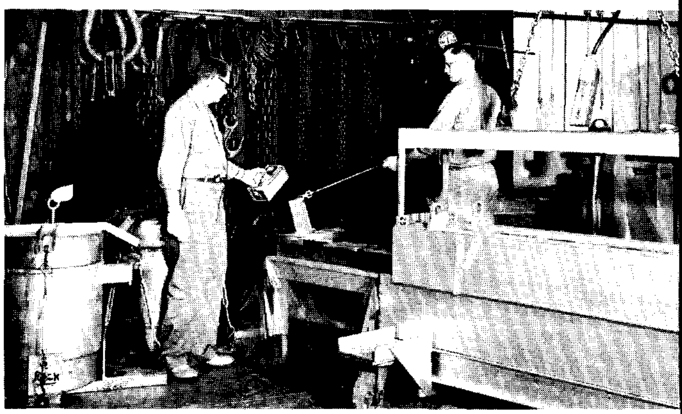
Radiation incident upon the ionization chamber produces a minute current which flows through a very high resistance in the grid circuit of the electrometer tube. The voltage thus produced at the grid causes a corresponding change in plate current which is indicated by the panel meter. A bucking current is provided through the meter in order that the no-signal plate current of the electrometer may be balanced out and readings of radiation intensity may start from the meter zero reading. Sensitivity is varied by switching appropriate values of grid resistance in the electrometer circuit.

The instrument is calibrated by adjusting a resistance in series with the meter. An individual adjustment is provided for each range. Zero setting is accomplished by means of a rheostat in the filament circuit of the electrometer tube. By varying the filament voltage, the plate current may be varied and thus adjusted to a value equal to the bucking current flowing through the meter. All high resistance points in the circuit are insulated with Teflon to insure minimum leakage.

SENSITIVITY. Both models are calibrated in three separate full-scale ranges in easily read increments of the meter scale, covering the total range of which the instrument is capable.

Ranges are based on radium gamma radiation intensity. Accuracy of calibration is such that indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed. For use in abnormal environmental conditions, air temperature and density correction data and curves are included with each instrument. Sensitivity dependency upon battery aging is limited to a 10% variation while the unit can be zeroed by means of the panel zero control.

Illustration below shows the T/A Juno in use at the Nuclear Radiation Laboratory of Admiral Corporation, monitoring for radio-activity as sample is transferred from "coffin" to shipping container.



SPECIFICATIONS:

IONIZATION CHAMBER:

Volume: 27 cubic inches.
Window Opening: 3" x 4⅝".
Alpha Window: 0.3 mil (0.45 mg/cm²) rubber hydrochloride.
Alpha Absorber: 0.01" cellulose acetate sheet.
Beta Absorber: 0.102" aluminum.

BATTERIES:

4 Eveready No. 412 22½ Volt "B" Batteries.
2 Eveready No. E12 1.35 Volt "A" Batteries.
2 Mallory No. TR-115 6.5 Volt "B" Batteries.

TUBE:

1 Sub-Miniature Electrometer Type CK 5886.

RANGES:

Model SRJ-7 Juno (standard range): 50, 500, 5000 MR/HR full-scale. (Improved A.E.C. Model SIC-17B).
Model HRJ-7 Juno (high range): 250, 2500, 25,000 MR/HR full-scale. (Improved A.E.C. Model SIC-17D).

TIME CONSTANTS:

50 MR/HR – 18 Seconds
500 MR/HR – 4 Seconds
5000 MR/HR – 2.5 Seconds

OPERATING TEMPERATURE RANGE: 35°F to 135°F

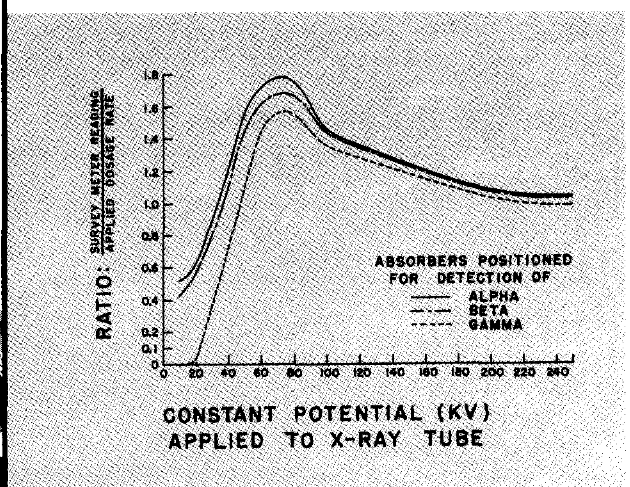
CASE:

Hard-chrome plated aluminum, with engraved markings on top of case; gasketed, dust and moisture-resistant. Dimensions: 9½" x 5¾" x 4".

HANDLE:

Aluminum, especially cast low-porosity, smoothly polished.

WEIGHT: Net 6 lbs. 11 oz. Shipping: 10 lbs.



The Juno can be used for X-ray detection and measurement by reference to the above curves.

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Tech

MANUAL OF OPERATION

JUNO RADIATION SURVEY METER

Models SRJ-6 and HRJ-6

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MANUAL OF OPERATION

JUNO RADIATION SURVEY METER

Models SRJ-6 and HRJ-6

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Technical Associates

JUNO RADIATION SURVEY METER

Models SRJ-6 and HRJ-6

1. GENERAL DESCRIPTION

The Juno Survey Meter is a portable, battery operated instrument for measuring the intensity of, and distinguishing between alpha, beta and gamma radiation. This instrument is normally supplied in two models: SRJ-6 (standard range) which has a sensitivity range suitable for all routine applications; and HRJ-6 (high range) for use where exceptionally high radiation levels are likely to be encountered. Both models meet A.E.C. specifications.

The instrument comprises an ionization chamber, an electrometer circuit, an indicating meter calibrated directly in MR/HR, a removable plug-in battery pack, and two absorption filters for the rejection of either alpha or beta particles. The Juno is self-contained in a hard-chrome plated aluminum case which can be easily decontaminated when necessary.

To easily identify the High Range Juno (HRJ-6), the range selector switch knob and the meter face are red in color.

11. SPECIFICATIONS

Ionization Chamber:	Volume: 27 cubic inches
	Window Opening: 3" X 4 5/8"
	Alpha Screen: 0.4 mil (0.68 mg/cm^2) rubber hydrochloride, or 0.25 mil (0.89 mg/cm^2) mylar film
	Alpha Rejection Absorber: 0.01" cellulose acetate sheet
	Beta Rejection: 0.102" aluminum
Batteries:	4 each $22\frac{1}{2}$ Volt "B" Batteries
	2 each 1.35 Volt "A" Batteries
	2 each 6.5 Volt "B" Batteries

Tube:	1 each Sub-Miniature Electrometer Type CK 5886
Ranges:	Model SRJ-6 Juno (standard range): 50, 500, 5000 MR/HR full-scale (Improved A.E.C. Model S1C-17B). White meter face. Model HRJ-6 Juno (high range): 250, 2500, 25,000 MR/HR full-scale. (Improved A.E.C. Model S1C-17D). Red meter face.
Case:	Hard-chrome plated aluminum with engraved markings on top of case; gasketed, dust and moisture resistant. Dimensions: $9\frac{1}{2}$" X 5 3/4" X 4".
Handle:	Aluminum, especially cast low-porosity, smoothly polished.
Weight:	6 lbs. 11 oz. net.

III. THEORY OF OPERATION

Refer to Fig. No. 1 for the circuit diagram.

A. Ionization Chamber

The ionization chamber is a rectangular aluminum case, (the inside of which is coated with aquadag) located in the forward end, bottom of the Juno case. Air at atmospheric pressure is the ionization medium. The collector, an aluminum rod coated with aquadag, is extremely well insulated by means of a teflon support bushing. Alpha, beta and/or gamma radiation, when passing through the chamber, collides with individual molecules of air. A collision causes an electron to be displaced from its normal energy level. Once removed sufficiently far from its normal energy level it is subjected to static electric force. This force pulls the free electron to the collector which is 90 volts positive with respect to the chamber walls. The molecule, or atom, after losing an electron assumes a positive potential (such a charged atom is called an ion) and is attracted by the negatively charged walls. Since the collector is well insulated the electrons which land on its surface build up a charge, resulting in a more negative potential. This negative shift in the collector is what is detected by the electrometer circuit.

The reason for choosing aluminum coated with aquadag is to duplicate the performance of a hypothetical air wall chamber as nearly as possible. In order to give a relatively correct reading on all types of radiation and all energies, the solid material of which a chamber is made must nearly duplicate the ionizing properties of air and therefore have approximately the same atomic weight. Aquadag approaches this very closely and aluminum is the most acceptable of those metals which have satisfactory structural properties.

B. Electrometer Tube and Grid Resistors

The electrometer tube is a specially constructed, high vacuum triode. It requires a very low power signal on its grid to control its plate current. The low power input permits the use of an extremely high grid resistor, (R-1, R-2, or R-3). Hence, a very small current through the grid resistor will make a readily observed change in the plate current. In turn, the plate current is conducted through a 20 microampere meter which provides the visual indication of the level of radiation in the chamber. The CK 5886 electrometer tube filament operates on 10 ma., 1.25 volts. The plate voltage is 6.5V and the plate current (with no radiation) is 75 micro amps. The tube is supported on its leads. The base is specially treated for high insulation value in high humidities and will probably be permanently damaged if touched with fingers. The three grid resistors are also specially treated. The housing for the switch and electrometer is at bias potential so that the ionization of air in the tube compartment will not affect the voltage of the electrometer grid.

C. Juno Circuit

B-3 is in series with 82,000 ohms and supplies 75 micro amps to the meter. The electrometer tube with a plate voltage of 6.5volts, and filament voltage of approximately 1.25 volts, has a plate current of

75 micro amps also. These two currents exactly cancel in the meter, providing the instrument is properly zeroed. On increasing the radiation sufficiently to go from zero to full scale, the current through the electrometer tube changes from 75 micro amps to 55 micro amps. It is this difference that is indicated on the meter. The meter is shorted in the OFF and ON positions so as to lessen the chance of damage from shock and vibration. With the Selector Switch in the ON position the filament of the electrometer is allowed to warm up. This increases the life of the tube and reduces Zero drift. With the Selector Switch in the SET position, the bias voltage, filament voltage, plate voltage, and bucking voltage are applied. In addition the grid resistance is shorted out. This permits accurate zeroing of the instrument in the presence of radiation. When the Selector Switch is turned to the x1, x10, or x100 position, the ionization current generated in the chamber causes voltage drop across R-1, R-2, or R-3, respectively. Slight variations in these resistances are compensated for by the calibration adjustments R-10, R-11 and R-12, respectively. Zeroing is accomplished by changing the filament voltage. R-6 and R-7 should never be turned fully counter-clockwise as this would place the full potential of B-2 on the sensitive electrometer tube filament and might damage the tube. <u>Care must also be taken not to let either meter lead touch the case of the instrument as this would place 90 volts across the electrometer filament.</u>

IV. OPERATION

A. To measure radiation intensities:

1. Turn the Selector Switch to the ON position and wait five seconds for the electrometer tube filament to warm up.
2. Turn the Selector Switch to the SET position and adjust the ZERO control until the meter reads exactly zero.

3. Turn the Selector Switch to the "x1" position. If the meter reads off scale the radiation present is greater than 50 mr/hr and the Selector Switch should be turned to either the "x10" or "x100" position.

4. The instrument is now ready for reading gamma radiation intensity. To read gamma and beta simultaneously, slide back the aluminum screen by pulling up right hand tab "G" in the handle. To read alpha, beta and gamma simultaneously, slide back both the aluminum and acetate filters by pulling up both tabs in the handle.

CAUTION

WITH BOTH FILTERS BACK, THE ALPHA SCREEN CAN BE VERY EASILY DAMAGED. A VERY DELICATE TOUCH MAY CAUSE IT TO RIP.

V. CALIBRATION

A. Internal Adjustments

Calibration. There are three internal calibration controls; one for each range. These controls are accessible, through holes in the top of the case, by removing the cover plugs labeled x1, x10, and x100. These controls should not be changed unless there are calibrated radium or Co^{60} sources available for accurate recalibration. The proper procedure for calibrating the Model SRJ-6 (Standard Range) is as follows:

1. Turn the instrument ON and allow several minutes warm-up.
2. Turn to the SET position and zero the meter with the Zero Control.
3. Place the instrument in a radiation field of 15 MR/HR and turn the switch to the x1 position.
4. Remove the cover plug labled x1 on the top of the case and adjust the internal control until the meter reads 15 MR/HR.
5. Place the instrument in a radiation field of 45 MR/HR and check the meter reading. Readjust the calibration control if necessary. Accuracy of the calibration on all three ranges should be such that

indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed.

6. Place the instrument in radiation fields of 150, 450, 1500 and 4500 MR/HR. With the range selector switch in the appropriate positions, and using the corresponding calibration controls, calibrate the x10 and x100 ranges using the procedure given above.
7. To calibrate the Model HRJ-6 (High Range), use the above procedures and increase the radiation intensities by a factor of five.

B. Internal Zero Adjustment

If the external Zero Control will not zero the meter, it is an indication that the 1.35 volt filament cells (B-2) have dropped slightly in voltage. To compensate for this, an internal Zero adjustment is provided which is accessible through a hole in the side of the case as mentioned in Section VI, paragraph A. This control should be adjusted in the following manner:

1. Turn the Selector Switch to the SET position.
2. Turn the external Zero control to approximately 3/4 of a revolution from the extreme counter-clockwise position.
3. Adjust the internal Zero adjustment until the meter reads zero.

VI. MAINTENANCE

A. Battery Replacement

All batteries are contained in a removable plug-in battery pack. To gain access to the pack, remove the four screws from the back, end plate (not the bottom plate). Move the filter control tabs to the up position and remove the end plate. Special attention should be given to placing the batteries in their proper positions. The instrument will not function properly if polarity is reversed. Refer to Figure 2 for battery types, location, and polarity.

The 1.35 volt mercury cells (B-2) which supply the tube filament current, will need to be replaced more frequently than the other batteries. These cells must be replaced when it becomes impossible to zero the instrument by means of both the external Zero control and the Internal Zero control (accessible through a hole in the side of the case).

B. Alpha Screen Replacement

The Alpha screen, which covers the bottom of the chamber, is very delicate. If this screen is touched, or allowed to touch a surface being measured, it may be perforated or torn.

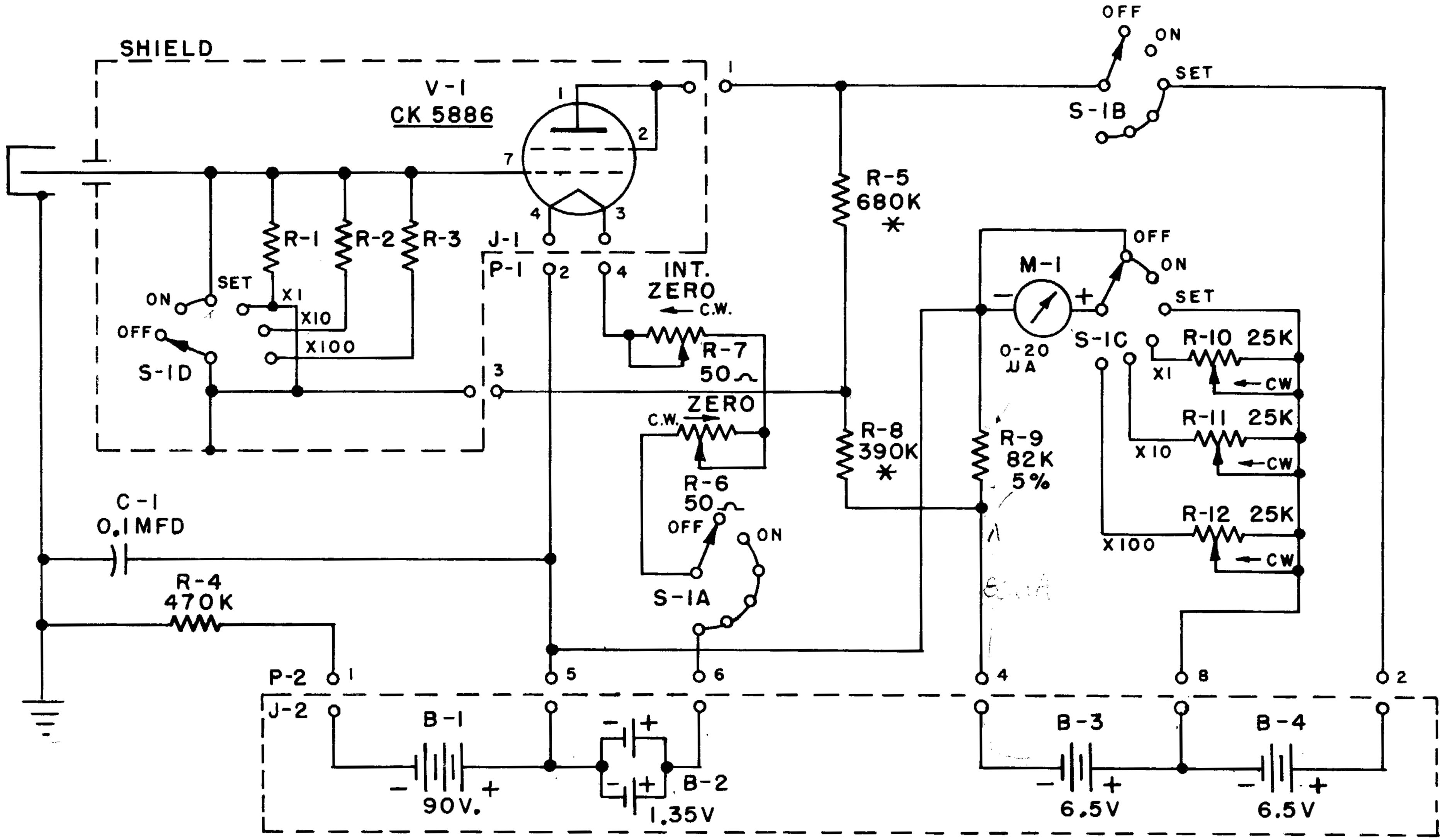
Replacement screens are available from Technical Associates and may be easily replaced by following the procedure given below:

1. Remove the four nuts which form the feet of the instrument.
2. Remove the bottom plate and slide the two filters back to expose the Alpha screen.
3. Remove the two small screws on either side of the metal frame of the Alpha screen. The frame can now be slid towards the filters, and out of the slot which retains one end of the frame.
4. Slide the frame until it is out of the slot, then tilt it up and remove by sliding towards the front of the instrument.
5. The new Alpha screen can now be installed by reversing the above procedure.

TECHNICAL ASSOCIATES

JUNO MODEL 6 PARTS LIST

	Standard Range Juno SRJ-6	High Range Juno HRJ-6
R 1	1.4×10^{11} Ohms	4×10^{10} Ohms
R 2	1.4×10^{10} Ohms	4×10^{9} Ohms
R 3	1.4×10^{9} Ohms	4×10^{8} Ohms
R 4 Resistor	470K, ½ watt, 10% - Allen Bradley Type EB 4741	
R 5 Resistor	Selected on test (nominal value 680K, ½ watt, 10%)	
R 6 Zero Control	50 Ohms, 2 watts - Clarostat Type CM 10042	
R 7 Internal Zero	50 Ohms, 2 watts - Clarostat Type CM 10042	
R 8 Resistor	Selected on test (nominal value 390K, ½ watt, 10%)	
R 9 Resistor	82K, ½ watt, 5% - Allen Bradley Type EB 8235	
R 10, R 11, R 12	Calibration Controls - 25 K Ohms, 2 watts - Clarostat Type CM 10040	
C 1 Capacitor	0.1 MFD., 400 volts - Sprague Type 4 TM-P1, or equal	
J 1 Receptacle	Amphenol Type 78-S4S	
J 2 Receptacle	Amphenol Type 26-183	
P 1 Plug	Amphenol Type 86-CP-4S	
P 2 Plug	Amphenol Type 26-182	
V 1 Tube	Raytheon Electrometer Type CK 5886	
M 1 Meter	0-20 microamperes - Marion Type MM3 or Simpson Type 1327 (SRJ-6 Scale calibration 0-50 MR/HR, White face) (HRJ-6 Scale calibration 0-250 MR/HR, Red face)	
S 1A,B,C Switch	Grigsby Allison Type 12260-4MLW-1 (special)	
S 1D Switch	Technical Associates Type SW-3	
B 1 Battery	22½ volts (4 required) - Eveready No. 412, or RCA No. VS084, or equal.	
B 2 Battery	1.35 volts (2 required) - Eveready No. E-12, or Mallory No. RM-12R, or equal.	
B 3, B 4 Battery	6.5 volts (2 required) - Mallory No. TR-115, or equal.	
Alpha Screen	Technical Associates Type A-19204	
Handle Assembly	Technical Associates Type B-1000-B	
Beta Filter	Technical Associates Type A-1111	



TECHNICAL ASSOCIATES
BURBANK, CALIFORNIA

SRJ-6	HRJ-6
R-1 = 1.4×10^{11} Ω	R-1 = 4×10^{10} Ω
R-2 = 1.4×10^{10} Ω	R-2 = 4×10^{9} Ω
R-3 = 1.4×10^{9} Ω	R-3 = 4×10^{8} Ω

* NOMINAL VALUES. MAY VARY FROM UNIT TO UNIT BECAUSE OF TUBE VARIATIONS.

NEXT ASSEM.	NO. REQ'D	MATERIAL
SCALE		JUNO MODEL 6 CIRCUIT DIAGRAM
DRAWN	DATE	
Rasmussen	12-30-57	
CHEK'D	DATE	TOLERANCES FRACTIONAL ± DECIMAL ± UNLESS OTHERWISE NOTED
Gorn	12-30-57	A-19201 REV. B 2-23-59

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BURBANK, CALIFORNIA

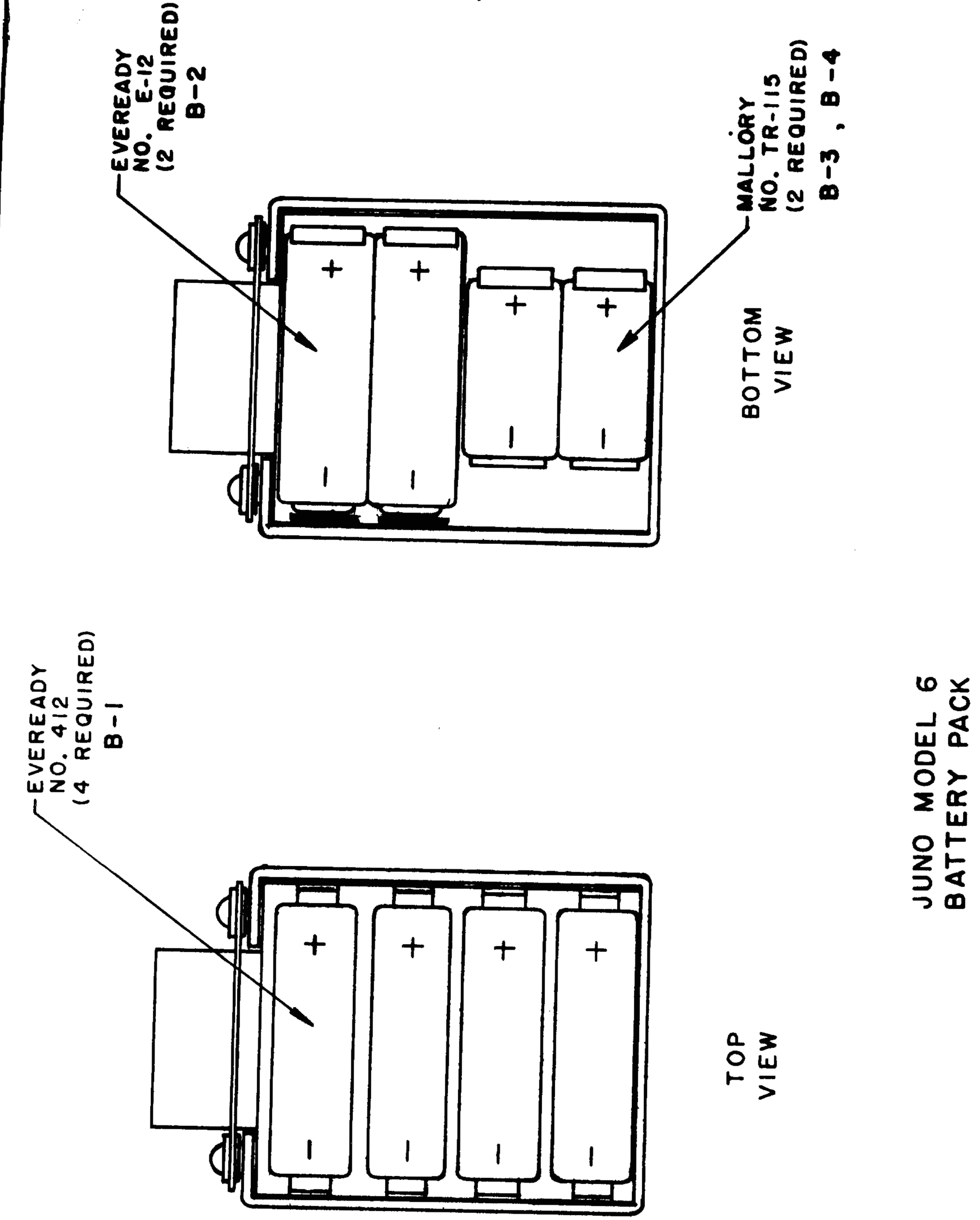

FIGURE 2

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CHICAGO —
IN 3-3588

BEN Z. RUBIN CO.

Electronic Manufacturers Representatives

16130 MEYERS RD

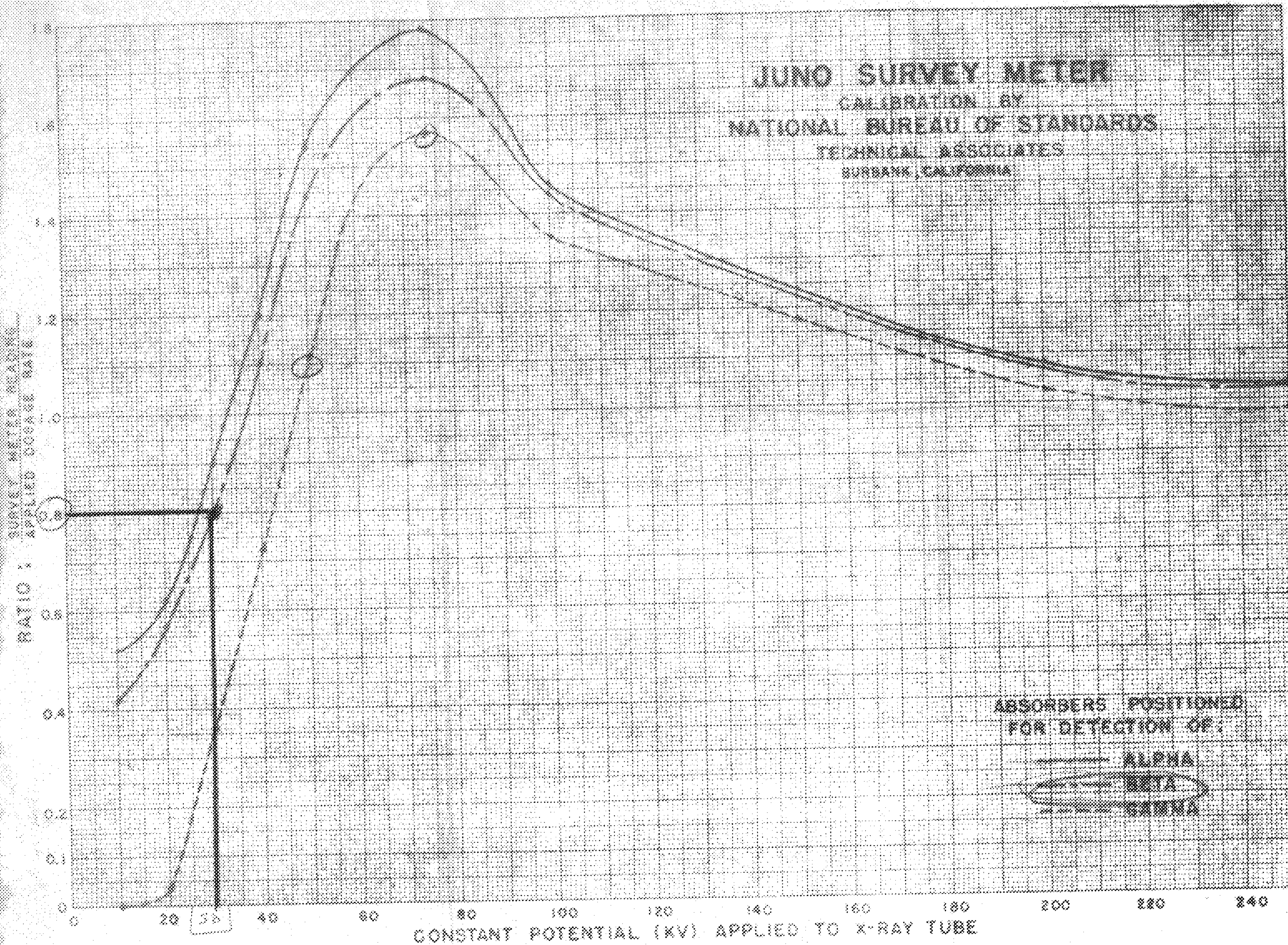
~~16200 CHEYENNE AVENUE~~
DETROIT 35, MICHIGAN

BEN Z. RUBIN

Juno Model 6 Inspection Tag

Date 3-5-59 Serial 1735

1. Subchassis test with source ___
2. Install & check screens & slides E.V.
3. Internal assembly & hardware insp. E.V.
4. Case engraving & plating insp. E.V.
5. Install case & level feet E.V.
6. Install Battery Pack (check for inspection stamp) ___
7. Install & check backplate E.V.
8. Calibration Zero Set ___ X1 ___
   X10 ___ X100 ___
9. Final case cleanup & inspection ___


JUNO SURVEY METER
CALIBRATION BY
NATIONAL BUREAU OF STANDARDS
TECHNICAL ASSOCIATES
BURBANK, CALIFORNIA
ABSORBERS POSITIONED
FOR DETECTION OF:
ALPHA
BETA
GAMMA
RATIO : SURVEY METER READING / APPLIED DOSAGE RATE
CONSTANT POTENTIAL (KV) APPLIED TO X-RAY TUBE
0
20
35
40
60
80
100
120
140
160
180
200
220
240
0.1
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8

QUOTATION FROM

TECHNICAL ASSOCIATES

INSTRUMENTATION FOR NUCLEAR RESEARCH
140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA
TELEPHONES: VIctoria 9-1994 • THornwall 8-8133

To: General Electric Company
4855 Electric Avenue
Milwaukee 1, Wisconsin

Date: January 23, 1959

Your Inquiry No.: Letter 1/19/59

Our No.: 394

Attention: J. J. Jech, Coolidge Lab.
X-Ray Department

Item	Quantity	Description	Unit Price	Total
1.	1 each	Technical Associates' Model SRJ-6 or HRJ-6 Juno Radiation Survey Meter as described in Bulletin No. 159 attached.	295.00	295.00

Terms: **Net 30 days**

F.O.B.: Burbank, California

Delivery Schedule: 15 days after receipt of order

Shipment via: Railway Express

Enclosures: Bulletin No. 159

Copies: (1)

TECHNICAL ASSOCIATES

by Baron Getman
Baron Getman, Asst. Sales M

TECHNICAL ASSOCIATES

INSTRUMENTATION FOR NUCLEAR RESEARCH

140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA

TELEPHONES: Victoria 9-5838 • THornwall 8-6649

December 1, 1959

To All Technical Associates' Catalog Holders:

Enclosed herewith are five (5) new pages describing the latest products added to the Technical Associates' line. Included also is our latest price list revision. Please insert these pages and price list in the catalog which, our records show, was previously issued to you.

Bulletin No.	Model No.	Product
167	HSM-10	New Beta/Gamma Hand and Shoe Monitor
		* * * * * * *
168	PPM-8	Beta/Gamma Portal Type Personnel Monitor
	LIM-18	Beta/Gamma Laundry Inspection Monitor
		* * * * * * *
169	SA-20	Single Channel Pulse Height Analyzer
	LA-6	Non-overloading Linear Amplifier
		* * * * * * *
170	SM-10	Gamma Ray Spectrometer
	SS-30	Motor-Driven Spectrum Scanner
		* * * * * * *
171		Star Series of Gamma Ray Spectrometry Systems

Please notify us if your catalog has been misplaced and we will send another copy to you.

Very truly yours,

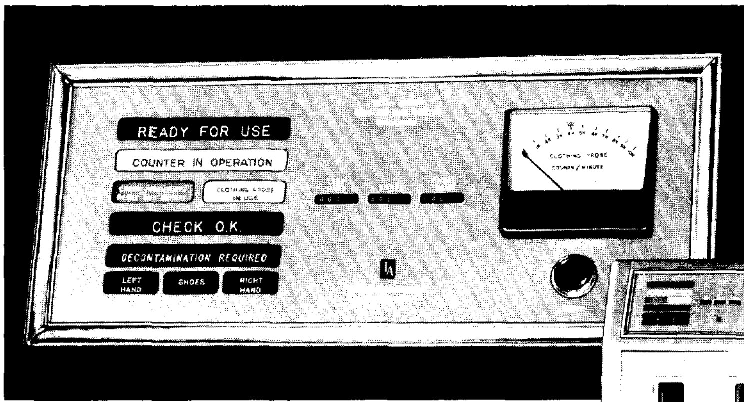
TECHNICAL ASSOCIATES

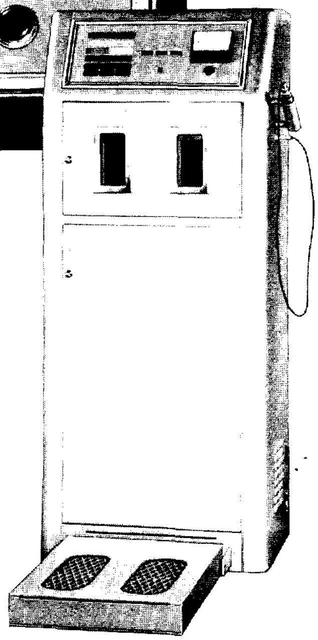
INSTRUMENTATION FOR NUCLEAR RESEARCH

Beta-Gamma HAND and SHOE MONITOR

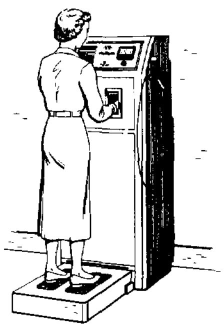
Model HSM-10

Completely automatic monitoring.
Safe, error-proof, and easy-to-use.
Wide range of warning levels.
Positive warning of incomplete check.
Includes external clothing probe.





DESCRIPTION: The Model HSM-10 is a personnel monitor designed to provide completely automatic detection and measurement of beta-gamma contamination on the back and palm of each hand and the bottom surfaces of both shoes. It employs the decade scaling principle and provides register read-outs for the total count on each hand and the combined count for both shoes. Included as standard equipment is an external clothing probe with 5-foot self-coiling cable for checking clothing, hair, face, etc.



OPERATION:

No skill is required in the operation of the Model HSM-10 Monitor. The user simply follows the instructions on the illuminated multi-colored panels at the top of the instrument.

When the monitor is ready for testing, the blue "READY FOR USE" panel will be illuminated. To start the operation, the user merely steps on the shoe deck and inserts hands into the two waist-high probe openings. The counting process is started and maintained by pressure of the finger-tips at the rear of the probe openings, and by the weight of the user on the shoe deck. As soon as the counting starts, the "READY FOR USE" panel darkens, and the yellow "COUNTER IN OPERATION" panel lights up.

NOTE: If at any time during the counting cycle, the user should remove either hand, or step off the shoe deck, the cycle will automatically stop, and the orange panel, reading "CHECK INCOMPLETE–RESET AND REPEAT," will be illuminated. This positive warning prevents erroneous readings.

After a short length of time – as preset by the mechanical timer – the "COUNTER IN OPERATION" panel darkens and either the green "CHECK O.K." panel or the red "DECONTAMINATION REQUIRED" panel lights up, depending upon whether the radioactivity present is above or below the preset maximum allowable level. The user then pushes the large red "RESET" pushbutton on the front panel, and the instrument is ready for the next user.

If the "DECONTAMINATION REQUIRED" panel lights up, one or more of the small red panels marked "LEFT HAND," "SHOES," or "RIGHT HAND" will also be illuminated, depending upon the location of the contamination. The degree of contamination can be checked by noting the register readings.

The clothing probe, which is located on the right side of the instrument cabinet, is actuated by a switch located just above the probe holder. When this is done, the white "CLOTHING PROBE IN USE" panel lights up. The output of the clothing probe is read on a count rate meter which is calibrated 0 to 10,000 counts per minute.

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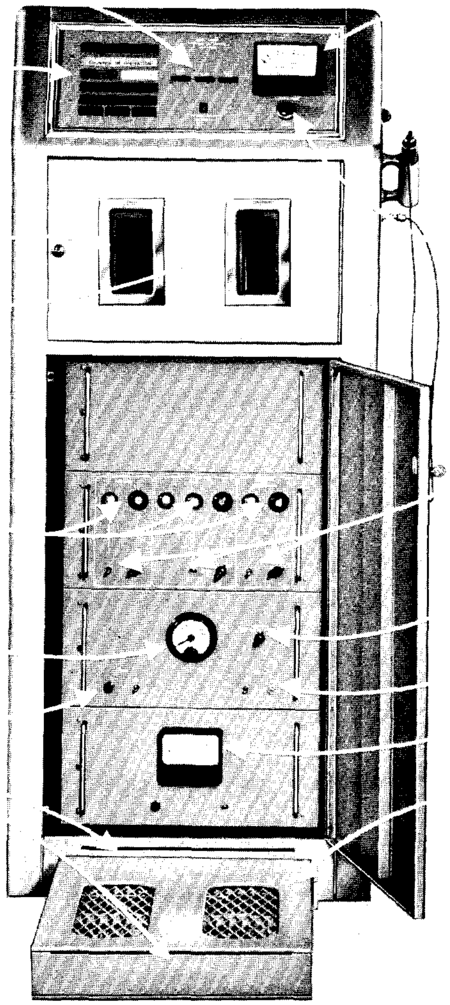

FLEXIBILITY

The Model HSM-10 offers an unusually wide range of operating limits and warning levels, and thus can serve any health physics requirement. Use of three switches in each channel provides as many as 15 different scaling factors. Time intervals on the mechanical timer are variable from 1 to 120 seconds.

CONSTRUCTION: The Model HSM-10 is housed in a metal cabinet with a smooth grey hammertone finish. A door, with lock, covers all controls, protecting the instrument from misadjustment by unauthorized personnel. Adjustments, tube replacements, and routine servicing can be done without removing the chassis from the cabinet.

SPECIFICATIONS:

SENSITIVITY: Minimum Beta energy 0.2 MEV.

TUBES: T/A Type T1100 halogen-quenched.

ALARM SETTINGS: Hand Channels—100 to 10,000 counts in 15 steps. Shoe Channel—1000 to 100,000 counts in 15 steps.

COUNTING PERIOD: Variable from 1 to 120 seconds.

REGISTER RANGE: 0 to 99999, five digits on each of three Sodeco Registers.

WARNING LEVEL INDICATOR: Adjustable by the Health Physicist.

POWER SUPPLY REQUIRED: 300 watts, 95-125 volts 60 cycle A.C.

DIMENSIONS: Cabinet: 65″ high x 27″ wide x 18″ deep. Foot Deck: 25″ long x 18″ wide x 4″ high.

SHIPPING WEIGHT: 650 lbs.

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INSTRUMENTATION FOR NUCLEAR RESEARCH

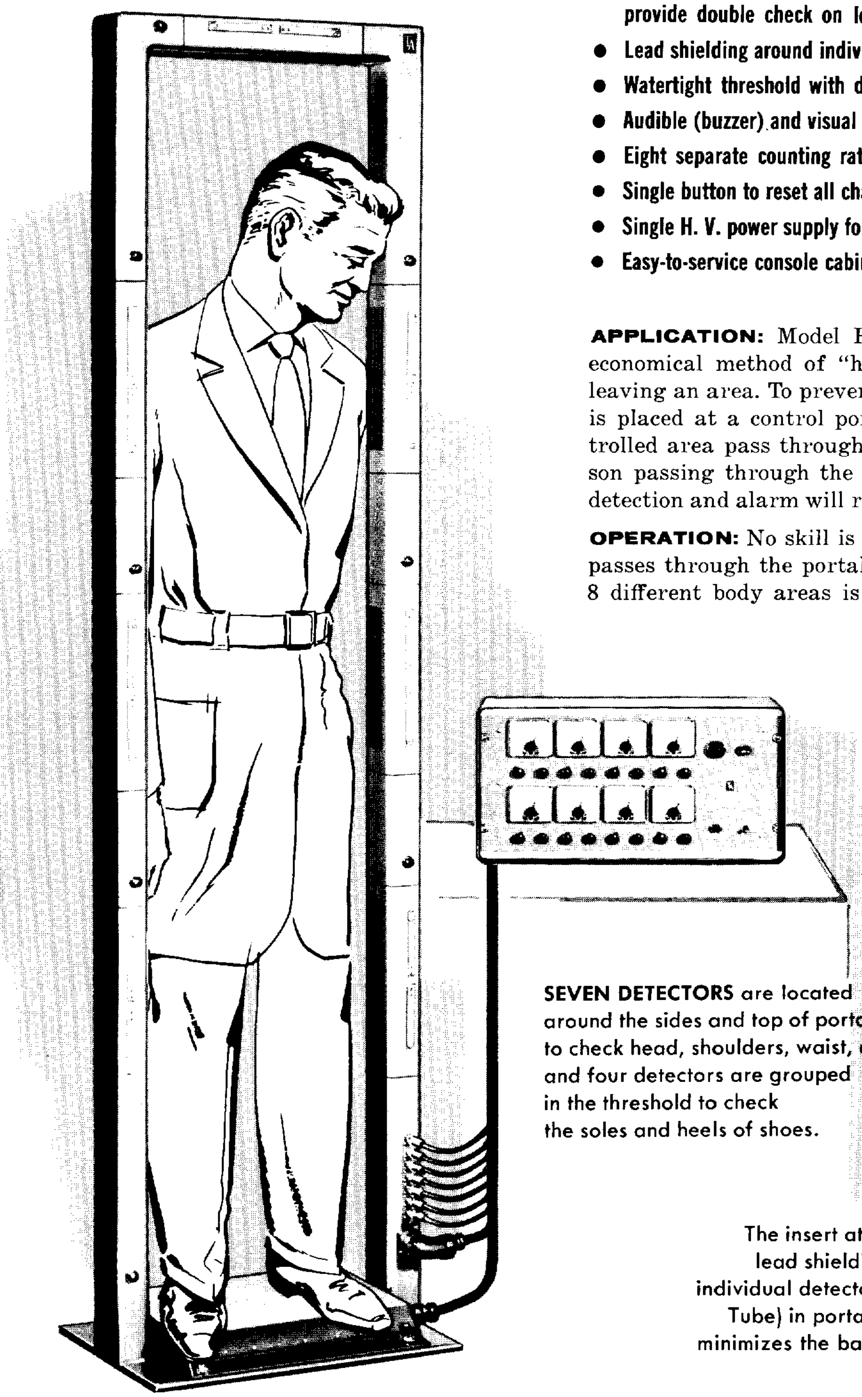
BETA-GAMMA PERSONNEL and LAUNDRY MONITORS

Model PPM-8 Portal Type • Model LIM-18 Laundry Type

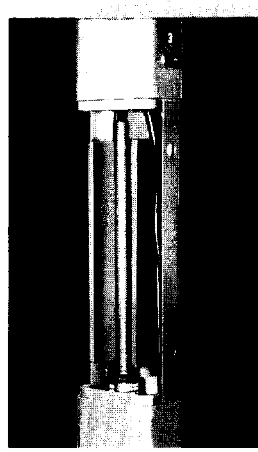
- **Alarm lights on portal and meter indicators on console panel provide double check on location of contamination.**
- **Lead shielding around individual detectors minimizes background.**
- **Watertight threshold with detachable plastic foot mat for easy decontamination.**
- **Audible (buzzer) and visual (red light) alarms.**
- **Eight separate counting rate circuit channels with individual alarm settings.**
- **Single button to reset all channels.**
- **Single H. V. power supply for all channels.**
- **Easy-to-service console cabinet.**

APPLICATION: Model PPM-8 Portal Monitor provides a quick, efficient, economical method of "head to toe" monitoring of personnel entering or leaving an area. To prevent the spread of contamination, the Portal Monitor is placed at a control point so that personnel entering or leaving the controlled area pass through the portal. Should the contamination on any person passing through the portal exceed a preset radiation level, immediate detection and alarm will result.

OPERATION: No skill is required by personnel being monitored. As person passes through the portal, any detected change in the level of radiation at 8 different body areas is indicated on a corresponding meter. An audible alarm sounds when the preset radiation level is exceeded, and indicator lights on *both* portal and console panel glow "RED" to indicate the exact spots of contamination. The inside dimension of the portal is purposely narrow to prevent personnel from moving through too rapidly to complete a good check; however, passage can usually be made at 2-second intervals.



SEVEN DETECTORS are located around the sides and top of portal to check head, shoulders, waist, and legs; and four detectors are grouped in the threshold to check the soles and heels of shoes.



The insert at right shows the lead shielding behind each individual detector (T/A #1120 Tube) in portal. This shielding minimizes the background count.

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5M-9/59

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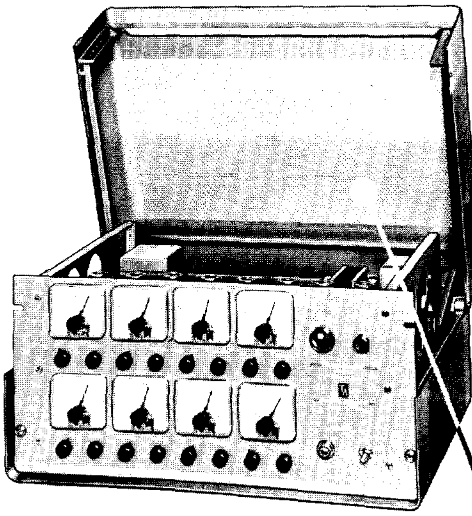
PECIFICATIONS

of PPM-8 PORTAL MONITOR



RANGE: Portal Channels (7), 0-1000 CPM full scale.
Threshold Channel (1), 0-2000 CPM full scale.

RESPONSE TIME: 2 to 4 seconds continuously variable.

ALARM SETTING: Minimum 1.5 x background reading.

SENSITIVITY: Less than 0.15 μc (Beta/Gamma) on body surfaces.
Less than 2 μc (Beta) on soles of shoes.

DETECTORS: Portal Frame – 7 T/A No. T-1120 Halogen-quenched tubes.
Threshold – 4 T/A No. T-1100 Halogen-quenched tubes.

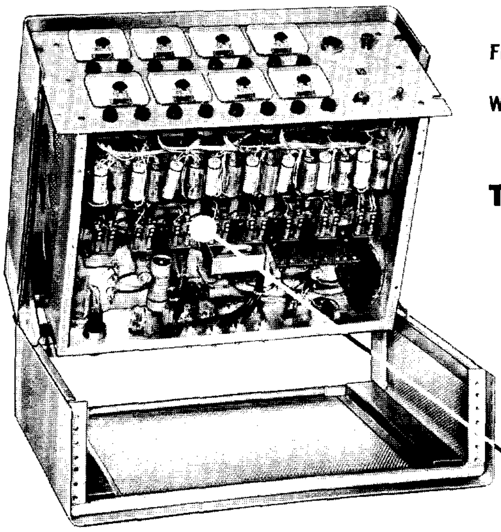
REMOTE ALARM RESET: Back panel mounted jack for remote reset accessory.

POWER SUPPLY REQUIRED: 110 volt 60 cycle 50 watts.

DIMENSIONS: Portal Frame (Outside) – 20″ wide x 15″ deep x 84″ high.
(Inside) – 16″ wide x 15″ deep x 77″ high.
Console Cabinet – 22″ wide x 15″ deep x 11″ high.

FINISH: *Portal and Console Cabinet – Hammertone grey.*
Console Panel – Flat dark grey.

WEIGHT: Portal, 98 lbs. Console, 54 lbs. Total packed for shipment, 200 lbs.



T/A Easy-to-Service CONSOLE CABINET

Top section raised to service tubes and upper chassis.

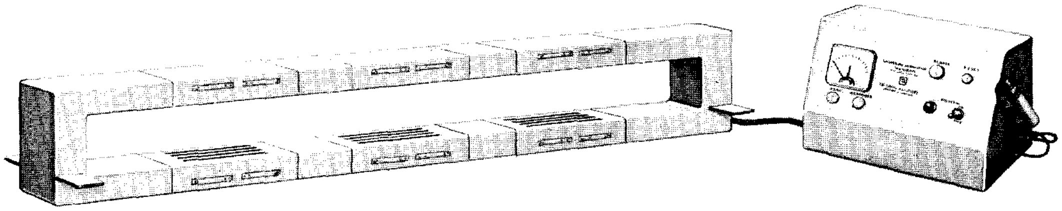
Complete chassis and panel raised to service circuit boards and under-chassis components.

LIM-18 LAUNDRY INSPECTION MONITOR

This is a simplified, low-cost instrument for monitoring clothing and equipment worn in Beta/Gamma contaminated areas. After being washed and prior to re-issue, the material is passed through the monitoring frame where it is scanned by six lead-shielded detectors. Laundered material having residual contamination in excess of permissible preset level will cause an immediate alarm at the Single Channel Radiation Console. A T/A Model P-7 Hand Probe is standard equipment with the Model LIM-18 Monitor for the purpose of localizing detected contamination.

SPECIFICATIONS

RANGE: 0-2000 CPM full scale.
RESPONSE TIME: 2 to 4 seconds.
ALARM SETTING: Minimum 1.5 x background reading.
DETECTORS: 6 T/A No. T-1120 Halogen-quenched tubes in frame.
1 Victoreen 1B85 G/M tube in hand probe.
SENSITIVITY: Less than 0.15 micro-curies (Beta/Gamma).
POWER SUPPLY REQUIRED: 110 volts 60 cycle 35 watts.
DIMENSIONS: Frame approximately 44″ wide x 4″ high inside.
(Can be varied within reasonable limits.)
WEIGHT: Total shipping – 175 lbs.



TECHNICAL ASSOCIATES

140 West Providencia Avenue • Burbank, California

T E C H N I C A L   A S S O C I A T E S
INSTRUMENTATION FOR NUCLEAR RESEARCH
140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA
TELEPHONES: VIctoria 9-5838 • THornwall 8-6649

March 1, 1959

To All Technical Associates' Catalog Holders:

Herewith four (4) new pages and our latest price list revision for insertion in the catalog which, our records show, was previously issued to you:

Bulletin	Model	Product	Replaces
164	GS-7	New Binary Scaler	New Product
166	DS-5B	New Decade Scaler	Bulletin 140
144 (revised)	IC-1	Ionization Chamber and Counter Tubes	Bulletin 144
165	CP-3	New Cutie Pie Survey Meter	Bulletin 147

Our latest price list revision includes changes in all personnel monitors and prices for new instruments listed above.

Please notify us if your catalog has been misplaced and we will send another copy to you.

Very truly yours,

TECHNICAL ASSOCIATES

PRICE LIST

TECHNICAL ASSOCIATES • 140 W. Providencia Ave. • Burbank, Calif.

Revised March 1, 1959
Subject to Change Without Notice

PERSONNEL MONITORS

ALM-1X	Alpha Hand Monitor (Argonne Count Rate Meter Design) with external Alpha Probe	$2,875.00
ALM-2X	Beta/Gamma Hand and Foot Monitor (Argonne Count Rate Meter Design) with External Beta/Gamma Probe	2,975.00
AHC-2	Alpha Hand Counter (Hanford Binary Scaler Type)	2,675.00
HSC-1	Beta/Gamma Hand and Shoe Counter (Hanford Binary Scaler Type)	2,650.00
	Note: Add $75.00 per instrument for 50 cycle, 115 volt.	

ANALYTICAL INSTRUMENTS

*DS-5B	Decade Scaling Unit (5 microseconds)	835.00
*DS-5BA	Decade Scaling Unit (1 microsecond)	885.00
DU-1	One microsecond plug-in decade unit	107.50
DU-5	Five microsecond plug-in decade unit	57.50
**CR-2	Count Register used with DS-5B or DS-5BA	65.00
PT-1	Pre-determined Timer (Long Counting Intervals—999 Minutes)	95.00
**PT-2	Pre-determined Timer (Short Counting Intervals—120 Seconds)	95.00
**PT-3	Pre-determined Timer, Liebel-Flarsheim (Range 1 second to 60 minutes)	110.00
*GS-7	Binary Scaling Unit (Scale of 256)	655.00
*RM-7	Dual Linear and Log Count Rate Meter	595.00
RM-7C	Dual Linear and Log Count Rate Meter with special time constants	610.00
*SM-10	Medical Spectrometer (Single Channel Pulse Height Analyzer, with built-in Linear Amplifier and Ratemeter)	675.00
*SA-20	Analytical Spectrometer (Single Channel Pulse Height Analyzer)	595.00
AP-20	Alpha Poppy Laboratory Monitoring Instrument—rack mounted 8¾" x 19"	550.00
*LA-5a	Linear Amplifier (specify delay line 1 or 2 microseconds) cable lengths to 10 ft.	535.00
*LA-5b	Linear Amplifier (specify delay line 1 or 2 microseconds) cable lengths 10' to 100'	565.00
PA-5	Pre-Amplifier for LA-5 with cables	115.00
RHV-1	High Voltage Power Supply — rack mounted 5¼" x 19"	325.00

*Prices on all analytical instruments are for cabinet mounted models, unless otherwise noted. If a rack mounted instrument is desired, deduct $10.00 from the price and add the letter "R" to the instrument designation.

**These accessories will be supplied in a cabinet or panel mounted at customer's option.

DETECTORS, PROBES AND ACCESSORIES

SD-1	Scintillation Detector with 1" x 1" NaI crystal, complete with cables	455.00
SD-2	Scintillation Detector with 2" x 2" NaI crystal, complete with cables	765.00
SD-2W	Well-type Scintillation Detector with 1¾" x 2" NaI crystal (⅝" x 1½" well) complete with cables for use with LS-8 or LS-8X Shields	695.00
SD-3	Scintillation Detector with 1½" Alpha Phosphor, complete with cables	495.00
SD-4	Scintillation Detector with 1½" Beta Anthracene Crystal, complete with cables	545.00
SD-12	Scintillation Detector for Analytical Spectrometry with 2" x 2" NaI crystal, complete with cables	825.00
SD-12W	Well-type Scintillation Detector for Analytical Spectrometry, with 1¾" x 2" NaI crystal (⅝" x 1½" well), complete with cables for use with LS-8 or LS-8X Shields	755.00
CH-1	Crystal Housing for SD-1 Scintillation Detector	25.00
CH-2	Crystal Housing for SD-2 or SD-12 Scintillation Detector	30.00
CH-2W	Crystal Housing for SD-2W and SD-12W Scintillation Detectors	30.00
NS-1	Nose Shield for Model SD-1 Detector	95.00
NS-2	Nose Shield for Model SD-2 Detector	115.00
C-1a	Collimator Type A (20° Flat Field) for SD-1 Detector	29.50
C-2a	Collimator Type A (20° Flat Field) for SD-2 Detector	39.50
C-1b	Collimator Type B (Straight Bore) for SD-1 Detector	35.00

5M - 3-1-59

PRICE LIST (Continued)

C-2b	Collimator Type B (Straight Bore) for SD-2 Detector	45.00
C-1c	Collimator Type C (Focusing) for SD-1 Detector	75.00
C-2c	Collimator Type C (Honeycomb) for SD-2 Detector	95.00
AS-11	Alpha Detector (1") for SD-1, complete with mount	79.50
AS-12	Alpha Detector (1½") for SD-2, complete with mount	85.00
BS-11	Beta Detector (1") for SD-1, complete with mount	79.50
BS-12	Beta Detector (1½") for SD-2, complete with mount	95.00
MS-1	Mobile Stand for Scintillation Detector, counter weighted and with shelf for Scaler or Rate Meter	295.00
DL-1	Distance Locator (Plastic disc with 10 c.m. rubber pointer) for use with NS-1 Nose Shield	10.00
DL-2	Distance Locator (Plastic disc with 10 c.m. rubber pointer) for use with NS-2 Nose Shield	10.00
P-7	Beta/Gamma Probe Assembly with 1B85 Tube, cable and connector	39.50
P-8	End Window Probe (less tube) complete with cable and connector	45.00
P-8X	End Window Probe Assembly with T/A T-1180 Tube, cable and connector	75.00
P-9	Alpha Probe for use with AP-20	135.00

IONIZATION CHAMBERS

IC-1	Ionization Chamber with windows (Beta/Gamma)	115.00
IC-2	Ionization Chamber—Solid Wall (Gamma)	105.00

SURVEY METERS

CP-3	New Cutie Pie Portable Survey Meter	265.00
CP-3A	New Cutie Pie Portable Survey Meter with special ranges (0-25, 0-250, 0-2500 mr/hr)	295.00
SRJ-6	New Juno Survey Meter with plug-in battery pack and replaceable alpha window (Standard Range)	295.00
HRJ-6	New Juno Survey Meter with plug-in battery pack and replaceable alpha window (High Range)	295.00

LEAD SHIELDS

LS-1	Complete with Type ST-1 Sample Tray, Type SK-1 Socket and Type TM-1 Tube Mount	185.00
LS-2A	Standard with Type TM-6 Tube Mount and Sample Tray Holder, Type ST-2A Sample Tray and 10 Type PL-2 Aluminum Planchets	200.00
LS-2B	Micrometric with 10 Type PL-1 Planchets	285.00
LS-4A	For liquids complete with Type TM-1 Tube Mount, Type SK-1 Socket, and one Type ST-5 Marinelli Beaker	200.00
LS-4B	Modified to accommodate special tubes with aluminum inner liner	235.00
LS-4C	For solids, complete with Type TM-1 Tube Mount, Type SK-1 Socket, one Type ST-6 Ore Container and 100 Type ST-6A Paper Sleeves	225.00
LS-5	Complete with Type TM-3 Tube Mount, Type SK-2 Socket, Type STH-1 Sample Tray Holder, Type ST-4A Sample Tray, and 10 Type PL-2 Aluminum Planchets	260.00
LS-6	Complete with Type TM-7 Tube Mount, one Type ST-3B Sample Tray and 10 Type PL-3 Aluminum Planchets	275.00
LS-6X	Eight-inch height extension for LS-6 Shield	98.50
LS-6L	Lid with 3" opening and retaining collar for Models SD-1, SD-2, SD-12 Scintillation Detectors	72.50
LS-6P	Plug for 3" opening in LS-6L	12.50
LS-7A	Multi-Purpose Type complete with SD-1 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	720.00
LS-7B	Multi-Purpose Type complete with SD-2 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	1,030.00
LS-7C	Multi-Purpose Type complete with TM-8 Tube Mount, three ST-7 Sample Trays and 10 PL-3 Planchets	325.00
LS-7M	Multi-Purpose Type—Shield only, with adapter ring, three ST-7 Sample Trays and 10 PL-3 Planchets	265.00
LS-8	For well counting (shield only, less detector)	225.00

PRICE LIST (Continued)

TECHNICAL ASSOCIATES • 140 W. Providencia Ave. • Burbank, Calif.

LS-8W	For well counting, complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	920.00
LS-8X	For well counting with 2" shielding in all directions (Shield only, less Detector)	290.00
LS-8WX	For well counting with 2" shielding in all directions complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	985.00

COUNTER TUBES

T-1100	Thin wall type tube 3" long used in Model ALM-2, ALM-2X and HSC-1	20.00
T-1120	Thin wall type tube 7" long used in Models ALM-2, ALM-2X and HSC-1	35.00
T-1140	Mica End Window, used in TM-7, TM-8 Tube Mounts and P-8 Probe	47.50
T-1160	Mica End Window (Organic Quenched) used in TM-7, TM-8 Tube Mounts and P-8 Probe	47.50
T-1180	Mica End Window Alpha/Beta/Gamma sensitive used in P-8X Probe	50.00

LABORATORY ACCESSORIES

AB-2	Absorber Set	85.00
ST-1	Sample Tray	6.50
ST-2, ST-3, ST-4	Sample Trays	3.50
ST-5	Marinelli Beaker	4.25
ST-6	Ore Container	12.50
ST-6A	Paper Sleeves for Ore Container per C	2.00
ST-7	Sample Tray for LS-7	2.50
STH-1	Sample Tray Holder with tray and ten planchets	13.50
SK-1, SK-2, SK-3	Sockets	5.00
TM-1, TM-2, TM-3, TM-4	Tube Mount	15.00
TM-5	Tube Mount (micrometric for LS-2 Lead Shield)	100.00
TM-6	Tube Mount and Sample Tray Holder	22.50
TM-7	Tube Mount and Sample Tray Holder	27.50
TM-8	Tube Mount and Adapting Ring for LS-7 Multi-Purpose Shield	60.00
LC-1	Lead Source Container for four radium needles	45.00
LC-3	Lead Source Container 1" lead walls, 1½" x 3" inside dimensions	40.00
LC-3A	Lead Source Container 1⅜" lead walls, ¾" x 2¼" inside dimensions	47.50
LC-4	Lead Source Container 1½" lead walls, 1½" x 3" inside dimensions	50.00
LC-4A	Lead Source Container 1¾" lead walls, ¾" x 2½" inside dimensions	57.50
LC-9	Mobile Source Unit — compartment 3" x 6" in shield of 2" lead. Mounted on heavy duty hand cart	225.00

Lead Brick, machined all sides 2" x 3" x 6"		8.50
Lead Brick, machined all sides 2" x 4" x 8"		12.50
Lead Brick, extruded shape		Prices upon application
Planchets, Type PL-1, Sheet steel, tinned	per C	3.25
	per M	30.00
	5M	27.00/M
Planchets, Type PL-2 & PL-3, aluminum	per C	3.25
	per M	30.00
	5M	27.00/M
Planchets, Type PL-2C & PL-3C, copper	per C	4.50
	per M	40.00
	per 5M	36.00/M
Planchets, PL-2S, stainless steel	per C	9.00
	per M	65.00
	per 5M	58.50/M
Planchets, Type PL-3S, stainless steel	per C	12.00
	per M	85.00
	per 5M	76.50/M
Planchets, Type PL-4, aluminum	per C	5.00
	per M	45.00
	per 5M	40.50/M
Planchets, special materials and sizes		Prices quoted upon request

PRICE LIST (Continued)

IN GENERAL

Unit prices are given in this price list, unless otherwise noted.

All prices quoted herein are f.o.b. Burbank, California. Payment terms, net 30 days upon approved credit.

No extra charge is made for packing for domestic shipments. Export charges will be quoted upon application.

We reserve the right to alter specifications at any time without incurring the obligation of incorporating new features in previously manufactured equipment.

Prices are subject to change without notice. Quotations remain firm for 30 days.

Shipping instructions: Please include shipping instructions when ordering; in the event that shipping instructions are not given, we will use our best judgment in the matter.

SERVICE CHARGES

Service charges for repairs are usually billed on an hourly basis, however, if desired, an estimate can be given before the work is undertaken. The unit to be repaired should be shipped prepaid to us.

WARRANTY

Technical Associates warrants instruments and equipment (except tubes, fuses, batteries and crystals), manufactured by it to be free from defects in workmanship or materials under normal use for a period of one year from the date of shipment from the factory to the buyer. Tubes, fuses, batteries and crystals are subject to the guarantee established by the manufacturer of them, however, Technical Associates will assist the customer to obtain full benefits of these guarantees.

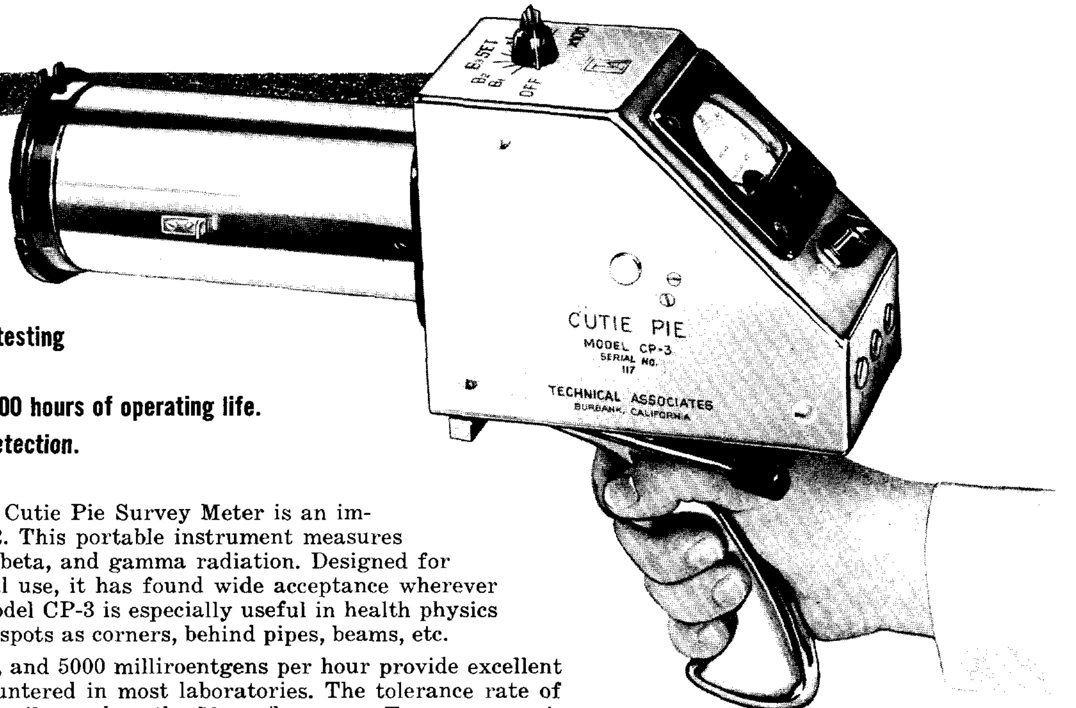
If, within the one year warranty period, any Technical Associates' instrumentation or equipment requires service as a result of a defect, the buyer may return it to the factory of Technical Associates at Burbank, California or to a service station designated by Technical Associates, transportation charges prepaid, for service at no charge under the warranty. The buyer is urged to communicate with Technical Associates when warranty service is required, stating the nature of the difficulty and giving model and serial number of instrument. It may be possible to diagnose the trouble and send a replacement part or assembly, thereby avoiding the expense of shipment.

Technical Associates will return the instrument to the buyer, transportation charges prepaid, after repairs or replacement under warranty are completed. The liability to Technical Associates under this warranty is limited to the cost of replacement of defective parts upon prompt notification of such defect.

INSTRUMENTATION FOR NUCLEAR RESEARCH

CUTIE PIE, MODEL CP-3

PORTABLE ALPHA, BETA, and GAMMA SURVEY METER



- **Built-in alpha and beta absorption filters.**
- **3 ranges: 0-50, 500, or 5000 mr/hr.**
- **Selector switch positions permit testing of all batteries before use.**
- **New battery pack provides over 800 hours of operating life.**
- **Thin end window permits alpha detection.**

APPLICATION: The Model CP-3 Cutie Pie Survey Meter is an improved version of the Model CP-2. This portable instrument measures and distinguishes between alpha, beta, and gamma radiation. Designed for laboratory, reactor, and industrial use, it has found wide acceptance wherever radioisotopes are handled. The Model CP-3 is especially useful in health physics work to monitor such inaccessible spots as corners, behind pipes, beams, etc.

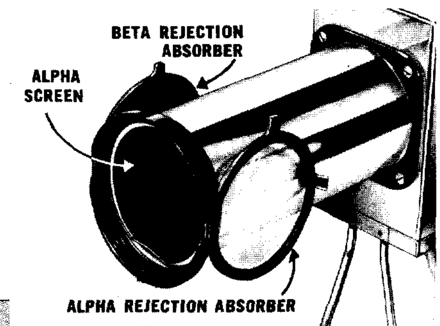
Three full-scale ranges of 50, 500, and 5000 milliroentgens per hour provide excellent coverage of radiation levels encountered in most laboratories. The tolerance rate of 7.5 mr/hr for a 40-hour week is easily read on the 50 mr/hr range. To assure maximum reliability, the range selector switch includes 3 test positions for checking batteries prior to use.

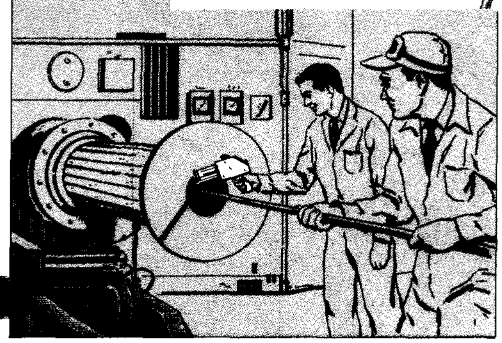
DESCRIPTION: The Model CP-3 Cutie Pie is a gun-type survey meter comprising an ionization chamber, an electrometer circuit, absorption filters for the rejection of alpha or beta particles, an indicating meter, and a battery complement identical to that of the Juno Radiation Survey Meter, Models SRJ-6 or HRJ-6. The undesired radiations are easily rejected by swinging the proper absorber into place in the absorber bracket mounted on the front of the ionization chamber.

The Model CP-3 has a bright, chrome-plated all-aluminum ionization chamber and case. The end of the chamber is closed with a rubber hydrochloride alpha screen .0003″ thick (0.45 mg/cm^2), which is frame-mounted and held in place by clips, thus permitting its easy replacement. The case is chrome-plated aluminum for easy cleaning and decontamination. All edges are rounded. Rubber gaskets provide protection against high humidity conditions.

The T/A Model CP-3 incorporates circuit improvements and battery pack which extends the battery life to more than 800 operating hours and permits the testing of all batteries prior to use. This is done by turning the selector switch to each of the 3 battery test positions. Batteries of proper voltage produce a reading in the green sector on the meter. A set position permits the meter to be adjusted to read zero even in a radiation field. The remaining 3 switch positions permit the selection of radiation measuring ranges.

Model CP-3 is shown with both absorption filters locked at side of the chamber.





Cutie Pie is shown testing radioactivity of vacuum melted steel.

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PECIFICATIONS

RADIATION RANGES: 50, 500, and 5000 mr/hr full scale.

CALIBRATION: Factory calibrated, using gamma standard calibrated by the National Bureau of Standards. Calibration accuracy $\pm 10\%$. Internal individual calibration controls for each range, screwdriver adjusted from outside of case. Access is permitted by means of snap plugs.

CIRCUIT: Reliable single tube electrometer circuit. Ranges of sensitivity are obtained by switching input grid resistors. This is accomplished by a special Teflon insulated switch. All high resistance points in the circuit are insulated with Teflon or Kel-F to insure minimum leakage. Ranges and corresponding input resistance are:

50 mr/hr	1.4×10^{11} ohms
500 mr/hr	1.4×10^{10} ohms
5000 mr/hr	1.4×10^{9} ohms

The circuit contains five individual potentiometers for purposes of zeroing and calibration.

METER: High quality 3½" meter, scale length 2.36", with 50 scale divisions. Appropriately calibrated to read in milliroentgens per hour for gamma radiation. Mounted in position to permit excellent visibility.

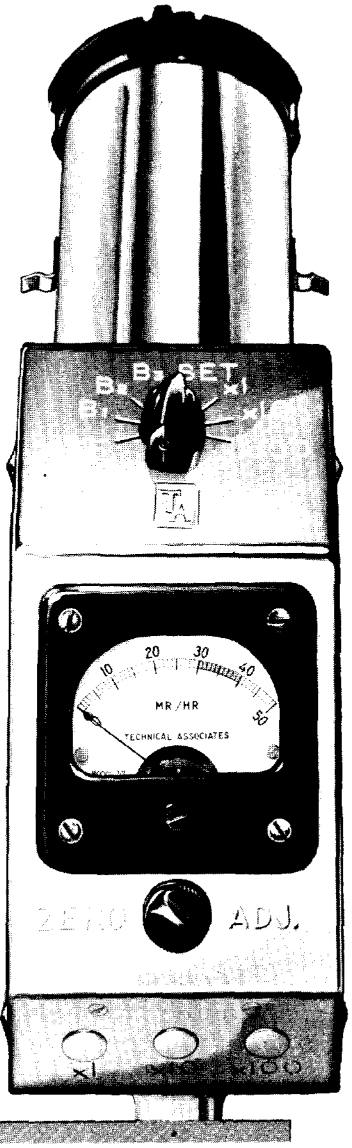
CONTROLS: Single control switches meter to zero position, battery test points, and 3 operating ranges. Meter Zero Control is located directly below the meter and zeros the meter by adjusting the filament voltage. Coarse Meter Zero Control and Calibration Control are screwdriver adjustments located beneath snap plugs on sides of instrument case and are provided for use only after battery voltages have dropped considerably.

TIME CONSTANTS: Range 50 mr/hr 6 seconds
Range 500 mr/hr less than 1 second
Range 5000 mr/hr less than 1 second

ZERO DRIFT: Negligible after 15 minutes warm-up period.

BATTERY LIFE: Over 800 operating hours.

IONIZATION CHAMBER:
Aluminum Cylinder: 2⅞" inside diameter, 6⅜" long.
Volume: Approximately 36 cubic inches.
Window opening: 2¾" in diameter.
Alpha Screen: Easily removable, ring-mounted rubber hydrochloride .0003" thick (0.45 mg/cm^2).
Alpha Rejection Absorber: Hinge held, ring-mounted cellulose acetate 0.01" thick.
Beta Rejection Absorber: Hinge held, aluminum disc 0.102" thick.



CASE: Formed and welded sheet aluminum with chrome finish and large, clearly engraved markings.

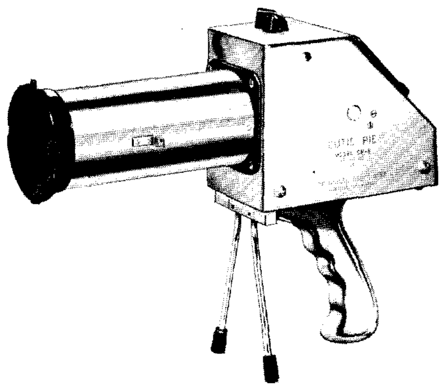
HANDLE: Cast aluminum, free from porosity and highly polished. Hollow construction to reduce weight.

BATTERY COMPLEMENT:
4 Eveready No. 412 22½ Volt "B" Batteries
2 Eveready No. E12 1.35 Volt "A" Batteries
2 Mallory No. TR-115 6.5 Volt "B" Batteries

VACUUM TUBE: Raytheon Type 5886.

WEIGHT: 4 lbs. 12 oz. net. Shipping Weight: 8 lbs.

A special Model CP-3A is available at slightly higher cost, for applications where higher sensitivity is required. This instrument is equipped with ranges of 0-25, 0-250, 0-2500 mr/hr.



MODEL CP-3 CUTIE PIE,
with front tripod feet in position for bench or table use.

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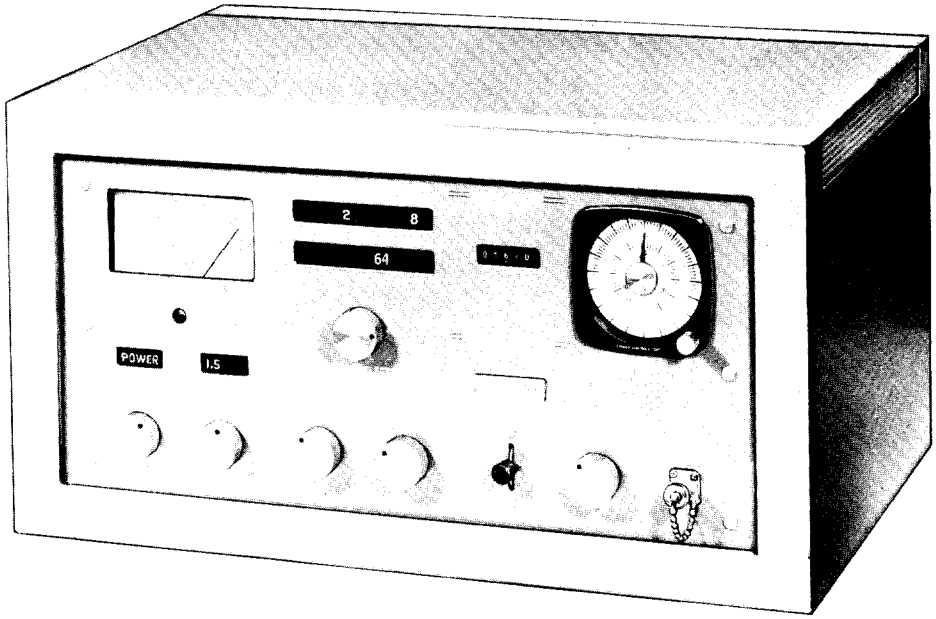
INSTRUMENTATION FOR NUCLEAR RESEARCH

MODEL GS-7 BINARY SCALER



- **with automatic electric reset**
- **predetermined count**
- **elapsed time indicator**
- **binary scale of 256**
- **300-3000 volt detector supply**

APPLICATION and SCOPE OF USE...

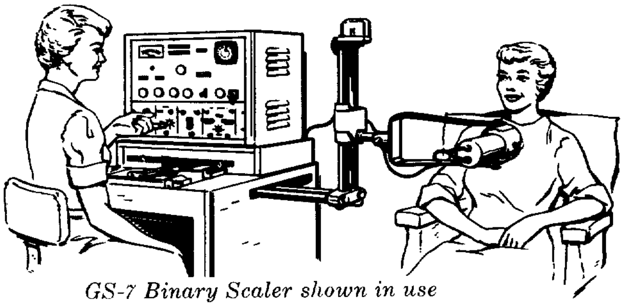
The Model GS-7 Binary Scaler is a general purpose, precision counting instrument which features extreme simplicity in operation, as well as unusual flexibility in counting procedures. It is designed for use with Geiger, scintillation, or proportional detectors, and has many applications in diagnostic and therapeutic procedures in nuclear medicine, radiochemical studies, and other laboratory counting problems. Exceptional reliability is assured through the use of newly developed components of the highest quality. The GS-7 has a resolving time of 5 microseconds. For counting problems requiring shorter resolving time, the GS-7A, with 1 microsecond resolution, is available.

OPERATION: The GS-7 uses 8 binary scaling stages, providing an electronic scaling factor up to 256. A scale selector switch allows a wide choice of scaling speeds. The total recorded count is determined by multiplying the reading on the five-digit register by the scaling factor, and adding the values of the interpolation lights which are illuminated. Built-in features include an elapsed time indicator, which gives the exact amount of time elapsed during any counting run. The GS-7 is available with either a timer reading in seconds, or in hundredths of a minute. Either timer indicates a total elapsed time of 60 minutes.

An outstanding feature of the GS-7 is the automatic electric reset button, which simultaneously resets the register, timer, and binary scale indicators in one single operation. Laboratory technicians will quickly recognize the tremendous value of this feature in simplifying operation and assuring faster, more efficient counting procedures.

The GS-7 incorporates an accurately regulated 300-3000 volts D.C. detector supply, with extremely accurate settings accomplished by "coarse" and "fine" adjustments. A panel switch turns the high voltage on and off, without changing the voltage setting.

Predetermined count selection is provided by a switch which enables the user to automatically stop the scaling action after 1, 10, or 100 register counts. When the preset count is reached, the scaler stops, and the time required to accumulate the count is read on the timer. The GS-7 may also be coupled with such external accessories as the Predetermined Timers PT-1, PT-2, or PT-3, to gain the added advantage of preselected counting time.



GS-7 Binary Scaler shown in use with scanner for thyroid "mapping."

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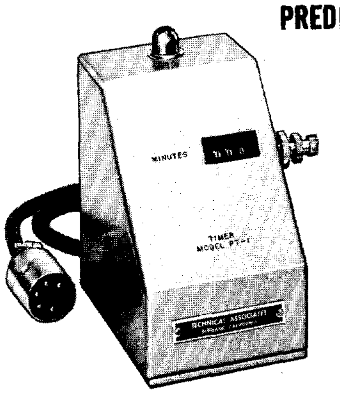
for use with
Technical Associates Scalers

PREDETERMINED TIMER, Model PT-1



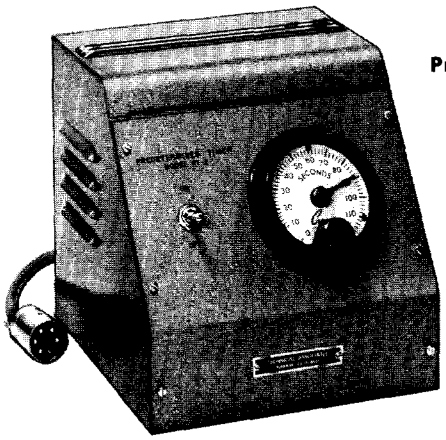
Provides preset time control for GS-7 Binary Scaler from 1 minute to 999 minutes, with 1 minute increments. For the convenience of the operator, an indicator light goes off when counting period ends.

ACCURACY of any selected time interval is ±0.2%.

SIZE: 5″ x 3½″ x 5″.

WEIGHT: 2 lbs.

PREDETERMINED TIMER, Model PT-2



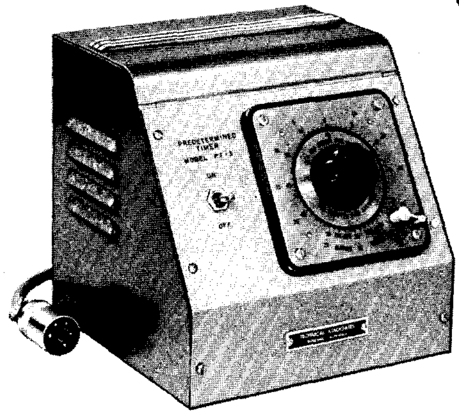
For use where short counting intervals prevail. Provides pre-set time control from 0 to 120 seconds, with 1 second increments. Available in other ranges and dial divisions upon request.

ACCURACY: Overall ±½ of 1% of full scale. Repeat ±¼ of 1% of full scale.

SIZE: 8″ x 8″ x 8″.

WEIGHT: 5 lbs.

PREDETERMINED TIMER, Model PT-3



***Contains Liebel-Flarsheim Model 2-D Nuclear Timer.* Combines pre-set and elapsed time with timing range from 1 second minimum to 60 minutes maximum, in one second divisions.**

ACCURACY:
±1/10th second

SIZE:
8″ High
8″ Wide
8″ Deep

WEIGHT:
6 lbs.

pecifications
of GS-7 Binary Scaler

RANGE: Diode coupled binary scale of 256, with scale selection of 4, 8, 16, 32, 64, 128, and 256, followed by a 5-digit Sodeco Register providing an aggregate count capability of 6400 cps.

ELAPSED TIMER: New Cramer #691, clock face type, with 60 minute total elapsed time and accuracy of .01 second. Choice of increments of one second or one hundredth of a minute, as ordered.

RESOLVING TIME: 5 microseconds on standard GS-7. *1 microsecond resolution time on* Model GS-7A.

HIGH VOLTAGE POWER SUPPLY: Variable from 300 to 3000 volts by means of "Coarse" and "Fine" Controls.

HIGH VOLTAGE METER RANGES: 300 to 1500 volts full-scale; 600 to 3000 volts full-scale.

REGULATION: Less than .002% change in high voltage for 1% line voltage change between 95 and 130 volts A.C.

ELECTRIC RESET: High speed electrical reset instantly resets register, timer, and binary scale indicators by simply depressing a single push-button.

PREDETERMINED COUNT: Stops count register at 1, 10 or 100, and also stops elapsed time indicator.

ON REAR PANEL: Latch-lock connectors for PT-1, PT-2 or PT-3 Predetermined Timers, and SD-1 or SD-2 Scintillation Detectors. Signal input and high voltage output connector. Test signal switch, permitting check of scaling stages. Oscilloscope connector.

INPUT SENSITIVITY: Variable from 0.15 volts to 3.0 volts negative pulse, with chassis-mounted control. Factory adjusted for 0.25 volts.

POWER REQUIREMENTS: 100 to 130 volts, 60 cycle 180 watts. Available for 50 cycle, 110 volts or 220 volts, on request.

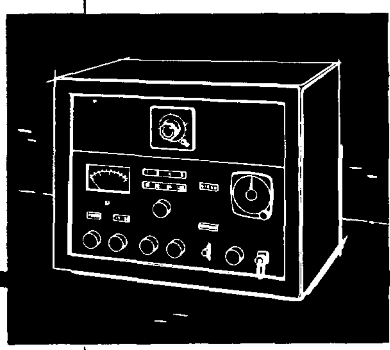
CONNECTORS:

Signal Input (front and rear)	UG-931/U
Preamplifier	Cannon XL-3-13
External Register	Cannon XL-4-13
External Timer	Cannon P5-13
Scope Output	Switchcraft #11
Power Input	Amphenol 61-M10

DIMENSIONS: In cabinet: 20½″W x 10¾″H x 13¾″D (Model GS-7). For rack mounting: 19″W x 8¾″H x 13″D (Model GS-7R).

WEIGHT: 35 lbs.

FINISH: Smooth grey hammertone.



GS-7 AND TIMER AVAILABLE AS A COMPLETE UNIT

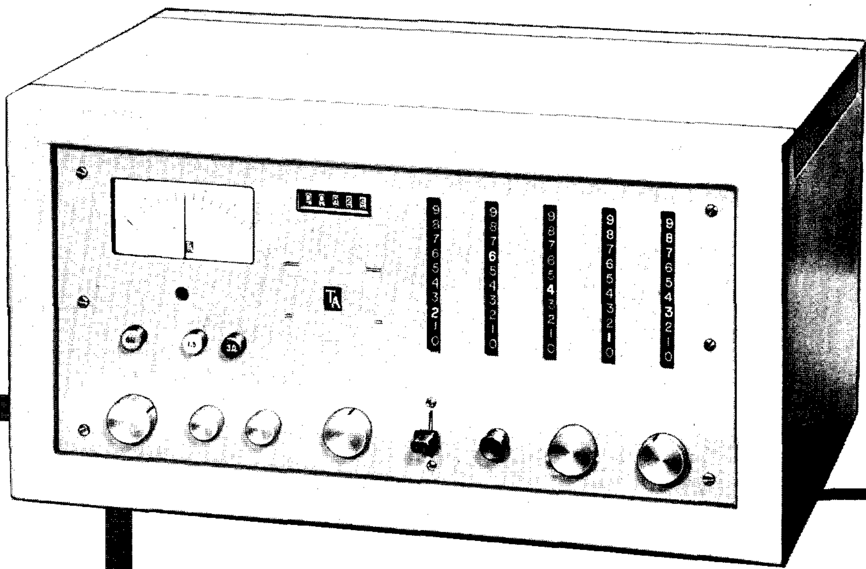
All of the timers shown can be supplied on a 19″ panel for mounting with the GS-7 Binary Scaler in a single cabinet, at customer's option.

TECHNICAL ASSOCIATES

140 WEST PROVIDENCIA AVE. • BURBANK, CALIFORNIA

INSTRUMENTATION FOR NUCLEAR RESEARCH

DECADE SCALER
Model DS-5B and Model DS-5BA



Five decade units for direct read-out.
Push-button electric reset.
Highly stable +300 to +3000 volt D.C. detector supply.
Choice of 10 predetermined counts.
Built-in elapsed time indicator.
Choice of 1 or 5 microsecond resolving time.

APPLICATION. Technical Associates Models DS-5B and DS-5BA Decade Scalers are precision counting instruments for use with Geiger, Scintillation, or Proportional Detectors, and have been carefully designed to combine exceptional versatility with extreme reliability and simplicity of operation. Model DS-5B provides 5 microsecond resolving time; Model DS-5BA provides 1 microsecond resolving time for higher counting rates. In addition to operation as a conventional scaler, they may be used with a printing medical scanner or with printing timers or similar external accessories.

DECADE UNITS. Five Model DU-5 decades provide a count capability of 99,999. By use of the Model CR-2 External Register, this may be extended to 1×10^8 counts. A special Model DU-1 one-microsecond decade is used as the first decade in Model DS-5BA.

HIGH VOLTAGE DETECTOR SUPPLY. Built-in high voltage detector supply provides 300 to 3000 volts of exceptionally stable direct current. Desired voltages are obtained by a dual voltage range selector switch in conjunction with coarse and fine controls.

PREDETERMINED COUNT. A single control provides choice of ten predetermined counts (4-10-40-100-400-1K-4K-10K-40K-100K) or manual operation for counting against time.

ELAPSED TIME INDICATOR. The time elapsed during any counting operation is registered on a five digit (odometer type) indicator which will indicate up to 999.99 minutes of elapsed time. Elapsed time may be accurately read to hundredths of a minute.

PRESET TIME. A connector is provided at rear of instrument to accept T/A Models PT-1, PT-2, or PT-3 Predetermined Timers, for applications where the total number of counts for a specific period of time is desired.

PUSH-BUTTON RESET. Resetting the entire instrument is accomplished by the operation of a single push-button, which electrically resets the 5 decades and the elapsed time indicator, as well as external accessories. A two-position stop-count lever type switch is provided for manual control of the instrument.

INSTRUMENT TEST. A 60 cycle test switch permits checking the instrument's operation with the 3600 cpm line frequency.

AUTO-NORMAL CONTROL. When the Auto-Normal switch is in the normal position, the Model DS-5B or DS-5BA operates as a standard scaler and offers predetermined count and manual operation. When the switch is in auto position, the instrument may be used with printing medical scanners in making body scans, or with print-out timers in half-life decay studies. In auto position, the scaler will count to any of the 10 predetermined counts to which the predetermined count control has been set, then automatically reset the entire instrument to zero, and resume counting and recycling. Each time the predetermined count is reached, a positive pulse is provided for operating external accessories.

TA

TECHNICAL ASSOCIATES

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5M-2/59

Printed in U.S.A.

PECIFICATIONS

MODELS DS-5B and DS-5BA

INPUT SENSITIVITY: Chassis mounted pulse height control variable from 0.1 to 6 volts. (Factory adjusted to 0.25V.)

INPUT SIGNAL POLARITY: Negative pulses.

RESOLVING TIME: Model DS-5B: 5 microseconds. Model DS-5BA: 1 microsecond.

RANGE: Count capability of 99,999. This may be extended to 1 x 10^8 counts by using a Model CR-2 External Count Register.

ELAPSED TIME INDICATOR: 5 digit odometer type, indicating in hundredths of a minute with a maximum capability of 999.99 minutes.

HIGH VOLTAGE POWER SUPPLY:

Range: +300 volts to +3000 volts D.C. continuously variable by adjustment of "course" and "fine" panel mounted potentiometer controls.

Polarity: Positive output (negative ground).

Stability: 0.01% drift per day maximum.

Regulation: Less than 0.002% change in high voltage for a 1% line voltage change between 95 to 130 volts A.C.

Ripple: Less than 0.01% of voltage

Current: Maximum output 1 ma on 1500 volt range; 0.3 ma on 3000 volt range.

Automatic Time Delay: Prevents high voltage from being turned on until regulator tubes are in operation, thereby eliminating excessive voltage output.

High Voltage Meter: Large 4" meter face calibrated to within ±1.5% full scale. Scales are 300V to 1500V, and 600V to 3000V full scale.

LOW VOLTAGE SUPPLY: Used for Scintillation Detector Preamplifier. Provides 250V D.C. plate voltage and 6.3V A.C. filament voltage.

PANEL MOUNTED CONTROLS:

Combined Power and H. V. Switch: Turns unit on and selects the high voltage power supply range.

Coarse and Fine Controls: Provide continuous variation of high voltage.

Auto-Normal Control: Normal position for conventional scaler use; auto position for use with external printing devices.

Stop-Count Control: Starts and stops counting operations.

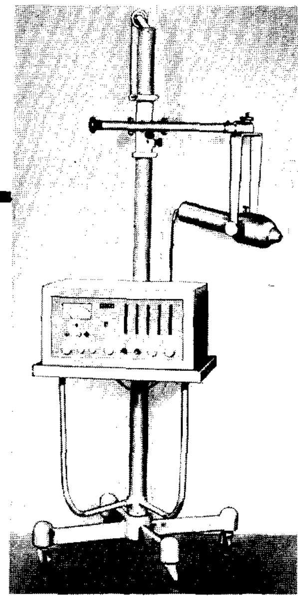
Reset Button: Electrically resets all 5 decades, elapsed time indicator, and external accessories (if in use).

Predetermined Count: Stops count and elapsed time indicator after 4-10-40-100-400-1K-10K-40K-100K counts. Has position for manual control by operator or predetermined timer unit.

60-Cycle Test Switch: Permits checking the instrument's operation with the 3600 cpm line frequency.

ON REAR PANEL:

Latch Lock Connectors: Connect T/A Model CR-2 Count Register, T/A Models PT-1, PT-2, or PT-3 Predetermined Timers, and T/A Models SD-1, SD-2, or SD-2W Scintillation Detectors to the DS-5B or DS-5BA.



Model DS-5B
Decade Scaler
shown with Model SD-1 Scintillation Detector and Model MS-1 Stand for thyroid uptake work

CONNECTORS:

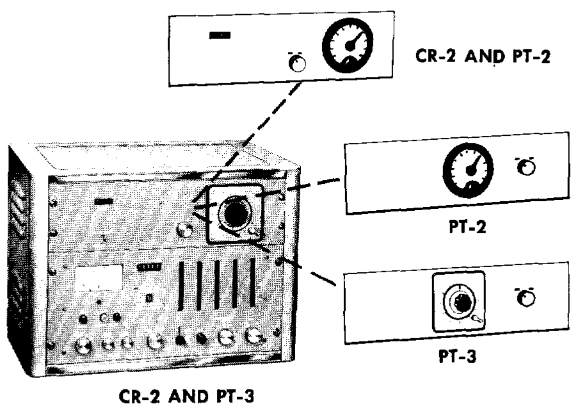
High Voltage and Signal Input	UG-931/U
Separate High Voltage Output	Amphenol 83-798
Detector Preamplifier Power Supply	Cannon XL-3-13
External Count Register	Cannon XL-4-13
External Predetermined Timer	Cannon P5-13
Power Input	Bryant 7486
Scope or Ratemeter Jack	Switchcraft No. 11

POWER REQUIREMENTS: 95 to 130 volts, 60 cycle, 200 watts. Available for 50 cycle and/or 220 volt operation on special order.

DIMENSIONS: Cabinet 20" wide x 11" high x 13" deep. Panel 19" wide x 8¾" high x 13" deep.

WEIGHT: 40 lbs. net. Shipping weight: 46 lbs.

CABINET: Smooth grey hammertone finish.



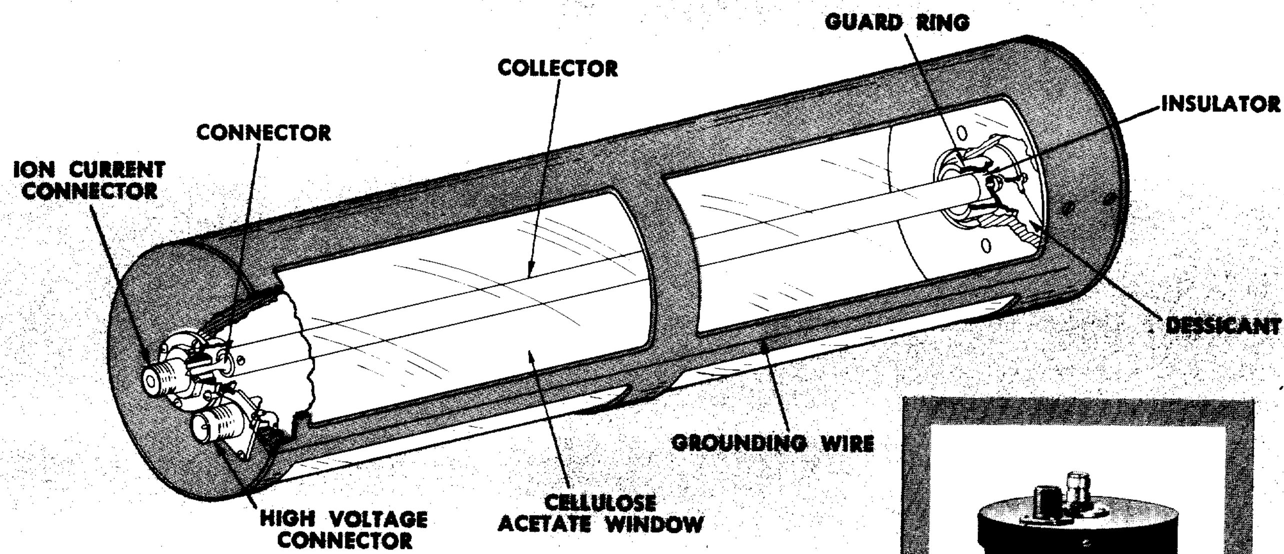
DS-5B or DS-5BA available in Single Cabinet with Timer and/or External Register

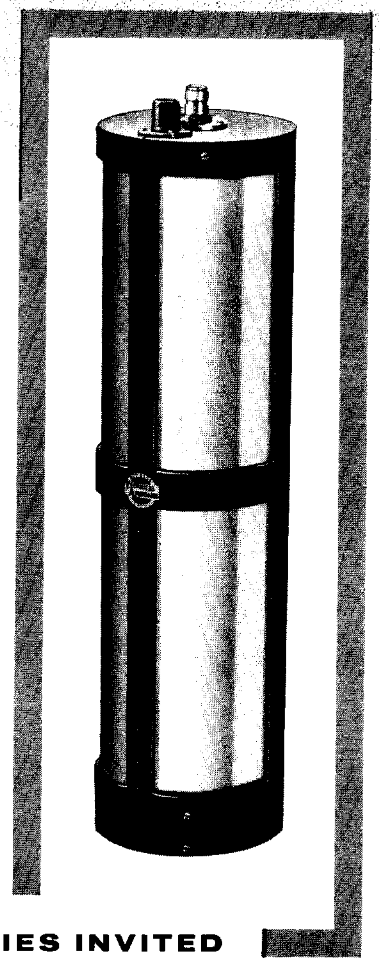
T/A Model PT-2 or Model PT-3 Predetermined Timer, as well as Model CR-2 External Register, can be supplied on a 19" panel for mounting with Models DS-5B or DS-5BA Decade Scaler in a single cabinet, at customer's option.

TECHNICAL ASSOCIATES
140 West Providencia Avenue Burbank, California

INSTRUMENTATION FOR NUCLEAR RESEARCH

IONIZATION CHAMBERS (MODELS IC-1 and IC-2)





APPLICATION: These ionization chambers are used for detection and measurement of Beta and Gamma radiation or Gamma radiation only. They can be installed in "hot" locations in a laboratory or reactor installation where it is desirable to monitor for control, health, or safety purposes. Model IC-1 has approximately one-half of the wall area cut away in the form of four windows which are fitted with .005" thick cellulose acetate. It is sensitive to soft radiation and is used for the detection and measurement of Beta and Gamma radiation. Model IC-2 is of solid wall construction and is used for the detection and measurement of Gamma radiation.

CONSTRUCTION: These chambers consist of a bakelite tube 5" in diameter x 18¾" long, with bakelite end plates. One end plate holds the high voltage input and signal output connectors. At the other end of the chamber, a space is provided to hold a dessicant to assure reliable operation under conditions of high humidity. Silica jell is used as the dessicant and is supplied in a cloth bag suitable for insertion in the cavity provided.

The collector is an aluminum tube ½" in diameter x 17⅜" long, and is supported by Teflon insulation at the back end, and by polystyrene insulation at the connector end. Guard rings are provided at either end to further reduce leakage. Leakage resistance is 10^{9} ohms or higher to either ground or high voltage.

The inside of the 5" cylinder and the inside of the end plates are coated with aquadag to form a conducting surface. The aquadag coating is connected to the high voltage input connector. The electrical continuity resistance of the aquadag coating is held to less than 5000 ohms. Careful craftsmanship throughout assembly and testing insures that rigid insulation specifications are maintained.

SPECIFICATIONS:

- OPERATING VOLTAGE RANGE: 275 to 325 volts D.C.
- SENSITIVITY: Less than 1 mr/hr with micro-micro ammeter on 0.1 volt 10^{-11} ampere range.
- ENERGY DEPENDENCE: Small corrective factor below 0.3 mev; flat above 0.3 mev.
- DIMENSIONS: 5" dia. x 20" long. • WEIGHT: Net 3 lbs. Shipping 6 lbs.

INQUIRIES INVITED

In addition to the types described, Technical Associates is prepared to supply ionization chambers for special purposes to customer specifications.

TA

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140 WEST PROVIDENCIA AVENUE • BURBANK, CALIFORNIA

4M-10/58

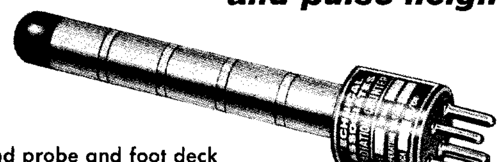
Printed in U.S.A.

HALOGEN QUENCHED permanently sensitive

Radiation Counter Tubes used in T/A Equipment

Beta-Gamma sensitive stainless steel wall type tubes

. . . for greater sensitivity and pulse height

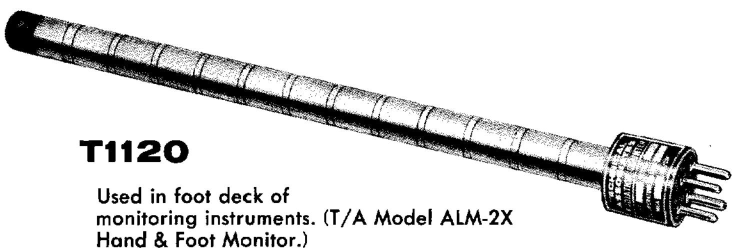


T1100

Used in hand probe and foot deck of monitoring instruments. (T/A Model ALM-2X Hand & Foot Monitor *hand probe only*, and T/A Model HSC-1 Hand & Shoe Counter.)

Cathode size: length 3", dia. 5/8", wall thickness 30-40 mg/cm^2.

Tube base standard small 4 pin.



T1120

Used in foot deck of monitoring instruments. (T/A Model ALM-2X Hand & Foot Monitor.)

Cathode size: length 7", dia. 5/8", wall thickness 30-40 mg/cm^2.

Tube base standard small 4 pin.

Mica end-window type tubes

T1140

Alpha-beta sensitive.

Used in general radio-assay work and radiochemical analysis. (T/A Model LS-6 Lead Shield, T/A Model TM-8 Tube Mount in conjunction with LS-7 Lead Shield, and T/A Model P-8 Probe.)

End window diameter 1 3/32"; thickness 1.4-2 mg/cm^2.

Tube base standard medium 4 pin.

T1180

Alpha-beta-gamma sensitive.

Used in general laboratory survey instruments where greater alpha and beta sensitivity are required. (T/A Model P-8X Probe in conjunction with a count rate meter or scaler.)

End window diameter 25/32"; thickness 1.4-2 mg/cm^2.

Tube base connector standard single pin.

SPECIFICATIONS

	T1100	T1120	T1140	T1160*	T1180
OPERATING VOLTAGE:	900V DC	900V DC	700V DC	1300V DC	700V DC
PLATEAU LENGTH IN EXCESS OF:	200 Volts	200 Volts	200 Volts	250 Volts	180 Volts
SLOPE OF PLATEAU:	10% per 100V	10% per 100V	5% to 10% per 100V	1.5% per 100V	10% per 100V
STARTING VOLTAGE (0.3V Pulses):	825V max.	825V max.	625V max.	1180V max.	620V max.
MAXIMUM COUNTING RATE:	1700 cps	1700 cps	830 cps	1100 cps	1100 cps
BACKGROUND (Shielded with 2" lead and 1/8" aluminum):	50 cpm max.	75 cpm max.	50 cpm max.	50 cpm max.	75 cpm max.
DEAD TIME (Approximate):	100 µ sec.	100 µ sec.	200 µ sec.	150 µ sec.	150 µ sec.
OPERATING TEMPERATURE:	—55° to +75°C	—55° to +75°C	—55° to +75°C	+15° to +50°C	—55° to +75°C
OVERALL DIMENSIONS:	5 5/8" long, 1 5/32" dia.	11 25/32" long, 1 5/32" dia.	4 11/32" long 1 3/8" dia.	4 11/32" long, 1 3/8" dia.	6" long, 1" dia.
LIFE EXPECTANCY IN COUNTS:	Unlimited	Unlimited	Unlimited	Approx. 1.5×10^8	Unlimited

*T1160 is identical to T1140, except that it contains an organic quenching agent.

PRICE LIST

TECHNICAL ASSOCIATES • 140 W. Providencia Ave. • Burbank, Calif.

Revised February 1, 1961

Subject to Change Without Notice

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			AUTOMATED SAMPLE CHANGING SYSTEMS	
174		ASC-1	Gas Flow Detection of Alpha/Beta activity (proportional or Geiger, window or windowless) complete with 200 planchet holders and planchets (less cylinder of gas)	$5375.00
174		ASC-2	Gamma Scintillation Detection complete with 200 planchet holders and planchets (less cylinder of gas)	5575.00
174		ASC-3	Both Gas Flow (Alpha/Beta) and Scintillation (Gamma) Detection, simultaneously or separately, complete with 200 planchet holders and planchets (less cylinder of gas)	7985.00
			ANALYTICAL AND COUNTING INSTRUMENTS	
173		LLB-40A	Low Level Beta System with Amperex Type 18516/18518 Tubes complete with stand	3750.00
173		LLB-40B	Low Level Beta System with Amperex Type 18515/18517 Tubes complete with stand	3690.00
173		PT-1R	Predetermined Timer for LLB-40	110.00
173		ACS-42	Anti-Coincidence Scaler for use with Amperex Beta Counters, mounted in T/A Model C-1225 cabinet	1030.50
177	*	GTS-6	High Speed Decade Scaler (1 microsecond) with built-in preset time and preset count (less H.V. Supply)	750.00
166	*	DS-5B	Decade Scaler (5 microseconds)	825.00
166	*	DS-5BA	Decade Scaler (1 microsecond)	915.00
166		DU-1	One microsecond plug-in decade unit	147.50
166		DU-5	Five microsecond plug-in decade unit	57.50
166	**	CR-2	Count Register used with DS-5B or DS-5BA	65.00
164	**	PT-1	Pre-determined Timer (Long Counting Intervals — 999 minutes)	95.00
164	**	PT-2	Pre-determined Timer (Short Counting Intervals — 120 seconds)	95.00
164	**	PT-3	Pre-determined Timer, Liebel-Flarsheim (1 second/60 minutes)	100.00
164	**	PT-4	Pre-determined Timer, Liebel-Flarsheim (.01 minutes/60 minutes)	100.00
164	*	GS-7S	Binary Scaler (Elapsed time in seconds)	725.00
164	*	GS-7D	Binary Scaler (Elapsed time in .01 minute)	725.00
170	*	SM-10	Spectrometer (Single Channel Pulse Height Analyzer, with built-in Linear Amplifier and Rate Meter)	765.00
169	*	SA-20	Single Channel Pulse Height Analyzer	685.00
169	*	LA-6	Linear Amplifier (Non-overloading type)	595.00
170	*	SS-30	Spectrum Scanner	475.00
		PA-6	Pre-Amplifier for LA-6	115.00
			HIGH VOLTAGE SUPPLIES	
163	*	RHV-1B	Regulated High Voltage Supply (1500-3000 volts) Two Ranges, Continuously Variable	375.00
178	*	RHV-2	Reversible Polarity High Voltage Supply (500V to 2500V) Continuously Variable	450.00
178	*	RHV-3	Regulated High Voltage Supply (500V to 5000V) Two Ranges for Geiger and Proportional	425.00

* Prices shown are for instruments supplied in 19" panel for rack mounting unless otherwise noted. For single instrument mounted in T/A Model C-875 "Easy-to-Service" Console Cabinet add $30.00 to prices shown. See reverse side of Bulletin No. 168 for description of "Easy-to-Service" cabinet.

** These accessories will be supplied in a cabinet or panel mounted at customer's option.

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
		STAR SERIES SPECTROMETRY SYSTEMS	
171	Polaris	Includes SM-10 and RHV-1 mounted in C-1400 cabinet, complete with interconnecting cables and system test	1180.00
171	Lyra (Decade)	Includes SM-10 and DS-5B mounted in C-1750 cabinet, complete with interconnecting cables and system test	1635.00
171	Lyra (Binary)	Includes SM-10 and GS-7 mounted in C-1750 cabinet, complete with interconnecting cables and system test	1535.00
171	Arcturus	Includes SM-10, RHV-1, SS-30 and Texas Instruments Rectilinear Recorder Model RR1M-A16 in P-1 Panel Mount installed in C-3150 cabinet, with interconnecting cables and system test	2250.00
171	Capella (Decade)	Includes LA-6, SA-20, DS-5B, PT-3 or PT-4 and CR-2 mounted in C-3150 cabinet, with interconnecting cables and system test	2330.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
171	Capella (Binary)	Includes LA-6, SA-20, GS-7, CR-2 and PT-3 or PT-4 mounted in C-3150 cabinet, with interconnecting cables and system test	2230.00
		NOTE: For special applications requiring other combinations of T/A instruments, please request a quotation.	
		SCINTILLATION DETECTORS AND ACCESSORIES	
157	SD-1	Scintillation Detector with 1" x 1" NaI crystal, complete with cables	455.00
157	SD-2	Scintillation Detector with 2" x 2" NaI crystal, complete with cables	765.00
157	SD-2W	Well-type Scintillation Detector with 1¾" x 2" NaI crystal (⅝" x 1½" well) complete with cables for use with LS-8 or LS-8X Shields	695.00
157	SD-3	Scintillation Detector with 1½" Alpha Phosphor, complete with cables	495.00
157	SD-4	Scintillation Detector with 1½" Beta Anthracene Crystal, complete with cables	545.00
179	SD-11	Premium Resolution Scintillation Detector (Cathode Follower Type) with 1" x 1" NaI crystal, complete with cables	515.00
179	SD-12	Premium Resolution Scintillation Detector (Cathode Follower Type) with 2" x 2" NaI crystal, complete with cables	825.00
179	SD-12W	Premium Resolution Well-type Scintillation Detector (Cathode Follower Type) with 1¾" x 2" NaI crystal (⅝" x 1½" well) complete with cables for use with LS-8 or LS-8X Shields	755.00
157	CH-1	Crystal Housing for SD-1 or SD-11 Scintillation Detector	25.00
157	CH-2	Crystal Housing for SD-2 or SD-12 Scintillation Detector	30.00
157	CH-2W	Crystal Housing for SD-2W and SD-12W Scintillation Detectors	30.00
157	NS-1	Nose Shield for Model SD-1 or SD-11 Detector	95.00
157	NS-2	Nose Shield for Model SD-2 or SD-12 Detector	115.00
157	C-1a	Collimator Type A (20° Flat Field) for SD-1 or SD-11 Detector	29.50
157	C-2a	Collimator Type A (20° Flat Field) for SD-2 or SD-12 Detector	39.50
157	C-1b	Collimator Type B (Straight Bore) for SD-1 or SD-11 Detector	35.00
157	C-2b	Collimator Type B (Straight Bore) for SD-2 or SD-12 Detector	45.00
157	C-1c	Collimator Type C (Focusing) for SD-1 or SD-11 Detector	75.00
157	C-2c	Collimator Type C (Honeycomb) for SD-2 or SD-12 Detector	95.00
157	AS-11	Alpha Detector (1") for SD-1, complete with mount	79.50
157	AS-12	Alpha Detector (1½") for SD-2, complete with mount	85.00
157	BS-11	Beta Detector (1") for SD-1, complete with mount	79.50
157	BS-12	Beta Detector (1½") for SD-2, complete with mount	95.00
166	MS-1	Mobile Stand for Scintillation Detector, counter weighted and with shelf for Scaler or Rate Meter	295.00
		GAS FLOW DETECTORS AND G/M PROBES	
176	MSC-1	Shielded Gas Flow Counter (window and windowless) complete with GD-1 Detector and Pre-Amplifier and GR-1 Gas Regulator (less cylinder of gas)	750.00
158	P-7	Beta/Gamma Probe Assembly with T-1090 Tube, cable and connector	39.50
158	P-8	End Window Probe (less tube) complete with cable and connector	45.00
158	P-8X	End Window Probe Assembly with T/A T-1180 Tube, cable and connector	87.50
	P-10	Beta/Gamma Probe Assembly with T-1110 G.M. Tube, cable and connector	75.00
		COUNTER TUBES	
	T-1090	Metal Thin wall, 3-11/16" long, used in Model F-6 Geiger Counter, P-7 Probe or other Beta/Gamma applications	15.00
144	T-1100	Thin wall type 3" long used in Models ALM-2, ALM-2X, PPM-8 and HSC-1	27.00
144	T-1110	Thin wall 3" long used in P-10 Probe	27.00
144	T-1120	Thin wall type 7" long used in Model PPM-8	53.00
144	T-1140	Mica End Window used in TM-7, TM-8 Tube Mounts and P-8 Probe	58.50
144	T-1160	Mica End Window (Organic Quenched) used in TM-7, TM-8 Tube Mounts and P-8 Probe	67.00
144	T-1180	Mica End Window, Alpha/Beta/Gamma sensitive, used in P-8X Probe	61.00
173	A-18515	Beta Counter (Amperex) for low activity, low energy	186.50
173	A-18516	Beta Counter (Amperex) for low activity, higher energy	206.25
173	A-18517	Guard Tube (Amperex) for use with A-18515	373.00
173	A-18518	Guard Tube (Amperex) for use with A-18516	412.50
		IONIZATION CHAMBERS	
144	IC-1	Ionization Chamber with windows (Beta/Gamma)	115.00
144	IC-2	Ionization Chamber — Solid Wall (Gamma)	105.00
		PERSONNEL MONITORS	
167	HSM-10	Beta/Gamma Hand and Shoe Monitor (Dresden Automatic Design) with external Beta/Gamma Probe	3575.00
161	ALM-2X	Beta/Gamma Hand and Foot Monitor (Argonne Count Rate Meter Design) with external Beta/Gamma Probes	3175.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
175	AHM-11	Alpha Hand Monitor (Scintillation Type - Dresden Design)	2975.00
146	HSC-1	Beta/Gamma Hand and Shoe Counter (Hanford Binary Scaler Type)	2750.00
168	PPM-8	Beta/Gamma Portal Type Monitor	2150.00
168	LIM-18	Beta/Gamma Laundry Monitor	1150.00
		SURVEY METERS	
165	CP-3	New Cutie Pie Portable Survey Meter	265.00
165	CP-3A	New Cutie Pie Portable Survey Meter with special ranges (0-25, 0-250, 0-2500 mr/hr)	295.00
180	SRJ-7	New Juno Survey Meter with plug-in battery pack and replaceable Alpha window (Standard Range)	325.00
180	HRJ-7	New Juno Survey Meter with plug-in battery pack and replaceable Alpha window (High Range)	325.00
136	F-6	Geiger Counter for Uranium Prospecting	159.50
137	FS-11	Scintillation Counter for Uranium Prospecting	449.50
		LEAD SHIELDS	
152	LS-1	Complete with Type ST-1 Sample Tray, Type SK-1 Socket and Type TM-1 Tube Mount	185.00
152	LS-2A	Standard with Type TM-6 Tube Mount and Sample Tray Holder, Type ST-2A Sample Tray and 10 Type PL-2 Aluminum Planchets	200.00
152	LS-2B	Micrometric with 10 Type PL-1 Planchets	285.00
153	LS-4A	For liquids complete with Type TM-1 Tube Mount, Type SK-1 Socket, and one Type ST-5 Marinelli Beaker	200.00
153	LS-4B	Modified to accommodate special tubes with aluminum inner liner	235.00
153	LS-4C	For solids, complete with Type TM-1 Tube Mount, Type SK-1 Socket, one Type ST-6 Ore Container and 100 Type ST-6A Paper Sleeves	225.00
151	LS-5	Complete with Type TM-3 Tube Mount, Type SK-2 Socket, Type STH-1 Sample Tray Holder, Type ST-4A Sample Tray, and 10 Type PL-2 Aluminum Planchets	260.00
152	LS-6	Complete with Type TM-7 Tube Mount, one Type ST-3B Sample Tray and 10 Type PL-3 Aluminum Planchets	295.00
	LS-6X	Eight-inch height extension for LS-6 Shield	98.50
	LS-6L	Lid with 3" opening and retaining collar for Models SD-1, SD-2, SD-12 Scintillation Detectors	72.50
	LS-6P	Plug for 3" opening in LS-6L	12.50
160	LS-7A	Multi-Purpose Type complete with SD-1 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	780.00
160	LS-7B	Multi-Purpose Type complete with SD-2 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	1090.00
160	LS-7C	Multi-Purpose Type complete with TM-8 Tube Mount, three ST-7 Sample Trays and 10 PL-3 Planchets	385.00
160	LS-7M	Multi-Purpose Type — Shield only, with adapter ring, three ST-7 Sample Trays and 10 PL-3 Planchets	325.00
148	LS-8	For well counting (shield only, less detector)	265.00
148	LS-8W	For well counting, complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	960.00
	LS-18W	For well counting, complete with SD-12W Scintillation Detector and 1¾" x 2" well crystal	1020.00
148	LS-8X	For well counting with 2" shielding in all directions (Shield only less Detector)	350.00
148	LS-8WX	For well counting with 2" shielding in all directions complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	1035.00
	LS-18WX	For well counting with 2" shielding in all directions complete with SD-12W Scintillation Detector and 1¾" x 2" well crystal	1095.00
173	LS-41	Lead, Steel and Mercury Shield for Amperex Beta Counters (less tubes), but complete with stand	2100.00
		LABORATORY ACCESSORIES	
162	AB-2	Absorber Set	85.00
153	ST-1	Sample Tray	6.50
154	ST-2, ST-3, ST-4	Sample Trays	3.50
153	ST-5	Marinelli Beaker	4.25
153	ST-6	Ore Container	12.50
153	ST-6A	Paper Sleeves for Ore Container per C	2.00
160	ST-7	Sample Tray for LS-7	2.50
154	STH-1	Sample Tray Holder with tray and ten planchets	13.50
154	SK-1, SK-2, SK-3	Sockets	5.00
154	TM-1, TM-2, TM-3, TM-4	Tube Mount	15.00
154	TM-5	Tube Mount (micrometric for LS-2 Lead Shield)	100.00
154	TM-6	Tube Mount and Sample Tray Holder	22.50
154	TM-7	Tube Mount and Sample Tray Holder	27.50
160	TM-8	Tube Mount and Adapting Ring for LS-7 Multi-Purpose Shield	60.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product		Price F.O.B. Burbank
162	LC-1	Lead Source Container for four radium needles		45.00
162	LC-3	Lead Source Container 1" lead walls, 1½" x 3" inside dimensions		40.00
162	LC-3A	Lead Source Container 1⅜" lead walls ¾" x 2¼" inside dimensions		47.50
162	LC-4	Lead Source Container 1½" lead walls, 1½" x 3" inside dimensions		50.00
162	LC-4A	Lead Source Container 1¾" lead walls ¾" x 2½" inside dimensions		57.50
162	LC-9	Mobile Source Unit — compartment 3" x 6" in shield of 2" lead. Mounted on heavy duty hand cart		250.00
130		Lead Brick, machined all sides 2" x 3" x 6"		8.50
130		Lead Brick, machined all sides 2" x 4" x 8"		12.50
130		Lead Brick, extruded shape		**Prices upon application**
153		Planchets, Type PL-1, Sheet steel, tinned	per C	3.25
			per M	30.00
			per 5M	27.00/M
153		Planchets, Type PL-2 & PL-3, aluminum	per C	3.25
			per M	30.00
			per 5M	27.00/M
153		Planchets, Type PL-2C & PL-3C, copper	per C	4.50
			per M	40.00
			per 5M	36.00/M
153		Planchets, PL-2S, stainless steel	per C	9.00
			per M	65.00
			per 5M	58.50/M
153		Planchets, Type PL-3S, stainless steel	per C	12.00
			per M	85.00
			per 5M	76.50/M
153		Planchets, Type PL-4, aluminum	per C	5.00
			per M	45.00
			per 5M	40.50/M
153		Planchets, special materials and sizes		**Prices quoted upon request**
174		Planchet Holder for ASC-1, ASC-2, ASC-3	per C	6.00
			per M	55.00
174		Sample Tray for ASC-1, ASC-2, ASC-3	per C	8.00
			per M	75.00

CABINETS

Model No.	Description	Price
C-875	8¾" height "Easy-to-Service" console cabinet for standard 19" width panel	30.00
C-1050	10½" height console cabinet for standard 19" width panels	35.00
C-1225	12¼" height console cabinet for standard 19" width panels	37.50
C-1400	14" height console cabinet for standard 19" width panels	40.00
C-1750	17½" height console cabinet for standard 19" width panels	45.00
C-2100	21" height console cabinet for standard 19" width panels	50.00
C-3150	31½" height console cabinet for standard 19" width panels	60.00
C-4375	43¾" height console cabinet for standard 19" width panels	70.00

IN GENERAL

Unit prices are given in this price list unless otherwise noted.

All prices quoted herein are f.o.b. Burbank, California. Payment terms, net 30 days upon approved credit.

No extra charge is made for packing for domestic shipments. Export charges will be quoted upon application. We reserve the right to alter specifications at any time without incurring the obligation of incorporating new features in previously manufactured equipment. Prices are subject to change without notice. Quotations remain firm for 30 days.

Shipping instruments: Please include shipping instructions when ordering; in the event that shipping instructions are not given, we will use our best judgment in the matter.

SERVICE CHARGES

Services charges for repairs are usually billed on an hourly basis, however, if desired, an estimate can be given before the work is undertaken. The unit to be repaired should be shipped prepaid to us.

WARRANTY

Technical Associates warrants instruments and equipment (except tubes, fuses, batteries and crystals), manufactured by them to be free from defects in workmanship or materials under normal use for a period of one year from the date of shipment from the factory to the buyer. Tubes, fuses, batteries and crystals are subject to the guarantee established by the manufacturer of them, however, Technical Associates will assist the customer to obtain full benefits of these guarantees.

If, within the one year warranty period, any Technical Associates instrumentation or equipment requires service as a result of a defect, the buyer may return it to the factory of Technical Associates at Burbank, California or to a service station designated by Technical Associates, transportation charges prepaid, for service at no charge under the warranty. The buyer is urged to communicate with Technical Associates when warranty service is required, stating the nature of the difficulty and giving model and serial number of instrument. It may be possible to diagnose the trouble and send a replacement part or assembly, thereby avoiding the expense of shipment.

Technical Associates will return the instrument to the buyer, transportation charges prepaid, after repairs or replacement under warranty are completed. The liability to Technical Associates under this warranty is limited to the cost of replacement of defective parts upon prompt notification of such defect.

TECHNICAL ASSOCIATES
INSTRUMENTATION FOR NUCLEAR RESEARCH
140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA
TELEPHONES: VIctoria 9-1994 • THornwall 8-8133

January 23, 1959

General Electric Company
4855 Electric Avenue
Milwaukee 1, Wisconsin

Attention: Mr. J. J. Jech, Coolidge Lab.
X-Ray Department

Gentlemen:

Your letter of January 19 was received and read with considerable interest. In response we are enclosing our descriptive Bulletin No. 159 which explains the Juno Survey Meter in complete detail. You will also find enclosed our quotation and a X-Ray Calibration Chart which was made by the National Bureau of Standards on our Juno.

The calibration chart provides the user of the Juno with a correction factor so that he may use the instrument to determine X-Ray dosage rates.

To use the calibration chart it is necessary to know the KEV level at which the x-ray unit is operating. We have red lined an example on the chart. In the example, the Juno is being used with the alpha rejection absorber in place and is therefore positioned for detection of beta. Further, the KEV level of the x-ray unit being monitored is 30 as marked on the base line. In this case the correction factor would be .8, therefore the reading of the Juno should be multiplied by .8 to obtain the correct x-ray dosage rate.

Should you find the Juno acceptable for your particular application, it is advisable to check the calibration with some known dosage rates.

We trust you will feel free to contact us should you have any further questions.

Very truly yours,

TECHNICAL ASSOCIATES

Baron Getman

Baron Getman
Assistant Sales Manager

BG:rt
Encl.

P.S. If you would like to have a copy of our complete catalog, please fill in and return the enclosed postcard.

TECHNICAL ASSOCIATES

140 West Providencia Avenue
Burbank, California

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Organization..

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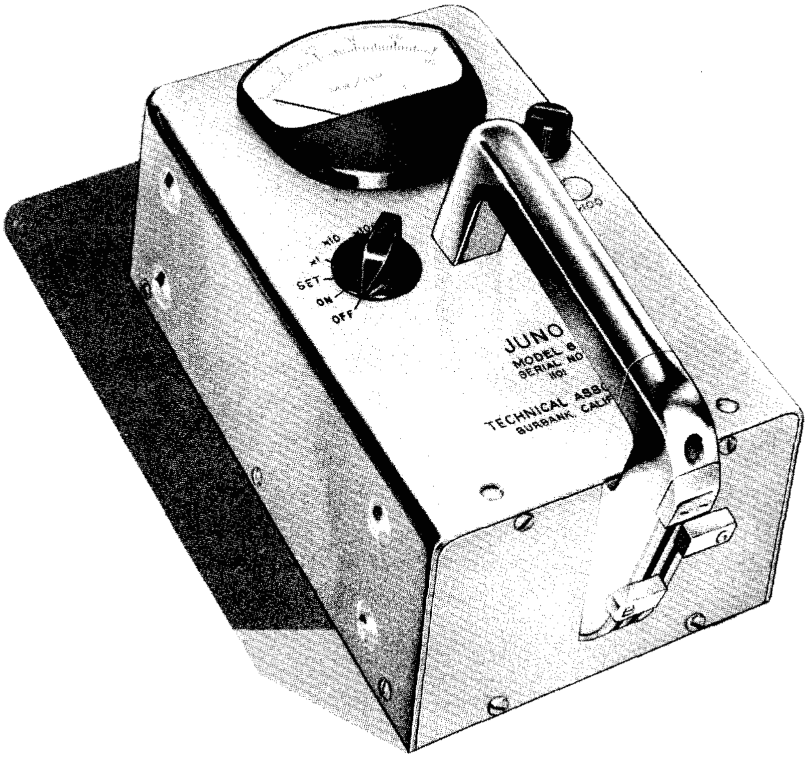
INSTRUMENTATION FOR NUCLEAR RESEARCH

JUNO RADIATION SURVEY METER

MODELS SRJ-6 and HRJ-6



APPLICATION. The Juno Survey Meter is a portable instrument for measuring the intensity of, and discriminating between alpha, beta, and gamma radiation. It is used to protect personnel from the danger of over-exposure to radiation from radioactive materials or X-rays. While primarily intended for inspection of flat surfaces, the instrument is suitable for most uses where a high degree of accuracy is desired.

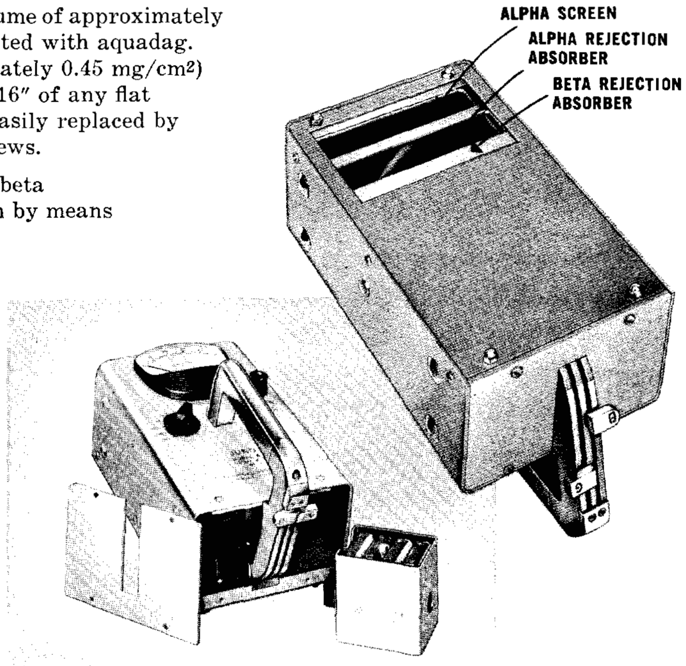
The T/A Juno is an improved version of the original Hanford instrument and is available in two models: SRJ-6 (standard range) for all normal applications; and HRJ-6 (high range) for use where exceptionally high intensity radiation is likely to be encountered. Both models meet A.E.C. specifications.

DESCRIPTION: The instrument comprises an ionization chamber, an electrometer circuit, absorption filters for the rejection of either alpha or beta particles, suitable batteries mounted in a removable power pack, and an indicating meter. The unit is battery operated and is self-contained. To easily identify the High Range Juno, its knobs and meter dials are finished in brilliant red.

The ionization chamber has a volume of approximately 27 cubic inches. All surfaces within the chamber are coated with aquadag. The chamber is covered by a screen of .0003" (approximately 0.45 mg/cm^2) rubber hydrochloride film. The alpha screen is within 7/16" of any flat surface on which the instrument may be placed, and is easily replaced by simply removing the bottom plate and two retaining screws.

Two absorbers are provided to reject either alpha or beta radiation. These are readily moved in and out of position by means of sliding tabs fitted in rails which form part of the handle. The tab marked "G," with a square end, operates the absorber which rejects alpha and beta, thus permitting a reading of gamma only. The tab marked "B," with a rounded end, operates the absorber which rejects alpha, permitting a reading of beta and gamma. The total of all three types of radiation is read, when both tabs are in "open" position.

The high quality microammeter, which is calibrated in milliroentgens per hour for gamma radiation, has a large easy-to-read face and is mounted in position to permit excellent visibility. Battery life is approximately 300 hours in normal intermittent use. An easily removable battery pack, with simple positive contacts, assures trouble-free operation over long periods of service.



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Printed in U.S.A.

Models SRJ-6 and HRJ-6 have similar circuits, the principal difference being the value of grid resistances used.

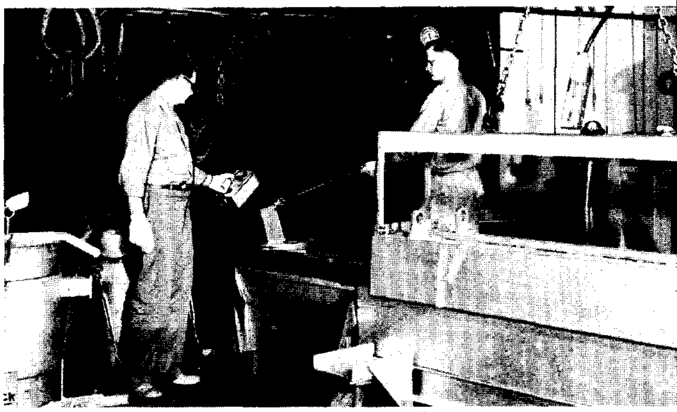
Radiation incident upon the ionization chamber produces a minute current which flows through a very high resistance in the grid circuit of the electrometer tube. The voltage thus produced at the grid causes a corresponding change in plate current which is indicated by the panel meter. A bucking current is provided through the meter in order that the no-signal plate current of the electrometer may be balanced out and readings of radiation intensity may start from the meter zero reading. Sensitivity is varied by switching appropriate values of grid resistance in the electrometer circuit.

The instrument is calibrated by adjusting a resistance in series with the meter. An individual adjustment is provided for each range. Zero setting is accomplished by means of a rheostat in the filament circuit of the electrometer tube. By varying the filament voltage, the plate current may be varied and thus adjusted to a value equal to the bucking current flowing through the meter. All high resistance points in the circuit are insulated with Teflon to insure minimum leakage.

SENSITIVITY. Both models are calibrated in three separate full-scale ranges in easily read increments of the meter scale, covering the total range of which the instrument is capable.

Ranges are based on radium gamma radiation intensity. Accuracy of calibration is such that indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed. Sensitivity dependency upon battery aging is limited to a 10% variation while the unit can be zeroed by means of the panel zero control.

Illustration below shows the T/A Juno in use at the Nuclear Radiation Laboratory of Admiral Corporation, monitoring for radio-activity as sample is transferred from "coffin" to shipping container.



SPECIFICATIONS:

IONIZATION CHAMBER:
- Volume: 27 cubic inches.
- Window Opening: 3″ x 4⅝″.
- Alpha Screen: 0.3 mil (0.45 mg/cm2) rubber hydrochloride.
- Alpha Rejection Absorber: 0.01″ cellulose acetate sheet.
- Beta Rejection Absorber: 0.102″ aluminum.

BATTERIES:
- 4 Eveready No. 412 22½ Volt "B" Batteries.
- 2 Eveready No. E12 1.35 Volt "A" Batteries.
- 2 Mallory No. TR-115 6.5 Volt "B" Batteries.

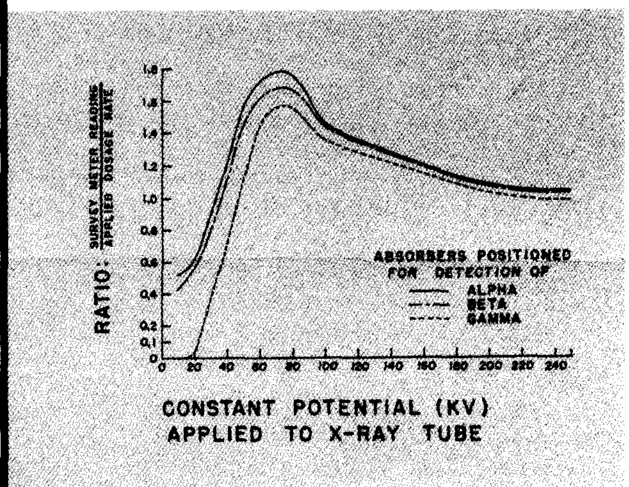
TUBE:
- 1 Sub-Miniature Electrometer Type CK 5886.

RANGES:
- Model SRJ-6 Juno (standard range): 50, 500, 5000 MR/HR full-scale. (Improved A.E.C. Model SIC-17B).
- Model HRJ-6 Juno (high range): 250, 2500, 25,000 MR/HR full-scale. (Improved A.E.C. Model SIC-17D).

CASE:
- Hard-chrome plated aluminum, with engraved markings on top of case; gasketed, dust and moisture-resistant. Dimensions: 9½″ x 5¾″ x 4″.

HANDLE:
- Aluminum, especially cast low-porosity, smoothly polished.

WEIGHT:
- Net 6 lbs. 11 oz. Shipping: 10 lbs.



The Juno can be used for X-ray detection and measurement by reference to the above curves.

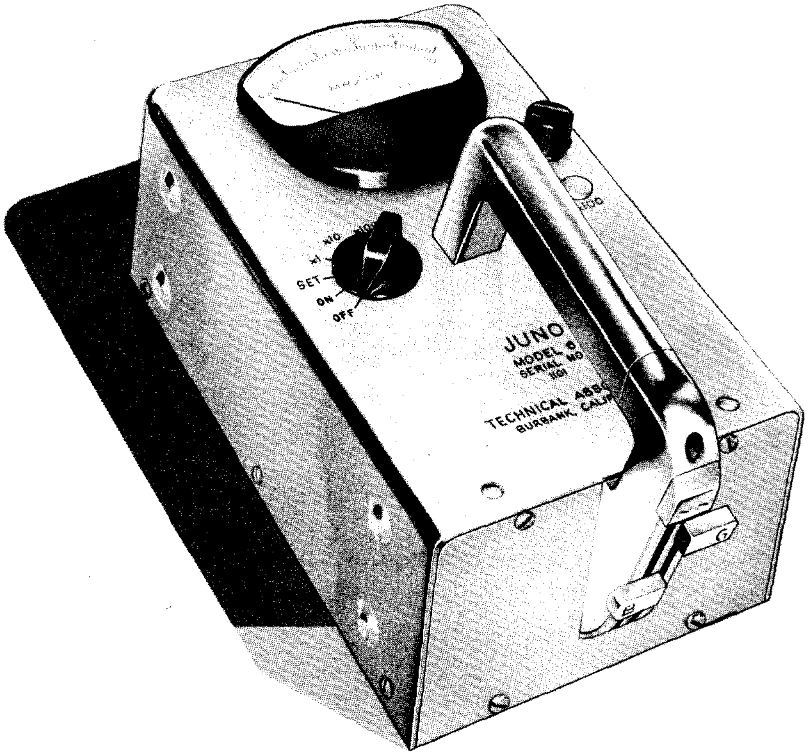
INSTRUMENTATION FOR NUCLEAR RESEARCH

Nom On order 26389
your req 11635

JUNO RADIATION SURVEY METER

MODELS SRJ-6 and HRJ-6

Cost 295.00 Dely approx 5/1/59



APPLICATION. The Juno Survey Meter is a portable instrument for measuring the intensity of, and discriminating between alpha, beta, and gamma radiation. It is used to protect personnel from the danger of over-exposure to radiation from radioactive materials or X-rays. While primarily intended for inspection of flat surfaces, the instrument is suitable for most uses where a high degree of accuracy is desired.

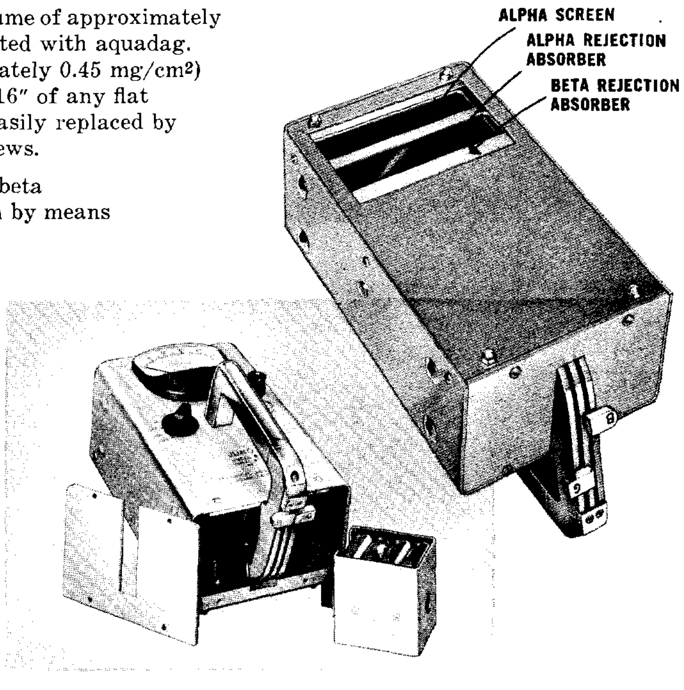
The T/A Juno is an improved version of the original Hanford instrument and is available in two models: SRJ-6 (standard range) for all normal applications; and HRJ-6 (high range) for use where exceptionally high intensity radiation is likely to be encountered. Both models meet A.E.C. specifications.

DESCRIPTION: The instrument comprises an ionization chamber, an electrometer circuit, absorption filters for the rejection of either alpha or beta particles, suitable batteries mounted in a removable power pack, and an indicating meter. The unit is battery operated and is self-contained. To easily identify the High Range Juno, its knobs and meter dials are finished in brilliant red.

The ionization chamber has a volume of approximately 27 cubic inches. All surfaces within the chamber are coated with aquadag. The chamber is covered by a screen of .0003″ (approximately 0.45 mg/cm^2) rubber hydrochloride film. The alpha screen is within 7/16″ of any flat surface on which the instrument may be placed, and is easily replaced by simply removing the bottom plate and two retaining screws.

Two absorbers are provided to reject either alpha or beta radiation. These are readily moved in and out of position by means of sliding tabs fitted in rails which form part of the handle. The tab marked "G," with a square end, operates the absorber which rejects alpha and beta, thus permitting a reading of gamma only. The tab marked "B," with a rounded end, operates the absorber which rejects alpha, permitting a reading of beta and gamma. The total of all three types of radiation is read, when both tabs are in "open" position.

The high quality microammeter, which is calibrated in milliroentgens per hour for gamma radiation, has a large easy-to-read face and is mounted in position to permit excellent visibility. Battery life is approximately 300 hours in normal intermittent use. An easily removable battery pack, with simple positive contacts, assures trouble-free operation over long periods of service.



TECHNICAL ASSOCIATES

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Models SRJ-6 and HRJ-6 have similar circuits, the principal difference being the value of grid resistances used.

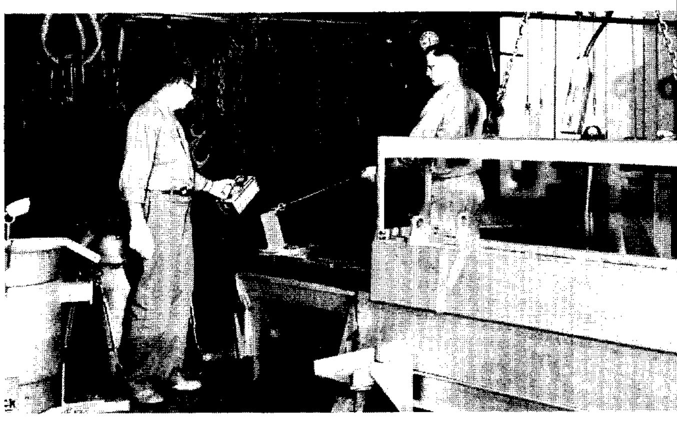
Radiation incident upon the ionization chamber produces a minute current which flows through a very high resistance in the grid circuit of the electrometer tube. The voltage thus produced at the grid causes a corresponding change in plate current which is indicated by the panel meter. A bucking current is provided through the meter in order that the no-signal plate current of the electrometer may be balanced out and readings of radiation intensity may start from the meter zero reading. Sensitivity is varied by switching appropriate values of grid resistance in the electrometer circuit.

The instrument is calibrated by adjusting a resistance in series with the meter. An individual adjustment is provided for each range. Zero setting is accomplished by means of a rheostat in the filament circuit of the electrometer tube. By varying the filament voltage, the plate current may be varied and thus adjusted to a value equal to the bucking current flowing through the meter. All high resistance points in the circuit are insulated with Teflon to insure minimum leakage.

SENSITIVITY. Both models are calibrated in three separate full-scale ranges in easily read increments of the meter scale, covering the total range of which the instrument is capable.

Ranges are based on radium gamma radiation intensity. Accuracy of calibration is such that indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed. Sensitivity dependency upon battery aging is limited to a 10% variation while the unit can be zeroed by means of the panel zero control.

Illustration below shows the T/A Juno in use at the Nuclear Radiation Laboratory of Admiral Corporation, monitoring for radio-activity as sample is transferred from "coffin" to shipping container.



SPECIFICATIONS:

IONIZATION CHAMBER:

Volume: 27 cubic inches.
Window Opening: 3" x 4⅝".
Alpha Screen: 0.3 mil (0.45 mg/cm^2) rubber hydrochloride.
Alpha Rejection Absorber: 0.01" cellulose acetate sheet.
Beta Rejection Absorber: 0.102" aluminum.

BATTERIES:

4 Eveready No. 412 22½ Volt "B" Batteries.
2 Eveready No. E12 1.35 Volt "A" Batteries.
2 Mallory No. TR-115 6.5 Volt "B" Batteries.

TUBE:

1 Sub-Miniature Electrometer Type CK 5886.

RANGES:

Model SRJ-6 Juno (standard range): 50, 500, 5000 MR/HR full-scale. (Improved A.E.C. Model SIC-17B).
Model HRJ-6 Juno (high range): 250, 2500, 25,000 MR/HR full-scale. (Improved A.E.C. Model SIC-17D).

CASE:

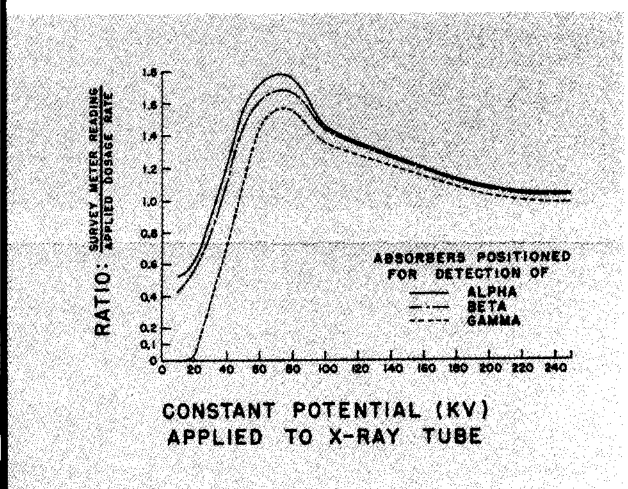
Hard-chrome plated aluminum, with engraved markings on top of case; gasketed, dust and moisture-resistant. Dimensions: 9½" x 5¾" x 4".

HANDLE:

Aluminum, especially cast low-porosity, smoothly polished.

WEIGHT:

Net 6 lbs. 11 oz. Shipping: 10 lbs.



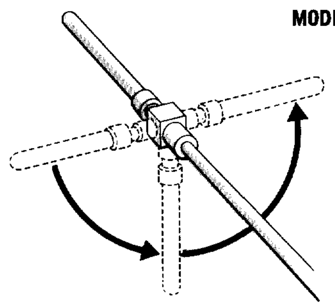
The Juno can be used for X-ray detection and measurement by reference to the above curves.

INSTRUMENTATION FOR NUCLEAR RESEARCH

HIGH RANGE SURVEY METER

MODELS CP-TP-1A and CP-TP-1B

- **Full-scale ranges to 5000 R/HR.**
  CP-TP-1A: 0 to .5, 5, or 50 R/HR.
  CP-TP-1B: 0 to 50, 500, or 5000 R/HR.
- **Interchangeable ionization chambers.**
- **3-position rotating chamber.**



MODEL 1B CHAMBER is shown connected to forward end of bracket. Dotted lines indicate the 3 positions to which the chamber can be rotated.

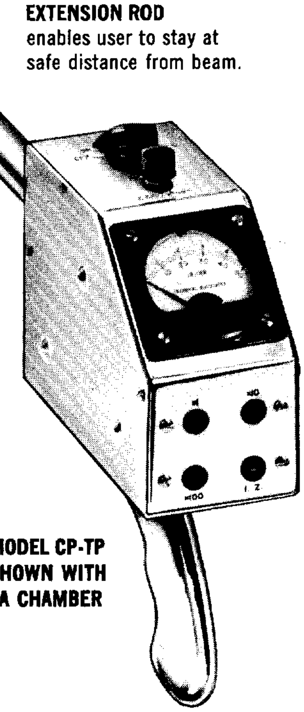
APPLICATION. The T/A Model CP-TP is the only portable, battery operated survey meter especially designed to enable the health physicist to measure high intensity beta and gamma radiation fields. The instrument features a 40″ extension rod with swivel bracket for rotating the chamber, thus allowing the user to stand behind a shield or out of the direct line of a beam.

EXTENSION ROD enables user to stay at safe distance from beam.

DESCRIPTION. Technical Associates' CP-TP High Range Survey Meter is available in two models, each having three linear ranges: CP-TP-1A provides 0 to .5, 5, and 50 R/HR (beta and gamma); CP-TP-1B provides 0 to 50, 500, and 5000 R/HR (gamma only).

The basic instrument is the same for both models, the only difference being the type of ionization chamber selected. The lower and higher ranges are determined by the size and configuration of the ionization chambers and their electrometer circuits. Each chamber contains its own electrometer circuit. The chambers are interchangeable on the instrument. The CP-TP-1A chamber has a removable beta absorber to allow measurement of beta radiation through an acetate end-window.

The instrument case is chrome-plated aluminum for easy decontamination. It contains the range selector switch, zeroing and calibration controls, batteries, and a high quality wide-face meter. The unit has a pistol grip handle for easy manipulation. Each model comes complete with a 40″ extension rod, which is detachable from the instrument case. Either ionization chamber can be connected directly to the case, if desired. The swivel bracket at the end of the extension rod has two connectors for use in attaching the chamber for the desired ranges. One connector is at the forward end and the other is on the side. The swivel bracket rotates, thus moving the chamber connected to the side of bracket into 3 separate positions: right, left, and downward.



MODEL CP-TP SHOWN WITH 1A CHAMBER

SPECIFICATIONS:

RANGES: Model CP-TP-1A: 0.5, 5, 50 R/HR.
Model CP-TP-1B: 50, 500, 5000 R/HR.

CONTROLS: Combined "Off-On" and range selector switch. Individual calibration controls for each range. Zero control can be set in radiation field.

CIRCUIT: Reliable single tube electrometer circuit with all high resistance points insulated with Teflon or Kel-F to insure minimum leakage.

METER: Wide-face 3½″ meter with dual scale calibrated in R/HR (black scale for 1A chamber, red scale for 1B chamber). Divided into 50 divisions. Mounted to provide excellent visibility.

ZERO DRIFT: Negligible after 15 minute warm-up.

IONIZATION CHAMBERS:
Model CP-TP-1A: Cylindrical bakelite internally coated with aquadag. Volume approx. 42 cubic inches. Chamber has a removable beta absorber (432 mg/cm²) to allow beta measurements through an acetate end-window (6 mg/cm²).
Model CP-TP-1B: Cylindrical aluminum internally coated with aquadag. Volume approx. 3 cubic inches. Sensitive to gamma only.

NOTE: Both chambers include their own electrometer circuit for specific ranges.

EXTENSION: Made of polished aluminum tubing 40″ long, with connector on one end for mounting on instrument case and swivel connector at the other end for mounting chamber.

INSTRUMENT CASE: Chrome-plated aluminum with all markings engraved for easy decontamination.

BATTERIES: 4 Eveready No. 412, 22.5 volts.
2 Burgess No. W5BP, 7.5 volts.
2 Eveready "D" Cells, 1.5 volts.

WEIGHT: 6 lbs.

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7M-9/61

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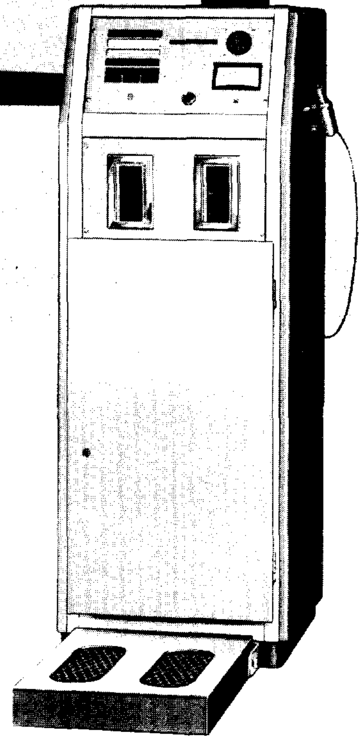
INSTRUMENTATION FOR NUCLEAR RESEARCH

Beta-Gamma HAND and SHOE MONITOR
Model HSM-10A

- **Completely automatic monitoring.**
- **Error-proof, illuminated read-out panel.**
- **Alarm settings as low as background.**
- **Positive warning of incomplete check.**
- **External clothing probe with separate circuitry, meter, and speaker.**

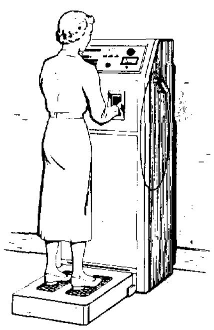


APPLICATION. The Model HSM-10A Hand and Shoe Monitor is a health physics instrument designed to provide completely automatic detection and measurement of beta-gamma contamination on the palm and back of each hand, the bottom surfaces of both shoes, and also the hair and clothing. Its simple, fool-proof operation allows an individual to perform this check without direct supervision of the health physicist.

DESCRIPTION. The Model HSM-10A employs the decade scaling principle and features illuminated multi-colored panels that enable the user to tell – in one look – whether he is contaminated, and where. Separate register read-outs are provided on the monitor panel, showing the total count on each hand and the combined count for both shoes.

An outstanding feature of the instrument is the new lower warning levels, which permit alarm settings as low as the background count. Count ranges are adjustable from 10 to 190, in increments of 10, with variable time settings from 1 to 120 seconds.

A separate rate meter circuit is utilized for the external clothing probe, including a speaker for audible check and a meter for visual check. All the detecting elements and sections exposed to radiation are designed for easy decontamination. A roll of kraft paper is mounted in the base for use over the shoe deck to prevent contaminated material from dropping into the detector chambers.



OPERATION. No skill is required in the operation of the Model HSM-10A Monitor. The user simply checks the illuminated multi-colored panels on the front of the instrument.

When the monitor is turned on, the blue "Ready for Use" panel will be illuminated. The user merely steps on the shoe deck and inserts hands into the two waist-high probe openings. The counting process is started and continued by pressure of the finger-tips at the rear of the probe openings, and by the weight of the person on the shoe deck. As soon as the counting starts, the "Ready for Use" panel darkens, and the yellow "Counter in Operation" panel lights up.

NOTE: If at any time during the counting cycle, the user removes either hand from the hand probe or steps off the shoe deck, the cycle will automatically stop and the orange panel reading "Check Incomplete – Reset and Repeat" will light up. This positive warning prevents erroneous readings.

As soon as the preset time has elapsed, the "Counter in Operation" panel darkens and either the green "Check O.K." panel or the bold red "Decontamination Required" panel lights up, depending upon whether the radioactivity present is above or below the alarm setting. If decontamination is required, bold red panels marked "Left Hand," "Right Hand," or "Shoes" will light up, indicating the location of contamination. The degree of contamination is indicated by the registers on the monitor panel.

The clothing probe, mounted on the right side of the instrument, is used to detect contamination on the hair and clothing. The output of the clothing probe is read visually on the count rate meter and aurally by the speaker, both of which are mounted on the monitor panel.

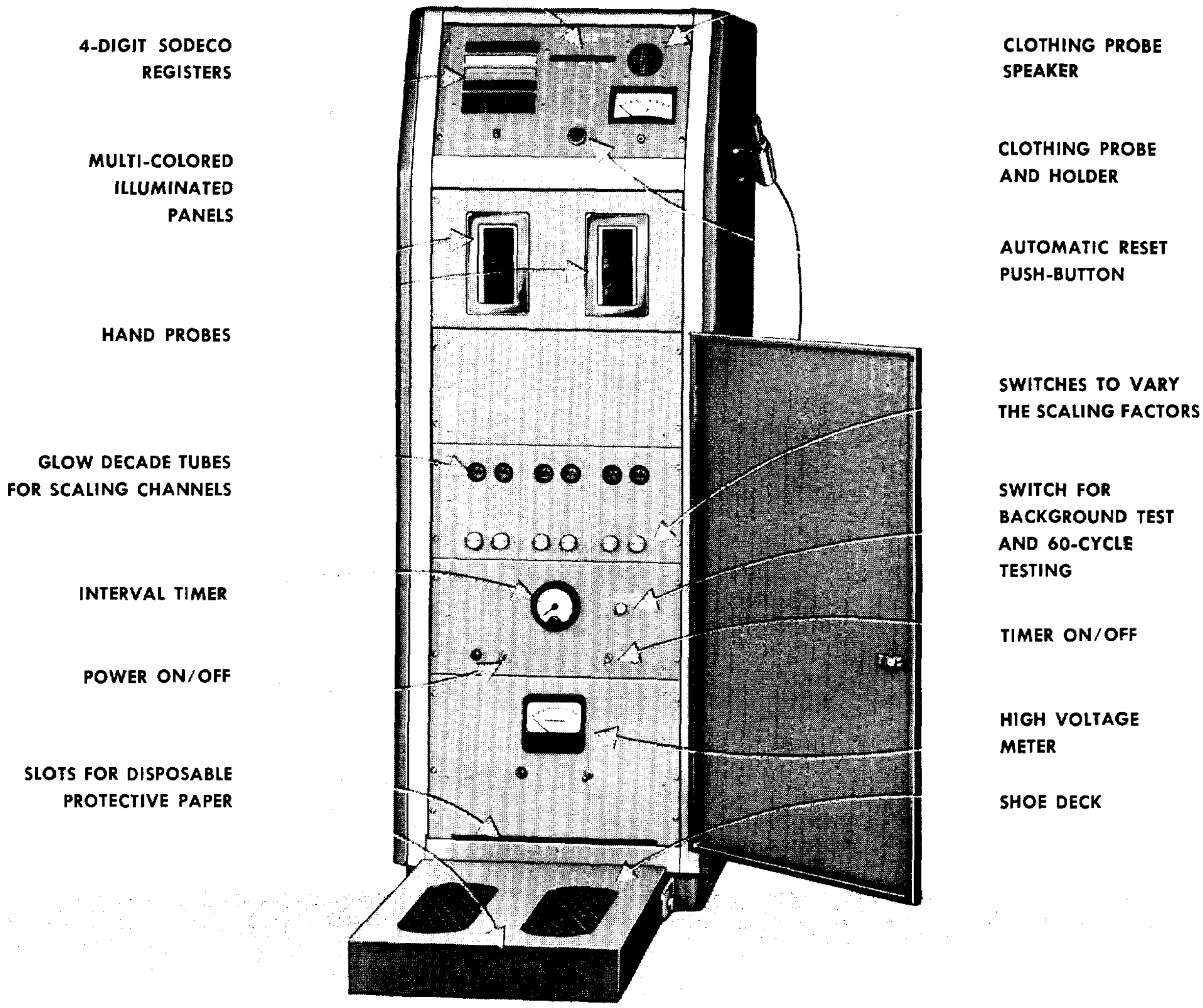
After the check is completed, the user pushes the large red "Reset" button on the front panel, and the instrument is ready for the next user.

TECHNICAL ASSOCIATES

140 WEST PROVIDENCIA AVENUE • BURBANK, CALIFORNIA

5M-8/61

Printed in U.S.A.



Alarm Settings: Preset Count Ranges: 10 to 190 counts, in increments of 10. Preset Time Periods: Variable from 1 to 120 seconds.

Sensitivity: Less than 0.15 μc of 0.2 MEV or higher energy.

Detectors: Hand Probes: 4 T/A Type T-1100 halogen quenched Geiger tubes in each hand probe.

Shoe Deck: 2 T/A Type T-1100 halogen quenched Geiger tubes in each shoe probe.

Clothing Probe: 1 T/A Type T-1110 halogen quenched Geiger tube.

Shielding: Hand and shoe detectors are shielded with 1/2" of lead.

Register Range: 0 to 9999, four digits on each of three Sodeco Registers.

Speaker for Clothing Probe: 2 1/2" adjustable volume.

Meter for Clothing Probe: 5" Assembly Products meter, registering to 10,000 cpm.

Power Requirements: 105 to 125 volts, 60 cycle A.C., 300 watts.

Dimensions: Cabinet: 67 3/4" high x 27 1/2" wide x 24" deep. Shoe Deck: 23" long x 18" wide x 4 1/4" high.

Finish: Grey baked enamel.

Shipping Weight: 650 lbs.

The complete unit is housed in a sturdy metal cabinet with grey baked enamel finish. Locked doors cover all controls, protecting the instrument from misadjustment by unauthorized personnel.

TECHNICAL ASSOCIATES

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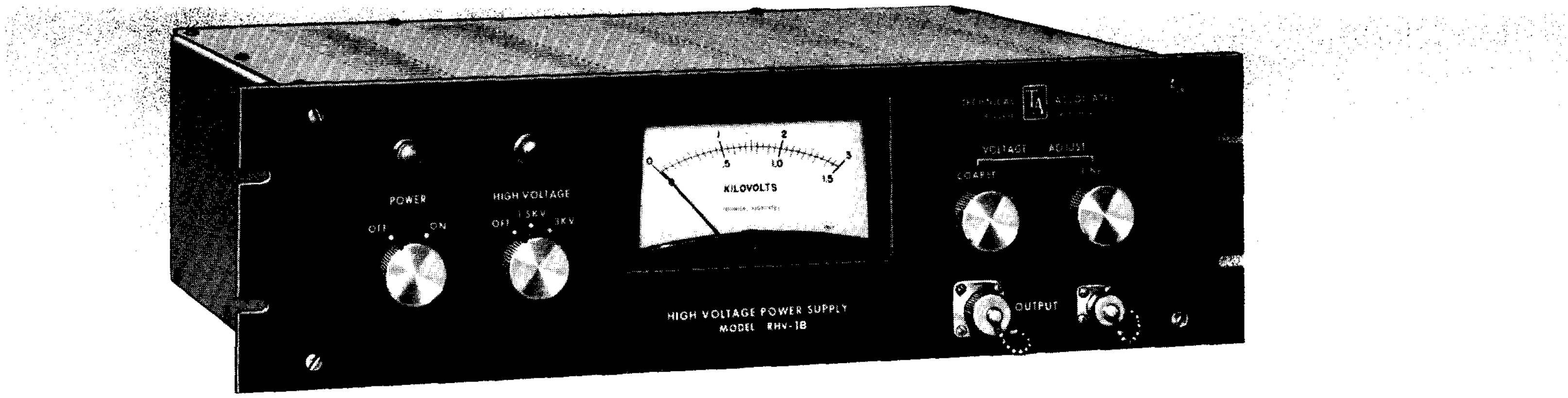
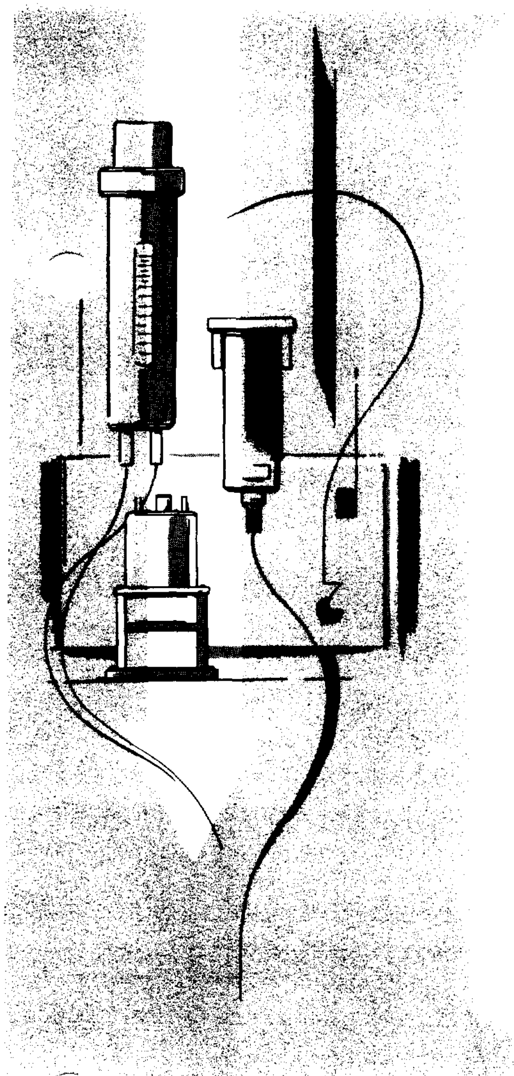
TA

INSTRUMENTATION FOR NUCLEAR RESEARCH

REGULATED HIGH VOLTAGE POWER SUPPLY

MODEL RHV-1B





APPLICATION. The Technical Associates Model RHV-1B High Voltage Power Supply is specifically designed for nuclear applications. It supplies operating current for gas flow counters, scintillation detectors, Geiger tubes, ionization chambers, and other applications where high voltage and low current are required. Because of its outstanding stability and reliability, the instrument is ideal for use as a component in spectrometry systems.

DESCRIPTION. The Model RHV-1B is highly stable and free from jitter, bounce, and corona. The residual ripple is less than 10 millivolts under all conditions. The instrument employs precision deposited carbon resistors which are unaffected by temperature changes. The output voltage is essentially unchanged by line or load fluctuations. An automatic time delay prevents the high voltage from being turned on until regulator tubes are in operation, thereby eliminating damage to the detectors.

Front panel controls are provided for power, range selection, and variable coarse and fine adjustments of output voltage. An "off" position is provided on the range switch to allow the high voltage to be turned off independently of the main power switch and without disturbing the settings of the "Coarse" and "Fine" controls. When the range switch is returned to range position, no warm-up time is required.

Separate indicator lights are provided for power switch and range switch. The 4½" meter has a tilted dial and was selected for easier and more accurate reading. For maximum convenience, output receptacles are provided on both front panel and rear chassis.

2 RANGES: +300V *to* +1500 V, *and* +600V to +3000V D.C. continuously variable by adjustment of "coarse" and "fine" potentiometer controls.

POLARITY: Positive output (negative ground).

STABILITY: Less than .01% drift per day after *warm-up.*

LINE REGULATION: Less than .01% change in high voltage for 1 volt line change between 105 to *125 volts.*

LOAD REGULATION: Output voltage decrease is less than .02% from no load to full load.

CURRENT OUTPUT: *Maximum output 1 ma on* 1500 volt range: 0.3 ma on 3000 volt range.

RIPPLE: Less than 10 millivolts at any voltage.

POWER REQUIREMENTS: 105 to 125 Volts A.C., 50/60 cycles, 120 watts.

PANEL CONTROLS:
- Power Switch: "On" and "Off."
- 3-Position High Voltage Switch: "Off," "1.5KV," and "3KV."
- High Voltage Adjustments: *"Coarse" and "Fine."*

HIGH VOLTAGE METER: 4½" meter with 2 scales.

HIGH VOLTAGE RECEPTACLES: One each Amphenol 83-798 and one each UG-931/U located on rear of chassis. Identical set of receptacles on front panel.

INPUT CONNECTOR: 3-prong safety plug Bryant 7486 with 6 foot cord.

DIMENSIONS: 19" wide x 5¼" high x 13" deep. For rack mounting.

WEIGHT: *18 pounds net; 26 pounds packed for shipment.*

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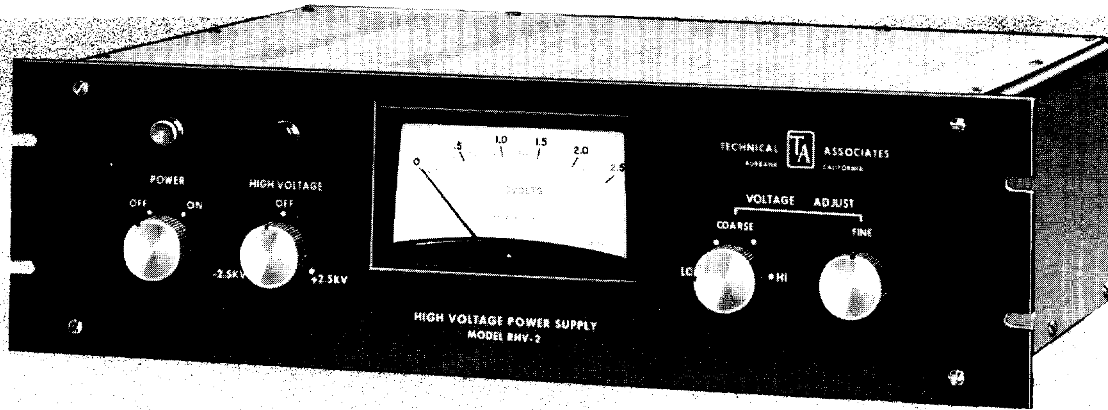
Printed in U.S.A.

HIGH VOLTAGE POWER SUPPLY

MODEL RHV-2

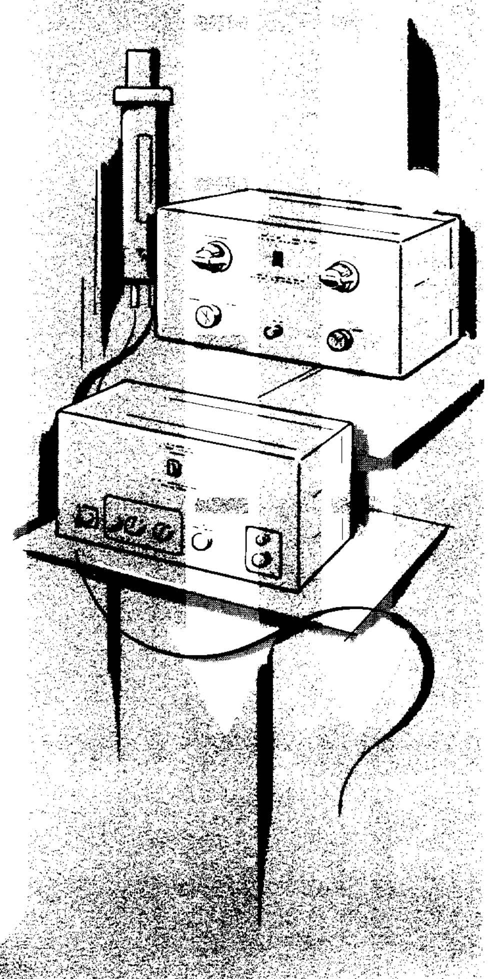


APPLICATION. The T/A Model RHV-2 is designed expressly for applications in analytical spectrometry and general systems where great stability and minimum ripple content are needed and a choice of positive or negative output polarity is desirable. It will supply operating current for Geiger tubes, scintillation detectors, gas flow counters, ionization chambers, and other sensing components requiring stable high voltage and low current.

DESCRIPTION. The Model RHV-2 High Voltage Power Supply is engineered for high performance and reliability. The circuit design is conservative and the components selected operate well below their rated limits. The instrument is highly stable and free from noise and corona. An automatic time delay prevents the high voltage from being turned on until regulator tubes are in operation, thus eliminating damage to detectors.

Front panel controls are provided for power, positive or negative range selection, and variable coarse and fine adjustments of output voltage. An "off" position is provided on the range switch to allow the high voltage to be turned off independently of the main power switch and without disturbing the coarse and fine adjustments. When the range switch is returned to range position, no warm-up time is required. The instrument has separate indicator lights for power switch and range selector switch. The 4½" meter has a tilted dial and was selected for easier, more accurate reading.

The continuously variable type of voltage control featured in the Model RHV-2 permits the precise selection of the optimum voltage for a particular scintillation detector to insure maximum gain and, at the same time, minimum noise level. The high voltage transformer is hermetically sealed for long life.



2 RANGES: +500 volts to +2500 volts D.C.
−500 volts to −2500 volts D.C.

POLARITY: Positive or negative, selected by front panel switch.

LONG TERM STABILITY: Less than .02% drift per day after warm-up.

LINE REGULATION: Less than .1% for variations from 105 volts to 125 volts.

LOAD REGULATION: Output voltage decrease is less than .01% from no load to full load.

RIPPLE: Less than 10 millivolts on either polarity.

CURRENT OUTPUT: Maximum output 3 ma at 500 volts, 1 ma at 1500 volts, 0.6 ma at 2500 volts.

POWER REQUIREMENTS: 105 to 125 volts A.C., 50/60 cycles, 130 watts.

PANEL CONTROLS:
Power Switch: "On" and "Off."
3-Position High Voltage Switch: "Off," "−2.5KV," and "+2.5KV."
High Voltage Adjustments: "Coarse" — 4-position switch with overlapping ranges; "Fine" — continuously variable potentiometer.

HIGH VOLTAGE METER: 4½" meter with 0 to 2.5KV scale.

RECEPTACLE: High voltage output UG-931/U.

INPUT CONNECTOR: 3-prong safety plug Bryant 7486 with 6-foot cord.

DIMENSIONS: 19" wide x 5¼" high x 14½" deep. For rack mounting.

WEIGHT: 20 pounds net; 26 pounds packed for shipment.

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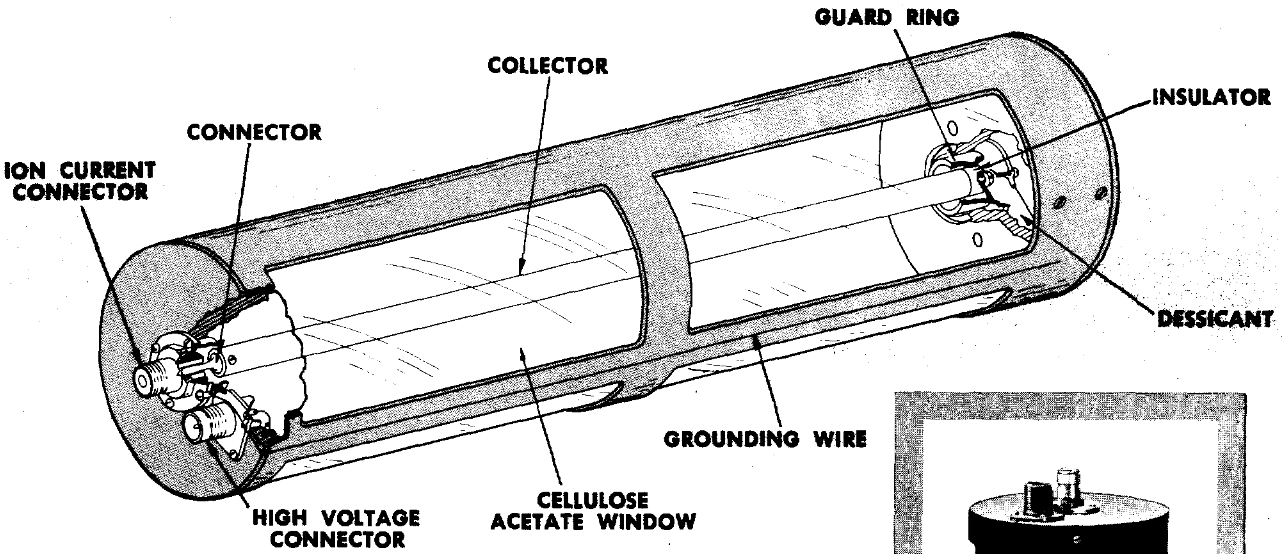
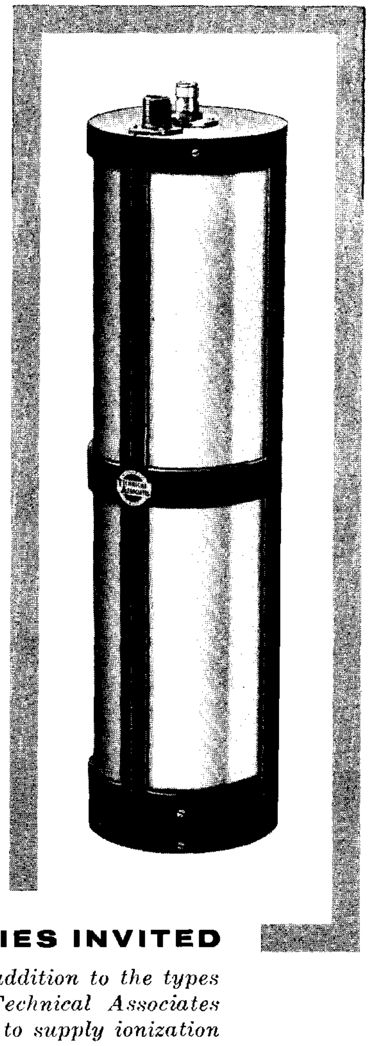
INSTRUMENTATION FOR NUCLEAR RESEARCH

IONIZATION CHAMBERS (MODELS IC-1 and IC-2)





APPLICATION: These ionization chambers are used for detection and measurement of Beta and Gamma radiation or Gamma radiation only. They can be installed in "hot" locations in a laboratory or reactor installation where it is desirable to monitor for control, health, or safety purposes. Model IC-1 has approximately one-half of the wall area cut away in the form of four windows which are fitted with .005" thick cellulose acetate. It is sensitive to soft radiation and is used for the detection and measurement of Beta and Gamma radiation. Model IC-2 is of solid wall construction and is used for the detection and measurement of Gamma radiation.

CONSTRUCTION: These chambers consist of a bakelite tube 5" in diameter x 18¾" long, with bakelite end plates. One end plate holds the high voltage input and signal output connectors. At the other end of the chamber, a space is provided to hold a dessicant to assure reliable operation under conditions of high humidity. Silica jell is used as the dessicant and is supplied in a cloth bag suitable for insertion in the cavity provided.

The collector is an aluminum tube ½" in diameter x 17⅜" long, and is supported by Teflon insulation at the back end, and by polystyrene insulation at the connector end. Guard rings are provided at either end to further reduce leakage. Leakage resistance is 10^9 ohms or higher to either ground or high voltage.

The inside of the 5" cylinder and the inside of the end plates are coated with aquadag to form a conducting surface. The aquadag coating is connected to the high voltage input connector. The electrical continuity resistance of the aquadag coating is held to less than 5000 ohms. Careful craftsmanship throughout assembly and testing insures that rigid insulation specifications are maintained.

SPECIFICATIONS:

- **OPERATING VOLTAGE RANGE:** 275 to 325 volts D.C.
- **SENSITIVITY:** Less than 1 mr/hr with micro-micro ammeter on 0.1 volt 10^{-11} ampere range.
- **ENERGY DEPENDENCE:** Small corrective factor below 0.3 mev; flat above 0.3 mev.
- **DIMENSIONS:** 5" dia. x 20" long. • **WEIGHT:** Net 3 lbs. Shipping 6 lbs.

INQUIRIES INVITED

In addition to the types described, Technical Associates is prepared to supply ionization chambers for special purposes to customer specifications.

TA

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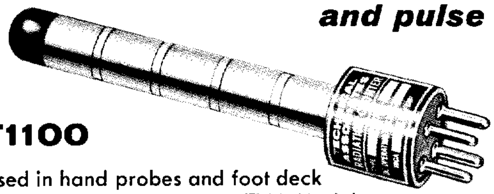
HALOGEN QUENCHED permanently sensitive

Radiation Counter Tubes used in T/A Equipment

Beta-Gamma sensitive stainless steel wall type tubes

...for greater sensitivity and pulse height



T1100

Used in hand probes and foot deck of monitoring instruments. (T/A Models HSM-10A, HSC-1, and ALM-2X Hand & Shoe Monitors, and Model PPM-8 Portal Monitor).

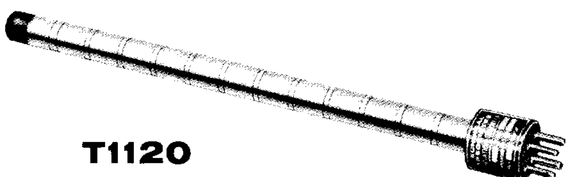
Cathode size: length 3″, diameter ⅝″, wall thickness 30-40 mg/cm^2.

Tube base: standard small 4 pin.

T1110

Used in clothing probe of monitoring instruments & Model P-10 Probe Assembly.

Cathode size: Same as T1100, except small 3 pin base.



T1120

Used in portal frame detectors of PPM-8 Portal Monitor and frame detectors of LIM-18 Laundry Monitor.

Cathode size: length 7″, diameter ⅝″, wall thickness 30-40 mg/cm^2.

Tube base: standard small 4 pin.

Mica end-window type tubes

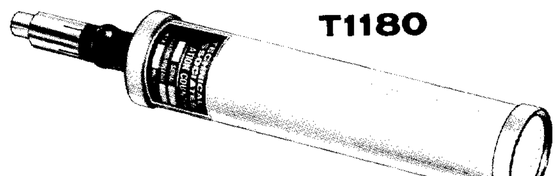
T1140

Alpha-beta sensitive.

Used in general radio-assay work and radiochemical analysis. (T/A Model LS-6 Lead Shield, T/A Model TM-8 Tube Mount in conjunction with LS-7 Lead Shield, and T/A Model P-8 Probe.)

End window diameter 1$\frac{3}{32}$″; thickness 1.4-2 mg/cm^2.

Tube base standard medium 4 pin.



T1180

Alpha-beta-gamma sensitive.

Used in general laboratory survey instruments where greater alpha and beta sensitivity are required. (T/A Model P-8X Probe in conjunction with a count rate meter or scaler.)

End window diameter $\frac{25}{32}$″; thickness 1.4-2 mg/cm^2.

Tube base connector standard single pin.

SPECIFICATIONS

	T1090*	T1100	T1120	T1140	T1160**	T1180
OPERATING VOLTAGE:	900V DC	900V DC	900V DC	900V DC	1300V DC	700V DC
PLATEAU LENGTH IN EXCESS OF:	200 Volts	200 Volts	200 Volts	200 Volts	250 Volts	180 Volts
SLOPE OF PLATEAU:	3% per 100V	10% per 100V	10% per 100V	5% to 10% per 100V	1.5% per 100V	10% per 100V
STARTING VOLTAGE (0.3V Pulses):	825V max.	825V max.	825V max.	825V max.	1180V max.	620V max.
MAXIMUM COUNTING RATE:	1700 cps	1700 cps	1700 cps	830 cps	1100 cps	1100 cps
BACKGROUND (Shielded with 2″ lead and ⅛″ aluminum):	50 cpm max.	50 cpm max.	75 cpm max.	50 cpm max.	50 cpm max.	75 cpm max.
DEAD TIME (Approximate):	100 μ sec.	100 μ sec.	100 μ sec.	200 μ sec.	150 μ sec.	150 μ sec.
OPERATING TEMPERATURE:	—30° to +80°C	—55° to +75°C	—55° to +75°C	—55° to +75°C	+15° to +50°C	—55° to +75°C
OVERALL DIMENSIONS:	4⅛″ long, $\frac{15}{16}$″ dia.	5⅜″ long, 1$\frac{5}{32}$″ dia.	11$\frac{25}{32}$″ long, 1$\frac{5}{32}$″ dia.	4$\frac{11}{32}$″ long 1⅜″ dia.	4$\frac{11}{32}$″ long, 1⅜″ dia.	6″ long, 1″ dia.
LIFE EXPECTANCY IN COUNTS:	Approx. 1 x 10^9	Unlimited	Unlimited	Unlimited	Approx. 1.5 x 10^8	Unlimited

*T1090 has organic quenching agent; base connector is single pin as in T1180.

**T1160 is identical to T1140, except it contains an organic quenching agent.

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NUCOR

THE NU-TEC POCKET MONITOR ... MODEL RM-100

A Tra... Radiation Detector

NUCOR'S new, inexpensive, wide range fully transistorized pocket monitor is a Geiger-Mueller tube type radiation detector of the most modern design.

Packaged in a lightweight non-breakable plastic case, it is the ideal instrument for carrying in a pocket or belt holder for health physics purposes.

SPECIFICATIONS

RANGES: Four scales:
0-10 mr/hr; 0-100 mr/hr;
0-1000 mr/hr; 0-100 r/hr.

ENERGY DEPENDENCE:
$\pm$15% for gamma or X-ray energies between 80KEV and 1.2 MEV.

SATURATION CHARACTERISTIC:
Will not jam or saturate in any field.

OPERATION CHECK:
All electronic circuits can be checked by a test position on the function selector switch. Complete radiological operation can be checked with a small radioactive source, such as a luminous watch dial.

READOUT: 1-1/4" meter provides immediate and visual readout. Phone jack provided for earphone.

CASE: Hi-impac plastic. Waterproof and shock resistant.

SIZE: 2 - 5/8" x 4-1/4" x 1-3/8" deep.

WEIGHT: 10 ounces.

POWER SUPPLY: One 4 volt battery provides more than 40 hours of continued operation.

MANUAL: Complete operating and instruction manual provided.

IMMEDIATE DELIVERY

ACCESSORY KIT: Earphone and Radioactive Test Source Included.

PRICE COMPLETE: $52.95 Includes Accessory Kit

RM-100/62

NUCOR®

NUCLEAR CORPORATION OF AMERICA
Instrument and Control Division
DENVILLE, NEW JERSEY

FROM: NUCLEAR CORPORATION OF AMERICA
Instrument and Control Division
2 Richwood Place
Denville, New Jersey

FOR RELEASE:

POCKET SIZE DETECTOR
MONITORS RADIATION

The NU-TEC, a pocket size radiation detector, designed for industrial applications and as a personal survival aid in atomic war, has been marketed by Nuclear Corporation of America, Denville, New Jersey.

Fully transistorized, and inexpensive ($52.95), the battery operated NU-TEC is a Geiger-Mueller tube type radiation detector sensitive to a wide range of gamma radiation energies.

Four ranges of 0 to 10/100/1000 mr/hr and 0 to 100 r/hr provide a direct and instanteous reading of the gamma or x-ray field present.

Packaged in a lightweight non-breakable plastic case, the "NU-TEC" is slightly larger than a pack of cigarettes and is the ideal instrument for carrying in a pocket or belt holder for health physics purposes.

An accessory kit containing an earphone and a radiation check source is included with the instrument. Used in situations where it is inconvenient to observe readings, the NU-TEC earphone can indicate changes in radiation levels. Radiation fields will produce a series of clicks in the earphone; the higher the radiation field, the greater the number of clicks.

A radiation check source can be used to obtain positive indications on the instrument. The check source provided with the NU-TEC utilizes a small harmless radiation field for checking the complete radiological response of the pocket monitor.

Further details and specification sheets may be obtained by writing to the Nuclear Corporation of America, Denville, New Jersey.

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PRICE LIST

TECHNICAL ASSOCIATES • 140 W. Providencia Ave. • Burbank, Calif.

Revised May 1, 1963
Subject to Change Without Notice

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			PERSONNEL MONITORS	
168		PPM-8	Beta/Gamma Portal Monitor complete	$1650.00
168		PPM-8C	Console for Model PPM-8 Portal Monitor	1295.00
168		LIM-18	Beta/Gamma Laundry Monitor	1150.00
184		HSM-10A	Beta/Gamma Hand and Shoe Monitor with external Beta/Gamma clothing probe	3575.00
207		FM-1	Frisker - Monitor (basic instrument less probes and alarms) mounted in cabinet	365.00
207		FM-1A	Frisker - Monitor (basic instrument with Rustrak Recorder and cabinet)	515.00
207		ALS-2	Plug-in Alarm for Frisker - Monitor	80.00
207		RAL-3	Remote Alarm for Frisker - Monitor	55.00
			SURVEY METERS	
185		CP-TP-1A	Cutie Pie Totem Pole Portable Survey 3 Range Meter, 0 to .5, 5, and 50 R/HR	460.00
185		CP-TP-1B	Cutie Pie Totem Pole Portable Survey 3 Range Meter, 0 to 50, 500 and 5000 R/HR	440.00
185		1A Chamber	Chamber only for CP-TP, range 0 to .5, 5 and 50 R/H	225.00
185		1B Chamber	Chamber only for CP-TP, ranges 0 to 50, 500, and 5000 R/HR	205.00
186		CP-3	Cutie Pie Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	295.00
186		CP-3A	Cutie Pie Portable Survey Meter 3 Ranges 0 to 25, 250 and 2500 MR/HR	295.00
186		CP-4	Cutie Pie Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	275.00
186		CP-4A	Cutie Pie Portable Survey Meter 3 Ranges 0 to 25, 250 and 2500 MR/HR	275.00
180		SRJ-7	Juno Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	325.00
180		HRJ-7	Juno Portable Survey Meter 3 Ranges 0 to 250, 2500 and 25,000 MR/HR	325.00
		F-6	Geiger Counter — Ranges 0-500, 0-5000 CPM	160.00
205		FS-11	Super Sensitive Gamma Scintillation Survey Meter — Ranges .01 over background .1, .25, 1.0, 2.5 MR/HR	450.00
			ANALYTICAL AND COUNTING INSTRUMENTS	
166	*	DS-5B	Decade Scaler (5 microseconds)	825.00
166	*	DS-5BA	Decade Scaler (1 microsecond)	915.00
200	*	DS-9	Decade Scaler (1 microsecond)	965.00
181	*	RM-8	Log-Linear Ratemeter	810.00
190	*	SM-10	Spectrometer (Single Channel Pulse Height Analyzer with built-in Linear Amplifier and Ratemeter)	765.00
169	*	SA-20	Single Channel Pulse Height Analyzer	685.00
190	*	SS-30	Spectrum Scanner	475.00
200		PA-6B	Pre-Amplifier	120.00
178	*	RHV-1B	Regulated High Voltage Power Supply 2 Ranges (1500 and 3000 volts)	375.00
190		MS-1	Mobile Stand for Scintillation Detector, counter-weighted and with shelf for scaler or Ratemeter	350.00

* Prices shown are for instruments supplied in 19" panel for rack mounting unless otherwise noted. For single instrument mounted in T/A Model C-875 "Easy-to-Service" Console cabinet add $30.00 to prices shown.

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			COUNTING INSTRUMENT ACCESSORIES	
203	**	PT-1	Predetermined Timer (Long counting intervals 999 minutes)	95.00
203	**	PT-2	Predetermined Timer (Short counting intervals 120 seconds)	95.00
203	**	PT-3	Predetermined Timer (Liebel-Flarsheim, 1 second-60 minutes)	100.00
200		PT-6	Electronic Timer	500.00
203	**	CR-2	Extended Count Register (4 digit)	65.00
166		DU-1	One microsecond plug-in decade unit	147.50
166		DU-5	Five microsecond plug-in decade unit	57.50

** These accessories will be supplied in a cabinet or panel mounted at customer's option.

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
		AUTOMATED COUNTING SYSTEMS	
189	MST-201	Multi-Sample Tabulator, 2" sample diameter, single channel complete with one DS-6 Scaler and Victor digital printer (less detector)	6420.00
189	MST-202	Multi-Sample Tabulator, 2" Sample diameter, dual channel complete with two DS-6 Scalers and Victor digital printer (less detector)	7250.00
189	MST-301	Multi-Sample Tabulator, 3" sample diameter, single channel complete with one DS-6 Scaler and Victor digital printer (less detector)	7670.00
189	MST-302	Multi-Sample Tabulator, 3" sample diameter, dual channel complete with two DS-6 Scalers and Victor digital printer (less detector)	8500.00
189	DS-6	Discriminating Decade Scaler for use with all model Multi-Sample Tabulator series	1050.00
189	MST-GF-2	Gas Flow Detector for all models of Multi-Sample Tabulator including lead shielding	440.00
189	MST-GM-2	Geiger Tube Detector with 1.860 dia. Window x 1.4 to 2 mg/cm^2 thick for all models of Multi-Sample Tabulator including lead shielding	380.00
189	MST-AS-2	Alpha Scintillation Detector with 3" diameter zinc sulfide phosphor for all models of Multi-Sample Tabulator	778.00
189	MST-BS-2	Beta Scintillation Detector with 2½" diameter Stilbene crystal for all models of Multi-Sample Tabulator	1075.00
189	MST-GS-2	Gamma Scintillation Detector with 2" diameter x 1" thick NaI crystal for all models of Multi-Sample Tabulator including lead shielding	685.00
201	GR-1	Gas Regulator for gas flow detectors used with Multi-Sample Tabulator and model GD-6 Flow Counter	47.50
		STAR SERIES SPECTROMETRY SYSTEMS	
171	Polaris	Includes SM-10 and RHV-1B mounted in C-1400 cabinet, complete with interconnecting cables and system test	1180.00
171	Lyra	Includes SM-10 and DS-5B mounted in C-1750 cabinet, complete with interconnecting cables and system test	1635.00
171	Arcturus	Includes SM-10, RHV-1B, SS-30 and Texas Instruments Rectilinear Recorder Model FRRIM-A16T in P-1 Panel Mount installed in C-3150 cabinet, with interconnecting cables and system test	2250.00
171	Orion	Includes SM-10, DS-9 and PT-6 mounted in C-2100 cabinet complete with cables	2280.00
		NOTE: For special applications requiring other combinations of T/A instruments please request a quotation.	
		SCINTILLATION DETECTORS AND ACCESSORIES	
202	SD-1	Scintillation Detector with 1" x 1" NaI crystal, complete with cables	455.00
202	SD-2	Scintillation Detector with 2" x 2" NaI crystal, complete with cables	765.00
202	SD-2W	Well-type Scintillation Detector with 1¾" x 2" NaI crystal (⅝" x 1½" well) complete with cables for use with LS-8 or LS-8X Shields	695.00
202	SD-3	Scintillation Detector with 1½" Alpha Phosphor, complete with cables	495.00
202	SD-4	Scintillation Detector with 1½" Beta Anthracene crystal, complete with cables	545.00
183	SD-6-1	Scintillation Detector with transistorized pre-amplifier, 2" photomultiplier tube and 1" x 1" NaI crystal, complete with cables. (For use in LS-6 Lead Shield with extension or LS-66) Universal Shield	445.00
183	SD-6-1.5	Scintillation Detector with transistorized pre-amplifier, 2" photomultiplier tube and 1½" x 1" NaI crystal, complete with cables. (For use in LS-6 Lead Shield with extension or LS-66) Universal Shield	575.00
183	SD-6-2	Scintillation Detector with transistorized pre-amplifier, 2" photomultiplier tube and 2" x 2" NaI crystal, complete with cables. (For use in LS-6 Lead Shield with extension or LS-66) Universal Shield	765.00
183	SD-6W	Well Scintillation Detector with transistorized pre-amplifier, 2" photomultiplier tube and 1¾" x 2" NaI crystal (⅝" x 1½" well) complete with cables. (For use in LS-66 Universal Shield)	695.00
202	CH-1	Crystal Housing SD-1 and SD-6-1 Scintillation Detector	30.00
183	CH-1.5	Crystal Housing for SD-6-1.5 Scintillation Detector	30.00
202	CH-2	Crystal Housing for SD-2 and SD-6-2 Scintillation Detector	30.00
202	CH-2W	Crystal Housing for SD-2W and SD-6W Scintillation Detector	30.00
202	NS-1	Nose Shield for Model SD-1 Detector	95.00
202	NS-2	Nose Shield for Model SD-2 Detector	115.00
202	C-1a	Collimator Type A (20° Flat Field) for SD-1 Detector	35.00
202	C-2a	Collimator Type A (20° Flat Field) for SD-2 Detector	45.00
202	C-1b	Collimator Type B (Straight Bore) for SD-1 Detector	40.00
202	C-2b	Collimator Type B (Straight Bore) for SD-2 Detector	50.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
202	C-1c	Collimator Type C (Forcusing) for SD-1 Detector	90.00
202	C-2c	Collimator Type C (Honeycomb) for SD-2 Detector	110.00
202	AS-11	Alpha Phosphor (1") for SD-1 and SD-6-1, complete with mount	79.50
202	AS-12	Alpha Phosphor (1½") for SD-2 and SD-6-2, complete with mount	85.00
202	BS-11	Beta Stilbene crystal (1") for SD-1 and SD-6-1, complete with mount	79.50
202	BS-12	Beta Stilbene crystal (1½") for SD-2 and SD-6-2, complete with mount	95.00
		GAS FLOW DETECTORS AND G.M. PROBES	
182	GD-6	Gas Flow Counter with built-in transistorized pre-amplifier (for use with LS-6 Lead Shield) includes extra window	395.00
204	P-7	Beta/Gamma Probe Assembly with T-1090 Tube, cable and connector	39.50
204	P-8	End Window Probe complete with T-1140 Tube, cable and connector	100.00
204	P-10	Beta/Gamma Probe Assembly with T-1110 G.M. Tube, cable and connector	65.00
204	P-AS-2	Alpha Scintillation Probe	315.00
201	GR-1	Gas Regulator for Gas Flow Detectors	47.50
204	AMS-2	Beta/Gamma Area Monitoring Station	85.00
		COUNTER TUBES	
144	T-1090	Metal Thin wall, 3 11/16" long, used in Model F-6 Geiger Counter, P-7 Probe or other Beta/Gamma applications	9.00
144	T-1100	Thin wall type 3" long used in Models PPM-8 and HSM-10A	27.00
144	T-1110	Thin wall 3" long used in P-10 Probe	27.00
144	T-1120	Thin wall type 7" long used in Model PPM-8	53.00
144	T-1140	Mica End Window used in TM-7, TM-8 Tube Mounts and P-8 Probe	58.50
144	T-1160	Mica End Window (Organic Quenched) used in TM-7, TM-8 Tube Mounts and P-8 Probe	67.00
144	T-1180	Mica End Window, Alpha/Beta/Gamma sensitive	61.00
		IONIZATION CHAMBERS	
144	IC-1	Ionization Chamber with windows (Beta/Gamma)	115.00
144	IC-2	Ionization Chamber — Solid Wall (Gamma)	105.00
		LEAD SHIELDS	
191	LS-1	Complete with Type ST-1 Sample Tray, Type SK-1 Socket and Type TM-1 Tube Mount	185.00
191	LS-2A	Standard with Type TM-6 Tube Mount and Sample Tray Holder, Type ST-2A Sample Tray and 10 Type PL-2 Aluminum Planchets	200.00
191	LS-2B	Micrometric with 10 Type PL-1 Planchets	285.00
192	LS-4A	For liquids complete with Type TM-1 Tube Mount, Type SK-1 Socket, and one Type ST-5 Marinelli Beaker	200.00
192	LS-4B	Modified to accommodate special tubes with aluminum inner liner	235.00
192	LS-4C	For solids, complete with Type TM-1 Tube Mount, Type SK-1 Socket, one Type ST-6 Ore Container and 100 Type ST-6A Paper Sleeves	225.00
192	LS-5	Complete with Type TM-3 Tube Mount, Type SK-2 Socket, Type STH-1 Sample Tray Holder, Type ST-4A Sample Tray, and 10 Type PL-2 Aluminum Planchets	275.00
193	LS-6	Complete with Type TM-7 Tube Mount, one Type ST-3B Sample Tray and 10 Type PL-3 Aluminum Planchets	295.00
193	LS-6X8	Eight-inch height extension for LS-6 shield used with SD-1, SD-2 and SD-6 Scintillation Detector	98.50
193	LS-6L	Lid with 3" opening and retaining collar for Models SD-1 and SD-2 Scintillation Detectors	72.50
193	LS-6P	Plug for 3" opening in LS-6L	12.50
206	LS-60	Top section of LS-66 for the purpose of converting a model LS-6 to universal	265.00
206	LS-66	Universal Lead Shield includes Detector Mount, lead ring for well detector and splash pan	540.00
194	LS-7A	Multi-Purpose Type complete with SD-1 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	780.00
194	LS-7B	Multi-Purpose Type complete with SD-2 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	1090.00
194	LS-7C	Multi-Purpose Type complete with TM-8 Tube Mount, three ST-7 Sample Trays and 10 PL-3 Planchets	385.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product		Price F.O.B. Burbank
194	LS-7M	Multi-Purpose Type — Shield only, with adapter ring, three ST-7 Sample Trays and 10 PL-3 Planchets		325.00
195	LS-8	For well counting (shield only, less detector)		265.00
195	LS-8W	For well counting, complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal		960.00
195	LS-8X	For well counting with 2" shielding in all directions (Shield only less Detector)		350.00
195	LS-8WX	For well counting with 2" shielding in all directions complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal		1035.00

LABORATORY ACCESSORIES

Bulletin No.	Model No.	Description of Product		Price F.O.B. Burbank
198	AB-2	Absorber Set		85.00
199	ST-1	Sample Tray		6.50
199	ST-2, ST-3, ST-3X, ST-3A, ST-3B, ST-4, ST-4A	Sample Trays		3.50
199	ST-5	Marinelli Beaker		4.25
199	ST-6	Ore Container		12.50
199	ST-6A	Paper Sleeves for Ore Container	per C	2.00
199	ST-7	Sample Tray for LS-7		2.50
199	STH-1	Sample Tray Holder with tray and ten planchets		13.50
199	SK-1, SK-2, SK-3	Sockets		12.00
199	TM-1, TM-2, TM-3, TM-4	Tube Mount		15.00
199	TM-5	Tube Mount (micrometric for LS-2 Lead Shield)		100.00
199	TM-6	Tube Mount and Sample Tray Holder		22.50
199	TM-7	Tube Mount and Sample Tray Holder		27.50
199	TM-8	Tube Mount and Adapting Ring for LS-7 Multi-Purpose Shield		70.00
206	SDM-9	Mount and Support Ring when SD-6 is used in LS-66 Shield		27.50
197	LC-1	Lead Source Container for four radium needles		45.00
197	LC-3	Lead Source Container 1" lead walls, 1½" x 3" inside dimensions		40.00
197	LC-3A	Lead Source Container 1⅜" lead walls ¾" x 2¼" inside dimensions		47.50
197	LC-4	Lead Source Container 1½" lead walls 1½" x 3" inside dimensions		60.00
197	LC-4A	Lead Source Container 1¾" lead walls ¾" x 2½" inside dimensions		67.50
197	LC-9	Mobile Source Unit — compartment 3" x 6" in shield of 2" lead. Mounted on heavy duty hand cart.		295.00
		Lead Brick, 2" x 3" x 6"		9.00
		Lead Brick, 2" x 4" x 8"		12.50
		Lead Brick, extruded shapes		**Prices upon application**
199		Planchets, Type PL-1, Sheet steel, tinned	per C	3.25
			per M	30.00
			per 5M	27.00/M
199		Planchets, Type PL-2, Aluminum	per C	3.25
			per M	30.00
			per 5M	27.00/M
199		Planchets, Type PL-3, Aluminum	per C	3.75
			per M	34.00
			per 5M	31.00/M
199		Planchets, Type PL-2C, Copper	per C	5.25
			per M	47.27
			per 5M	43.50/M
199		Planchets, Type PL-3C, Copper	per C	6.00
			per M	54.00
			per 5M	50.00/M
199		Planchets, Type PL-2S, Stainless Steel	per C	9.00
			per M	81.00
			per 5M	73.00/M
199		Planchets, Type PL-3S, Stainless Steel	per C	12.00
			per M	108.00
			per 5M	98.00/M
199		Planchets, Type PL-4, Aluminum	per C	5.00
			per M	45.00
			per 5M	40.50/M
189	PH-3	Plastic Holder for 3" diameter filter paper and wipe samples used with MST-300 series	per C	30.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product		Price F.O.B. Burbank
189	PH-2	Plastic Holder for 2" diameter filter paper and wipe samples used with MST-200 series	per C	30.00
189	PLH-30	Plastic Holder for 3" diameter planchets used with MST-300 series	per C	36.00
189	PLH-20	Plastic Holder for 2" diameter planchets used with MST-200 series	per C	30.00
189	PL-5	Aluminum Planchet 2" diameter x 3/16" deep used with MST-200 series	per C	8.00
189	PL-6	Aluminum Planchet 3" diameter x 3/16" deep used with MST-300 series	per C	11.00
		CABINETS		
	C-875	8¾" height "Easy-to-Service" console cabinet for standard 19" width panel		30.00
	C-1050	10½" height console cabinet for standard 19" width panels		35.00
	C-1225	12¼" height console cabinet for standard 19" width panels		37.50
	C-1400	14" height console cabinet for standard 19" width panels		40.00
	C-1750	17½" height console cabinet for standard 19" width panels		45.00
	C-2100	21" height console cabinet for standard 19" width panels		50.00
	C-2275	22¾" height console cabinet for standard 19" width panels		55.00
	C-2625	26¼" height console cabinet for standard 19" width panels		55.00
	C-3150	31½" height console cabinet for standard 19" width panels		60.00
	C-4375	43¾" height console cabinet for standard 19" width panels		70.00

IN GENERAL

Unit prices are given in this price list unless otherwise noted.

All prices quoted herein are f.o.b. Burbank, California. Payment terms, net 30 days upon approved credit.

No extra charge is made for packing for domestic shipments. Export charges will be quoted upon application. We reserve the right to alter specifications at any time without incurring the obligation of incorporating new features in previously manufactured equipment. Prices are subject to change without notice. Quotations remain firm for 30 days.

Shipping instruments: Please include shipping instructions when ordering; in the event that shipping instructions are not given, we will use our best judgment in the matter.

SERVICE CHARGES

Service charges for repairs are usually billed on an hourly basis, however, if desired, an estimate can be given before the work is undertaken. The unit to be repaired should be shipped prepaid to us.

WARRANTY

Technical Associates warrants instruments and equipment (except tubes, fuses, batteries and crystals), manufactured by them to be free from defects in workmanship or materials under normal use for a period of one year from the date of shipment from the factory to the buyer. Tubes, fuses, batteries and crystals are subject to the guarantee established by the manufacturer of them, however, Technical Associates will assist the customer to obtain full benefits of these guarantees.

If, within the one year warranty period, any Technical Associates instrumentation or equipment requires service as a result of a defect, the buyer may return it to the factory of Technical Associates at Burbank, California or to a service station designated by Technical Associates, transportation charges prepaid, for service at no change under the warranty. The buyer is urged to communicate with Technical Associates when warranty service is required, stating the nature of the difficulty and giving model and serial number of instrument. It may be possible to diagnose the trouble and send a replacement part or assembly, thereby avoiding the expense of shipment.

Technical Associates will return the instrument to the buyer, transportation charges prepaid, after repairs or replacement under warranty are completed. The liability to Technical Associates under this warranty is limited to the cost of replacements of defective parts upon prompt notification of such defect.

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INSTRUMENTATION FOR NUCLEAR RESEARCH
140 WEST PROVIDENCIA AVENUE • BURBANK • CALIFORNIA
TELEPHONES: Victoria 9-5838 • THornwall 8-6649

Dear Sir:

Technical Associates is pleased to announce the addition of several new products to our growing catalog.

In keeping with our practice to up-date catalogs in the field we are enclosing Bulletins No. 182, 183, 200, 205, 206 and 207 describing our new products and a current price list.

For the Counting Laboratory, we offer a new family of instruments. The Series SD-6 Scintillation Detectors, Gas Flow Counter Model GD-6, the Universal Lead Shield Model LS-66 and Decade Scaler Model DS-9, all have been engineered to meet the requirements of most sample counting applications.

Technical Associates' Model LS-6 Lead Shield, which has been the standard of the nuclear industry, was used as a basis for this unique, interchangeable package for sample measurement. Any Model LS-6 can be easily converted to the Universal Lead Shield Model LS-66 by adding the top section designated as LS-60.

For Monitoring, we offer the new Frisker-Monitor Model FM-1, a completely transistorized instrument with interchangeable probes for use when monitoring personnel or equipment for Alpha or Beta/Gamma activity, or for use as a Beta/Gamma laboratory monitor. Also offered is the new Super Sensitive Gamma Scintillation Survey Meter Model FS-11, which has a full scale range as low as .01 MR/HR over background.

Inquiries for further information or additional catalogs will be handled promptly.

Sincerely,

TECHNICAL ASSOCIATES

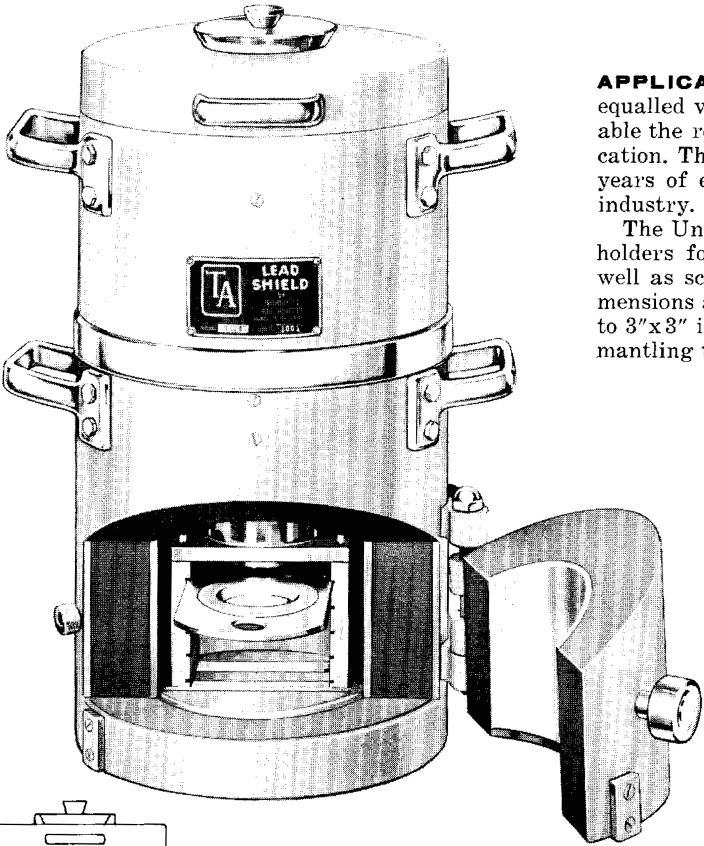
John E. Borg

John E. Borg
Sales Manager

JEB:rt
Encls.

P.S. Improved Model PPM-8 PORTAL MONITOR (Bulletin No. 168) with eight individually adjustable channels is available from stock. We offer this instrument for $1650.00 complete.

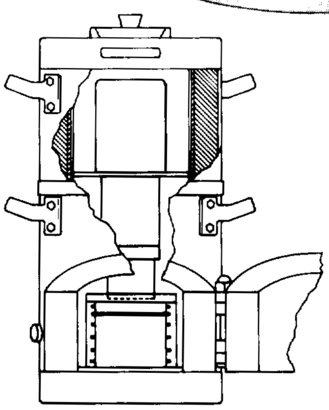
UNIVERSAL LEAD SHIELD
MODEL LS-66

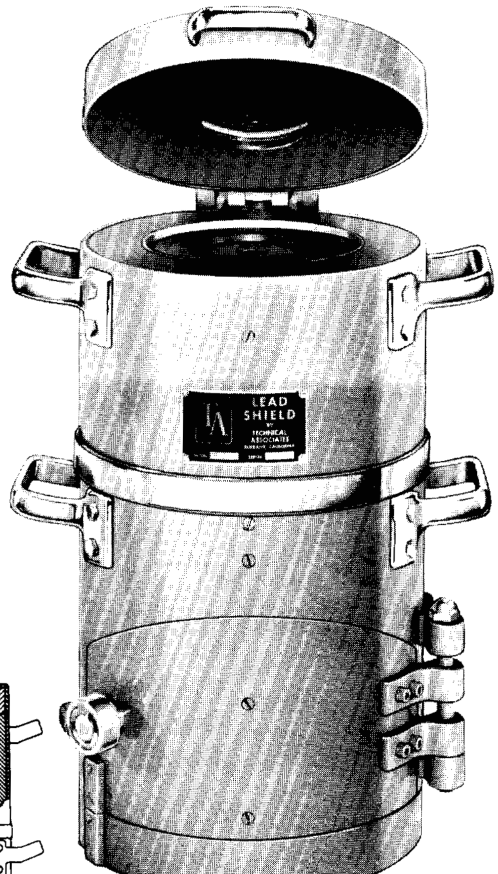


APPLICATION. The Model LS-66 Universal Shield provides unequalled versatility. Its unique design and 2-section construction enable the researcher to adapt the shield to any type of counting application. This new, all-purpose model reflects Technical Associates' 22 years of experience in manufacturing lead shields for the nuclear industry.

The Universal Shield is provided with mountings and sample tray holders for Geiger tubes, window or windowless flow counters, as well as scintillation detectors with well or solid crystals. Inside dimensions accommodate well scintillation assemblies with crystals up to 3"x3" in size. All detector assemblies can be installed without dismantling the shield.

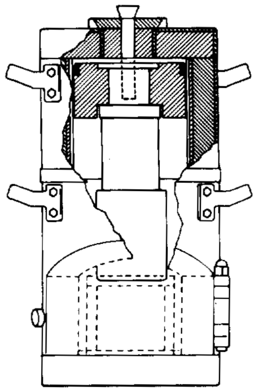
The bottom section of the Universal Shield is identical to the T/A Model LS-6, the most popular and widely used shield in the industry. Addition of the top section to the Model LS-6 easily converts it to the Universal Model LS-66.





MODEL SD-6 SCINTILLATION DETECTOR with SOLID CRYSTAL may be used in the Model LS-66 Universal Shield for counting samples in planchets. Mountings in bottom section of shield hold sample tray holders.

DESCRIPTION. The Model LS-66 is constructed of low porosity virgin lead meeting Federal Specification QQ-L-171. The upper plane of the door in the lower section is cut at a 30° angle and provides an efficient wedge-type seal for blocking stray radiation and light. The top section is designated as Model LS-60 and provides the well counting capability. The lid is counterbalanced for smooth easy operation and contains removable plugs to accept test tubes and a 50 ML beaker. A lead ring and splash pan are provided for installation around the well crystal, thus adding 2" to the shielding. The unit is lined with aluminum to minimize backscatter.



MODEL SD-6W SCINTILLATION DETECTOR with WELL CRYSTAL may be inserted in Model LS-66 Shield for counting liquid samples. A lead ring to further reduce background is provided for use around well crystal.

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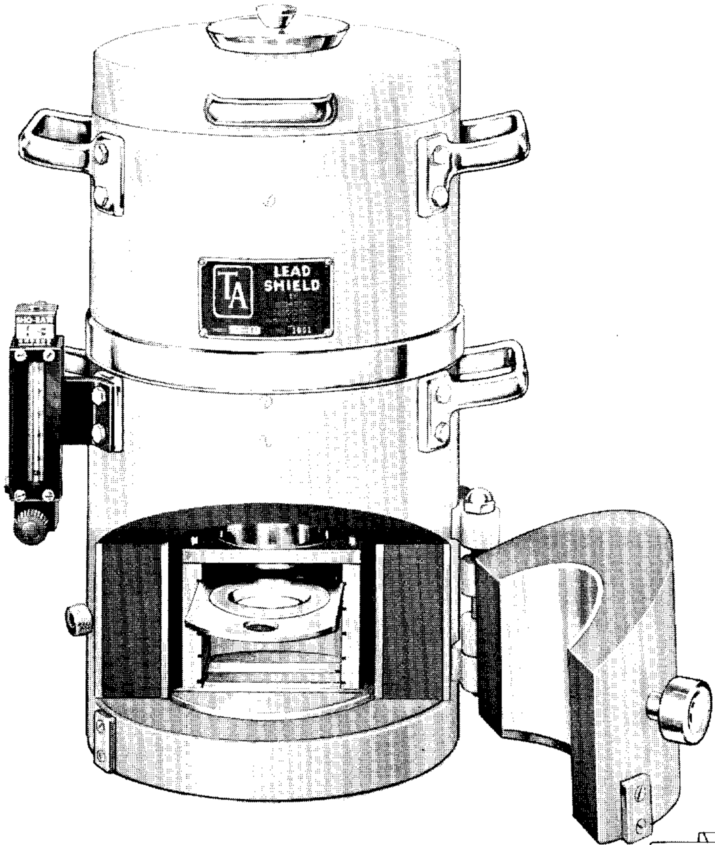
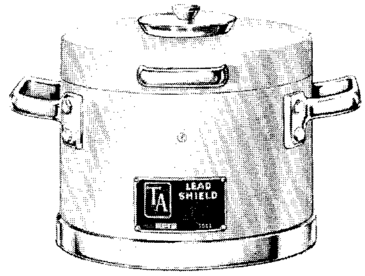
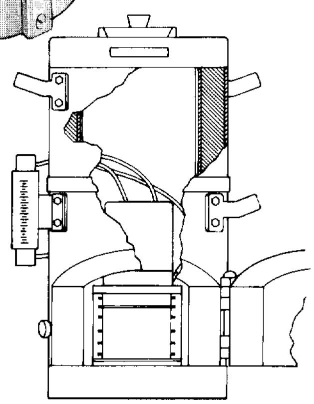


pecifications of

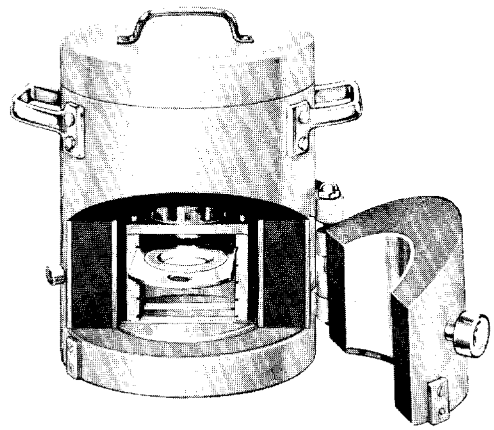
MODEL LS-66 UNIVERSAL SHIELD

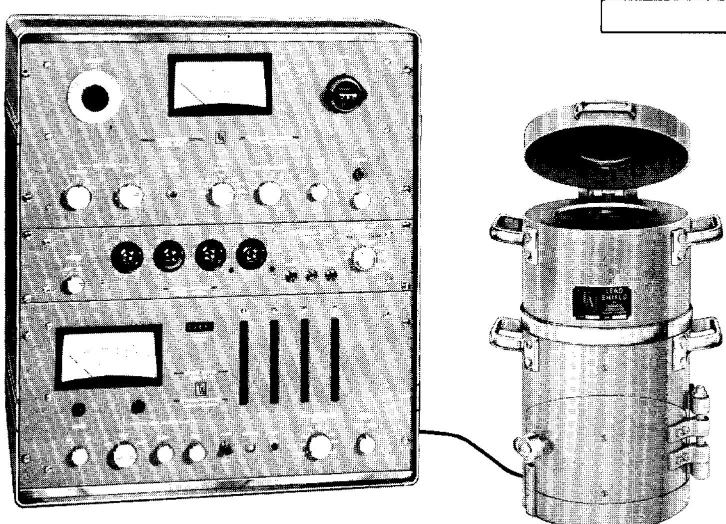
INSIDE DIMENSIONS: 5⅞" diameter x 15" high.
DOOR OPENING AREA: 4⅜" high (mean) x 5" wide.
GEOMETRIC REPRODUCIBILITY: 0.1%
SHIELDING: Well Counter — lead 3 5/32", brass ¼".
Solid Crystal — lead 1⅜", brass ¼".
WEIGHT: 355 lbs. Shipping weight, 375 lbs.
FINISH: Grey enamel. Chrome plated handles, hinges, and plugs.



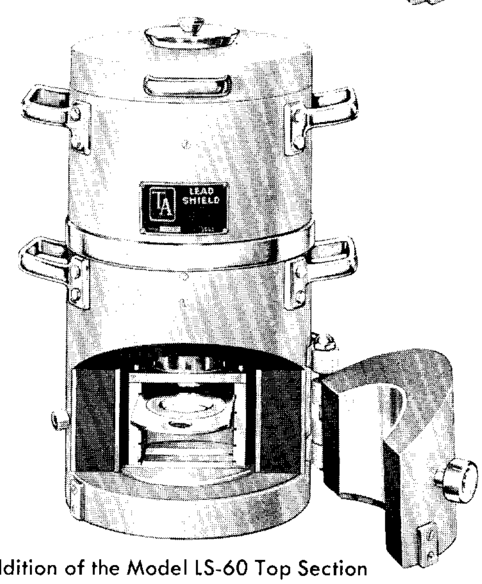


MODEL GD-6 GAS FLOW COUNTER
may be installed in the Universal Shield for window or windowless counting of alpha or beta emitting samples. A gas flow meter can be mounted on the shield.





Model LS-66 Universal Shield
shown with the Orion Spectrometry System, one of the many versatile T/A systems available for spectrometry applications.



Addition of the Model LS-60 Top Section to the LS-6 Lead Shield easily converts it to the Model LS-66 Universal Shield.

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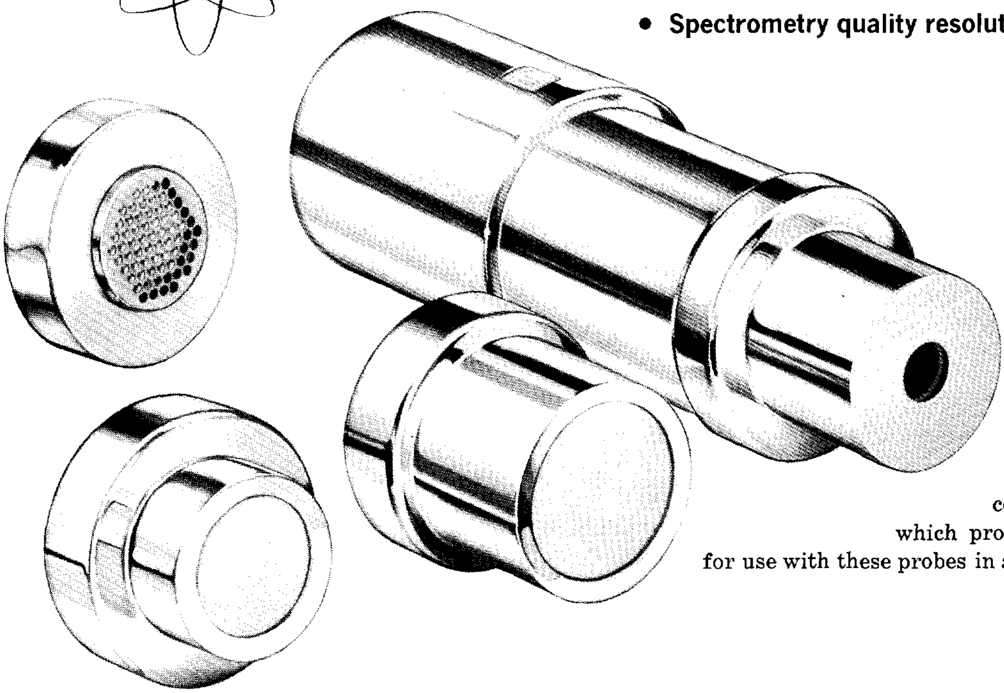
SCINTILLATION PROBES SERIES SD-6

- Built-in transistorized preamplifier.
- Interchangeable crystals.
- Spectrometry quality resolution.
- Dual polarity output.



APPLICATION. The T/A Series SD-6 Scintillation Probes are designed to offer maximum versatility. Interchangeable crystals allow the basic instrument to be used for counting alpha or beta particles from solid samples, as well as gamma activity from solid or liquid samples. The counting efficiency and resolution of these detector assemblies are ideal for gamma ray spectrometry applications, research, medical diagnostics, health physics, and isotope studies.

To utilize the versatility of the SD-6 Scintillation Probes, T/A has designed a completely universal shield, Model LS-66, which provides mountings and sample tray holders for use with these probes in any mode of operation. (See Bulletin #206)

DESCRIPTION. The scintillation detector assembly contains a 2″ photomultiplier tube with a mu metal shield and a transistorized dual preamplifier built as an integral part of the probe. Short leads from the photomultiplier tube assure high counting efficiency, even when the signals are very weak. A switch is provided to select the output polarity. The preamplifier for the negative output is extremely linear and has a gain of 10. The negative output of the preamplifier gives the SD-6 Series Detectors the versatility of operating into standard counting instruments with ¼ volt negative input. The positive output for spectrometry utilizes a double emitter follower circuit with unity gain. High voltage and signal cables are electrostatically shielded.

The crystals are hermetically sealed and optically coupled to the photomultipler tube by a rigid crystal mount. The crystal mount and probe casing are light tight and ruggedly constructed of brass. The assembly is hard chrome plated for durability and easy decontamination.

MODEL SD-6-1 employs a 1″x1″ Nal crystal with a 2″ photomultiplier tube for gamma ray detection.

MODEL SD-6-1.5 is identical to Model SD-6-1 except that it uses a 1½″ dia. x 1″ thick Nal crystal.

MODEL SD-6-2 employs a 2″x2″ Nal crystal with a 2″ photomultiplier tube. This larger crystal significantly increases the counting efficiencies and is recommended for spectrometry applications.

MODEL SD-6-2W uses a well type Nal crystal (1¾″ dia. x 2″ thick with a well 21/32″ dia. x 1³⁵⁄₆₄″ deep). The well crystal is a highly efficient detector for spectrometry and measurement of low level gamma-emitting samples in liquid or powder form.

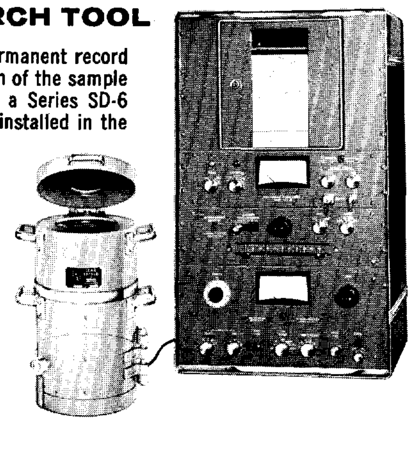
MODEL SD-6-B1.5 has a sealed light-tight 1½″ dia. Beta Stilbene crystal ½mm thick mounted behind an end window of polished aluminum foil .0005″ thick. This detector permits the counting of beta particles with energy greater than 40KV and is comparatively insensitive to gamma rays.

MODEL SD-6-A1.5 has a sealed light-tight 1½″ dia. Alpha Phosphor mounted behind an aluminum foil and protected by a perforated screen. This detector is not sensitive to gamma rays and yields a pulse height large enough to eliminate background count due to tube noise.

	SD-6-1	SD-6-1.5	SD-6-2	SD-6-2W	SD-6-B1.5	SD-6-A1.5
CRYSTAL:	1″x1″ Nal	1½″x1″ Nal	2″x2″ Nal	1¾″x2″ Nal (Well 21/32″ x 1³⁵⁄₆₄″)	1½″ Beta Stilbene (½mm thick)	1½″ Alpha Phosphor
RESOLUTION:	Does not apply		Pos. output only. Better than 10% for Cesium 137.		Does not apply	
PHOTOMULTIPLIER TUBE:	RCA 6655-A (Same for all Series SD-6 Models)					
PRE-AMPLIFIER:	All transistor dual polarity: Negative output has a gain of 10. Positive output is double emitter follower with unity gain.					
PLATEAU LENGTH:	200 volts minimum (negative output only)					
PLATEAU SLOPE:	Less than 5% per 100 volts using Cobalt 60 (negative output only)					
HIGH VOLTAGE REQUIREMENTS:	Stable positive polarity supply continuously variable from 500 to 1500 volts.					
LOW VOLTAGE REQUIREMENTS:	Probes are designed for use with instruments having 250 volt low voltage supply. Adaptable for instruments having 7 volt supply.					
CONNECTORS:	H.V. and Sig. Output. . UG-932/U Pre-Amp. Power. . Cannon XLR-3-12					
PROBE SIZE:	3½″ dia. x 9¾″		3½″ dia. x 10½″		3½″ dia. x 9″	
WEIGHT:	6½ pounds (Same for all Series SD-6 Models)					

AN IMPORTANT RESEARCH TOOL

To secure a permanent record of the spectrum of the sample being studied, a Series SD-6 Probe may be installed in the LS-66 Lead Shield, and the *signal fed into* the Arcturus Spectrometry System. (See Bulletin #171)



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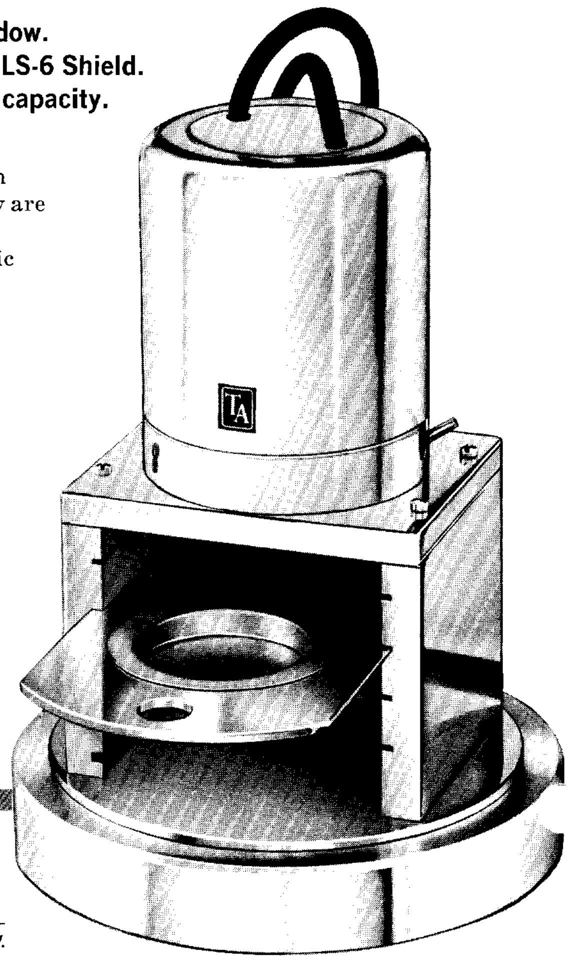
GAS FLOW COUNTER, MODEL GD-6

Exceptional plateau and high efficiency.
Proportional or Geiger operation.
Built-in transistorized preamplifier.
Ultra-thin nylon window.
Fits inside standard LS-6 Shield.
2″ diameter sample capacity.



APPLICATION. The Model GD-6 Flow Counter is engineered to produce high counting efficiencies where extremely low levels of alpha or beta radioactivity are to be measured. It is ideal for applications in biological, physical, and chemical research, or in environmental sampling for health physics and public health services. The instrument includes a sample tray holder which accepts samples up to 2″ in diameter and provides 5 reproducible geometries. The Model GD-6 is designed to fit inside the standard Model LS-6 Shield for background reduction during beta counting.

DESCRIPTION. The combination of the full 2 pi hemisphere, the precision collector wire, and the ultra-thin nylon window is the key to the high counting efficiency of the Model GD-6 Flow Counter. The instrument provides counting efficiencies which are 85% of internal counters. No purging time is required between counting cycles, thus allowing faster sample counting and reducing gas consumption.

The built-in transistorized preamplifier is coupled directly to the collector wire with a 1″ lead to eliminate loss of low amplitude signals. The preamplifier circuit is designed to operate with +250 Volts D.C., which is supplied by most scalers and ratemeters. A switch is provided to bypass the preamplifier when the Model GD-6 is used as a Geiger counter.

SPECIFICATIONS:

SAMPLE PANS: 2″ diameter x ¼″ deep, 2″ diameter x ⅛″ deep, and 2″ diameter x flat (aluminum or stainless).

HEMISPHERE: 2⅜″ diameter stainless steel.

COLLECTOR WIRE: 1 mil stainless steel.

WINDOW: 2¼″ diameter, 90 to 125 μg/cm² thick. (One extra window is supplied.)

COUNT YIELD: Alpha 38%, Beta 43% with C^{14}.

PLATEAU: Length, 300V; slope, 1% per 100V.

BACKGROUND: Alpha less than 0.1 cpm, Beta less than 30 cpm in LS-6 Shield.

COUNTING GAS: P-10 proportional, Q gas Geiger. (Incl. flow meter & low pressure regulator.)

OPERATING VOLTAGE: Proportional — Alpha 1200V, Beta 1800V, Geiger 1300V.

PREAMPLIFIER POWER REQUIREMENT: +250 Volts D.C. @ 10 ma.

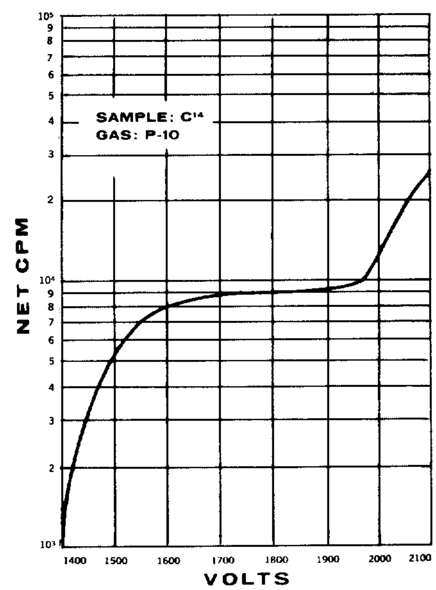
PREAMPLIFIER OUTPUT: 2 volts negative. (Triggers standard instruments having .25V negative input.)

CABLE CONNECTORS: Signal and High Voltage—UG-932/U Preamplifier Power — Cannon XLR-3-12C.

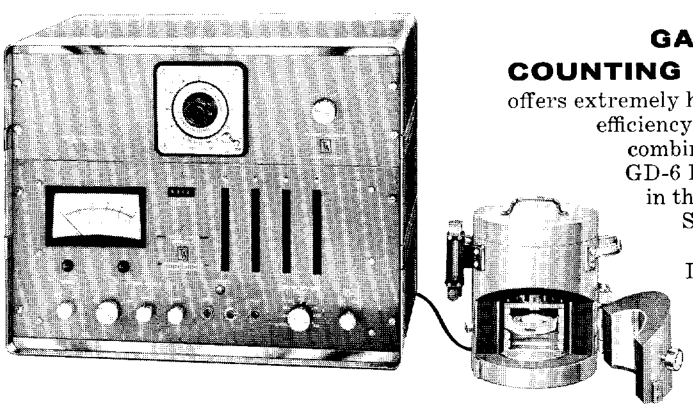
FINISH: Chrome.

SIZE: 5½″ diameter x 8″ high.

WEIGHT: 5 pounds.



This is an actual plateau from the Model GD-6 Flow Counter using a C^{14} sample.



GAS FLOW COUNTING SYSTEM

offers extremely high counting efficiency. The system combines the Model GD-6 Flow Counter in the Model LS-6 Shield and the Model DS-9 Decade Scaler with electro-mechanical timer.

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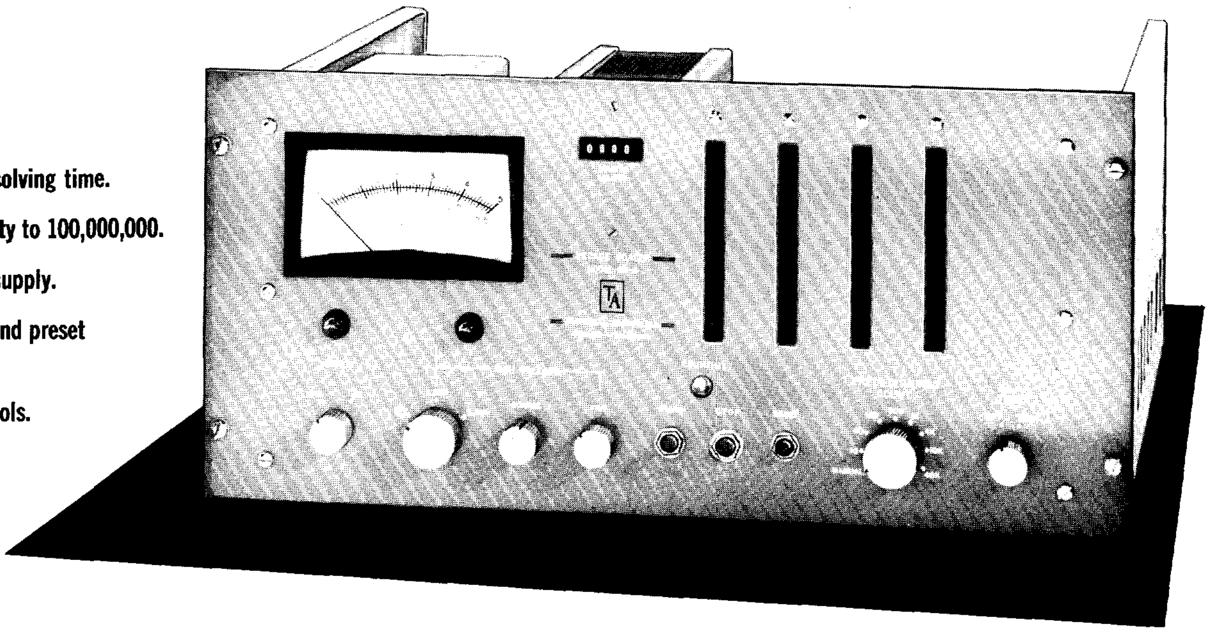
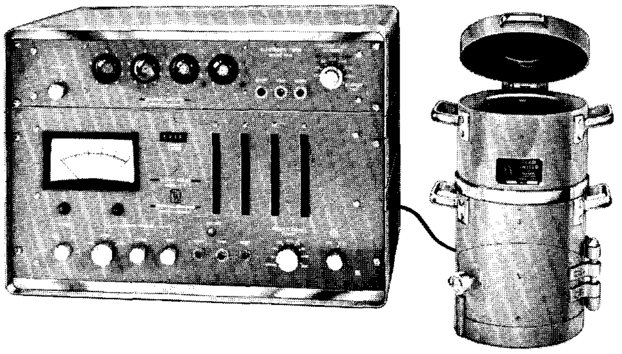
DECADE SCALER, MODEL DS-9

- 1 microsecond resolving time.
- Total count capacity to 100,000,000.
- 5000 volt power supply.
- Manual, remote, and preset count operation.
- Push-button controls.



APPLICATION. The Model DS-9 Decade Scaler is a precision counting instrument designed for use with any type of scintillation detector, Geiger tube, or proportional flow counter. This versatile scaler, combined with the appropriate detector and shield, provides an ideal radioisotope counting system for applications in research, health physics, and medicine. The instrument may be included as a component in analytical spectrometry systems as well. (See Bulletin No. 171.)

DESCRIPTION. The Model DS-9 Decade Scaler features 1 microsecond resolving time and provides count storage capacity to 100,000,000 with 4 direct reading decades and a four digit electro-mechanical register. The instrument has manual and preset count modes of operation and is adaptable to predetermined or elapsed timing with an electronic or electro-mechanical timer. Input sensitivity is variable from 0.2 to 2.0 negative volts. A stable regulated high voltage power supply features dual ranges 500 to 2500 and 1000 to 5000 volts, together with coarse and fine adjustments. Push-button controls are provided on the front panel for easy operation of "Start," "Stop," and "Reset."



RADIOISOTOPE COUNTING SYSTEM utilizes the Model DS-9 Decade Scaler and Model PT-6 Electronic Timer. System is shown with LS-66 Universal Shield which accommodates any type of detector.

SPECIFICATIONS

INPUT SENSITIVITY: 0.2 to 2.0 negative volts. (Set at factory 0.25V)
INPUT SIGNAL POLARITY: Negative.
RESOLVING TIME: 1 microsecond to pulse pair.
MAXIMUM COUNTING RATE: 250 KC.
COUNT CAPACITY: 100,000,000.
PRESET COUNT RANGES: 10, 40, 100, 400, 1000, 4000, 10,000, 40,000.
PUSH-BUTTON CONTROLS: Start, stop, reset.
HIGH VOLTAGE POWER SUPPLY:
- **Range:** 500 to 2500 volts and 1000 to 5000 volts continuously variable with "coarse" and "fine" controls.
- **Polarity:** Positive output (negative ground).
- **Stability:** Less than .01% drift per day after warm-up.
- **Regulation:** Less than .01% change in high voltage for a 1 volt line change between 105 to 125 volts A.C.
- **Ripple:** Less than 0.005% of output voltage.
- **Automatic Time Delay:** Prevents high voltage from being turned on until regulator tubes are in operation, thereby eliminating damage to detector.
- **High Voltage Meter:** Large 5" meter face calibrated to within ±2% full scale.

POWER REQUIREMENTS: 105 to 125 Volts A.C., 250 watts.
FINISH: Grey baked enamel.
SIZE: 8¾" high x 19" long x 15" deep.
WEIGHT: 40 lbs. Shipping weight: 46 lbs.

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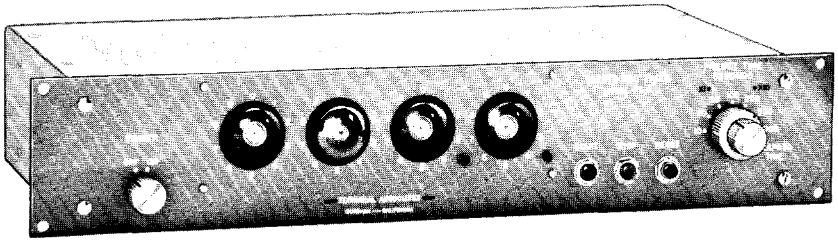
ELECTRONIC TIMER, MODEL PT-6



The T/A Model PT-6 Electronic Timer is designed for use with counting systems where short-time error must be minimized and long-time counting is required. The instrument incorporates fast start and stop circuitry, as well as push-button reset. This timer may be used with any electronically gated scalers or any scalers that stop and start with mechanical contact closures.

SPECIFICATIONS

TIME INDICATION: By 4 glow transfer tubes.

PRESET TIME: 10, 20, 50, 100, 200, 500, 1000, 5000, 10,000 seconds.

TIME RESOLUTION: To the nearest 1 second on times longer than 1000 seconds and 0.1 second on times less than 1000 seconds. (The X1-X10 switch changes the frequency of the timer drive by a factor of 10, thus moving the decimal point one place to the left or to the right as desired.)

ELAPSED TIME: 0 to 9999 seconds.

ACCURACY: Limited entirely by line frequency variations.

OUTPUT: Contact closure on accumulation of preset time as well as electronic gate output. A gate output is also provided on start and stop.

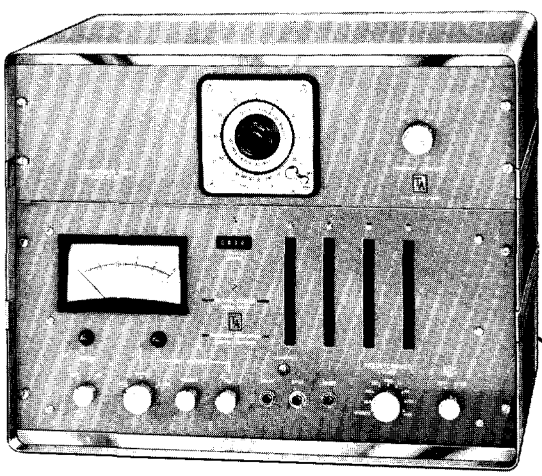
CONTROLS: Power, stop-start, reset, preset time, and elapsed time selector switches.

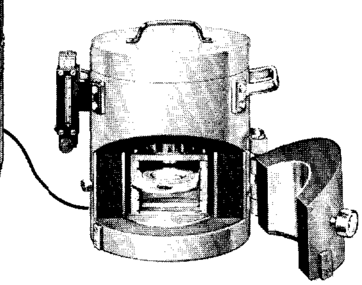
DIMENSIONS: 3½″ x 19″ x 9″ deep for rack or cabinet mounting. A line cord is included with the instrument and cabinets are available at slight extra cost.

POWER REQUIREMENTS: 115 volts, single phase, 60 cycle, 75 watts.

CONNECTORS: Output—AN-3102A-2029S • AC Power—Amphenol 160-3

PREAMPLIFIER, MODEL PA-6B. This instrument is designed to have low noise and good non-overloading characteristics for use with proportional flow counters and scintillation detectors where the signal output may be too low in amplitude to feed directly into a scaler, ratemeter, or other counting instrument. The Model PA-6B Preamplifier has an adjustable input sensitivity from 1 millivolt to 1000 millivolts and a gain of 250, thus allowing it to be used with any standard scaler or ratemeter. Cables are provided for power input and signal-high voltage input. The instrument is offered mounted on a standard 19″ panel or self-contained in a 4″ x 5″ x 8″ cabinet. The cable connectors and receptacles are as follows: power input (cable), Cannon XLR-3-12; high voltage input and signal input (cable), UG-932 A/U; and detector input (receptacle), UG-931/U.



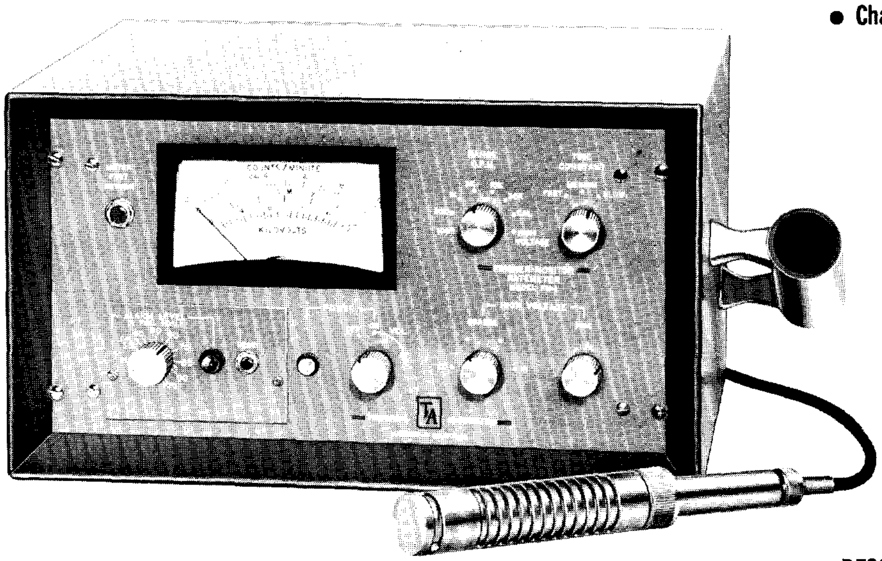


GAS FLOW COUNTING SYSTEM

offers extremely high counting efficiency. The system combines the Model GD-6 Flow Counter in the Model LS-6 Lead Shield and the Model DS-9 Decade Scaler with Electro-Mechanical Timer.

FRISKER-MONITOR, MODEL FM-1

- **Interchangeable alpha or beta/gamma probes.**
- **Completely transistorized with plug-in circuit boards.**
- **Chart recorder outputs to provide permanent records.**

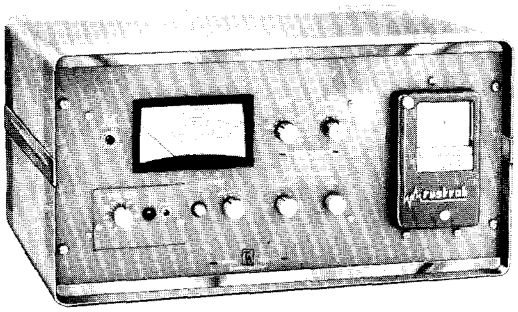


APPLICATION. The T/A Model FM-1 Frisker Monitor is a multi-purpose ratemeter designed primarily to detect radiation contamination on the clothes, hair, hands, and shoes of personnel moving about from active areas to clean areas. The basic unit is also used in checking laboratory equipment during decontamination processes.

With the inclusion of the Model ALS-2 Plug-In Alarm, the Frisker Monitor can be used as a continuous area monitor for laboratories and source rooms. The alarm will alert personnel when the radioactivity reaches the preset warning level.

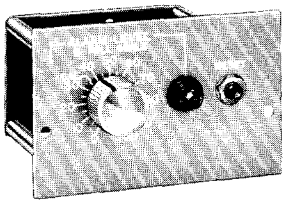
In addition to personnel and laboratory monitoring, this flexible instrument is ideal for educational demonstrations and medical isotope studies.

DESCRIPTION. The Model FM-1 Frisker Monitor features completely transistorized circuits on plug-in boards to assure long dependable service. Its 6 linear ranges and 3 time constants were selected to offer efficient capability for counting alpha, as well as beta/gamma, with a single instrument using interchangeable probe assemblies. The count rate is audible through a built-in 3½" loudspeaker and easily visible on a large 4½" meter face, which displays the full scale ranges. Included on the front panel are a fast zero control, calibration test signal, and high voltage controls with coarse and fine adjustments.

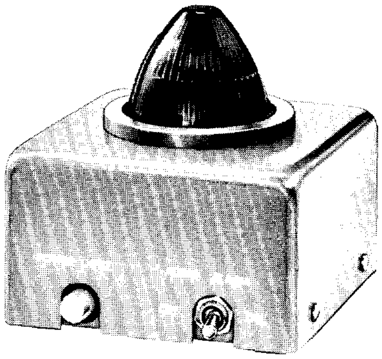


MODEL FM-1A FRISKER MONITOR
is shown mounted with chart recorder on a standard 19" panel.

RANGES: 0 to 100, 300, 1000, 3000, 10,000, 30,000.
TIME CONSTANTS: Fast, medium, slow (5 sec., 25 sec., 50 sec.)
ACCURACY: Better than 5% on all ranges.
INPUT SENSITIVITY: Negative, variable from .2 to 2 volts. (Factory set at .25 volts)
RESOLUTION: Less than 10 microseconds.
VISUAL READ-OUT: 4½" dual purpose meter for count rate read-out and high voltage.
AURAL READ-OUT: Audio amplifier and 3" speaker with volume control on panel.
FAST METER RETURN: Button on front panel.
RECORDER OUTPUTS: Connections to drive 10 MV and 1 MA strip chart recorder.
ZERO STABILITY: Grounded output, no drift.
TEST SIGNAL: 3600 cpm calibration check provided on front panel.
HIGH VOLTAGE: Regulated 500 to 1600 volt supply with coarse and fine adjustments on front panel.
POWER REQUIREMENTS: 115 volts, 60 cycle, 6 watts.
CONNECTORS: UG-931/U Signal & H.V. jack mates with UG-932/U plug.
AN 3102A-14S-5S Alarm receptacle mates with AN 3106A-14S-5P.
Switchcraft 13B recorder jack.
Amphenol 160-2 auxiliary power receptacle.
Cinch-Jones Type 3-141Y barrier terminal strip for 10 MV recorder output and external test signal input.
SIZE: 8¼" high x 17" wide x 10" deep.
WEIGHT: 20 pounds. Shipping weight: 28 pounds.



PLUG-IN ALARM To increase the versatility of the Frisker Monitor, a Model ALS-2 Plug-In Alarm is offered on an optional basis. This transistorized accessory is designed to alarm at a preset level and includes a red light indicator and reset button. The alarm settings are variable from 10% to 100% of full count range. The meter continues to read the exact count rate.



REMOTE ALARM Also available for use with the Frisker Monitor is the Model RAL-3 Remote Alarm Indicator. This accessory contains a clearly visible flashing red light and buzzer type audio signal which are activated when the radioactivity reaches the warning level set on the alarm. A front panel switch is provided to switch off the audio signal. The alarm is furnished with 25 feet of connecting cable, but can be used at greater distances.

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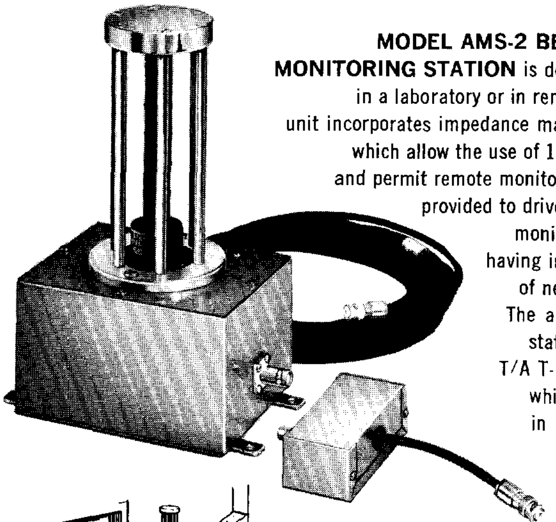
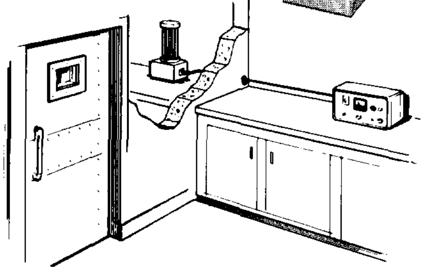
PROBE ASSEMBLIES and AREA MONITORING STATION

AREA MONITORING STATION

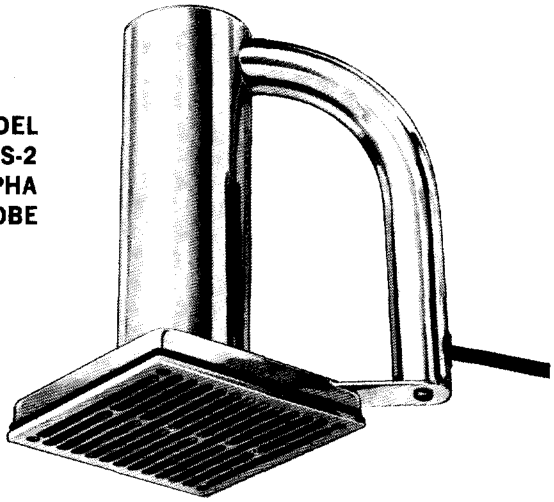


MODEL AMS-2 BETA/GAMMA MONITORING STATION is designed for use in a laboratory or in remote areas. The unit incorporates impedance matching circuits which allow the use of 1500 ft. of cable and permit remote monitoring. A pulse is provided to drive ratemeters or monitoring consoles having input sensitivity of negative ¼ volts. The area monitoring station includes a T/A T-1100 GM Tube, which is mounted in a chrome cage for protection.

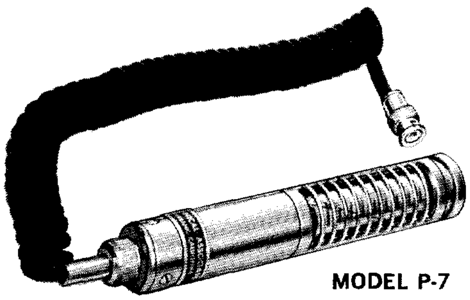


Monitoring Station can be placed in remote area from console, such as in separate isotope storage room.

MODEL P-AS-2 ALPHA PROBE

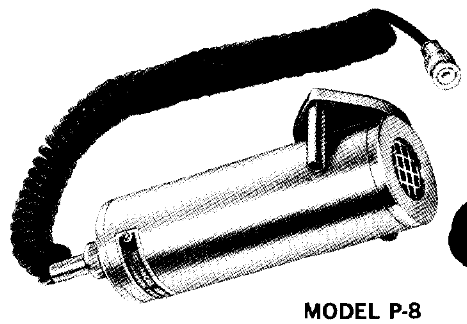


MODEL P-AS-2 PROBE is ideal for surveying contaminated areas or for "frisking" personnel, clothing, and equipment. It can be used with ratemeters, scalers, portable survey meters, or monitoring stations. The unit consists of a 4½"x4½" alpha phosphor covered with 1.0 mg/cm^2 aluminized mylar and optically coupled to a 2" photomultiplier tube. The probe is specially designed to assure high efficiency over the entire window surface. Power requirements are +900 to +1000 volts at approximately 25 micro-amps.



MODEL P-7 BETA/GAMMA PROBE

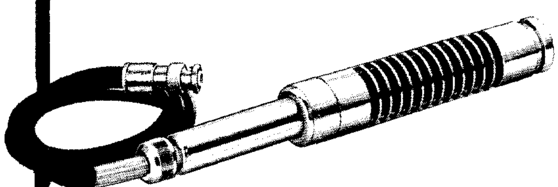
is primarily designed for use as a "frisker" with a ratemeter, scaler, portable survey meter, or as an accessory with monitoring stations. The unit includes a T/A T-1090 GM Tube (with organic quenching agent) and features a 180° rotating beta shield. The probe is ruggedly constructed of brass with chrome plating.



MODEL P-8 BETA/GAMMA PROBE

This end window probe includes the T/A Model T-1140 GM Tube and is ideal for detecting soft beta radiation. It can be used with counting instruments such as ratemeters, scalers, and portable survey meters. The unit is chrome-plated and features a snap action end cap which protects window and acts as a beta absorber when surveying for gamma only.

MODEL P-10 BETA/GAMMA PROBE



This probe is similar in application to the Model P-7 Probe, except that it utilizes a T/A T-1110 GM Tube (stainless steel, with halogen quenching agent). The unit features a 180° rotating beta shield and is constructed of durable chrome-plated brass.

NOTE: All probes are supplied with 8′ cable and a UG-932/U connector so that they can be connected directly to T/A equipment. Other connectors will be supplied on request.

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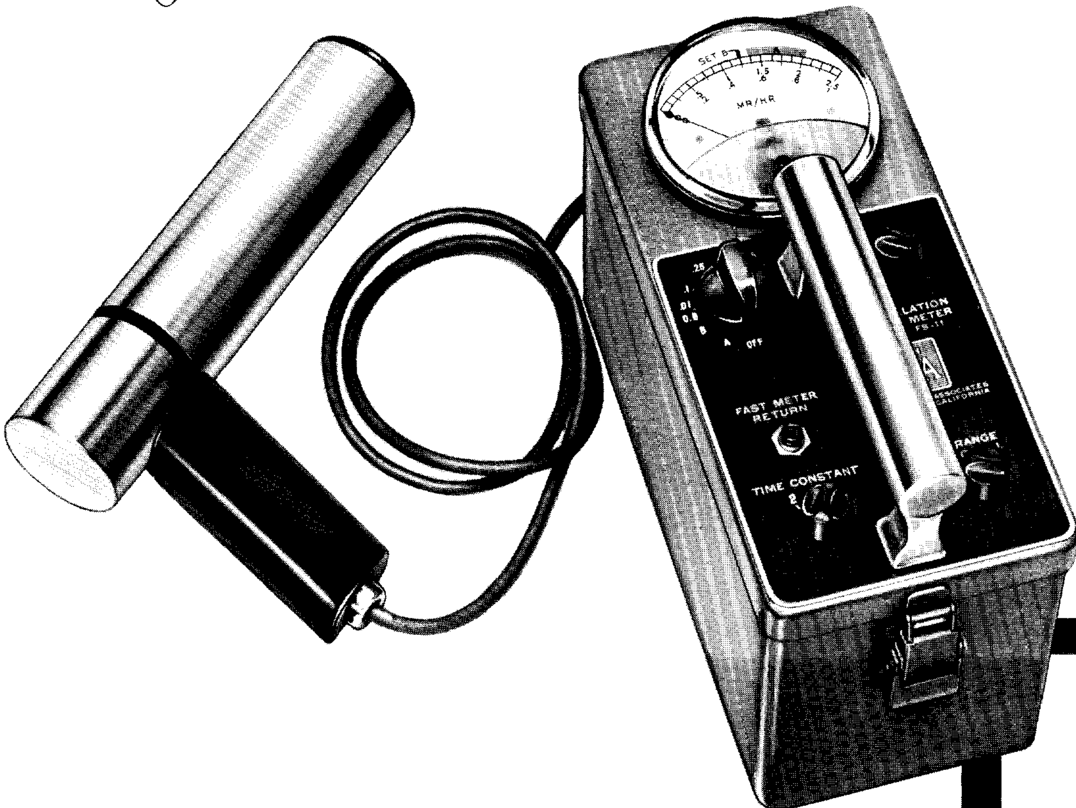
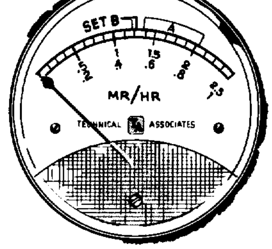
Super Sensitive GAMMA SCINTILLATION SURVEY METER

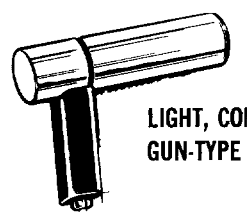
MODEL FS-11



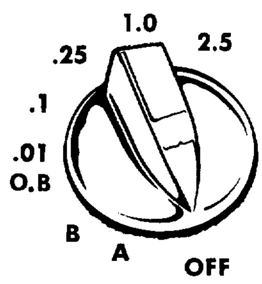
- **Full-scale range as low as .01 mr/hr over background.**
- **Large clear meter for easy reading of weak emitters.**
- **Built-in battery checker indicates remaining "life"in batteries.**
- **Light, gun-type probe can easily be placed in the best position for maximum sensitivity.**



LARGE, SUPER-VISIBLE METER



LIGHT, COMPACT GUN-TYPE PROBE



RANGE SELECTOR and BUILT-IN BATTERY CHECKER

APPLICATION.
The T/A Model FS-11 Scintillation Survey Meter is an extremely sensitive instrument with high statistical accuracy. It has many features that make it suitable for use in health physics, research, medicine, and ore prospecting. The design includes a top quality Sodium Iodide (Thalium activated) crystal to assure optimum efficiency for detecting and measuring very small amounts of gamma ray emitting radioactive material.

DESCRIPTION. The Model FS-11 Scintillation Survey Meter consists of a compact, lightweight, gun-type probe with a hermetically sealed 1"x1" Sodium Iodide crystal and photomultiplier tube. The instrument has five sensitivity ranges which are displayed on a large clear meter face. Each range is individually calibrated and holds calibrations for hundreds of hours. There is no zero drift because of the inherent stability of the circuit. Meter response is adjusted by a 3-position time constant control. A single control knob provides both range selection and battery check. The electronic circuit, meter, controls, and batteries are contained in a ruggedly constructed weatherproof case. Each instrument is supplied with a calibration source.

SPECIFICATIONS:

5 FULL-SCALE RANGES: .01 over background, .1, .25, 1.0, 2.5 MR/HR absolute.
TIME CONSTANTS: 2, 5, 15 seconds.
CONTROLS: Range Selector, "A" and "B" Battery Tester, "B" Adjust, Fast Meter Return, .01 MR/HR Range Background Adjust, Time Constant.
PROBE: Chrome-plated steel, convenient pistol grip, sealed construction.
CRYSTAL: 1"x1" NaI hermetically sealed, shock-mounted.
PHOTOMULTIPLIER TUBE: Selected RCA 6199, shock-mounted.
BATTERIES: (2) Eveready #467 $67\frac{1}{2}$ volt, (4) Eveready #D-99 $1\frac{1}{2}$ volt flashlight cells, (1) Eveready #412 $22\frac{1}{2}$ volt, (4) Eveready #912 penlight cells.
CASE DIMENSIONS: $10\frac{1}{4}$" long x $4\frac{3}{4}$" wide x $5\frac{7}{8}$" high.
FINISH: Hammertone grey.
WEIGHT 10 lbs. Shipping weight: 13 lbs.

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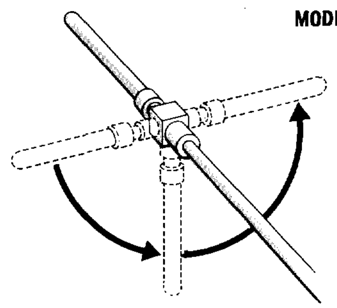
HIGH RANGE SURVEY METER

MODELS CP-TP-1A and CP-TP-1B

- **Full-scale ranges to 5000 R/HR.**
  CP-TP-1A: 0 to .5, 5, or 50 R/HR.
  CP-TP-1B: 0 to 50, 500, or 5000 R/HR.
- **Interchangeable ionization chambers.**
- **3-position rotating chamber.**



MODEL 1B CHAMBER is shown connected to forward end of bracket. Dotted lines indicate the 3 positions to which the chamber can be rotated.

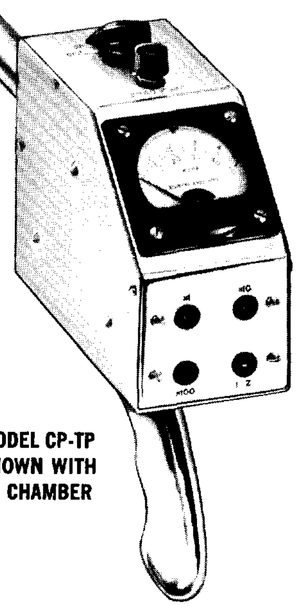
APPLICATION. The T/A Model CP-TP is the only portable, battery operated survey meter especially designed to enable the health physicist to measure high intensity beta and gamma radiation fields. The instrument features a 40″ extension rod with swivel bracket for rotating the chamber, thus allowing the user to stand behind a shield or out of the direct line of a beam.

EXTENSION ROD enables user to stay at safe distance from beam.

DESCRIPTION. Technical Associates' CP-TP High Range Survey Meter is available in two models, each having three linear ranges: CP-TP-1A provides 0 to .5, 5, and 50 R/HR (beta and gamma); CP-TP-1B provides 0 to 50, 500, and 5000 R/HR (gamma only).

The basic instrument is the same for both models, the only difference being the type of ionization chamber selected. The lower and higher ranges are determined by the size and configuration of the ionization chambers and their electrometer circuits. Each chamber contains its own electrometer circuit. The chambers are interchangeable on the instrument. The CP-TP-1A chamber has a removable beta absorber to allow measurement of beta radiation through an acetate end-window.

The instrument case is chrome-plated aluminum for easy decontamination. It contains the range selector switch, zeroing and calibration controls, batteries, and a high quality wide-face meter. The unit has a pistol grip handle for easy manipulation. Each model comes complete with a 40″ extension rod, which is detachable from the instrument case. Either ionization chamber can be connected directly to the case, if desired. The swivel bracket at the end of the extension rod has two connectors for use in attaching the chamber for the desired ranges. One connector is at the forward end and the other is on the side. The swivel bracket rotates, thus moving the chamber connected to the side of bracket into 3 separate positions: right, left, and downward.



MODEL CP-TP SHOWN WITH 1A CHAMBER

SPECIFICATIONS:

RANGES: Model CP-TP-1A: 0.5, 5, 50 R/HR.
Model CP-TP-1B: 50, 500, 5000 R/HR.

CONTROLS: Combined "Off-On" and range selector switch. Individual calibration controls for each range. Zero control can be set in radiation field.

CIRCUIT: Reliable single tube electrometer circuit with all high resistance points insulated with Teflon or Kel-F to insure minimum leakage.

METER: Wide-face 3½″ meter with dual scale calibrated in R/HR (black scale for 1A chamber, red scale for 1B chamber). Divided into 50 divisions. Mounted to provide excellent visibility.

ZERO DRIFT: Negligible after 15 minute warm-up.

IONIZATION CHAMBERS:
Model CP-TP-1A: Cylindrical bakelite internally coated with aquadag. Volume approx. 42 cubic inches. Chamber has a removable beta absorber (432 mg/cm²) to allow beta measurements through an acetate end-window (6 mg/cm²).
Model CP-TP-1B: Cylindrical aluminum internally coated with aquadag. Volume approx. 3 cubic inches. Sensitive to gamma only.
NOTE: Both chambers include their own electrometer circuit for specific ranges.

EXTENSION: Made of polished aluminum tubing 40″ long, with connector on one end for mounting on instrument case and swivel connector at the other end for mounting chamber.

INSTRUMENT CASE: Chrome-plated aluminum with all markings engraved for easy decontamination.

BATTERIES: 4 Eveready No. 412, 22.5 volts.
2 Burgess No. W5BP, 7.5 volts.
2 Eveready "D" Cells, 1.5 volts.

WEIGHT: 6 lbs.

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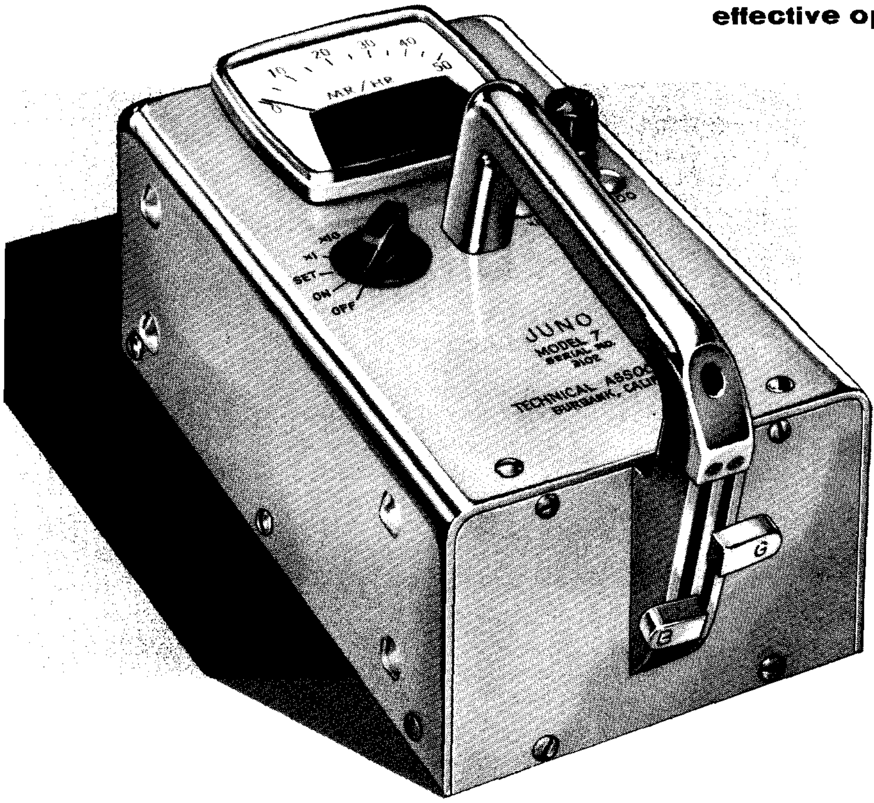
INSTRUMENTATION FOR NUCLEAR RESEARCH

JUNO SURVEY METER, Models SRJ-7 and HRJ-7

Incorporating design features which permit effective operation under high humidity conditions



APPLICATION. The Juno Survey Meter is a portable instrument for measuring the intensity of, and discriminating between alpha, beta, and gamma radiation. It is used to protect personnel from the danger of over-exposure to radiation from radioactive materials or X-rays. While primarily intended for inspection of flat surfaces, the instrument is suitable for most uses where a high degree of accuracy is desired.

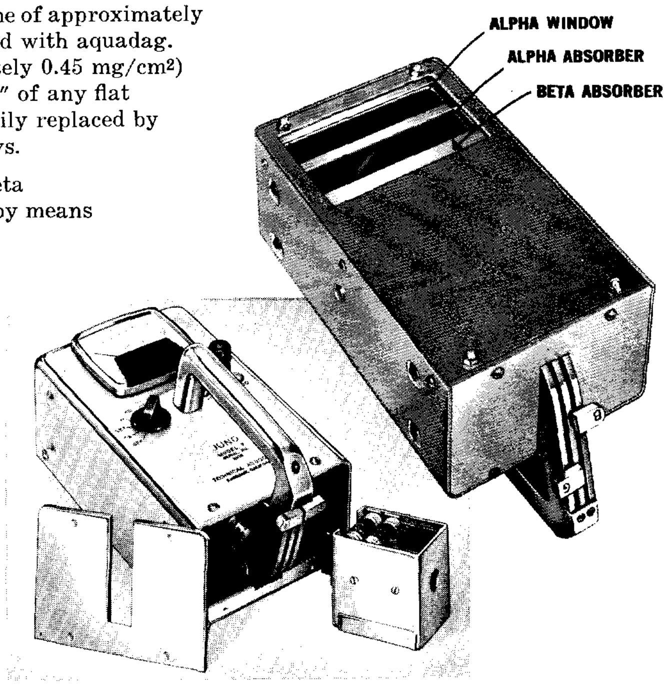
The T/A Juno is available in two models: SRJ-7 (standard range) for all normal applications; and HRJ-7 (high range) for use where exceptionally high intensity radiation is likely to be encountered. Both models meet A.E.C. specifications.

Models SRJ-7 and HRJ-7 are improved versions of the original Hanford instrument. The high impedance circuit switch box includes a desiccant cartridge and is sealed with gaskets. These design improvements insure high efficiency performance under adverse humidity conditions.

DESCRIPTION: The instrument comprises an ionization chamber, an electrometer circuit, absorption filters for the rejection of either alpha or beta particles, suitable batteries mounted in a removable power pack, and an indicating meter. The unit is battery operated and is self-contained. To easily identify the High Range Juno, its knobs and meter dials are finished in brilliant red.

The ionization chamber has a volume of approximately 27 cubic inches. All surfaces within the chamber are coated with aquadag. The chamber is covered by a screen of .0003″ (approximately 0.45 mg/cm²) rubber hydrochloride film. The alpha screen is within 7/16″ of any flat surface on which the instrument may be placed, and is easily replaced by simply removing the bottom plate and two retaining screws.

Two absorbers are provided to reject either alpha or beta radiation. These are readily moved in and out of position by means of sliding tabs fitted in rails which form part of the handle. The tab marked "G," with a square end, operates the absorber which rejects alpha and beta, thus permitting a reading of gamma only. The tab marked "B," with a rounded end, operates the absorber which rejects alpha, permitting a reading of beta and gamma. The total of all three types of radiation is read, when both tabs are in "open" position.



The high quality microammeter, which is calibrated in milliroentgens per hour for gamma radiation, has a large easy-to-read face and is mounted in position to permit excellent visibility. Battery life is approximately 800 hours in normal intermittent use. An easily removable battery pack, with simple positive contacts, assures trouble-free operation over long periods of service.

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Models SRJ-7 and HRJ-7 have similar circuits, the principal difference being the value of grid resistances used.

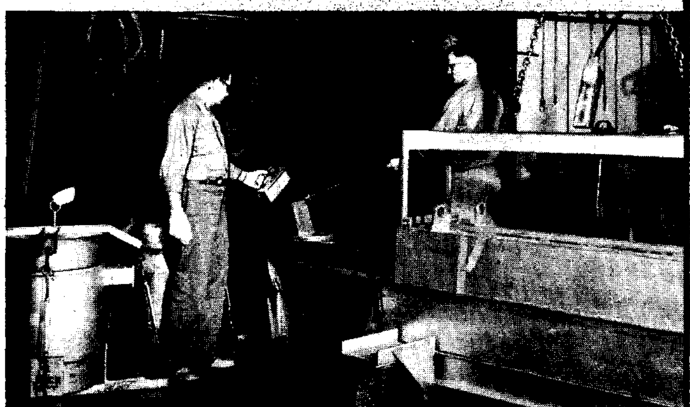
Radiation incident upon the ionization chamber produces a minute current which flows through a very high resistance in the grid circuit of the electrometer tube. The voltage thus produced at the grid causes a corresponding change in plate current which is indicated by the panel meter. A bucking current is provided through the meter in order that the no-signal plate current of the electrometer may be balanced out and readings of radiation intensity may start from the meter zero reading. Sensitivity is varied by switching appropriate values of grid resistance in the electrometer circuit.

The instrument is calibrated by adjusting a resistance in series with the meter. An individual adjustment is provided for each range. Zero setting is accomplished by means of a rheostat in the filament circuit of the electrometer tube. By varying the filament voltage, the plate current may be varied and thus adjusted to a value equal to the bucking current flowing through the meter. All high resistance points in the circuit are insulated with Teflon to insure minimum leakage.

SENSITIVITY. Both models are calibrated in three separate full-scale ranges in easily read increments of the meter scale, covering the total range of which the instrument is capable.

Ranges are based on radium gamma radiation intensity. Accuracy of calibration is such that indications on the meter will not be more than 5% lower nor more than 10% higher than the radiation intensity to which the chamber is exposed. For use in abnormal environmental conditions, air temperature and density correction data and curves are included with each instrument. Sensitivity dependency upon battery aging is limited to a 10% variation while the unit can be zeroed by means of the panel zero control.

Illustration below shows the T/A Juno in use at the Nuclear Radiation Laboratory of Admiral Corporation, monitoring for radio-activity as sample is transferred from "coffin" to shipping container.



SPECIFICATIONS:

IONIZATION CHAMBER:
Volume: 27 cubic inches.
Window Opening: 3" x 4⅝".
Alpha Window: 0.3 mil (0.45 mg/cm^2) rubber hydrochloride.
Alpha Absorber: 0.01" cellulose acetate sheet.
Beta Absorber: 0.102" aluminum.

BATTERIES:
4 Eveready No. 412 22½ Volt "B" Batteries.
2 Eveready No. E12 1.35 Volt "A" Batteries.
2 Mallory No. TR-115 6.5 Volt "B" Batteries.

TUBE:
1 Sub-Miniature Electrometer Type CK 5886.

RANGES:
Model SRJ-7 Juno (standard range): 50, 500, 5000 MR/HR full-scale. (Improved A.E.C. Model SIC-17B).
Model HRJ-7 Juno (high range): 250, 2500, 25,000 MR/HR full-scale. (Improved A.E.C. Model SIC-17D).

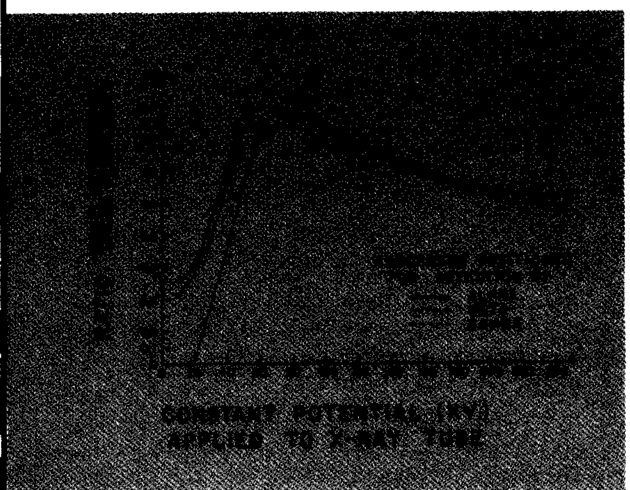
TIME CONSTANTS:
50 MR/HR – 18 Seconds
500 MR/HR – 4 Seconds
5000 MR/HR – 2.5 Seconds

OPERATING TEMPERATURE RANGE: 35°F to 135°F

CASE:
Hard-chrome plated aluminum, with engraved markings on top of case; gasketed, dust and moisture-resistant. Dimensions: 9½" x 5¾" x 4".

HANDLE:
Aluminum, especially cast low-porosity, smoothly polished.

WEIGHT: Net 6 lbs. 11 oz. Shipping: 10 lbs.



The Juno can be used for X-ray detection and measurement by reference to the above curves.

INSTRUMENTATION FOR NUCLEAR RESEARCH

CUTIE PIE

MODELS CP-3 and CP-3A

PORTABLE ALPHA, BETA, and GAMMA SURVEY METER

Cutie Pie is shown testing radioactivity at reactor site.

- **3 linear ranges to 5000 mr/hr.**
  - **CP-3: 0 to 50, 500, or 5000 mr/hr.**
  - **CP-3A: 0 to 25, 250, or 2500 mr/hr.**
- **Thin window permits alpha detection.**
- **Built-in alpha and beta absorbers.**
- **Selector switch positions permit checking all batteries.**
- **Zero adjustment in radiation field.**
- **New battery pack provides over 800-hour operating life.**

APPLICATION The T/A Models CP-3 and CP-3A Cutie Pie Survey Meters measure alpha, beta, and gamma radiation with excellent energy independence. These lightweight, portable instruments are improved versions of the original Cutie Pie design, which was developed under the Manhattan Project. They have found wide acceptance by health physicists for surveys at reactor sites and research and industrial laboratories, and are extensively used for determining shielding effectiveness, checking source shipping containers, monitoring areas, as well as for decontaminating and clean-up purposes. They are especially useful for monitoring such inaccessible spots as corners, behind pipes, beams, etc.

DESCRIPTION. The Models CP-3 and CP-3A comprise an ionization chamber, an electrometer circuit, alpha and beta absorbers, battery pack, and an indicating meter. Both units are battery operated and self-contained.

The ionization chamber is made of aluminum and coated internally with aquadag. The end of the chamber is closed with a rubber hydrochloride alpha window (0.45 mg/cm^2), which is frame-mounted and held in place with clips, thus permitting easy replacement. Alpha and beta absorbers are mounted with hinges on the front of the chamber. Undesired radiations are easily rejected by swinging the proper absorber into place.

Each instrument has three linear ranges: the CP-3 provides 0 to 50, 500, or 5000 mr/hr; the CP-3A provides 0 to 25, 250, 2500 mr/hr. These ranges provide excellent coverage of radiation levels normally encountered. To assure maximum reliability, the range selector switch includes three test positions for checking batteries prior to use. Batteries of proper voltage produce a reading in the green sector on the meter. A "Set" position permits the meter to be adjusted to read zero even in radiation fields. The remaining three switch positions permit the selection of ranges.

The instrument case is made of chrome-plated aluminum, with engraved lettering for easy decontamination. Rubber gaskets are used for protection against high humidity. The case contains the range selector switch, the zeroing control, and a large-face meter calibrated to read milliroentgens per hour, with 50 scale divisions. The meter is mounted in position for excellent visibility. A reliable high impedance electrometer circuit with an improved 800-hour battery complement assures long uninterrupted service. Both Models CP-3 and CP-3A provide front tripod feet for bench or table use.

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pecifications
of MODELS CP-3 and CP-3A

RADIATION RANGES: CP-3: 50, 500, and 5000 mr/hr full scale.
CP-3A: 25, 250, and 2500 mr/hr full scale.

CALIBRATION: Factory calibrated, using gamma standard calibrated by Nat'l Bureau of Standards. Calibration accuracy ±10%. Individual calibration control for each range.

CIRCUIT: Reliable single tube electrometer circuit. All high resistance points are insulated with Teflon or Kel-F to insure minimum leakage.

METER: High quality 3½" meter, with 50 scale divisions. Appropriately calibrated to read in milliroentgens per hour for gamma radiation.

CONTROLS: Single control switches meter to battery test points, zero position, and 3 operating ranges. Meter Zero Control is located directly below the meter.

ZERO DRIFT: Negligible after 15 minute warm-up.

TIME CONSTANTS:
CP-3: Range 50 mr/hr, 6 seconds • Range 500 mr/hr, less than 1 second • *Range 5000 mr/hr, less than 1 second.*
CP-3A: Range 25 mr/hr, 12 seconds • Range 250 mr/hr, 2 seconds • Range 2500 mr/hr, 1 second.

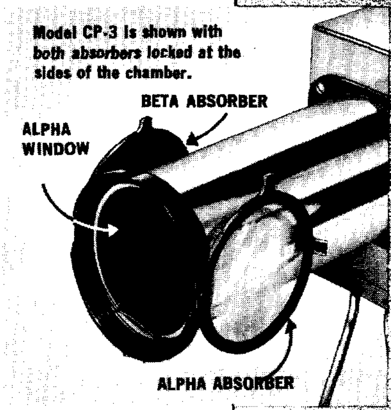
IONIZATION CHAMBER:
Aluminum Cylinder: 2⅞" inside diameter, 6⅜" long.
Volume: Approximately 36 cubic inches.
Window Opening: 2¾" diameter.
Alpha Window: Removable, ring-mounted rubber hydrochloride (0.45 mg/cm^2).
Alpha Absorber: Hinge-held, *ring-mounted cellulose acetate* (36 mg/cm^2).
Beta Absorber: Hinge-held, aluminum disc (720 mg/cm^2).

CASE: Chrome-plated aluminum, with *clearly engraved markings.*

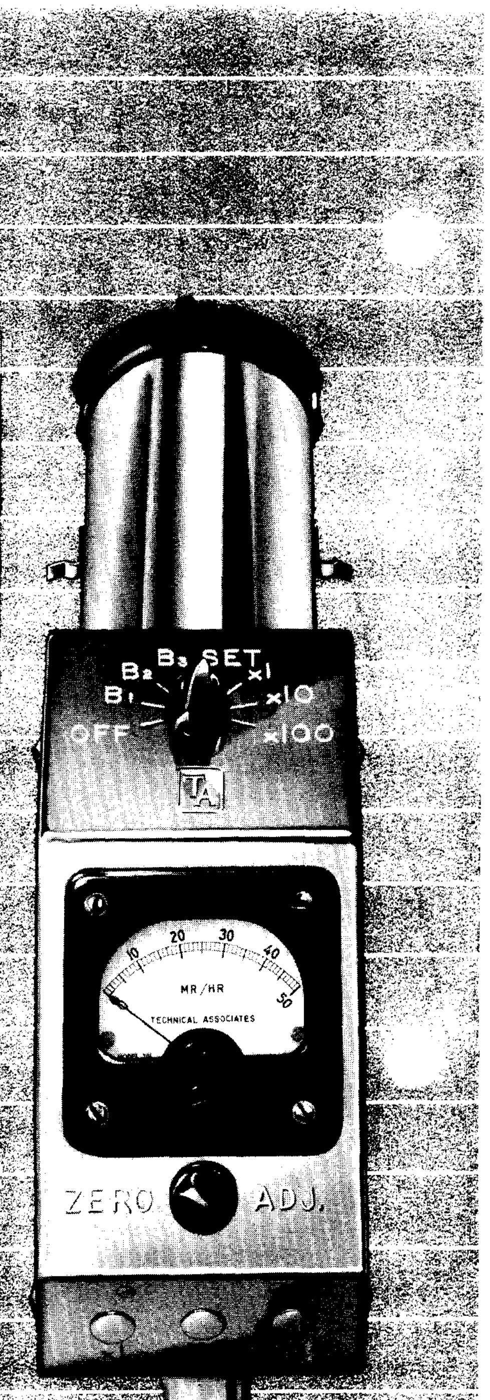
BATTERY LIFE: Over 800 operating hours.

BATTERY COMPLEMENT:
4 Eveready No. 412 22½ Volt "B" Batteries
2 Eveready No. E12 1.35 Volt "A" Batteries
2 Mallory No. TR-115 6.5 Volt "B" Batteries
(Battery complement is identical to the Model 7 Juno and CP-4.)

WEIGHT: 4 lbs. 12 oz. net. Shipping Weight: 8 lbs.



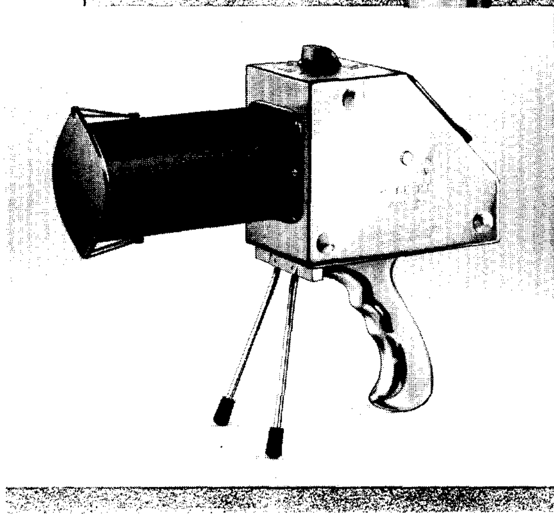
Model CP-3 is shown with both absorbers locked at the sides of the chamber.



CUTIE PIE, MODELS CP-4 and CP-4A
PORTABLE BETA and GAMMA SURVEY METER

For those customers who prefer a Cutie Pie with a chamber made of bakelite, instead of aluminum, and who require measurements of beta and gamma only, T/A offers Models CP-4 and CP-4A. These instruments utilize the same electrometer circuitry and include the outstanding features and specifications of Models CP-3 and CP-3A. The Model CP-4 has the same ranges as the Model CP-3 (0 to 50, 500, or 5000 mr/hr); while the Model CP-4A has the same ranges as the Model CP-3A (0 to 25, 250, or 2500 mr/hr).

The bakelite chamber of the Models CP-4 and CP-4A has a beta end-window (6 mg/cm^2), permitting detection of low energy beta particles. They have a bakelite beta absorber (432 mg/cm^2), in the form of a cap, which is easily placed in position over the end, thus permitting measurement of gamma only.



MODEL CP-4 CUTIE PIE
with front tripod feet in position for bench or table use.

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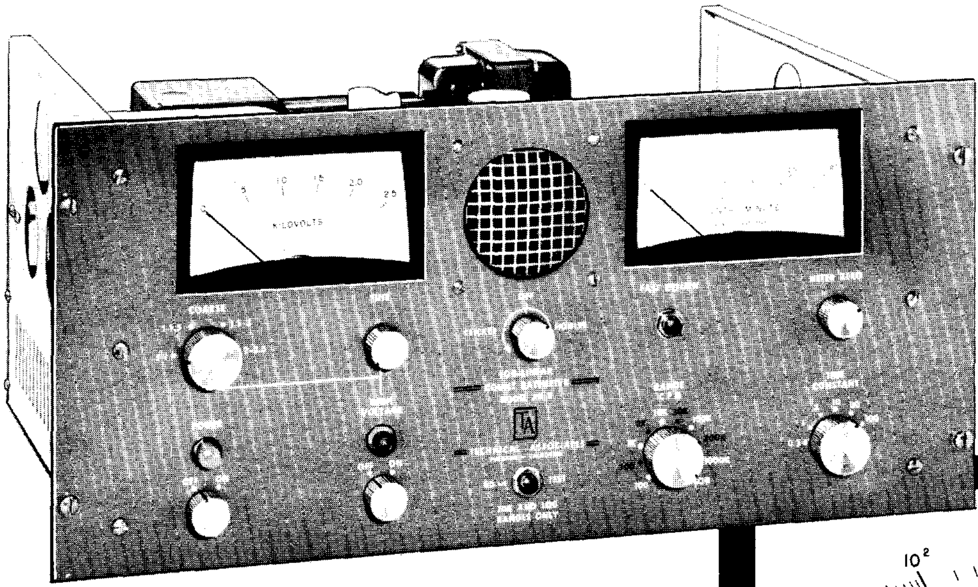
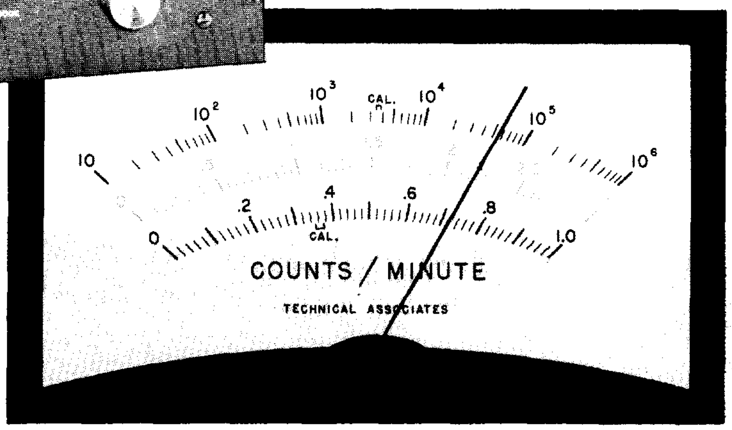
INSTRUMENTATION FOR NUCLEAR RESEARCH

LOG-LINEAR COUNT RATEMETER
MODEL RM-8



- Linear and log scales.
- 9 overlapping linear ranges.
- Choice of 7 time constants.
- 2% accuracy on all linear ranges.
- Outputs for galvenometer or potentiometer recorders.
- Speaker with "howler" or "clicker."
- Stable 2500 volt power supply.



APPLICATION. The Technical Associates Model RM-8 Log-Linear Count Ratemeter is an extremely precise and versatile radiation counting instrument. It converts randomly spaced pulses from an external detector into an average count rate per minute. The Model RM-8 presents this average on a wide panel meter in a logarithmic scale or in one of 9 different linear ranges. The count rate information may be fed to a chart recorder for permanent record. A front panel mounted speaker provides an aural indication of the count rate by means of a "clicker" or "howler."

The Model RM-8 is recommended for applications in laboratory research, reactor studies, medical radioisotope diagnostic studies, analytical procedures, etc., that require accurate measurement of counting rates, and is particularly suitable for studies concerned with changes in counting rates. The instrument is designed for use with Geiger tubes, scintillation detectors, proportional counters, and gas chromatograph scanners.

DESCRIPTION. The Model RM-8 Log-Linear Count Ratemeter features a 5-decade logarithmic scale which permits counts to be made over a full range of 10 to 1,000,000 cpm. The log scale makes it easy to chart rapid changes in count rates or to determine quickly the appropriate linear scale. 9 separate linear scales are available, ranging from 0-100 to 0-1,000,000 cpm. This wide choice of ranges permits the selection of an optimum range for a specific application.

The instrument provides six time constants, with one additional position for a special time constant, if desired. The availability of extremely short time constants on the upper ranges allows rapid response with no significant increase in probable error. Other front panel controls provide fast meter return, a meter zero control, a 60-cycle test, and a speaker for aural indication of the count rate.

The Model RM-8 has an exceptionally stable 600 to 2500 volt power supply with its own meter and with separate coarse and fine voltage adjustment controls. An outstanding feature of the instrument is its monostable circuit utilizing the EFP-60 secondary-emission tube. This circuit minimizes drift and assures excellent accuracy. The Model RM-8 will drive standard potentiometer or galvenometer chart recorders from either the logarithmic or linear ranges.

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P E C I F I C A T I O N S
of Model RM-8 Log-Linear Count Ratemeter

RANGES:

Log: 10 to 1,000,000 counts per minute over 5 decades.

Linear: 9 full scale ranges – 0 to 100, 0 to 300, 0 to 1000, 0 to 3000, 0 to 10,000, 0 to 30,000, 0 to 100,000, 0 to 300,000, and 0 to 1,000,000.

Range Meter: Easy-to-read 4½" meter provides direct indications of either log or linear count rate. Color coding of meter scales (black and green) identifies the scale in use.

ACCURACY: Linear Ranges: 2%
Log Ranges: 5%

TIME CONSTANTS:

Log: Variable with counting rate.

Linear: 6 individual constants may be selected for each range – 0.3, 1, 3.0, 10, 30, 100 seconds. An additional position is provided for a special time constant, if desired.

INPUT: Negative. Pulse adjustable between 0.1 and 5.0 volts. Factory preset at 0.25 volts.

RESOLUTION: 2 microseconds to pulse pairs.

AURAL SIGNAL: Panel mounted 3" speaker with internal volume control. Variable pitch control for "Howler" or "Clicker."

RECORDER OUTPUT: Cathode follower output – 0 to 1.0 MA, 0 to 10 MV, 0 to 100 MV for standard potentiometer or galvenometer type graphic recorders.

ZERO CONTROL: Front panel knob.

FAST RETURN: Front panel button.

TEST SIGNAL: 3600 counts per minute.

HIGH VOLTAGE SUPPLY:

Polarity: Positive

Range: 600 to 2500 volts

Current Output: 1 MA up to 1500 volts.
0.5 MA up to 2500 volts.

Meter: 4½" meter with 50 division scale.

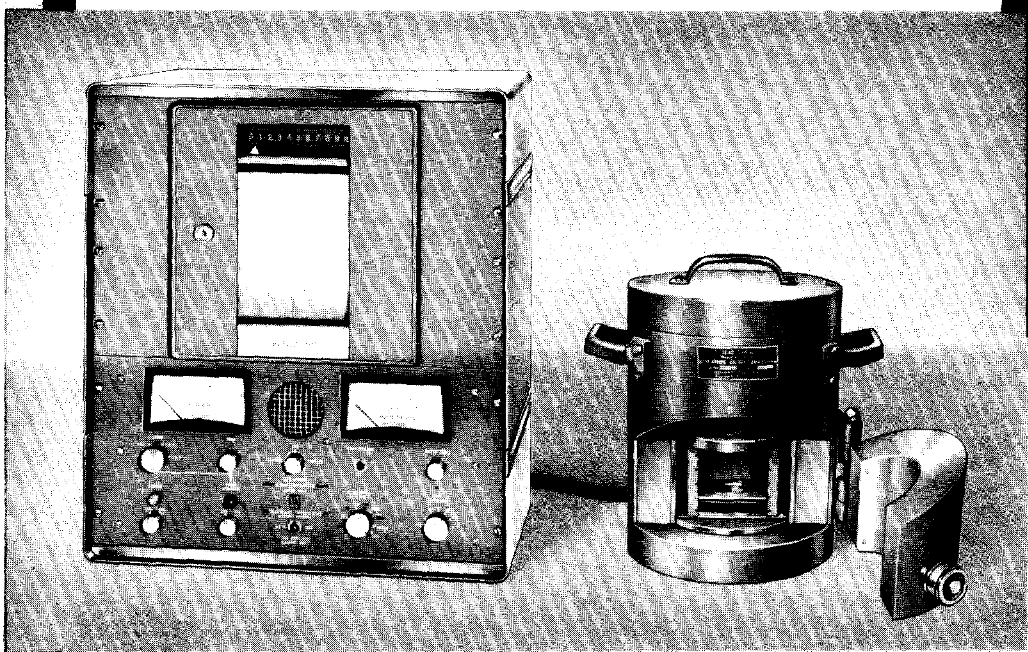
Ripple: Less than 10 millivolts.

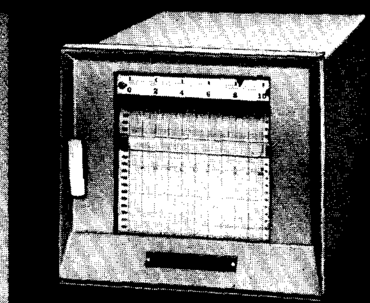
Line Regulation: Less than .01% output shift for 1% change in line voltage between 105 and 125 volts.

POWER REQUIREMENTS: 105 to 125 volts, 150 watts.

DIMENSIONS: 19" x 8¾" x 14"

WEIGHT: 32 lbs. Shipping weight: 38 lbs.





GRAPHIC RECORDER
Model GRP-1
(Potentiometer)

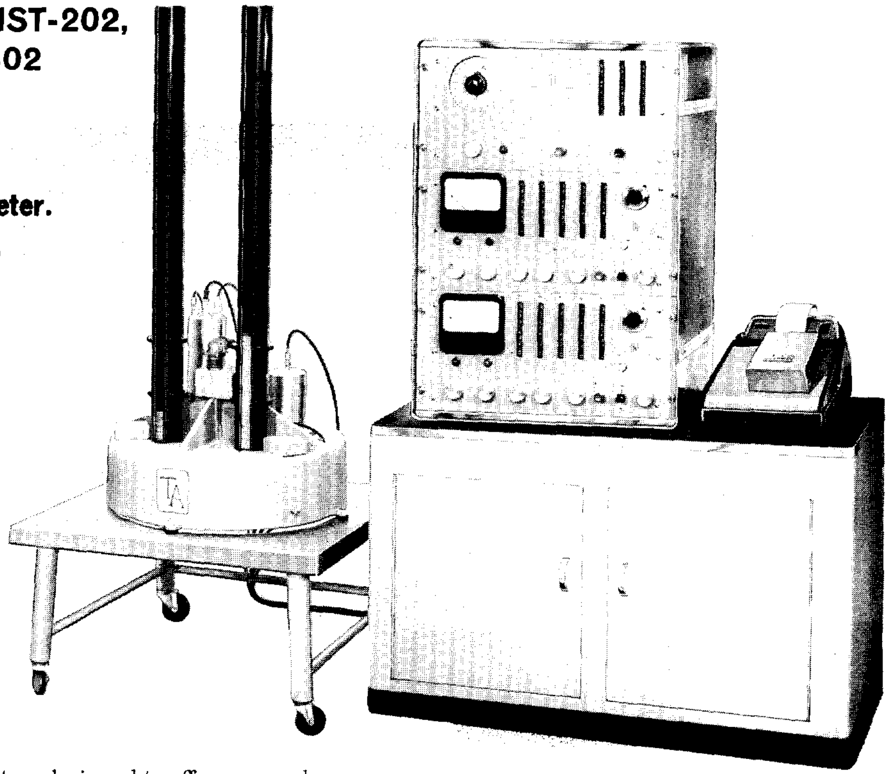
MODEL RM-8 RATEMETER shown with Model GRG-2F Graphic Recorder (Galvenometer) and Model LS-6 Lead Shield. This highly versatile ratemeter and lead shield combination meets numerous radiation counting applications in all phases of nuclear work.

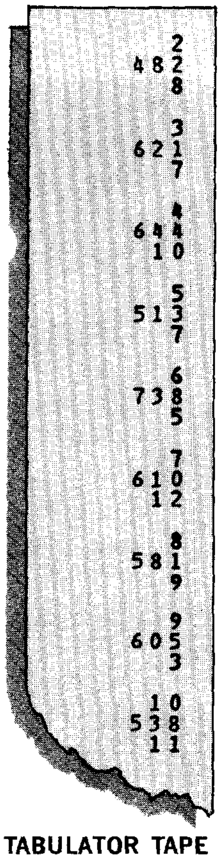
INSTRUMENTATION FOR NUCLEAR RESEARCH

MULTI-SAMPLE TABULATOR

MODELS MST-201, MST-202, MST-301, and MST-302

- **Handles samples up to 3″ in diameter.**
- **Counts 200 samples and provides full data on every sample.**
- **Features dual or single channels with discriminating scalers.**
- **Accommodates any 2 of five different types of detectors.**
- **Provides binary-coded outputs to operate printers or converters.**





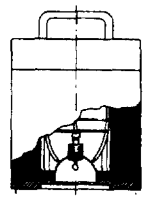
TABULATOR TAPE shows sample number and count from each detector (color-coded for easy identification).

APPLICATION. The T/A Multi-Sample Tabulator is an automatic sample changing system designed to offer unusual capacity and speed in detecting and measuring radiation contamination contained in large-size filter paper samples, wipe samples, solid samples, and evaporated samples. The exclusive dual channel feature allows the selection of any 2 of five types of detectors and thus the instrument can measure two different kinds of radiation or two different gamma energies of each sample. Complete data on each sample is obtained by a single programming.

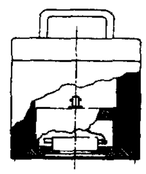
DESCRIPTION. The Multi-Sample Tabulator consists of an automatic sample changing mechanism with input and output storage towers that accommodate 200 samples and positions for mounting two separate detectors. The electronic console of the tabulator includes an automatic control unit and two Model DS-6 Decade Scalers (one for each detector). The control unit contains an interval timer, three decades for sample number count, and circuits to automatically start and stop the sample changer and reset the scaler decades. The scalers feature pulse height discrimination by means of a ten turn helipot mounted on the front panel and incorporate exceptionally stable 500V to 3000V power supplies.

OPERATION. The changer mechanism moves each sample from the input storage tower to the first detector position, then to the second detector position, and finally to the ouput storage tower. Accuracy of the lift mechanism assures reproducible counting of the sample in either detector position. The sample change time is 15 to 20 seconds. The samples are programmed through the system by the automatic control unit. They are counted to preset time by the Model DS-6 Scalers which provide outputs to feed sample numbers and binary-coded count information to digital printers or data converters to drive electric typewriters, teletypewriters, and card or tape punches.

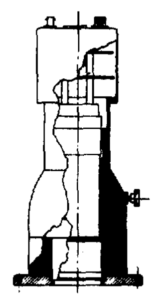
5 TYPES OF DETECTORS AVAILABLE:



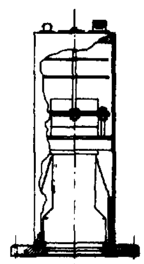
GAS FLOW COUNTER



END WINDOW G-M TUBE



GAMMA SCINTILLATION DETECTOR



ALPHA OR BETA SCINTILLATION DETECTOR

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MULTI-SAMPLE TABULATOR

CAPACITY: 200 samples

SAMPLE SIZE:

MST-300 SERIES:
3″ diam. holders for filter papers or wipe samples.
3″ diam. x 3/16″ deep planchets for solid samples.

MST-200 SERIES:
2″ diam. holders for filter papers or wipe samples.
2″ diam. x 3/16″ deep planchets for solid samples.

(Unit comes with 200 filter paper holders or planchets)

SAMPLE CHANGE TIME: 15 to 20 seconds.

PRE-SET TIME: 0 to 20 minutes in 1-second increments.

PRINT-OUT: System includes Victor Digital Printer with 2-color ribbon. (Data Converters available.)

DIMENSIONS:

MST-300 SERIES: Sample Changer: 32″ x 32″ x 73″ high. Console: 19″ wide x 27½″ high.

MST-200 SERIES: Sample Changer: 29″ x 29″ x 73″ high. Console: 19″ wide x 27½″ high.

WEIGHT: 450 lbs.

POWER REQUIREMENTS: 115 volts, 60 cycle, 450 watts.

MODEL DS-6 SCALER

INPUT POLARITY: Negative

INPUT SENSITIVITY: 0.2 volts negative.

AMPLIFIER: Non-overloading with X25 gain.

PULSE HEIGHT DISCRIMINATOR: Front panel control variable from +5 volts to +55 volts.

RESOLVING TIME: 5 microseconds

COUNT CAPACITY: 100,000 counts.

OUTPUT: Provides four line binary coded output to operate digital printers or converters to drive electric typewriters, card or tape punches.

HIGH VOLTAGE: 500 to 3000 volts in two ranges (1.5KV and 3.0KV with coarse and fine controls).

STABILITY: Less than .01% drift per day after warm-up.
REGULATION: Less than .01% change for 1 volt variation in line voltage.
RIPPLE: Less than 10 millivolts.

INPUT SELECTOR SWITCH: Selects Test, G.M., or Amp. input.

COUNT SWITCH: Up position permits instrument to count. *Down position prevents counting.*

MANUAL REMOTE SWITCH: Selects mode of operation.

DETECTORS

ALPHA SCINTILLATION DETECTOR (Model MST-AS-3)
Uses a 3″ diameter photomultiplier tube and a 3″ diameter Zinc Sulphide phosphor with transistorized preamplifier.

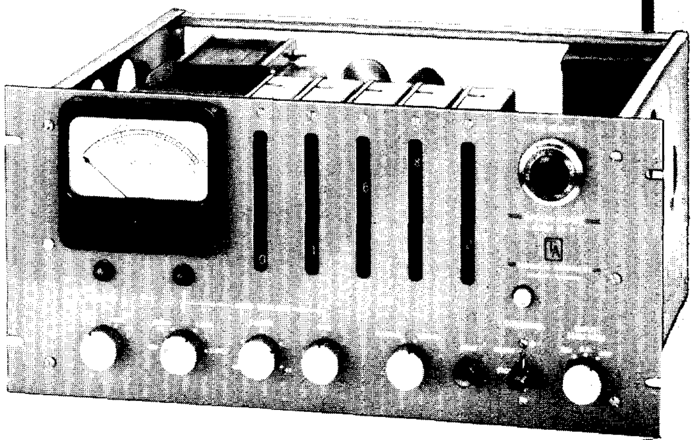
BETA SCINTILLATION DETECTOR (Model MST-BS-3)
Identical to Alpha Scintillation Detector, except that it uses a 2½″ diameter Stilbene phosphor.

MICA END WINDOW G-M TUBE (Model MST-GM-2)
Uses Anton 1001 G-M tube with 1½″ diameter mica window 1.4 to 2 mg/cm² thick. Shielding: ⅞″ lead, ¼″ brass.

GAMMA SCINTILLATION DETECTOR (Model MST-GS-2)
Uses 2″ diameter x 1″ thick solid NaI crystal with 2″ photomultiplier tube and transistorized preamplifier. Shielding: 1″ lead, ¼″ brass.

GAS FLOW COUNTER (Model MST-GF-2)
Consists of a 2 pi hemispherical chamber with 2″ diameter window and transistorized preamplifier. For Geiger or proportional counting. Shielding: 1⅛″ lead, ¼″ brass.

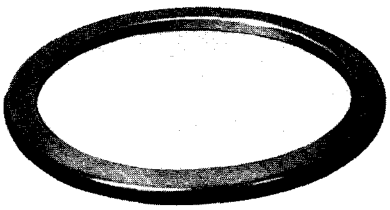
NOTE: 'Light-tight' design of sample changer permits use of windowless scintillation detectors.



SEPARATE MODELS AVAILABLE

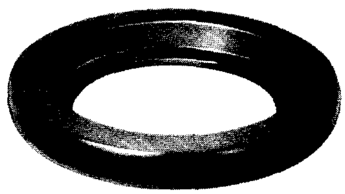
The T/A Multi-Sample Tabulator is available with single or dual channel system, and with capacity to hold samples up to 2″ or up to 3″ in diameter. (NOTE: The tabulator can be furnished with a single channel as a starter system. It can be converted to a dual channel system at any time by the addition of a detector and DS-6 Scaler.) Molded plastic holders are provided for paper samples or for 3/16″ deep metal planchets.

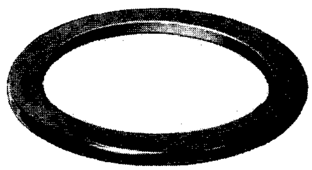
MST-201 — Single channel system. Has capacity of 200 samples up to 2″ in diameter.
MST-202 — Dual channel system. Has capacity of 200 samples up to 2″ in diameter.
MST-301 — Single channel system. Has capacity of 200 samples up to 3″ in diameter.
MST-302 — Dual channel system. Has capacity of 200 samples up to 3″ in diameter.



**MODEL PH-3
3″ FILTER
PAPER HOLDER**
for use with
MST-300 Series

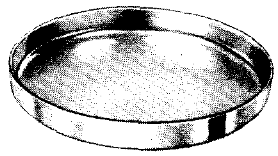
**MODEL PLH-20
2″ PLANCHET
HOLDER***
for use with
MST-200 Series





**MODEL PH-2
2″ FILTER
PAPER HOLDER**
for use with
MST-200 Series

**MODEL PL-5
PLANCHET***
(2″ diam. x 3/16″ deep)
for use with
MST-200 Series



**3″ Planchets and Holders available for MST-300 Series*

ECHNICAL ASSOCIATES

140 WEST PROVIDENCIA AVENUE • BURBANK, CALIFORNIA

PRICE LIST

TECHNICAL ASSOCIATES • 140 W. Providencia Ave. • Burbank, Calif.

Revised August 1, 1962
Subject to Change Without Notice

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			PERSONNEL MONITORS	
168		PPM-8	Beta/Gamma Portal Type Monitor	$1975.00
168		LIM-18	Beta/Gamma Laundry Monitor	1150.00
184		HSM-10A	Beta/Gamma Hand and Shoe Monitor with external Beta/Gamma clothing probe	3575.00
			SURVEY METERS	
185		CP-TP-1A	Cutie Pie Totem Pole Portable Survey 3 Range Meter, 0 to .5, 5, and 50 R/HR	460.00
185		CP-TP-1B	Cutie Pie Totem Pole Portable Survey 3 Range Meter, 0 to 50, 500 and 5000 R/HR	440.00
185		1A Chamber	Chamber only for CP-TP, ranges 0 to .5, 5 and 50 R/HR	225.00
185		1B Chamber	Chamber only for CP-TP, ranges 0 to 50, 500, and 5000 R/HR	205.00
186		CP-3	Cutie Pie Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	295.00
186		CP-3A	Cutie Pie Portable Survey Meter 3 Ranges 0 to 25, 250 and 2500 MR/HR	295.00
186		CP-4	Cutie Pie Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	275.00
186		CP-4A	Cutie Pie Portable Survey Meter 3 Ranges 0 to 25, 250 and 2500 MR/HR	275.00
180		SRJ-7	Juno Portable Survey Meter 3 Ranges 0 to 50, 500 and 5000 MR/HR	325.00
180		HRJ-7	Juno Portable Survey Meter 3 Ranges 0 to 250, 2500 and 25,000 MR/HR	325.00
136		F-6	Geiger Counter — Ranges 0-500, 0-5000 CPM	159.50
137		FS-11	Scintillation Counter — Ranges .01 over background .1, .25, 1.0, 2.5 MR/HR	449.50
			ANALYTICAL AND COUNTING INSTRUMENTS	
166	*	DS-5B	Decade Scaler (5 microseconds)	825.00
166	*	DS-5BA	Decade Scaler (1 microsecond)	915.00
200	*	DS-9	Decade Scaler (1 microsecond)	825.00
181	*	RM-8	Log-Linear Ratemeter	810.00
190	*	SM-10	Spectrometer (Single Channel Pulse Height Analyzer with built-in Linear Amplifier and Ratemeter)	765.00
169	*	SA-20	Single Channel Pulse Height Analyzer	685.00
190	*	SS-30	Spectrum Scanner	475.00
		PA-6	Pre-Amplifier	115.00
178	*	RHV-1B	Regulated High Voltage Power Supply 2 Ranges (1500 and 3000 volts)	375.00
190		MS-1	Mobile Stand for Scintillation Detector, counter-weighted and with shelf for scaler or Ratemeter	295.00

* Prices shown are for instruments supplied in 19" panel for rack mounting unless otherwise noted. For single instrument mounted in T/A Model C-875 "Easy-to-Service" Console cabinet add $30.00 to prices shown. See reverse side of Bulletin No. 168 for description of "Easy-to-Service" cabinet.

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			COUNTING INSTRUMENT ACCESSORIES	
203	**	PT-1	Predetermined Timer (Long counting intervals 999 minutes)	95.00
203	**	PT-2	Predetermined Timer (Short counting intervals 120 seconds)	95.00
203	**	PT-3	Predetermined Timer (Liebel-Flarsheim, 1 second-60 minutes)	100.00
203	**	CR-2	Extended Count Register (4 digit)	65.00
166		DU-1	One microsecond plug-in decade unit	147.50
166		DU-5	Five microsecond plug-in decade unit	57.50

** These accessories will be supplied in a cabinet or panel mounted at customer's option.

Bulletin No.		Model No.	Description of Product	Price F.O.B. Burbank
			AUTOMATED COUNTING SYSTEMS	
189		MST-201	Multi-Sample Tabulator, 2" sample diameter, single channel complete with one DS-6 Scaler and Victor Digital printer (less detector)	6420.00
189		MST-202	Multi-Sample Tabulator, 2" Sample diameter, dual channel complete with two DS-6 Scalers and Victor digital printer (less detector)	7250.00
189		MST-301	Multi-Sample Tabulator, 3" sample diameter, single channel complete with one DS-6 Scaler and Victor digital printer (less detector)	7670.00
189		MST-302	Multi-Sample Tabulator, 3" sample diameter, dual channel complete with two DS-6 Scalers and Victor digital printer (less detector)	8500.00
189		DS-6	Discriminating Decade Scaler for use with all model Multi-Sample Tabulator series	830.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
189	MST-GF-2	Gas Flow Detector for all models of Multi-Sample Tabulator including lead shielding	440.00
189	MST-GM-2	Geiger Tube Detector with Anton 1001 tube for all models of Multi-Sample Tabulator including lead shielding	380.00
189	MST-AS-2	Alpha Scintillation Detector with 3″ diameter zinc sulfide phosphor for all models of Multi-Sample Tabulator	778.00
189	MST-BS-2	Beta Scintillation Detector with 2½″ diameter Stilbene crystal for all models of Multi-Sample Tabulator	1075.00
189	MST-GS-2	Gamma Scintillation Detector with 2″ diameter x 1″ thick NaI crystal for all models of Multi-Sample Tabulator including lead shielding	685.00
201	ASC-21	Automatic Sample Changer, Single Channel System equipped with Gas Flow Detector, one power supply, one scaler and designed for time print-out	6975.00
201	ASC-22	Automatic Sample Changer, Single Channel System equipped with Gamma Scintillation Detector, one power supply, one scaler and designed for time print-out	7275.00
201	ASC-23	Automatic Sample Changer, Dual Channel System equipped with Gas Flow Detector and Gamma Scintillation Detector, two power supplies, two scalers and designed for time print-out	9675.00
201	GR-1	Gas Regulator for gas flow detectors used with Multi-Sample Tabulator and Automatic Sample Changer.	42.50

STAR SERIES SPECTROMETRY SYSTEMS

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
171	Polaris	Includes SM-10 and RHV-1B mounted in C-1400 cabinet, complete with interconnecting cables and system test	1180.00
171	Lyra	Includes SM-10 and DS-5B mounted in C-1750 cabinet, complete with interconnecting cables and system test	1635.00
171	Arcturus	Includes SM-10, RHV-1B, SS-30 and Texas Instruments Rectilinear Recorder Model RR1M-A16 in P-1 Panel Mount installed in C-3150 cabinet, with interconnecting cables and system test	2250.00

NOTE: For special applications requiring other combinations of T/A instruments, please request a quotation.

SCINTILLATION DETECTORS AND ACCESSORIES

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
188	SD-1	Scintillation Detector with 1″ x 1″ NaI crystal, complete with cables	455.00
188	SD-2	Scintillation Detector with 2″ x 2″ NaI crystal, complete with cables	765.00
188	SD-2W	Well-type Scintillation Detector with 1¾″ x 2″ NaI crystal (⅝″ x 1½″ well) complete with cables for use with LS-8 or LS-8X Shields	695.00
179	SD-3	Scintillation Detector with 1½″ Alpha Phosphor, complete with cables	495.00
179	SD-4	Scintillation Detector with 1½″ Beta Anthracene crystal, complete with cables	545.00
183	SD-6-1	Scintillation Detector with transistorized pre-amplifier, 2″ photomultiplier tube and 1″ x 1″ NaI crystal, complete wth cables. (For use in LS-6 Lead Shield with extension.)	445.00
183	SD-6-1.5	Scintillation Detector with transistorized pre-amplifier, 2″ photomultiplier tube and 1½″ x 1″ NaI crystal, complete with cables. (For use in LS-6 Lead Shield with extension.)	575.00
183	SD-6-2	Scintillation Detector with transistorized pre-amplifier, 2″ photomultiplier tube and 2″ x 2″ NaI crystal, complete with cables. (For use in LS-6 Lead Shield with extension.)	765.00
183	SD-6W	Well Scintillation Detector with transistorized pre-amplifier, 2″ photomultiplier tube and 1¾″ x 2″ NaI crystal (⅝″ x 1½″ well) complete with cables. (For use in LS-6 Lead Shield with extension and lid for well counting.)	695.00
202	CH-1	Crystal Housing for SD-1 and SD-6-1 Scintillation Detector	25.00
202	CH-2	Crystal Housing for SD-2 and SD-6-2 Scintillation Detector	30.00
202	CH-2W	Crystal Housing for SD-2W and SD-6W Scintillation Detector	30.00
202	NS-1	Nose Shield for Model SD-1 Detector	95.00
202	NS-2	Nose Shield for Model SD-2 Detector	115.00
202	C-1a	Collimator Type A (20° Flat Field) for SD-1 Detector	29.50
202	C-2a	Collimator Type A (20° Flat Field) for SD-2 Detector	39.50
202	C-1b	Collimator Type B (Straight Bore) for SD-1 Detector	35.00
202	C-2b	Collimator Type B (Straight Bore) for SD-2 Detector	45.00
202	C-1c	Collimator Type C (Focusing) for SD-1 Detector	75.00
202	C-2c	Collimator Type C (Honeycomb) for SD-2 Detector	95.00
202	AS-11	Alpha Phosphor (1″) for SD-1 and SD-6-1, complete with mount	79.50
202	AS-12	Alpha Phosphor (1½″) for SD-2 and SD-6-2, complete with mount	85.00
202	BS-11	Beta Stilbene crystal (1″) for SD-1 and SD-6-1, complete with mount	79.50
202	BS-12	Beta Stilbene crystal (1½″) for SD-2 and SD-6-2, complete with mount	95.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
		GAS FLOW DETECTORS AND G.M. PROBES	
182	GD-6	Gas Flow Counter with built-in transistorized pre-amplifier (for use with LS-6 Lead Shield with extension) includes extra window.	295.00
204	P-7	Beta/Gamma Probe Assembly with T-1090 Tube, cable and connector	39.50
204	P-8	End Window Probe (less tube) complete with cable and connector	45.00
204	P-8X	End Window Probe Assembly with T/A T-1180 Tube, cable and connector	87.50
204	P-10	Beta/Gamma Probe Assembly with T-1110 G.M. Tube, cable and connector	75.00
204	P-AS-2	Alpha Scintillation Probe	275.00
201	GR-1	Gas Regulator for Gas Flow Detectors	42.50
		COUNTER TUBES	
144	T-1090	Metal Thin wall, 3 11/16" long, used in Model F-6 Geiger Counter, P-7 Probe or other Beta/Gamma applications.	9.00
144	T-1100	Thin wall type 3" long used in Models PPM-8 and HSM-10A	27.00
144	T-1110	Thin wall 3" long used in P-10 Probe	27.00
144	T-1120	Thin wall type 7" long used in Model PPM-8	53.00
144	T-1140	Mica End Window used in TM-7, TM-8 Tube Mounts and P-8 Probe	58.50
144	T-1160	Mica End Window (Organic Quenched) used in TM-7, TM-8 Tube Mounts and P-8 Probe	67.00
144	T-1180	Mica End Window, Alpha/Beta/Gamma sensitive, used in P-8X Probe	61.00
		IONIZATION CHAMBERS	
144	IC-1	Ionization Chamber with windows (Beta/Gamma)	115.00
144	IC-2	Ionization Chamber — Solid Wall (Gamma)	105.00
		LEAD SHIELDS	
191	LS-1	Complete with Type ST-1 Sample Tray, Type SK-1 Socket and Type TM-1 Tube Mount	185.00
191	LS-2A	Standard with Type TM-6 Tube Mount and Sample Tray Holder, Type ST-2A Sample Tray and 10 Type PL-2 Aluminum Planchets	200.00
191	LS-2B	Micrometric with 10 Type PL-1 Planchets	285.00
192	LS-4A	For liquids complete with Type TM-1 Tube Mount, Type SK-1 Socket, and one Type ST-5 Marinelli Beaker	200.00
192	LS-4B	Modified to accommodate special tubes with aluminum inner liner	235.00
192	LS-4C	For solids, complete with Type TM-1 Tube Mount, Type SK-1 Socket, one Type ST-6 Ore Container and 100 Type ST-6A Paper Sleeves	225.00
192	LS-5	Complete with Type TM-3 Tube Mount, Type SK-2 Socket, Type STH-1 Sample Tray Holder, Type ST-4A Sample Tray, and 10 Type PL-2 Aluminum Planchets	260.00
193	LS-6	Complete with Type TM-7 Tube Mount, one Type ST-3B Sample Tray and 10 Type PL-3 Aluminum Planchets	295.00
193	LS-6X1	One-inch height extension for LS-6 shield when used with GD-6 Gas Flow Detector	48.00
193	LS-6X8	Eight-inch height extension for LS-6 shield used with SD-1, SD-2 and SD-6 Scintillation Detector	98.50
193	LS-6L	Lid with 3" opening and retaining collar for Models SD-1 and SD-2 Scintillation Detectors	72.50
193	LS-6P	Plug for 3" opening in LS-6L	12.50
194	LS-7A	Multi-Purpose Type complete with SD-1 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	780.00
194	LS-7B	Multi-Purpose Type complete with SD-2 Scintillation Detector, three ST-7 Sample Trays and 10 PL-3 Planchets	1090.00
194	LS-7C	Multi-Purpose Type complete with TM-8 Tube Mount, three ST-7 Sample Trays and 10 PL-3 Planchets	385.00
194	LS-7M	Multi-Purpose Type — Shield only, with adapter ring, three ST-7 Sample Trays and 10 PL-3 Planchets	325.00
195	LS-8	For well counting (shield only, less detector)	265.00
195	LS-8W	For well counting, complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	960.00
195	LS-8X	For well counting with 2" shielding in all directions (Shield only less Detector)	350.00
195	LS-8WX	For well counting with 2" shielding in all directions complete with SD-2W Scintillation Detector and 1¾" x 2" well crystal	1035.00
		LABORATORY ACCESSORIES	
198	AB-2	Absorber Set	85.00

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product		Price F.O.B. Burbank
199	ST-1	Sample Tray		6.50
199	ST-2, ST-3, ST-3X, ST-3A, ST-3B, ST-4, ST-4A	Sample Trays		3.50
199	ST-5	Marinelli Beaker		4.25
199	ST-6	Ore Container		12.50
199	ST-6A	Paper Sleeves for Ore Container	per C	2.00
199	ST-7	Sample Tray for LS-7		2.50
199	STH-1	Sample Tray Holder with tray and ten planchets		13.50
199	SK-1, SK-2, SK-3	Sockets		5.00
199	TM-1, TM-2, TM-3, TM-4	Tube Mount		15.00
199	TM-5	Tube Mount (micrometric for LS-2 Lead Shield)		100.00
199	TM-6	Tube Mount and Sample Tray Holder		22.50
199	TM-7	Tube Mount and Sample Tray Holder		27.50
199	TM-8	Tube Mount and Adapting Ring for LS-7 Multi-Purpose Shield		60.00
	SDM-9	Mount and Support Ring when SD-6 is used in LS-6 Shield		27.50
197	LC-1	Lead Source Container for four radium needles		45.00
197	LC-3	Lead Source Container 1" lead walls, 1½" x 3" inside dimensions		40.00
197	LC-3A	Lead Source Container 1⅜" lead walls ¾" x 2¼" inside dimensions		47.50
197	LC-4	Lead Source Container 1½" lead walls 1½" x 3" inside dimensions		60.00
197	LC-4A	Lead Source Container 1¾" lead walls ¾" x 2½" inside dimensions		67.50
197	LC-9	Mobile Source Unit — compartment 3" x 6" in shield of 2" lead. Mounted on heavy duty hand cart.		250.00
130		Lead Brick, 2" x 3" x 6"		9.00
130		Lead Brick, 2" x 4" x 8"		12.50
130		Lead Brick, extruded shapes		**Prices upon application**
199		Planchets, Type PL-1, Sheet steel, tinned	per C	3.25
			per M	30.00
			per 5M	27.00/M
199		Planchets, Type PL-2, Aluminum	per C	3.25
			per M	30.00
			per 5M	27.00/M
199		Planchets, Type PL-3, Aluminum	per C	3.75
			per M	35.00
			per 5M	31.50/M
199		Planchets, Type PL-2C, Copper	per C	5.25
			per M	47.00
			per 5M	42.30/M
199		Planchets, Type PL-3C, Copper	per C	6.00
			per M	55.00
			per 5M	49.50/M
199		Planchets, Type PL-2S, Stainless Steel	per C	9.00
			per M	65.00
			per 5M	58.50/M
199		Planchets, Type PL-3S, Stainless Steel	per C	12.00
			per M	85.00
			per 5M	76.50/M
199		Planchets, Type PL-4, Aluminum	per C	5.00
			per M	45.00
			per 5M	40.50/M
		Planchet Holder for ASC-21, ASC-22, ASC-23	per C	6.00
			per M	55.00
		Sample Tray for ASC-21, ASC-22, ASC-23	per C	8.00
			per M	75.00
189	PH-3	Plastic Holder for 3" diameter filter paper and wipe samples used with MST-300 series	per C	30.00
189	PH-2	Plastic Holder for 2" diameter filter paper and wipe samples used with MST-200 series	per C	30.00
189	PLH-30	Plastic Holder for 3" diameter planchets used with MST-300 series	per C	36.00
189	PLH-20	Plastic Holder for 2" diameter planchets used with MST-200 series	per C	30.00
189	PL-5	Aluminum Planchet 2" diameter x 3/16" deep used with MST-200 series	per C	8.00
189	PL-6	Aluminum Planchet 3" diameter x 3/16" deep used with MST-300 series	per C	11.00
		Planchets, special materials and sizes		**Prices quoted upon request**

PRICE LIST (Continued)

Bulletin No.	Model No.	Description of Product	Price F.O.B. Burbank
		CABINETS	
168	C-875	8¾" height "Easy-to-Service" console cabinet for standard 19" width panel	30.00
168	C-1050	10½" height console cabinet for standard 19" width panels	35.00
168	C-1225	12¼" height console cabinet for standard 19" width panels	37.50
168	C-1400	14" height console cabinet for standard 19" width panels	40.00
168	C-1750	17½" height console cabinet for standard 19" width panels	45.00
168	C-2100	21" height console cabinet for standard 19" width panels	50.00
168	C-2625	26¼" height console cabinet for standard 19" width panels	55.00
168	C-3150	31½" height console cabinet for standard 19" width panels	60.00
168	C-4375	43¾" height console cabinet for standard 19" width panels	70.00

IN GENERAL

Unit prices are given in this price list unless otherwise noted.

All prices quoted here in are f.o.b. Burbank, California. Payment terms, net 30 days upon approved credit.

No extra charge is made for packing for domestic shipments. Export charges will be quoted upon application. We reserve the right to alter specifications at any time without incurring the obligation of incorporating new features in previously manufactured equipment. Prices are subject to change without notice. Quotations remain firm for 30 days.

Shipping instruments: Please include shipping instructions when ordering; in the event that shipping instructions are not given, we will use our best judgment in the matter.

SERVICE CHARGES

Services charges for repairs are usually billed on an hourly basis, however, if desired, an estimate can be given before the work is undertaken. The unit to be repaired should be shipped prepaid to us.

WARRANTY

Technical Associates warrants instruments and equipment (except tubes, fuses, batteries and crystals), manufactured by them to be free from defects in workmanship or materials under normal use for a period of one year from the date of shipment from the factory to the buyer. Tubes, fuses, batteries and crystals are subject to the guarantee established by the manufacturer of them, however, Technical Associates will assist the customer to obtain full benefits of these guarantees.

If, within the one year warranty period, any Technical Associates instrumentation or equipment requires service as a result of a defect, the buyer may return it to the factory of Technical Associates at Burbank, California or to a service station designated by Technical Associates, transportation charges prepaid, for service at no charge under the warranty. The buyer is urged to communicate with Technical Associates when warranty service is required, stating the nature of the difficulty and giving model and serial number of instrument. It may be possible to diagnose the trouble and send a replacement part or assembly, thereby avoiding the expense of shipment.

Technical Associates will return the instrument to the buyer, transportation charges prepaid, after repairs or replacement under warranty are completed. The liability to Technical Associates under this warranty is limited to the cost of replacement of defective parts upon prompt notification of such defect.

Manual of Operation and Service Instructions

nuclear-chicago

NUCLEAR INSTRUMENT & CHEMICAL CORPORATION

INSTRUCTION BOOK

MODEL 2610A

#1747

SECTION I

GENERAL DESCRIPTION

PURPOSE

Model 2610A count-rate meter is a lightweight battery operated instrument designed for general survey work and for the location of small amounts of beta and gamma radiation in rooms, laboratories, on desks, laboratory coats, and similar areas. It has also been found useful for X-ray monitoring and geological surveying for radioactive ore.

GENERAL SPECIFICATIONS

1. The instrument consists of a single unit containing all circuit components, electron tubes, batteries, and a count-rate meter.

2. The detector is a thin-wall Geiger counter mounted in a metal probe at the end of a three foot cable. The probe has a rotary shield which, when covering the sensitive area of the counter, effectively cuts out beta radiation. The instrument then reads only the gamma ray component of the incident radiation, excluding all but the highest energy beta rays commonly encountered.

3. Three full scale ranges of 20, 2, and 0.2 milliroentgens per hour (mr/hr) have been provided to permit quick and convenient measurements of radiation dosage rates.

4. Each instrument is calibrated at the factory with a known ionization intensity produced by gamma rays from radium in equilibrium with its short-lived decay products.

5. When it is inconvenient to read the meter, the earphones may be plugged into the jack on the instrument. One "click" is produced in the phones for each ionizing event occuring in the counter.

MECHANICAL SPECIFICATIONS

1. The count-rate meter is housed in an aluminum case with a smooth enamel finish to make surface decontamination easy.

2. The instrument is ruggedly constructed for long operating life with both case and probe sealed against moisture.

3. The probe is conveniently mounted in the handle of the unit and is easily removed.

4. The range switch is located below the handle and can be controlled with a fingertip while the probe is carried in the other hand.

5. The plug-in Geiger tube (model D50) has a three pin "pee wee" base, requires no soldering, and the probe is quickly disassembled by a simple twist when necessary.

6. Cabinet dimensions: 10" x 4-3/4" x 5-3/4" deep.

7. Weight: 9-1/2 pounds.

ELECTRICAL SPECIFICATIONS

All the batteries necessary for proper operation of the instrument are shipped with the equipment. They consist of:

1. Three 300 volt battery packs which are used for GM tube potential. The life of these batteries is equal to shelf life.

2. One 67.5 volt battery which is used for B-plus potential.

3. One 1.5 volt battery which is used for filament potential.

The life of the 67.5 volt and 1.5 volt batteries is adequate to maintain sensitivities within 10% when operated continuously for 100 hours. When operated four hours a day, the life of these batteries is over 250 hours.

SECTION II

OPERATION

FACTORY CALIBRATION

The instrument has been calibrated using gamma rays from a radium source with the rotary shield on the metal probe closed. Therefore, the shield should be closed when reading gamma radiation in order to preserve the calibration. With the shield closed, no beta rays will be able to penetrate into the chamber and affect the reading. Gamma rays can thus be monitored in the presence of a beta background. When it is desired to admit beta rays into the chamber, the shield should be set in the open position.

The calibration of the instrument may be checked by use of the radium calibration source supplied with the unit.

RADIUM CALIBRATION SOURCE

The radium calibration source provides a convenient means of checking the calibration of the instrument. It is contained in a small plastic cylinder mounted at the rear of the instrument case.

To use the calibrating source, open the probe shield and hold a flat side of the source against the unshielded section of the probe. Move the source until the maximum reading of the meter is observed. The numerals stamped on that side of the source next to the Geiger counter represent the reading in mr/hr. which should be indicated on the meter. If the error is greater than 5% of full scale, readjust the instrument by means of the CALIBRATE control located at the top of the instrument.

The background reading of the meter will be increased if the calibrating source is mounted in its holder while the instrument is in use. If the source is not moved some distance from the instrument, this increase in meter reading should be taken into account.

TAKING A COUNT

When taking a count the Geiger counter may be used in its attached position if desired, or removed for probing in confined spaces or small areas.

The range switch has four positions: OFF and three full scale sensitivity selections of 20, 2, and 0.2 milliroentgens per hour. The maximum total dose to which any part of the body of a person shall be exposed continuously or intermittently in a given time is now 300 milliroentgens per week. On the basis of 48 hours per week of uniform exposure, the permissible dosage rate is 6.25 mr per hour. This dosage rate is indicated on the 20 mr/hr. scale.

The range switch should be turned first to the least sensitive scale (20 mr/hr) to prevent harming the meter if a strong radiation field is present. No warm-up period is necessary. The count-rate meter is ready to operate almost instantly. If no reading appears on the 20 mr/hr scale, the switch should be turned to the next more sensitive scale, etc. With the radium calibrating source removed from the vicinity of the instrument, cosmic ray background will indicate about 1/10 of full scale on the 0.2 mr/hr. range.

SECTION III

CIRCUIT THEORY

GEIGER TUBE

The Geiger tube used with the instrument detects beta and gamma radiation from a radioactive source. The three 300 volt batteries in series produce a 900 volt electric field between the anode and cathode of the Geiger tube. Entering beta or gamma rays collide with the atoms of gas in the tube, causing ionization of the gas and resulting in a current flow between the electrodes. The random height, random width voltage pulses produced by this minute current flow are then fed to a two tube self-relaxing trigger circuit. Refer to the schematic diagram at the rear of this manual.

TRIGGER CIRCUIT

The output of the GM tube is differentiated (sharpened) by C1 and R3 and fed to a one-shot multivibrator, or trigger circuit. The first tube of the trigger circuit (VT-1) is normally conducting, developing a DC voltage with respect to ground on the filaments of both tubes and biasing the second tube of the trigger circuit to cut-off.

When a negative pulse from the Geiger tube is impressed on the grid of VT-1, the conduction of the tube decreases and its plate goes in a positive direction. This positive surge in plate voltage is transmitted to VT-2 through C4, C5, or C6 and VT-2 then leaves cut-off. The plate current through VT-2 will further bias the first tube. This process will be self-maintaining and will terminate when the first tube is fully cut-off and the second tube is conducting heavily.

As C4, C5, or C6 becomes charged, the grid of VT-2 approaches the cathode potential. At this point, grid-cathode conduction ceases and the charging proceeds at a slower rate through R9, R10, and R5. The grid of VT-2 gradually goes negative decreasing the current flow through the tube and decreasing the bias on VT-1. When this bias decreases to the point where plate current will once again flow in the first tube, the circuit will rapidly trigger back to the initial condition with VT-1 conducting heavily and VT-2 cut-off. The time during which the second tube is conducting is varied by the range selector switch which changes the time constant of the coupling circuit. Since the range selector switch varies the "on" time of the second tube, it changes the number of input pulses necessary to give the same average current flow through VT-2.

METER-INTEGRATING CIRCUIT

Each time VT-2 conducts, a pulse of current is put into the meter integrating circuit made up of R8, C7, and the meter in the plate circuit of VT-2. These pulses of current are averaged by the charging and gradual discharging of the condenser through the resistor and meter. The time constant of the meter-integrating circuit, i.e., the time it takes the meter to reach 63% of its final reading is about 5 seconds. It will be noted that for any given amount of radiation, the meter needle fluctuates around an average reading; the largest fluctuations being on the most sensitive scale (0.2 mr/hr). This is due to the randomness of the radiation flux. The observer's final reading should be the average position, as seen by the eye, of the fluctuating needle.

LINEARITY

The linearity of the electronic count rate circuit corresponds very favorably (about 2%) with the linearity of the 0-20 micro-amp meter. However, the resolution time of the Geiger counter causes coincidence losses at the higher counting rates. The counter is insensitive for a time equal to:

$$N \frac{T}{60} \text{ Minutes during each minute.}$$

Where N = observed count rate in counts per minute
T = resolution time in seconds

Two particles or quanta entering the counter within this time interval produce only one pulse since the second particle enters the counter before most of the positive ions from the previous discharge are collected. Because of the random nature of emissions from a radioactive source, there is as much chance for pulses to occur during this time as during any other of equal duration.

Thus, the higher the counting rate, the higher is the number of counts "lost". Coincidence loss has been minimized on the 2 and 20 mr/hr. ranges by the introduction of slightly larger capacitors (C4 and C5) in the coupling circuit. Figure 1 shows the deviation of an average instrument from true linear calibration.

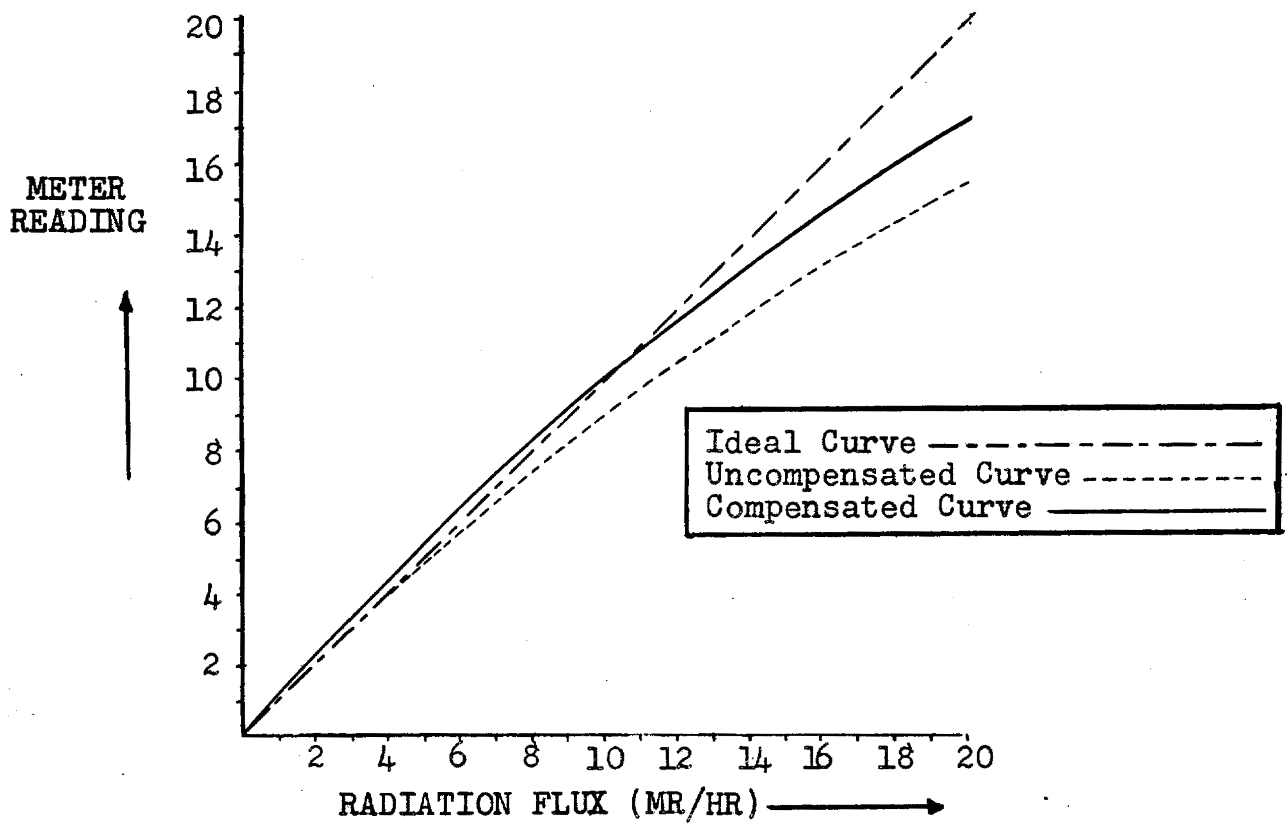


Figure 1

CALIBRATION CORRECTIONS *

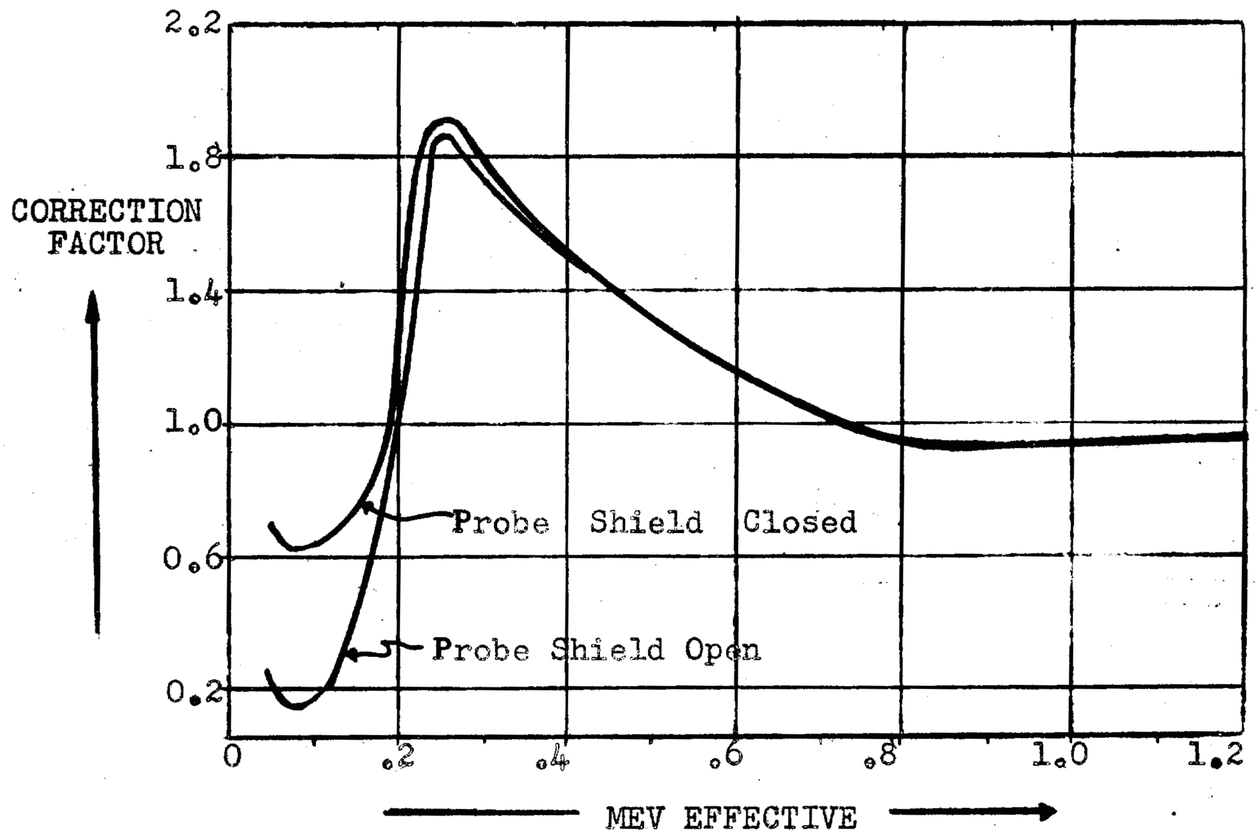
A plot of correction factor versus photon energy for a Geiger-Müller counter is shown below. For energies above 750 kv (.75 mev), the correction factor is equal to or near 1.0. For less energetic radiations the plot exhibits maximum and minimum values of correction factors caused by a change in efficiency of the Compton and photoelectric processes.

NOTE

This graph represents average readings taken on a number of 2610A count-rate meters. The graph serves merely to indicate the approximate error which may be expected from low energy radiation and is not to be taken as an absolute guide for each instrument.

This instrument was carefully calibrated at the factory using gamma rays from a radium source in equilibrium with its short-lived decay products. The calibration of the instrument will be correct for radium radiation since the gamma energies of RaC (which is the principle source of gammas in radium decay) fall for the most part on the flat portion of the curve below.

The relative energy and intensity of RaC gammas is given in the



* Excerpt from: National Bureau of Standards Circular No. 507 (7/25/51)

following chart:

	ENERGY	RELATIVE INTENSITY
	.6 mev	8.9
	1.12 mev	2.9
	1.76 mev	2.8
	2.19 mev	1

From the graph on the opposite page it may be seen that as the energy of radiation is reduced the correction factor rises and reaches a maximum value in the region of .25 to .3 mev. Upon further decreases in energy the correction factor drops rapidly and passes through a minimum around 0.1 mev, after which it again rises sharply.

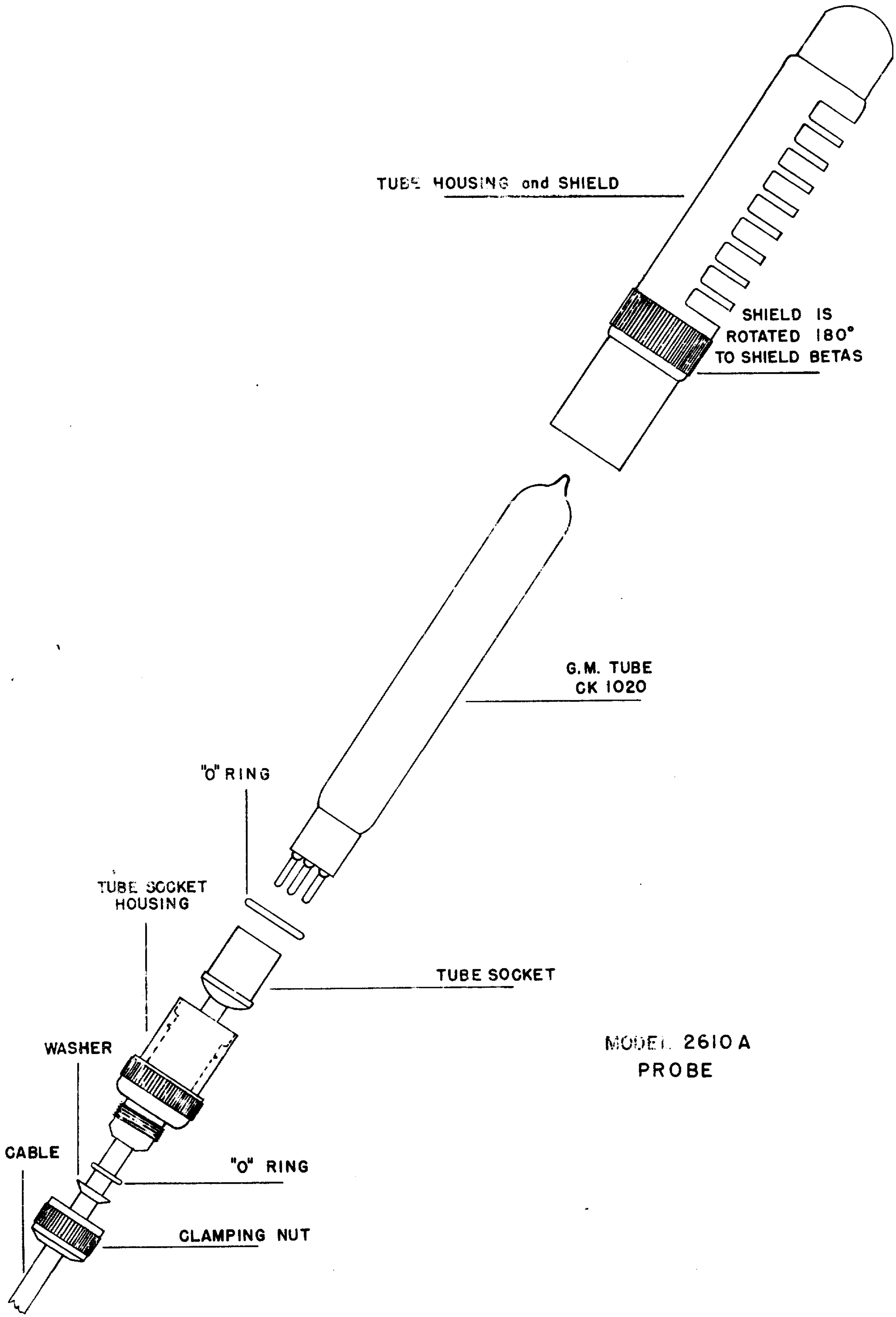
The response of a Geiger-Müller counter depends primarily upon the number of electrons that traverse the sensitive volume of the counter. This number is proportional to the number of electrons released in the vicinity of the sensitive volume and to the range of these electrons. The correction factor of a GM counter varies primarily in proportion to the ratio

$$\frac{\text{Energy of electrons generated in the counter vicinity}}{\text{Range of electrons generated in the counter vicinity}}$$

The range of an electron increases faster than its energy increases at moderately high energies and in direct proportion to its energy in the multimillion-volt region. Therefore, for energies within the plot, the energy-to-range ratio (the correction factor) must increase as the energy decreases. This assumption is approximately valid in the high energy region where most of the electrons arise from the Compton effect, because this effect is almost independent of the mode of binding of the electrons within matter.

At lower energies, electrons are released primarily because of the photoelectric effect. This effect is the more intense the more tightly bound are the electrons within matter, that is, the higher is the atomic number of the material. Therefore, the presence of high-atomic number materials in the proximity of the sensitive volume of a GM counter increases the response to low energy particles sharply. Accordingly, the correction factor must be expected to drop as one proceeds from high to low energies, as soon as the photoelectric effect becomes important. This drop may be seen in the plot and represents increased sensitivity of the GM counter to radiation energies in the 100 kv region.

From the chart it can be seen that the meter reading for low energy gamma emitters is essentially erroneous. To obtain the correct gamma dose rate, it is necessary to multiply the meter reading by the correction factor.



MODEL 2610 A
PROBE

SECTION IV

MAINTENANCE

CALIBRATION WITHOUT A STANDARD SOURCE

If a standard source is not available, an approximate calibration may be obtained by the use of an electronic pulse generator. The pulses should be negative, no more than 75 microseconds wide (preferably much narrower) with a fast rising time.

Feed the pulses into the input grid circuit. The screwdriver adjustment should be made so that full scale on the second range (2 mr/hr.) is indicated when 110 pulses per second are fed into the input. Full scale on the 0.2 mr/hr. range should then be 11.0 pulses per second.

This method of calibration was determined experimentally by averaging the pulses per minute at 1 mr/hr. for a large number of Geiger counters. Individual counters may differ by as much as a factor of two, so this method of calibration should only be used if a radium standard is not available.

GEIGER TUBE REPLACEMENT

1. With the tube socket housing held firmly in one hand and pointed to the operator, grasp the tube housing in the other hand and turn clockwise.

2. Slide the probe tube housing off the Geiger counter, being careful not to break the counter tube..

3. Grasp the Geiger counter by the base and remove it from the socket. CAUTION - The Geiger tube is very fragile and should be handled carefully.

4. See that the "O" ring is in the tube socket housing.

5. Insert a new Geiger counter in the tube socket. "O" ring now forms a seal between the housing and the base of the counter.

6. Carefully slide the probe tube housing over the Geiger counter and turn counter-clockwise on the tube socket housing.

HOW TO TEAR DOWN

The instrument should be "torn down" in the following manner for servicing.

1. Remove the two screws from the bottom of the cabinet.

2. Holding the cabinet with one hand and pulling on the handle with the other will remove the top section and chassis (which is attached to the top).

3. The top piece may be folded to one side to facilitate working on the circuit. This is done by removing the two screws that hold the circuit shelf. The top can then be rotated on the rivets to a position which exposes the circuit for examination.

In reassembling the instrument, care must be taken in lining up the top of the instrument with the groove in the top of the cabinet. Uniform pressure should be applied to the top to bring the bottom section evenly to the rubber seal. If the seal is not completely contacted, the cabinet is no longer waterproof.

BATTERY REPLACEMENT

1. BE CAREFUL - the high voltage batteries can give a shock which may be lethal.

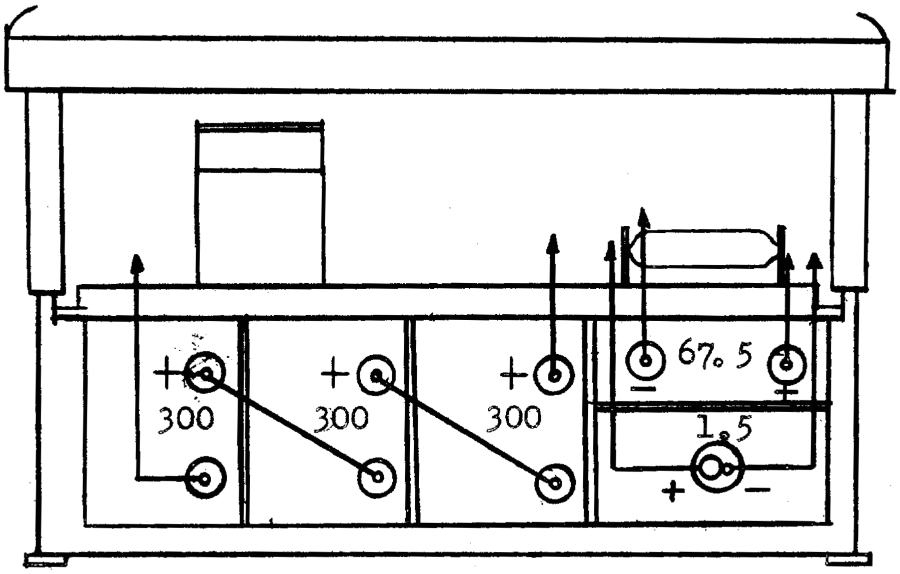
2. Turn the range selector switch to the OFF position. Remove the negative and positive leads from the high voltage batteries and disconnect the jumpers between the batteries.

3. If the low voltage batteries are to be replaced, their leads must be disconnected. The 67.5 volt battery has snap-type connections which are easily removed with a screwdriver or sharp-pointed instrument.

4. Remove the two screws that hold the center shelf. Tilt back the shelf and remove the batteries.

5. Replace the batteries as shown below. The low voltage batteries should be replaced first. Then insert the two end high voltage batteries and slide the center high voltage battery in position.

6. Replace the battery leads and jumper connections.



Battery Replacement and Wiring

SECTION V

TROUBLE SHOOTING

GENERAL

A visual inspection will often help in determining the cause of improper operation of the instrument. Listed below are some of the defects that may be found:

1. Loose screws and nuts.

2. Broken solder connections.

3. Damaged Insulation.

4. Pitted or dirty switch contacts.

5. Burned or broken resistors.

6. Exposed wiring, causing shorts with wiring, terminals, or ground.

7. Corroded or swollen batteries.

The following notes are given to aid in the diagnosis and repair of any failures not due to any of the above defects. The steps are given in the order in which they should be tried. If the first step does not locate the trouble, proceed to the second, etc.

NO METER INDICATION OF BACKGROUND OR OTHER RADIATION

1. Check high voltage batteries and plateau of Geiger counter to see if the counter is being operated in the plateau region. The ordinary life of the self-quenching organic vapor Geiger counter is about 10^8 counts. The counter should have a threshold voltage of from 800 to 825 volts when new. As the batteries age, the voltage will decrease. The high voltage should be at least 25 volts and not more than 200 volts above the threshold voltage of the Geiger tube.

2. Check the operation of the circuit with a pulse generator fed into the input grid circuit (see page 9). The circuit should trigger and give a meter indication with a 0.5 to 1.0 volt negative pulse.

3. Check circuit batteries and voltages.

4. Replace tubes.

ABNORMALLY HIGH METER READING WHEN NOT IN RADIATION FLUX

1. Put probe with counter in complete darkness. If meter reading

falls to the background value, the Geiger tube is photosensitive. Paint the tube with black glyptol or cover with black paper.

2. Remove the GM tube from the probe. If the meter no longer indicates, the counter was probably in continuous discharge and must be replaced.

3. Circuit may be oscillating. This can be detected in the headphones. Replace the tubes.

4. VT-2 may not be properly cut-off and thus may be drawing plate current with no signal. Replace VT-2.

5. VT-1 may have an open filament and thus not draw plate current necessary to bias VT-2 to cut-off. Replace VT-1.

6. Check voltages and test for shorted or open circuits.

ERRATIC METER MOVEMENT

1. If the meter needle moves to full scale and then starts to come down to zero again when brought into a more intense radiation field, the high voltage may be too low. If the high voltage is not enough above the threshold voltage at high radiation intensities, the output pulses will become too small to trigger the circuit. Normally, an instrument will not exhibit such symptoms unless the radiation intensity exceeds 2 to 20 r/hr (100 to 1000 times full scale on the least sensitive range). At this intensity, the Geiger counter becomes paralyzed.

2. Check operation of the circuit with a pulse generator. The circuit should trigger and give a meter indication with a 0.5 to 1.0 volt negative pulse fed into the input grid circuit (see page 9).

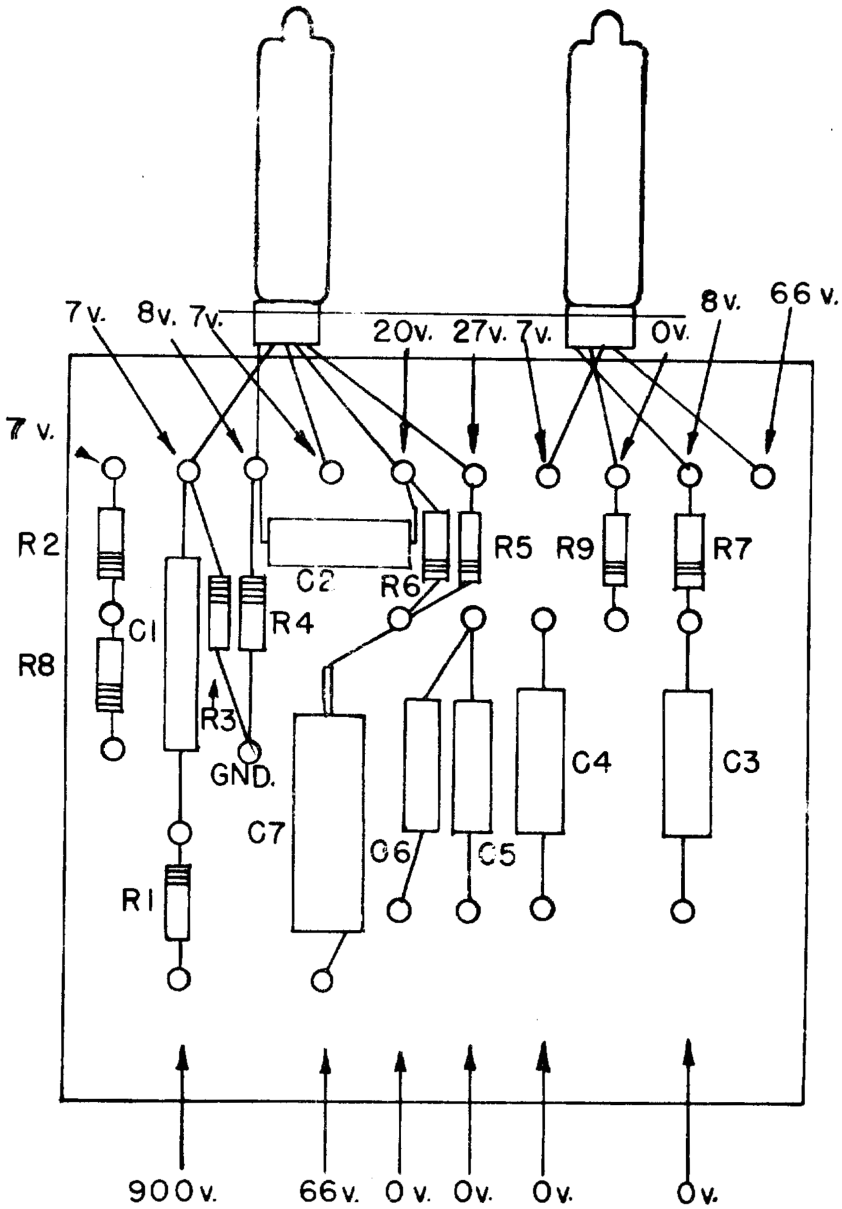
3. Check low voltage batteries and circuit voltages.

4. Replace tubes.

VOLTAGE MEASUREMENTS

A voltmeter of at least 5 megohms input resistance should be used for measuring circuit voltages. The voltages given on the circuit diagram (rear of this manual) and on the terminal board diagram (opposite page) were measured with new batteries. The voltages, excluding high voltage for the Geiger counter tube, may vary by as much as 15% to 20% without affecting circuit operation (except for calibration).

All voltages were measured with respect to ground.



Voltages to chassis measured on voltmeter with total resistance of 5 megohms.

SECTION VI

PARTS LIST

BATTERIES

			NUCLEAR PART NO.
B1	1.5 volt	Burgess 2F	BA003
B2	67.5 volt	Eveready 467	BA005
B3	300 volt (3 required)	Eveready 493	BA006

RESISTORS

All resistors are Allen-Bradley, ½ watt, 10% fixed composition type unless otherwise indicated.

R1	2.2 M		RC20AE225K
R2	2.7 M		RC20AE275K
R3	330 K		RC20AE334K
R4	33 K		RC20AE333K
R5	200 K		RC20AE204K
R6	1.2 M		RC20AE125K
R7	150 K		RC20AE154K
R8	33 K		RC20AE333K
R9	200 K		RC20AE204K
R10	500 K	2 Watt Potentiometer	RV030

CAPACITORS

C1	270 mmfd	1600 V	Mica		CM003
C2	.01 mfd	300 V	Mica	20%	CM35A103M
C3	.005 mfd	500 V	Mica	20%	CM35A502M
C4	.005 mfd	500 V	Silver Mica	2%	CM35C502G
C5	450 mmfd	500 V	Silver Mica	2%	CM35C451G
C6	33 mmfd	500 V	Silver Mica	2%	CM20C330G
C7	50 mfd	6 V	Electrolytic		CE008

TUBES

VT1	CK522	Raytheon	VTCK522AX
VT2	CK522	Raytheon	VTCK522AX
GM	CK1020 (D50)	Raytheon	VT-010

MISCELLANEOUS

Meter 0-20 milliamps (waterproof)	Simpson 185	MP003
Selector Switch	Centralab 2CHW11486	SW-011
46½-in. Probe Cable	Amphenol RG59U	CA-001
Radioactive Source	Nuclear R2	RA-001
Probe Assembly	Nuclear	PR-005
Phones (double headset)	Brush 200A	PH-001

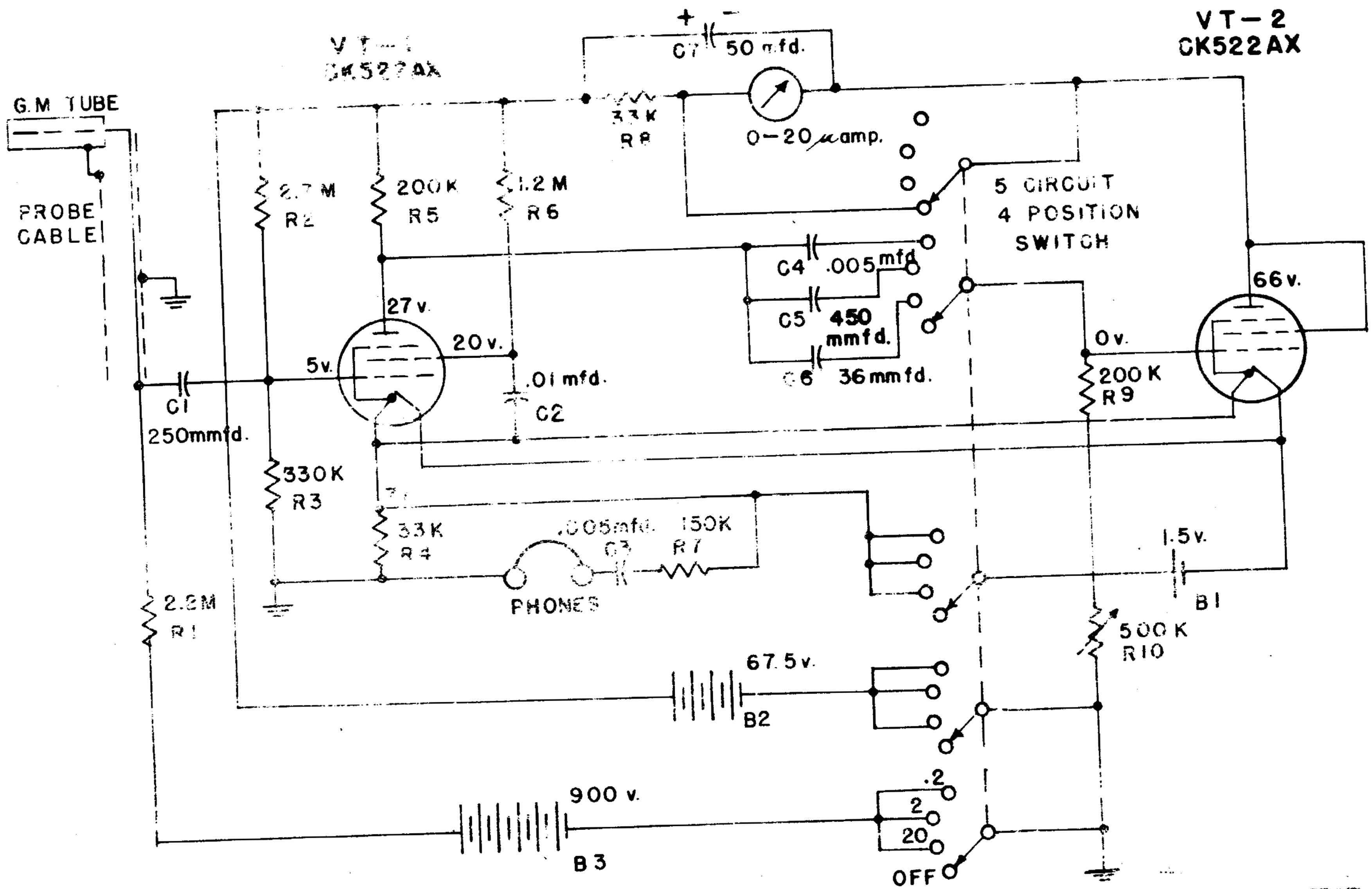
		NUCLEAR PART NO.
B1 Battery Plug	Cinch 2744	PL-002
B2 Battery Connectors	United Carr 52383	CO-023
	United Carr 52384	CO-024
3 Black Battery Plugs (for B3)	Amphenol 71-1M	PL-006
3 Red Battery Plugs (for B3)	Amphenol 71-1L	PL-007
Midget Phone Jack	Switchcraft 2J1065	JA-002
2 Phone Jack Covers	Croname A23559	JA-005
Phone Plug	Switchcraft 2P-1020	PL-004
Female Connector (GM Socket)	Amphenol 91MPF-3S	CO-012
2 Socket Nuts (for above)	Amphenol 91MC-3F	CG-002
2 Tube Sockets (5 pin min.)	Cinch 54A11953	SO-006
2 Retainer Rings (for above)	Cinch 20K12446	CL-016
Tube Holder	Nuclear	BC-024
2 Rubber "O" Rings for #10 screw	Lavelle	GR-007
"O" Ring-21/32 ID x 29/32 OD x 7/16	Lavelle	GR-008
2 ½" Rubber Grommets	Lavelle	GR-004
2 "O" Rings 3/8 OD x 1/4 ID x 1/16	Lavelle	GR-009
Handle, with Probe Holder	Nuclear	HA-005
Plastic Battery Insulator	Nuclear	IN-040
Selector Switch Knob	H. Davies 2110AZ	KN-015
Potentiometer Bracket	Nuclear	BC-023
2 Self-tap screws 10-32 Slotted, ½" Cad. Plated		SC-010
3 ft. Fungus Resistant Waxed Cable Cord		TW-001

SUGGESTED MAINTENANCE KIT OF PARTS FOR FIVE INSTRUMENTS, FOR ONE YEAR

2 Vacuum Tubes	Raytheon CK522	VTCK522AX
5 Geiger Counter Tubes	Raytheon CK1020	VT-010
2 GM Tube Sockets	Amphenol 91MPF3S	CO-012
2 Socket Housing Nuts	Amphenol 91MC-3F	CG-002
2 Capacitors, 50 mfd, 6 V, Electrolytic		CE-008
2 Capacitors, 270 mmfd, 1600 V, Mica		CM-003
2 Phone Jack Covers	Croname A23559	JA-005
1 Switch - wafer, 6 circuit, 4 position		SW-011
1 Meter, 0-20 ma (waterproof)	Simpson 185	MP-003
4 Screws, 10-32 Slotted, self-tapping		SC-010
10 rubber "O" Rings, 3/8 OD x 1/4 ID x 1/16		GR-009
5 Rubber "O" Rings, 21/32 ID x 29/32 OD x 7/16		GR-008

NOTE

Since battery replacements depend upon rate of usage as well as shelf life, no general recommendations can be made for spares.



NOTE — Voltages to chassis, measured on voltmeter with total resistance of 5 megohms.

DRAWN *C.Q.S.*	MODEL 2610A
CHECKED *E.J.W.*	PORTABLE BETA-GAMMA SURVEY METER NUCLEAR INSTRUMENT & CHEMICAL CORP CHICAGO, ILLINOIS
APPROVED	

Beckman®

Process Instruments Division

2500 Fullerton Road, Fullerton, California : LAmbert 5-8241 : from Los Angeles, OWen 7-1771

a division of Beckman Instruments, Inc.

October 31, 1958

General Electric Company
4855 Electric Avenue
Milwaukee 1, Wisconsin

Attention: J. J. Jech
X-Ray Department

Reference: Your letter dated October 13, 1958

Gentlemen:

In reply to your referenced inquiry, please be advised that we do not have a readily available parts list or kit to convert the Model V to a logarithmic type. (Model VL).

Due to the required special handling, the final cost for this conversion would exceed that of a new Model VL. In view of this fact, we obviously recommend the purchase of a new Model VL for $425.00 net exclusive of freight. Shipment for this item is seven days.

We trust that the above meets with your approval, and if any further questions should arise, please do not hesitate to contact this office or our local sales engineer, Mr. Herbert Feitler, 4914 West Belmont Avenue, Chicago 41, Illinois.

Very truly yours,

B. B. Goffin

B. B. Goffin
Product Specialist
Process Instruments

BBG:ch
cc: H. Feitler
Encl.

BULLETIN V-4010

micro- microammeter

measures one millionth of a millionth of an ampere

2 Beckman® instruments...

for measuring low level signals

d-c breaker amplifier

measures a-c and d-c voltages in the microvolt and fractional microvolt ranges

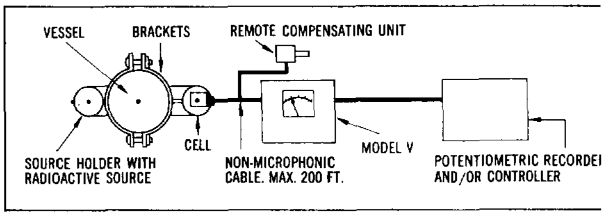
Beckman®

Scientific and Process Instruments Division

Beckman® / model V "Vibrating Reed" micro-microammeters

When the huge Savannah River Atomic Energy Project was started, an instrument which would measure electrical currents less than one millionth of a millionth of an ampere was needed, to measure radiation involved in nuclear reactions. Two Beckman instruments were submitted to fill this need, and after months of tests, placed first and second against all other entries, in stability, accuracy, and reproducibility. One of these was the Beckman Model V Micro-Microammeter–a vibrating-reed electrometer.

The extreme sensitivity of this instrument is useful for measuring output of radioactive sensing elements in reactor control and health monitoring; for tracing output of ionization chambers while monitoring and controlling liquid levels, thickness of coating or impregnation applied to moving sheets; for measuring

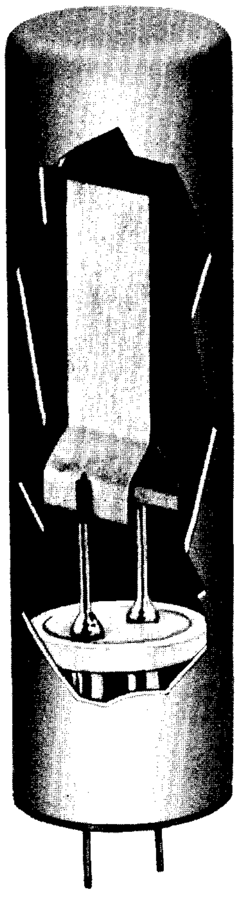


Typical Model V application in density measuring system.

currents across capacitors and resistors, output of phototubes, static electricity generated in turbulent systems, and research work involving micro-currents.

The Beckman Micro-Microammeter is available in four models. Three of these models (V, VS, V2) employ an alternating current vibrating-capacitance modulator, the Beckman Vibrode. Thirteen measuring ranges from 3×10^{-7} (0.3 microamperes) to 3×10^{-13} (0.3 micro-micro-amperes) are available. At the current sensitivity at which it is operated, zero-drift is negligible and an interruption of power does not affect the calibration.

Beckman / *vibrode*®



The Beckman Vibrode, a unique vibrating reed sealed in a metal envelope, changes a low-level d-c to a low-level a-c potential. The Vibrode holds the secret of the exceptional drift-free performance and low price of the Models V, VS and V2. Plates are perfectly parallel and are approximately .002 inches apart at rest position. The dry nitrogen gas in which they are sealed builds up a "cushion" and prevents any strain during operation. The Vibrode has a longer life than conventional vibrating reeds and is replaced as easily and inexpensively as a vacuum tube.

model V specifications:

Input power. 60 cycles, 103 to 127 volts, 100 watts.

Detection range. 3×10^{-13} to 3×10^{-7} ampere.

Indicator. 200 microamperes, 4½ inch scale.

Ambient Temperature requirements. 20°F to 115°F.

Zero drift. Less than 1 mv in 24 hours. Drift is not cumulative.

Response time. Time constant (4.0 to 0.12 second) varies with input capacity.

Warmup time. Amplifier, 3 to 5 minutes. Isothermal shield, 30 minutes.

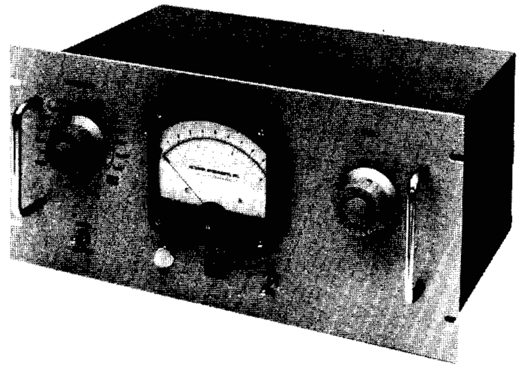
Output connections. Recorder, 50 millivolt potentiometer type. Multiple switch, Beckman 1710 multiple switch.

Accuracy and Reproducibility. ±1% on all ranges.

Output noise. Less than 3% with no input capacitance and less than 8% with 5,000 µµf input capacitance on 3×10^{-13} ampere range.

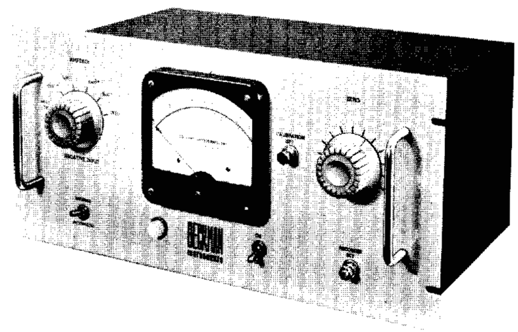
model V *multiple range model*

Model V is an outstanding precision instrument for measuring, recording and controlling micro-currents in any of 13 ranges. Designed for easy relay-rack mounting or supplied with attractive cabinet for bench use. Range: 3 x 10^{-13} to 3 x 10^{-7} ampere. Weight 38 lbs.



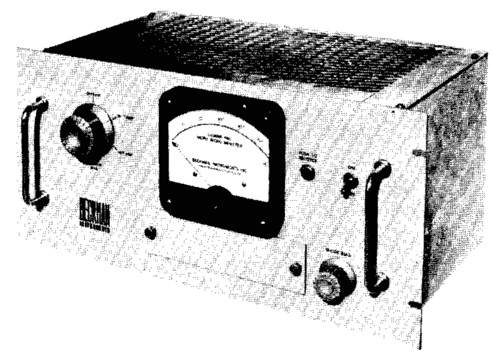
model V2 *limited range model*

Model V2 is an inexpensive unit for industrial applications and original equipment manufacturers. The range is 10 x 10^{-13} to 3 x 10^{-11} ampere. Weight 38 lbs.



model VL *logarithmic scale model*

A companion laboratory instrument to the Model V but without the Vibrode, Model VL does not convert a signal to a-c. It has a single logarithmic scale for measuring, recording and controlling micro-currents within the range of 10^{-13} to 10^{-7} ampere. No data is lost by range switching or by the meter going "off scale." The Model VL gives almost instantaneous response to input signal fluctuations between 10^{-11} and 10^{-7} ampere. Weight 38 lbs.

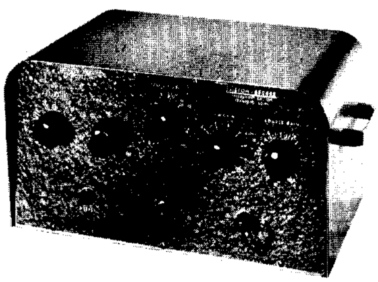


available with all models

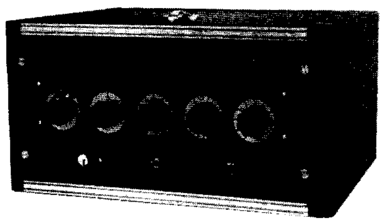
Regulated 200-volt d-c source available for polarizing ion chambers. Terminals provided for connecting external meter and for any 50 mv potentiometer-type recorder. Long input cables can be used without introducing large time constants. Source has maximum drift rate of 0.30 millivolts per second.

During World War II, a new method, superior in many respects to the suspension galvanometer, was developed for measuring d-c voltages and low-frequency a-c voltages in the microvolt and fractional microvolt regions. The Beckman d-c Breaker-Amplifier, which utilizes this new method, is insensitive to vibration, faster in response, and much more flexible than previous instruments. It has the lowest noise level and greatest zero stability of any d-c amplifier available commercially. It is capable of driving *directly* standard recorders, relays and meters. The Breaker-Amplifier is used extensively in both research and industry for replacing galvanometers in bridge circuits for measuring the Hall effect; for radiation measurements used in conjunction with barrier layer cells, phototubes, and thermocouples; in such diverse fields as optical pyrometry, precision tem perature measurements, colorimetry, high sensitivity photometry, spectroscopy, molecular-weight determinations, seismology, meteorology, petroleum exploration, and in physiology for the measurement of nerve-voltages in blood-flow meters, and in oximeters.

Beckman LB breaker-type ultrasensitive d-c amplifier



MODEL LB14 employs an 8-cycle breaker to provide discrimination against the effects of 60-cycle and higher frequency pickup of over 1000. It can be used as a null indicator on several ultra-precision Wheatstone and Mueller bridges without requiring additional shielding of the bridges.
Dimensions: 15½″ wide, 8″ high, 10″ deep. Weight: 40 lb.



MODEL LB10A makes use of an 80-cycle breaker in combination with a sharp cut-off filter to give a frequency response that is essentially flat to 10 cycles per second. This unit is more sensitive to the effects of 60-cycle pickup.
Dimensions: 22″wide, 10½″ high, 15″ deep. Weight: 60 lb.

specifications:

Input characteristics. The input transformer can be designed for any given input impedance from 5 ohms to 100,000 ohms. **Zero stability.** Drift is less than .005 μv per 8-hour day. **Gain stability.** With a stable power line, the amplifier will vary less than 0.3% over an 8-hour day. **Output characteristics.** The unit is linear to approximately 2 volts when terminated into 500 ohms, to 4 volts when used with a meter of infinite impedance. **Noise level.** Approaches theoretical limitations. **Immunity.** Discrimination against 60-cycle pickup of induced a-c signals is over 1:1000. **Controls.** Coarse gain control of 20 positions, 4DB per position. 7 test signals are provided for calibration ranging from 0.1 microvolts to 100 microvolts. **Power requirements.** 110 volts, 50 or 60 cycles, 20 watts.

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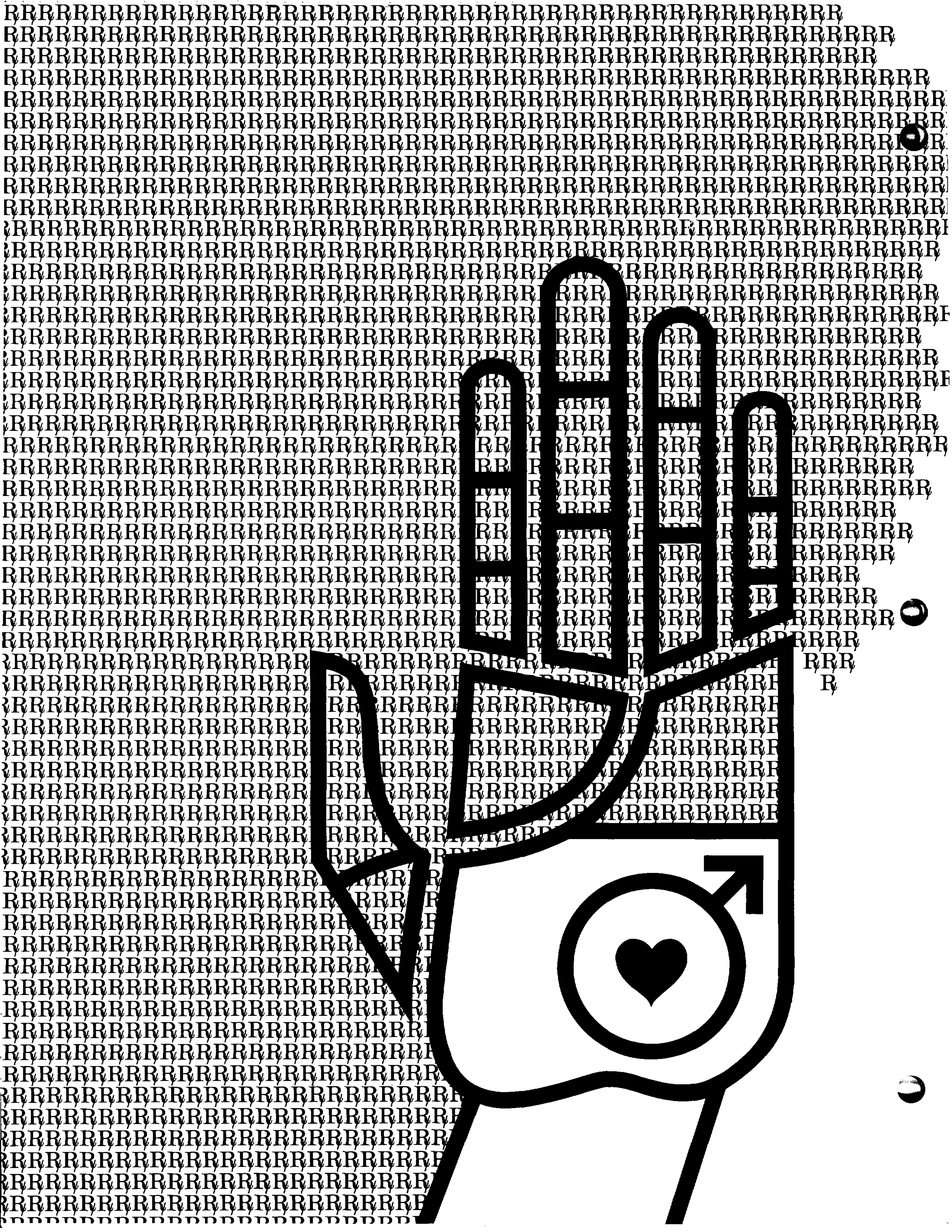

the Analyzer®

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Fullerton, California

Jim Notarian, Editor

Alan Chute, Art Director

Contents

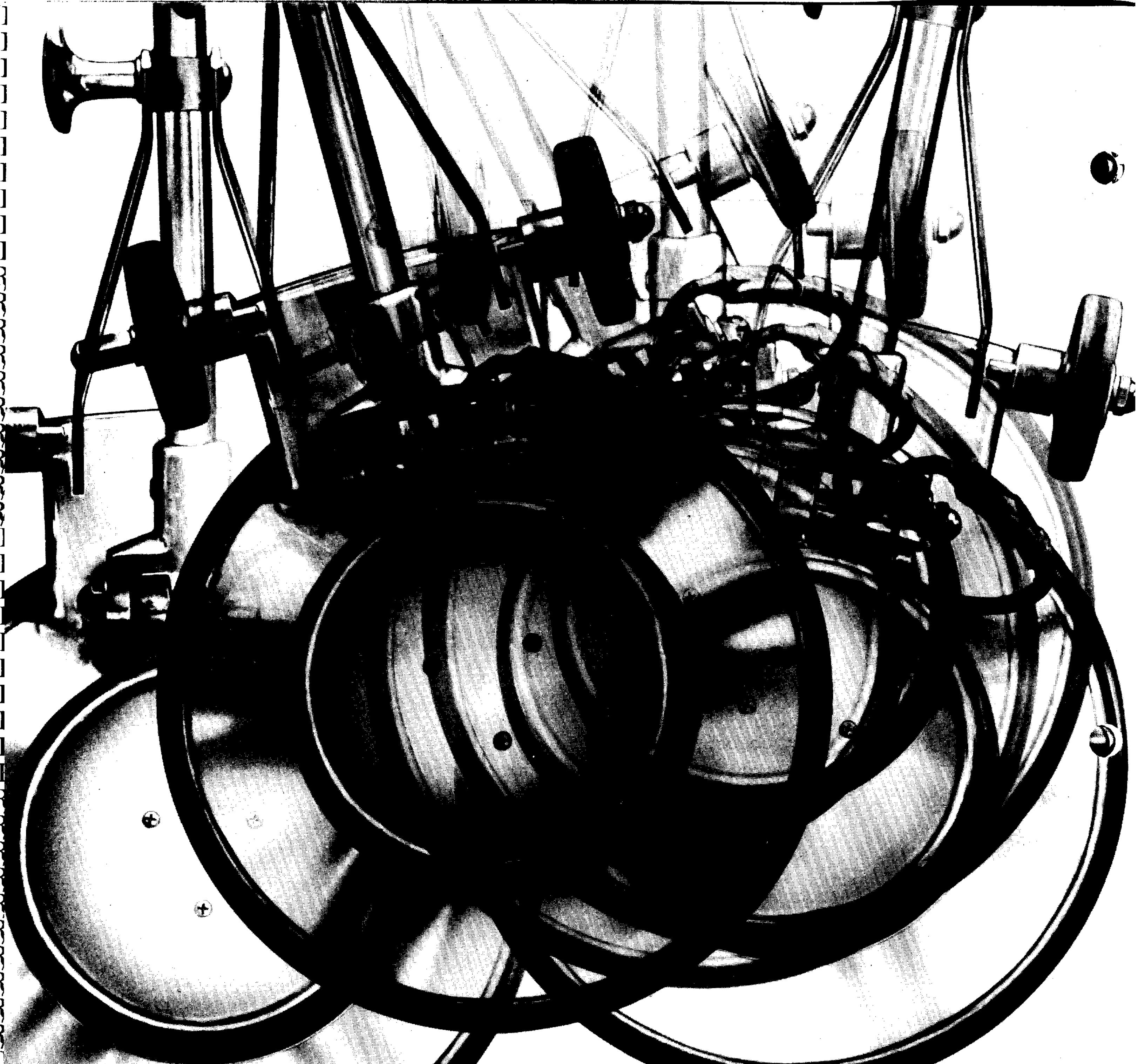
HIPPOCRATES: 460 B.C. - 377 B.C.
Facts about the Father of Medicine, Hippocrates, are surprisingly few. Born on the Greek Island of Cos, in a medical environment, Hippocrates apparently became his father's apprentice at an early age.

The Hippocratic Oath embodying a code of medical ethics, generally taken by recipients of the M.D. Degree, is attributed to Hippocrates. There is frequent speculation that he did not write it. Also, careful analysis of the text has revealed that the oath was written for a medical family guild instead of the medical profession as a whole.

The essence of Hippocratic thinking is contained in the treatise "On Epidemics." Here Hippocrates viewed the medical arts as having three main components: the disease, the patient and the physician.

Hippocrates remains today a symbol of greatness in medicine.

The staff of *The Analyzer* invites readers to submit material of general interest to instrument users. Articles may be either originals or abstracts of previously printed material. Unless otherwise stated in writing by the submitter, it will be assumed that such articles have not been copyrighted, published, or offered for publication elsewhere and that Beckman Instruments, Inc., is free to publish and disseminate accepted articles without incurring any liability to others, including the submitter. Manuscripts and all correspondence pertaining to *The Analyzer* should be addressed to: *Editor, The Analyzer, Scientific and Process Instruments Division, Beckman Instruments, Inc., Fullerton, California.*



How Johnson's Wax shines in quality control

William K. Miller, PhD: Analytical Supervisor, S. C. Johnson & Son, Inc.

Ever walk across the gleaming floors of a new office building and wonder how they got that way? Chances are, they are polished regularly with a very specially formulated mixture of carnauba wax and other key ingredients. Getting just the right "shine," wearing characteristics, non-slip surface, and other qualities is the continuing task of the Research & Development Division, S. C. Johnson and Son, Racine, Wisconsin.

Making such waxes for commercial and home use is the prime concern of the Johnson company. Founded in 1886 by Samuel Curtis Johnson, a parquet flooring salesman, the firm is now the world's leading manufacturer and marketer of floor waxes, furniture polishes, and a number of other home care products. Such trade names as Glo-Coat*, Klear*, Pledge*, Raid*, and Glade* have become household words. In commercial, industrial and institutional maintenance, Johnson markets such products as Step-Ahead*, Over and Under*, and Forward*.

Its line of more than 200 products, all manufactured in Racine, also includes coolants and lubricants for metal-working; finishing products for furniture manufacturers; agricultural waxes to protect fruits and vegetables, and chemical intermediates for printing inks, paints, and varnishes.

Johnson products are known throughout most of the free world. The Racine company formed its first international subsidiary in England in 1916 and now has 23 manufacturing and marketing associate companies operating in Europe, Africa, Latin America, and the Far East.

Behind this international reputation for high quality products is a unique balance of creative research, modern manufacturing techniques, and marketing skill.

The company's Research and Development Division, headquartered in the world-famous research tower designed by the late Frank Lloyd Wright, has more than 200 employees. In 1929, Johnson's lab consisted of only three people.

R & D activities at Johnson Wax are supported by a wide variety of analytical instruments. Many of these instruments are concentrated in the Analytical Section of the Quality Control Department. In addition to developing methods for quality control, this group performs analytical service for all R & D activity, the Production Division and the Household, Service Products, Chemical, and International Marketing Divisions.

Workhorse of the analytical instruments is a Beckman IR-4 Infrared Spectrophotometer. Johnson has been using infrared spectrophometry for 12 years. The present IR-4, more than five years old, turns out approximately 200 spectra a month, and the number is increasing. The Research Department recently added a Beckman IR-5A to its laboratory to lessen the load on the IR-4 and the Analytical Section.

One function of the Research Department is to study the composition of raw materials, especially waxes. Materials to be studied are separated into fractions by physical, chemical and chromatographic methods. The fractions may be subjected to chemical treatment for further separation. Each fraction is carefully analyzed, and infrared spectrophotometry plays a major role. The composition of carnauba wax and other natural products are much better known as a result of these studies.

Much of the confidence that customers place in Johnson products can be traced to rigid quality control, which extends from the analysis of raw materials, through production, packaging and finally to the finished products. For example, Glo-Coat Self-Polishing Floor Wax undergoes 75 quality control tests. Over and Under, a new floor sealer and undercoater marketed by the Service Products Division for commercial use, undergoes 57 tests on raw materials alone, and 27 additional tests on the finished product.

The Beckman IR-4 plays an important part in this quality control system, supplementing the chemical and physical methods used, to assure that raw materials meet specifications, and that the chemical composition and performance of finished products are consistent.

Adulteration in carnauba wax is detected by infrared spectrophotometry in the analysis of the incoming raw materials. By noting the relative depths of the absorption bands at 1460 and 1740 cm^{-1}, it is possible to detect adulteration of carnauba with paraffin wax. The effect of the paraffin in the carnauba spectrum can be seen in Figure 1-B. A quantitative determination of paraffin in carnauba can also be made by chromatography, but the detection and estimation by infrared is much faster.

Many production problems are also solved by the Beckman IR-4. For example, large particle size, instability, or other undesirable properties of polymer emulsions may be caused by incorrect ratio of monomers, insufficient emulsifier, wrong emulsifier system, or contamination with another material. The cause often can be determined simply by examining the infrared spectrum of the polymer. More often, it is necessary to separate the contaminant or emulsifier from the polymer, but the final step will be infrared examination of the spectra of the separated fractions.

Finished products can be analyzed in the same manner, if other quality control tests indicate the possibility of improper formulation.

Customer complaints are sometimes investigated by infra-

* Trademarks of S. C. Johnson & Son, Inc.

A

red spectrophotometry. The gellation of an emulsion floor polish can be caused by the housewife or custodian mixing two partially-used floor waxes that are not compatible. Infrared analysis quickly determines that contamination has occurred, and often identifies the contaminating product. The left part of Figure 2 shows a portion of the spectrum of Traffic Grade, an emulsion floor finish high in wax content, that is marketed by the Service Products Division. On the right is the spectrum of the same finish which has been contaminated by a small amount of a polymer floor finish. Such contamination, of course, would cause the product to perform differently on a floor.

Johnson's Service Products Division, which markets maintenance products for commercial, industrial, and institutional use, has made effective use of the infrared spectrophometer as a marketing tool.

Because labor costs take up to 95% of the commercial building maintenance budget, purchasing agents and maintenance supervisors are becoming convinced that performance is far more important than price, and that any floor finish should be selected on the basis of an on-the-floor test rather than chemical specifications. But, after selecting a product on its performance in a test, the purchaser wants proof that it will perform the same in all subsequent purchases.

The Service Products Division offers this proof with an infrared "fingerprint" of the product tested, plus an affidavit that all subsequent gallonage will have the same "fingerprint" and, hence, the same formulation and same performance.

Johnson's Analytical Section has developed a method for sample preparation of emulsion products that permits the running of an infrared spectrum of the entire non-volatile portion of the product. If the spectrum is identical to that of a previous batch, there can be no significant difference in the chemical composition. The same technique is used to

A. Dr. Miller makes a final check against the operating guide to prepare the Beckman IR-4 Infrared Spectrophotometer for an analysis. Figure 1. To maintain consistent quality in Johnson Wax products, purity checks are run against raw materials and finished goods on the infrared spectrophotometer. Graphs below show how adulteration of carnauba wax with paraffin can be detected.

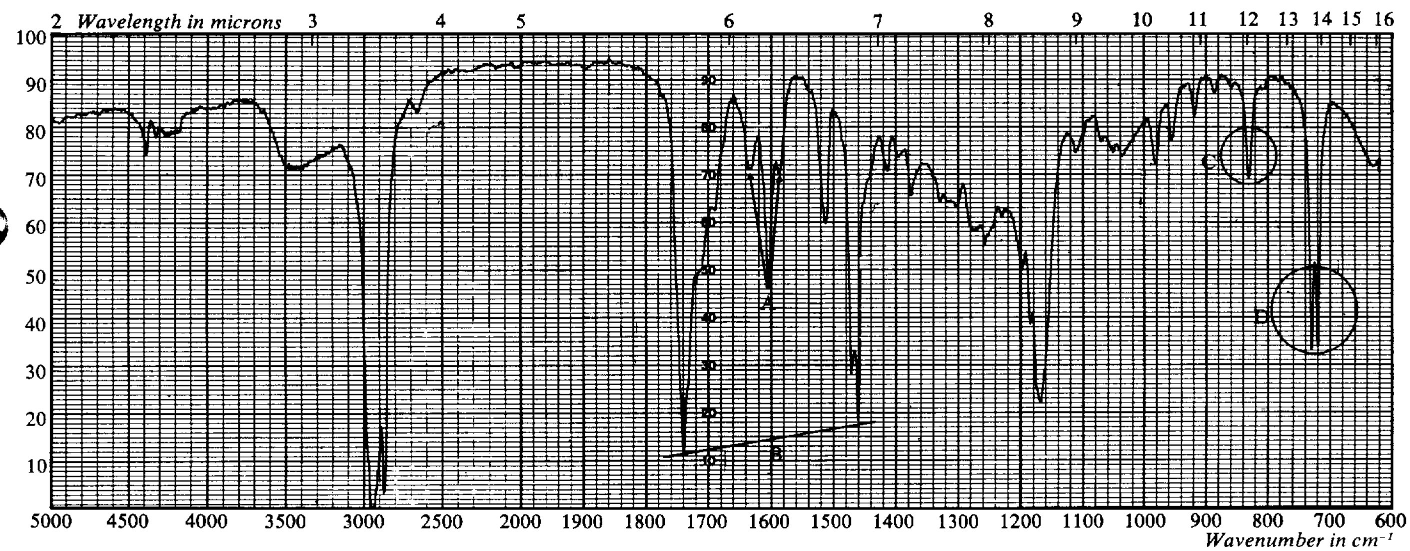


Figure 1-A Carnauba *A. These bands identify Carnauba Wax* *B. Note relative depth of bands* *C. Carnauba Wax only* *D. Wax*

Figure 1-B 90% Carnauba 10% Paraffin *A. Note relative depth of bands as compared to pure Carnauba*

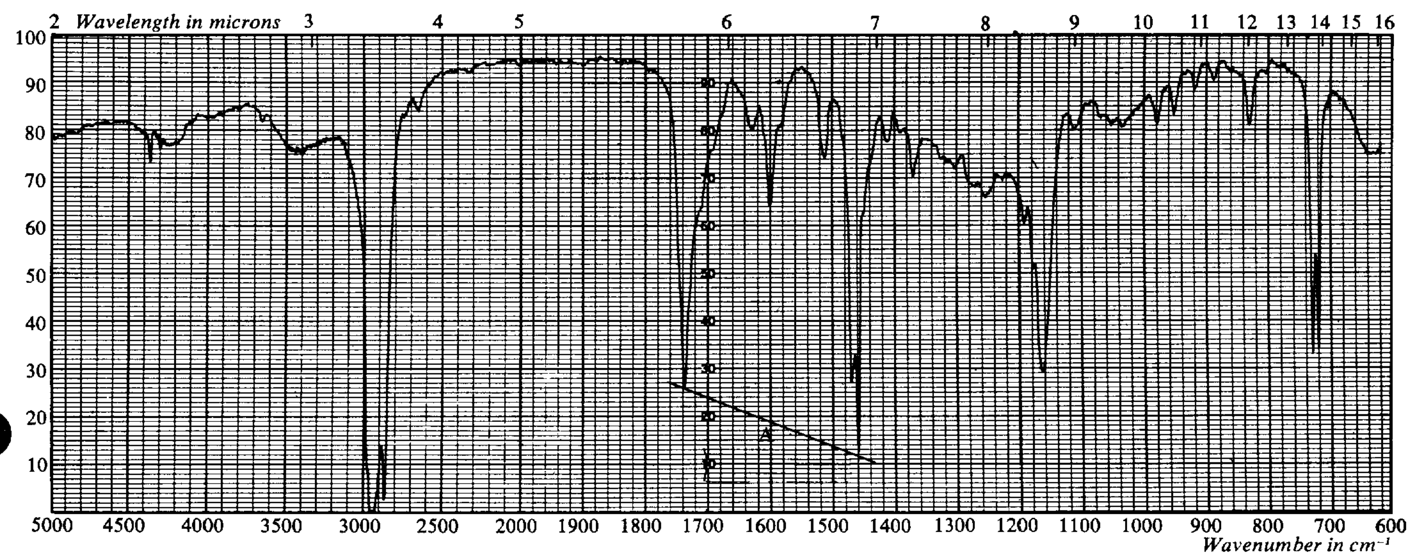
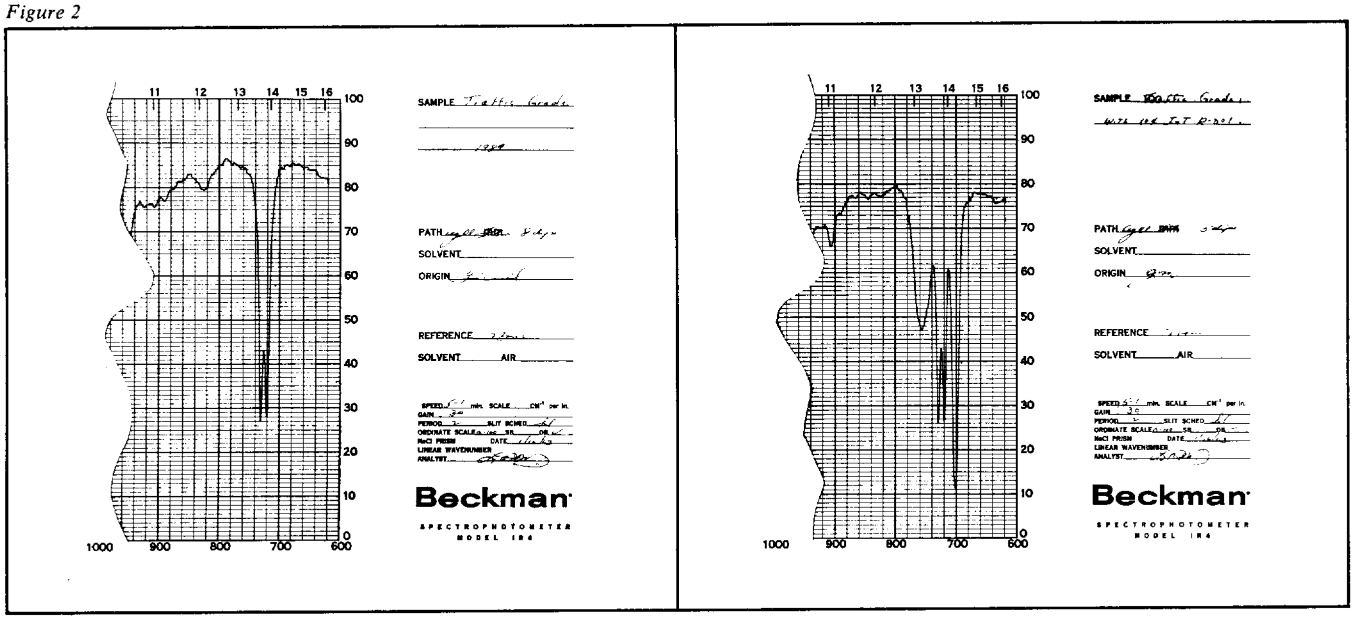


Figure 2


SAMPLE
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B

detect formula changes of competitive products. Major differences indicate formula change, while minor differences may result from poor quality control. If a formula change is indicated, the product is separated into the individual components by solvent extraction techniques, and the fractions are examined by infrared spectrophotometry.

The film of an emulsion floor polish is too brittle to be removed from a surface for infrared analysis. It cannot be applied directly to a sodium chloride plate because the water in the product will cloud the plate. The product cannot be cast from a solvent because no solvent will dissolve all of the non-volatile components of an emulsion floor polish. However, a film can be cast directly on a silver chloride disc by the following technique. A disc of silver chloride, 25 mm in diameter and 1 mm in thickness, is placed in a die which has a cavity of 1½" in diameter. A pressure of 10,000 to 12,000 psi is applied for two minutes, producing a thinner disc of greater transparency. Two holes are drilled through the disc near the edge and directly across from each other, and a thin steel or copper wire hook is inserted into one of the holes to allow the disc to be suspended by the wire. The disc is dipped into the test emulsion and suspended for two minutes in an oven at 110°C. After the disc is removed from the oven and allowed to cool, the wire hook is inserted in the opposite hole and the dipping and drying process repeated until a film of sufficient thickness is built up. This is indicated by testing the absorption on the spectrophotometer. An average of about six dips is required. The silver chloride disc can be taped over an opening cut in a piece of cardboard for insertion into the cell holder of the instrument.

The silver chloride disc can be re-used after cleaning with hot water and soap. In extreme cases, hot solvents or even scraping with a razor blade may be necessary. When the infrared transparency of the discs become low, they can generally be rejuvenated by immersion in concentrated ammonia for two minutes, rinsing, drying and pressing again in the die.

Polymer emulsion can be cast on the silver chloride discs in the same manner. Fewer dips are required because of the higher non-volatile content of most polymer emulsions. Alternatively, polymers can be cast from a solution in a suitable solvent. Most laboratories evaporate the water, and then dissolve the polymer. Johnson analytical chemists have found that a more efficient method of dissolving the polymer is to add the solvent directly to the emulsion, and heat until the water has been removed by azeotropic distillation. The polymer generally is in solution when all of the water has been removed. Dissolution is accelerated because of the extremely high surface area of the polymer in suspension. Chlorobenzene is an excellent solvent for most polymers. The final preparation of the sample for infrared analysis is accomplished by depositing the polymer solution on a sodium chloride plate, and evaporating the solvent by applying heat from an infrared lamp.

In addition to the IR-4 and IR-5A, Beckman analytical instruments at Johnson Wax include a DK®-2 Ultraviolet Spectrophotometer with flame attachment, two DU® Ultraviolet Spectrophotometers, a Beckman Hygromite® electrolytic hygrometer for determining moisture in aerosol propellents, and more than a dozen pH meters.

C

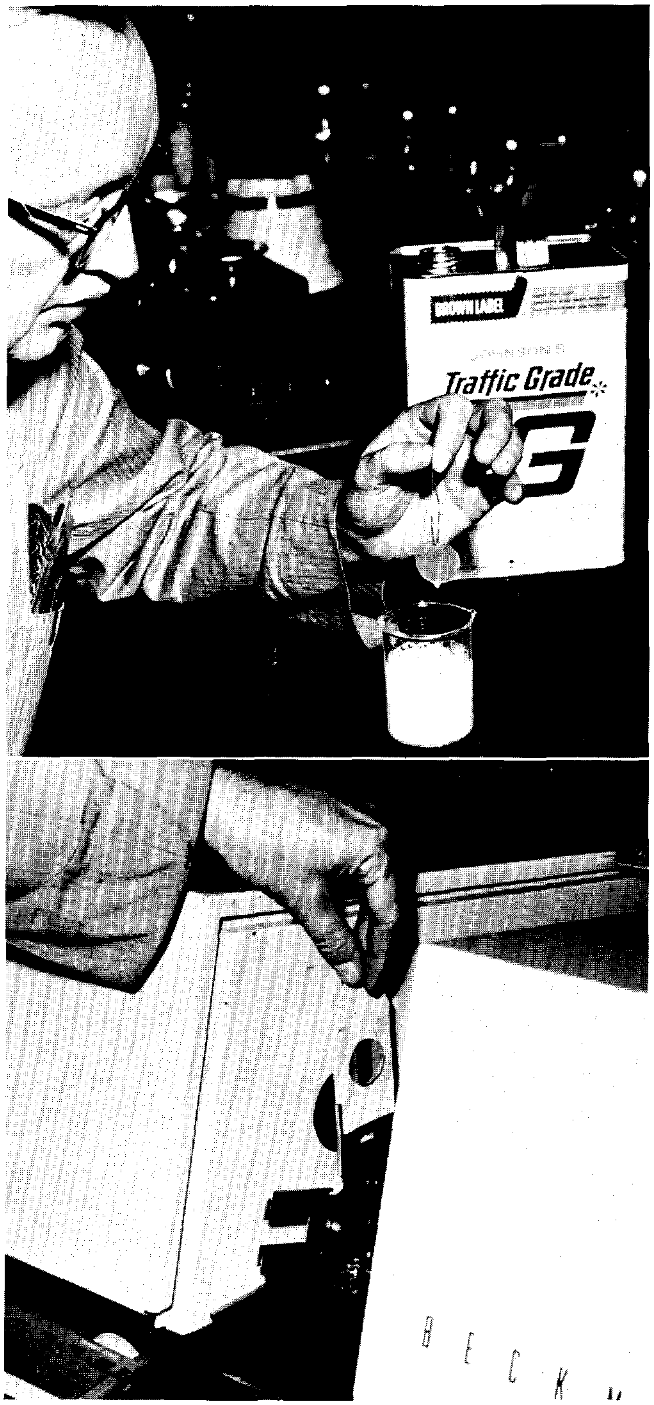

Figure 2. Contamination of finished products can be quickly detected by infrared spectrophotometry. The left spectrum is that of a water emulsion floor finish marketed by the Johnson Wax Service Products Division. At right is the same product that has been contaminated by a small amount of an ingredient used in a polymer floor finish.

B. *Dr. William K. Miller (right), Analytical Supervisor, and Chemist Lee R. Williamson examine an infrared spectrum in the Johnson Wax Quality Control Department.*

C. *Silver chloride disc is dipped into a water emulsion floor wax, top, to prepare a sample for infrared examination of the entire non-volatile content of a finished product. The disc is then oven-heated to evaporate the water. The dipping and drying process is repeated until a film of sufficient thickness is built up. The disc is then mounted, bottom, on a cardboard and inserted into the IR-4.*


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Fire-gas analyzer used in training of New York firemen

James T. Ward, Assistant Chief: Division of Training, New York Fire Department

Firemen entering burning buildings are faced with many more dangers than heat, flame, and falling debris. Among these additional hazards are the quick drop in oxygen content of the air and the rapid rise of carbon monoxide. These elements could render ordinary filter masks almost useless and leave the user at the mercy of the flames.

In order to study these hazards, the New York City Fire Department recently dedicated a new Fire-Gas Analysis System. Installed on the apparatus floor of the Department's Welfare Island training tower, the system reads out samplings of gases piped from adjoining fire-training rooms.

Initial findings of the system indicate that oxygen content drops as low as 10 per cent and carbon monoxide concentration rises as high as 2 per cent minutes after the start of an ordinary fire. These statistics, much higher that fire fighters' previous estimates, indicate that the fire service should take a much harder look at protective breathing. A filter mask could be potentially dangerous in a concentration of 2 per cent CO. And what happens to a fire fighter with a self-contained mask when his air supply is exhausted inside a vehicular tunnel?

Answers to such questions received high priority when plans for the recently completed training center were on the drawing boards. Live-fire training rooms were incorporated into the training tower, and doctors stressed that such training should be conducted under rigid control and supervision. Such rigid control called for a fire-gas analysis system. Collected samples in evacuated containers for later analysis were rejected as inadequate for planned operations. It was decided that continuous, industrial-type monitoring equipment would be the minimum acceptable for installation, and the contract was eventually let to Beckman Instruments, Inc.

To eliminate warm up time, the console, which uses ordinary house current, is never de-energized. In its present state of development, the fire-gas analysis unit consists of sampling pipes leading from monitoring stations in two live-fire rooms (the cellar and the first floor) to an instrument console. A thermocouple directly connected to an electrical pyrometer at the console is located at each monitoring station.

Equipment used in the unit is as follows:

1. An electrical pyrometer with a range from 0° to 2,500°F and a selective rotary-switching device to enable the operator to read temperature at any of the fixed stations.

2. A Beckman Model 115 Carbon Monoxide Analyzer (non-dispersive infrared type) with a range of 0 to 10 per cent carbon monoxide. This instrument compares the effect of two infrared beams of energy passing through gaseous atmospheres. One beam passes through a reference cell containing a gas that does not absorb infrared energy. The other beam passes through the sample cell with the gas under test. The difference in output energy is proportional to the amount of carbon monoxide present in the gas under test. The concentration of gas is recorded on a strip chart recorder, and is indicated by the meter on the instrument.

3. A Beckman Model F3 Oxygen Analyzer (magnetic susceptibility type) with a range of 0 to 25 per cent oxygen. This instrument measures the partial pressure of the oxygen present in the gas sample using the known magnetic properties of oxygen gas. Oxygen, when introduced into a magnetic field, is unique in that it is paramagnetic, and reacts in a similar manner to soft iron. Other common gases, with a few exceptions, are diamagnetic. The electrical energy, automatically expended in balancing the instrument under changing conditions, is read out directly on the instrument meter and actuates the pen on the strip-chart recorder.

4. In addition to the direct-reading meters furnished with each analyzer, a single-pen electronic recorder is also used with each.

5. A system of piping and individual control valves to enable the operator to sample at any fixed station.

6. A bank of compressed gas cylinders containing the zero and span gases used in the system.

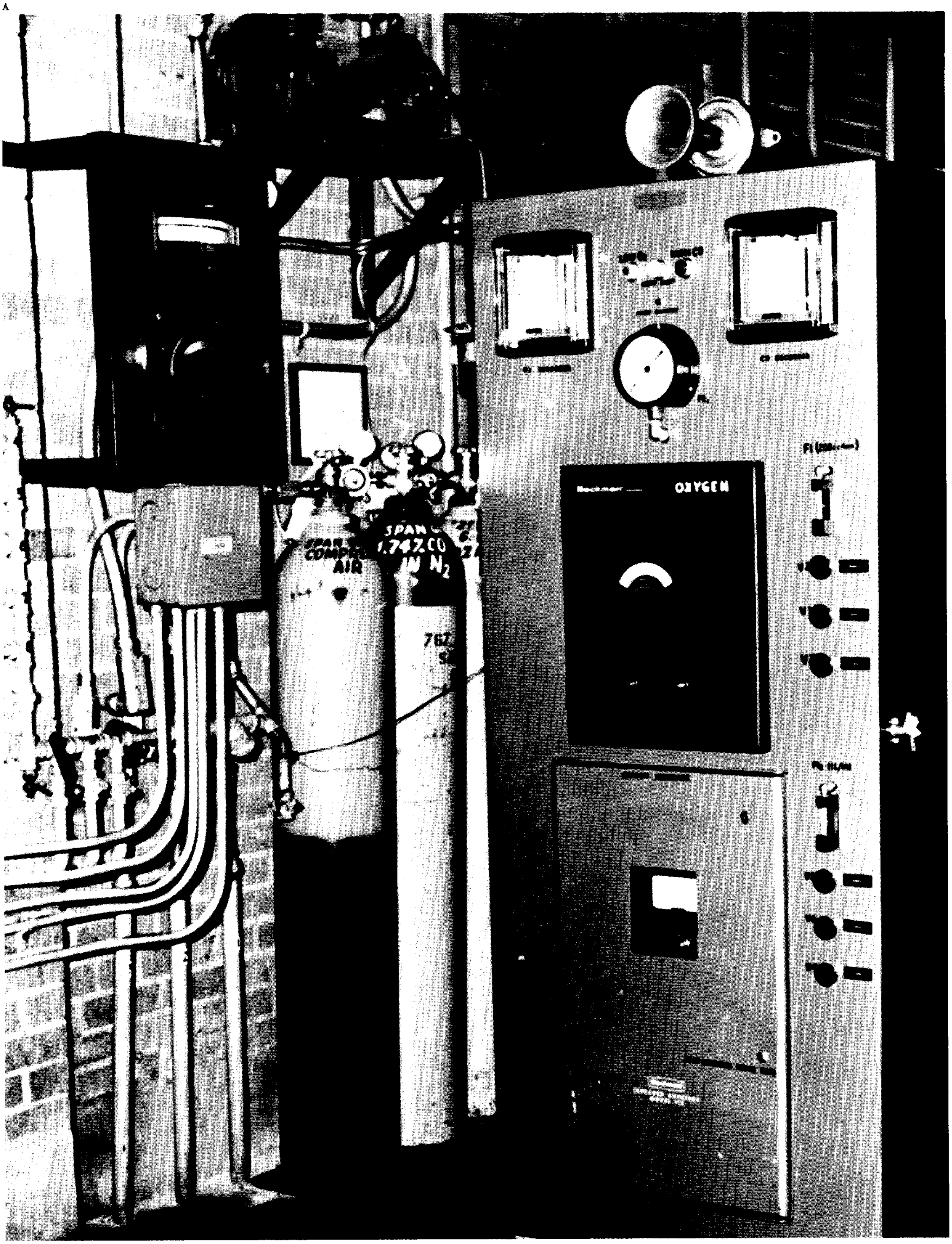
Fire rooms from which samplings are taken are of Class I construction and are finished with a special concrete that can withstand repeated fires without spalling or cracking. With a coat of paint and some furniture, the rooms closely approximate the same type occupancy and construction found in high-rise buildings.

Both rooms are larger than normal but are suitable for testing the fire fighter and his equipment. They will be more useful when plans for compartmentation are completed. By shifting fire-resistive partitions, different room layouts can be arranged, which will closely simulate actual apartments and office suites.

No scientific conclusions can be drawn from the relatively small number of fire-gas samplings taken to date. But many highly practical findings have developed.

In *Class A* fires with a fuel load that included a foam rubber mattress (single-bed size), carbon monoxide concentrations reached more than 2 per cent by volume in a matter of minutes, and in one test reached 6 per cent. For the same fire, oxygen content gradually dropped off to below 10 per cent. Readouts from the analyzer indicated that the most

A



dangerous atmosphere was found above the fire with, of course, the greatest heat concentration. It is reasonable to assume that the same conditions, and probably worse, would meet fire fighters stretching into a high-rise apartment house.

Tests, made thus far, indicate a need for a prompt and adequate ventilation above the fire by men wearing self-contained masks.

The gas analysis unit permits live-fire training under the strictest of controls. The training staff, under the direction of Battalion Chief Herbert Whyte and Captain Joseph Carroll, is planning to expand the monitoring capacity of the analyzer to include other fire gases. Eventually, gases generated by almost any type of fire will have their intensities registered by the fire-gas analysis unit.

The New York Fire Department plans to make test results, as well as the conclusions drawn from them, available to the entire fire service.

Portions of this article have been reprinted from *Fire Engineering*, June 1964.

A. *Fire-gas analysis system installed in the Welfare Island training tower, New York City Fire Department, includes a Beckman Model 115 carbon monoxide analyzer and a Beckman Model F3 oxygen analyzer. Figure 1. Diagram shows arrangement of vacuum pump and piping which draw samples from fire rooms. Note location of thermocouples, numbered one through eight.*

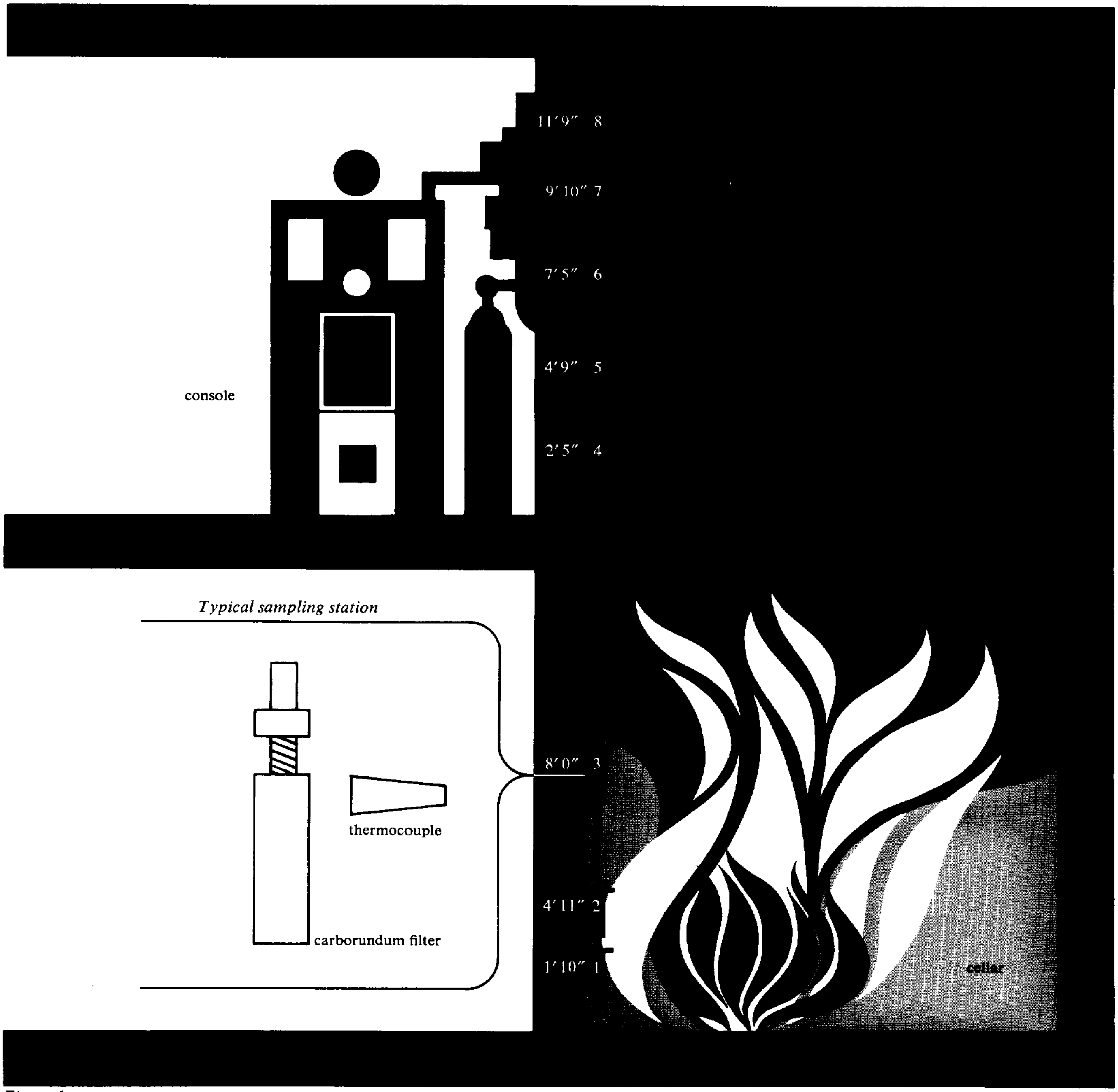
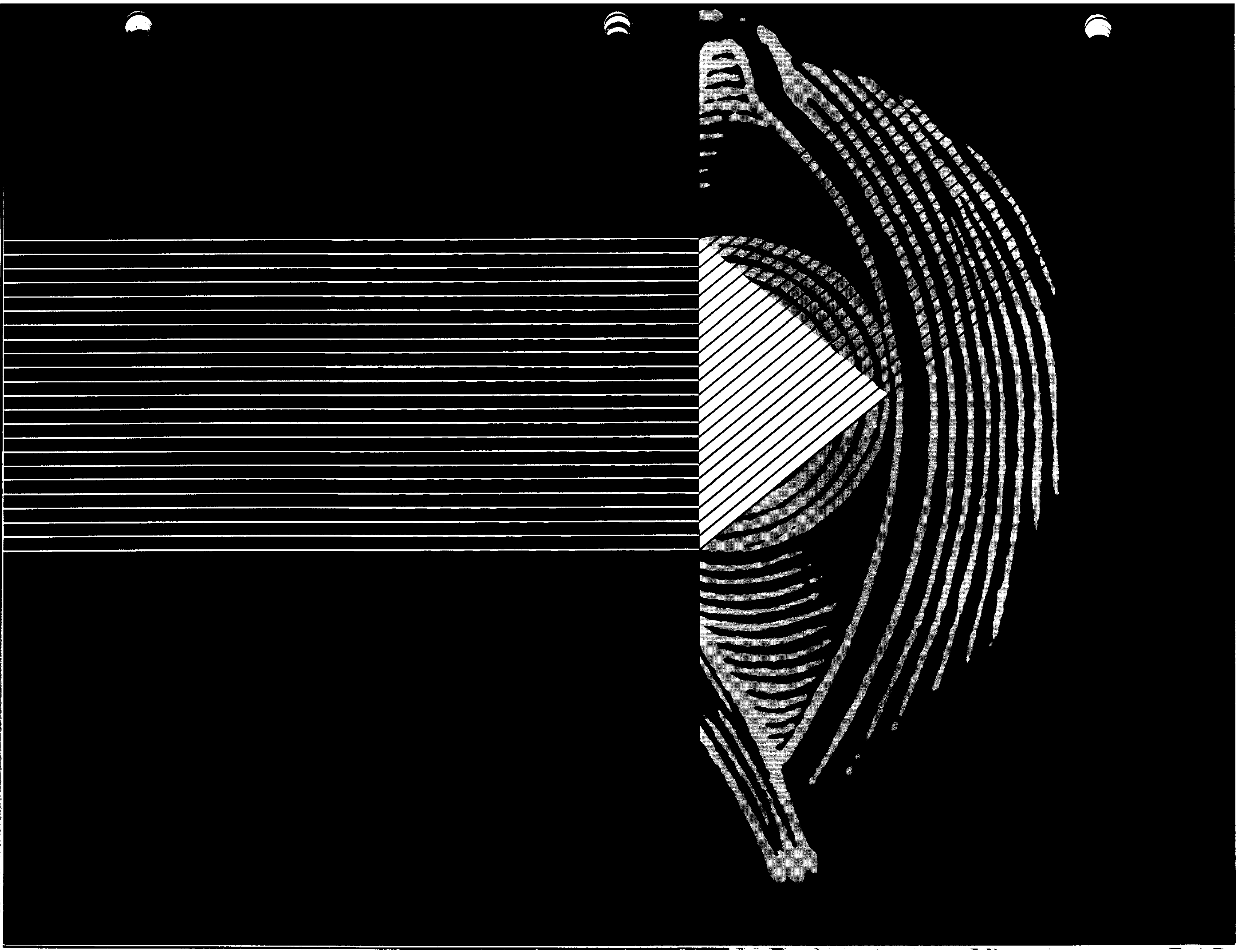


Figure 1



Infrared spectrophotometers and resolution

Howard J. Sloane: Senior Applications Chemist, Beckman Instruments, Inc., Fullerton, California

Richard Cavenah: Associate Applications Chemist, Beckman Instruments, Inc., Fullerton, California

From time to time, we have been confronted with the question "What is the best resolution of the IR-9?" Sounds like a simple question, but the answer may be rather complex.

Perhaps the first thing that needs to be asked in return is "What do you mean by resolution?" and, second, "How shall we measure it?"

The most obvious aspect of this elusive word "resolution" is that it provides a means for measuring our instrument's capability for showing the separation of two closely-spaced lines or bands. Qualitatively, this idea is quite acceptable, but now we must ask what constitutes separation. Are bands resolved when it is barely possible to tell that there are two bands rather than one, or must our record indicate a *degree of separation* such that the valley between peaks is a certain given displacement above them? Certain criteria have been suggested for making this judgment of separation but, unfortunately, to date no standard is universally accepted. Moreover, in practice, it is rather impractical to attempt to measure resolution at all infrared wavelengths in this manner since this would require seeking out virtually an infinite number of absorption or emission line pairs of exactly the proper known separation.

To answer our original question, therefore, it would probably be best to resort to the instrument designer's view of resolution and to consider three terms in this regard. These are *theoretical resolution, limiting resolution,* and *practical resolution.*

Theoretical resolution is determined entirely from the number, type, and size of dispersing elements, how they are employed, and the wavelength under consideration without regard to the remainder of the real instrument. For example, the theoretical resolution of a single prism instrument at a given wavelength is determined from the size and angle of the prism, the number of passes through it, and the variation of refractive index with wavelength at the chosen wavelength. In practice, this term is useful only to the extent that it describes the ultimate theoretical resolving power of which this dispersing system is capable.

When our dispersing system is placed into a spectrophotometer the term *limiting resolution* becomes useful. The limiting resolution is the best resolution that would have been attainable if our system were not energy-limited. In this case, resolution may be limited by optical aberrations, misalignments and so-called "Rayleigh diffraction" which produces an optical widening of the actual slit image. Limiting resolution for many spectrophotometers in the infrared region, however, is frequently not attainable because of energy limitations. Limiting resolution is a particularly useful concept because, in practical operation, no improvement can be realized by narrowing the slits beyond this limiting width.

A contributing factor to limiting resolution, especially in the infrared region, is the Rayleigh diffraction limit. Interestingly, the calculation of this limiting slit width is rather simple for a given spectrophotometer. To a good first approximation, the Rayleigh limit is simply the f-number of the system (a pure number) times the wavelength under consideration. Thus, in the IR-4, -7, -9, -11, and -12 series, the f-number is 10, and at 10 microns, for example, the diffraction limit is 10 x 10 = 100 microns, or 0.1 mm slit width. At 3 microns, limiting slits are 0.03 mm, etc. Thus, we now realize that at the wavelengths specified, there would never be any reason to narrow the slit widths to less than the above calculated limiting widths, for no further improvement in resolution could be realized.

We have still not, however, satisfactorily answered our initial question concerning the IR-9's "best resolution." In a real infrared spectrophotometer, we must first acknowledge the fact that we are normally dealing with an energy-limited system employing a noise-limited detector. In consideration of this, we may refer to the term *practical resolution,* or the resolution that can be obtained for a given specified signal-to-noise ratio and instrument period (the latter determines the maximum scanning speed which may be used).

Dr. Wilbur Kaye, of Beckman's Research Department, has suggested that practical resolution may be denoted compactly and symbolically as $R_p^{s/n}$. Thus, if one were able to obtain 1 cm^{-1} resolution at a 2% noise level (signal-to-noise is thus $\frac{100}{2} = 50$) and an 8-second period, one could express practical resolution as $R_8^{50} = 1$ cm^{-1}.

Here then, finally, is a suitable yardstick for measurements that will answer our question. Note that we must answer with qualifications, always specifying the conditions (i.e., s/n and p) under which the resolution is attainable.

The term commonly used to describe resolution in a quantitative fashion is spectral slit width*, which is the width in cm^{-1} (or microns) measured at half peak intensity of the band of energy emerging from the instrument's exit slit. Technically speaking then, we wish to calculate the instrument's spectral slit width, and this can be done by reference to its dispersion curve.

The dispersion curve for the IR-9, for example, is shown in Figure 1 and it gives the dispersion in cm^{-1} per mm of slit width for the entire wavenumber range covered by the instrument. These data are calculated from knowledge of the theoretical resolution provided by this particular monochromator and, thus depend on the prisms and gratings used and their manner of use.

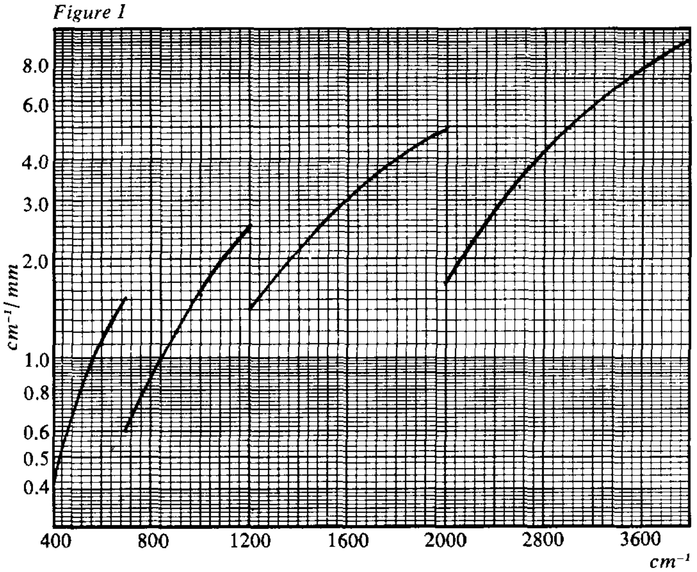
Spectral slit width may now be estimated by multiplying the dispersion, J, at any particular wavenumber by the mechanical slit width taken from the instrument's slit width readout dial. Thus, for example, a mechanical slit width of 0.5 mm at 1600 cm^{-1} where J=3 cm^{-1}/mm will produce a spectral slit width J=3(0.5)=1.5 cm^{-1}.

It should be realized, however, that the sample calculation shown above is really a first order approximation of the spectral slit width in that it does not include the effects of slit widening due to diffraction and slight imperfections in the optics and instrument alignment. At very narrow slits these factors, especially the diffraction term, can contribute appreciably to spectral slit width.

While this calculation does tell us approximately what bandwidth is emerging from the exit slit under a static (i.e., non-scanning) condition, it still falls short of satisfying our practical resolution requirement in that the parameters necessary to record at the calculated spectral slit width have not been specified.

In considering the dynamic or scanning conditions necessary to realize a given resolution, the operator must make a compromise in gain setting and period which determine noise level and permissable scanning speed. For example, the spectral slit width of 1.5 cm^{-1} might be used to record a spectrum with a 1% noise level and at 100 cm^{-1}/min. scanning speed, or at 0.5% noise and 25 cm^{-1}/min. scanning speed; however, the benefit of both the low noise level *and* fast scanning speed cannot be realized simultaneously at the specified slit width.

Figure 1



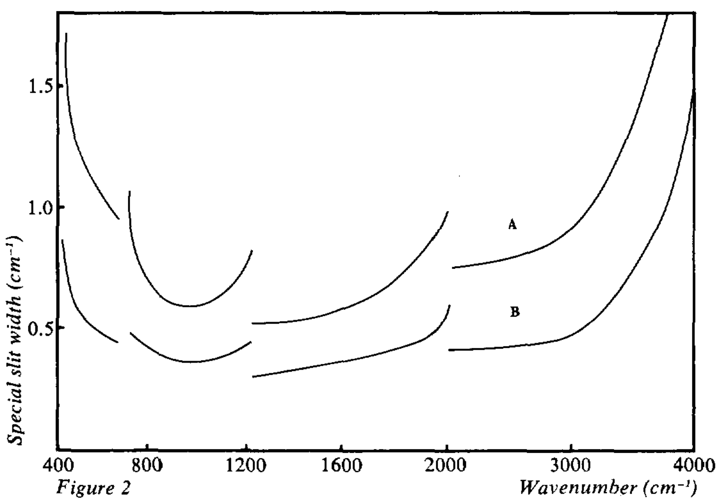


Figure 2

In Figure 2 are plotted experimental data taken on an IR-9. Curve A illustrates the approximate spectral slit width that can be achieved for the particular conditions of a 1% noise level and two-second period; i.e., it is a plot of R_2^{100} as a function of wavenumber and is uncorrected for aberration and diffraction effects which are relatively minor contributors at wide slits.

Similarly, Curve B is a plot of R_{32}^{25} corrected for slit widening due to diffraction and it very nearly represents limiting resolution conditions for the IR-9.

The points for Figure 2 were taken by setting the gain and period switches to give the indicated noise levels and then experimentally determining at 50 or 100 cm^{-1} intervals the mechanical slit setting necessary to produce the true indicated periods. The latter were measured as the time in seconds for the pen to travel 98% of full chart length in response to a sudden block or unblock signal in the sample beam.

The mechanical slit settings measured were then converted to spectral slit width values by means of the dispersion curve discussed above.

The results of Curve B, Figure 2, then go a long way toward answering the question of "best resolution." Note, however, that this is a qualified answer and corresponds only to the R_{32}^{25} conditions.

It should be pointed out again, however, that there is a limit to the practical resolution achievable under dynamic conditions; i.e., slit width cannot be decreased indefinitely at the expense of noise and/or period. The limiting factor for this type of instrument is, in fact, precisely the limiting resolution discussed earlier. In practice, the practical resolution achievable for an instrument like the IR-9 is normally within a factor of 2 of diffraction limits when operating under the most severe conditions.

That calculated diffraction limits cannot be reached exactly reflects the fact that we are dealing with a real instrument with imperfect optics. Nevertheless, the achievement of even this factor of 2 is a tribute to today's instrument design engineers.

It might be worthwhile now to discuss some of the features of the resolution curves shown in Figure 2.

Note first that under the conditions of noise and period specified, the curves are relatively flat through most of the instrument's range. This points out one of the truly important advantages of a properly-designed grating instrument; i.e., nearly constant resolution as a function of wavelength. This is in sharp contrast to the early simple sodium chloride prism instruments in which dispersion is a rather steep function of wavelength. Typically, such an instrument would yield 4 cm^{-1} spectral slit width at 1000 cm^{-1} and as much as 20-30 cm^{-1} spectral slit width at 3000 cm^{-1}.

A rather subtle point in the design of this instrument involves the choice of the scribing of gratings and their blaze wavelengths in such a manner that no marked change in resolution takes place over the regions of change in gratings or orders (at 671 cm^{-1}, 1200 cm and 2000 cm^{-1} in the IR-9). This proper choice then avoids large discrepancies in the nature of spectra recorded on both sides of the grating or order changes because of radically different spectral slit widths.

We do note that the curve rises more sharply at the ends of the instrument range. At the 400 cm^{-1} end, this rise is due to the absorption of the KBr prism just before its transmission cut-off.

If necessary, considerable improvement of the practical resolution at the 4000 cm^{-1} end can be accomplished by operating the source at a higher temperature, thus significantly increasing the energy input to the monochromator. This is done at some expense in source life, however, and this "trick" is only effective at high frequencies because of the nature of the blackbody emission curve.

Finally, it is observed that Curve B predicts the region of best achievable practical resolution is the 1200-1400 cm^{-1} region. This is borne out in practice by the high resolution spectrum of the ν_4 band of methane taken at 60 mm pressure in a 10 cm cell for the 1220-1390 cm^{-1} region (Figure 3).

For this curve, R^{25}_{64} is estimated at less than 0.3 cm^{-1} as judged from the spacing of the doublets at 1237, 1260, and 1266 cm^{-1}. Diffraction limits at 1250 cm^{-1} corresponds to 0.12 cm^{-1} and, therefore, good agreement with the factor of 2 of achievable practical resolution for the above conditions is observed.

*In some of Beckman's previous literature and manuals, this quantity has been described as "effective band width" and the term spectral slit width was defined as two times this quantity. Most recent literature is in conformance with the above, i.e., half-intensity band width.

A. *Application Engineers Howard J. Sloane and Richard Cavenah discuss resolution capabilities as they operate the Beckman IR-9 Infrared Spectrophotometer.*

Figure 1. Dispersion curve for IR-9 showing dispersion in cm^{-1}/mm of slit width as a function of wavenumber. Data are calculated from knowledge of dispersing elements and their manner of use.

Figure 2. Practical resolution of IR-9 for two given sets of conditions: (A) For 1% noise and 2 second period (R^{100}_{2}), slit widths uncorrected for slit widening due to diffraction. (B) For 4% noise and 32 second period (R^{25}_{32}), corrected for diffraction.

Figure 3. High resolution scan of ν_4 band of methane in 1220-1390 cm^{-1} region. R^{25}_{64} is less than 0.3 cm^{-1} as judged from spacing of doublets at 1237, 1260, and 1266 cm^{-1}.

A

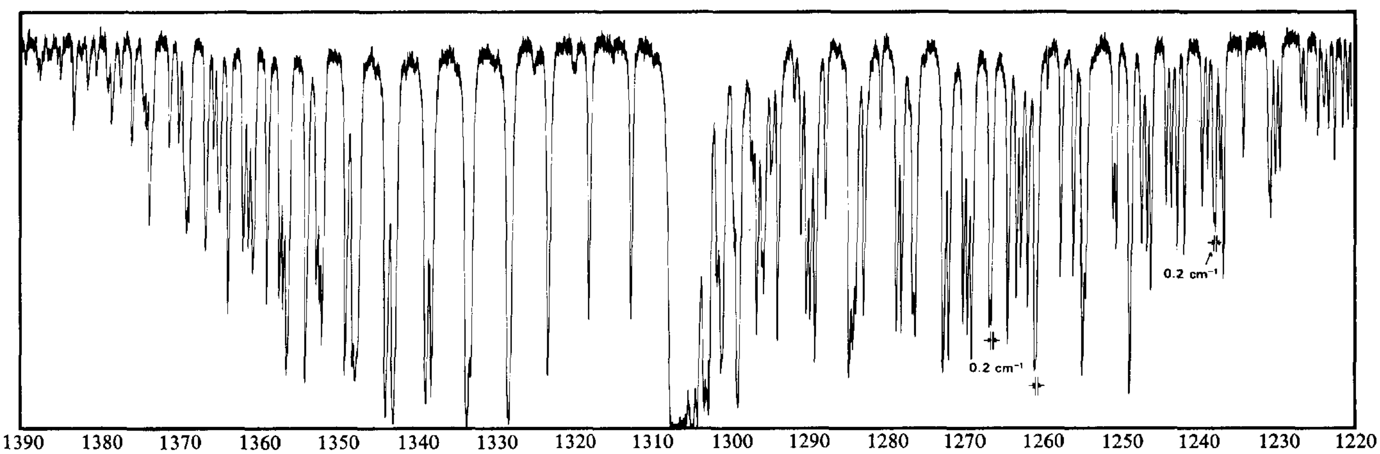


Figure 3

the Analyzer Subject Index Volumes I-V Numbers 1, 2, 3, 4

*Inside back cover

the Analyzer Title Index Volumes I-V Numbers 1, 2, 3, 4

*Inside back cover

Beam and stream lines

Physiological measurements group formed

Beckman Instruments, Inc. has announced the formation of a new unit, the Physiological Measurements Group, to develop physiological instruments and systems for hospitals, clinics and biological research applications.

Joseph W. Lewis, Beckman vice president, said the new group's research director will be Dr. Alan R. Kahn, M.D., who also serves as corporate medical director. Dr. Kahn will coordinate physiological instrumentation programs of all Beckman divisions.

Frank J. Domingues will be projects manager for the group, and will supervise development and engineering programs for physiological instruments.

Lewis said the group will be concerned with the development of new concepts in patient monitoring systems for present and potential medical markets. He indicated that new areas of instrument research will include the development of fetal monitoring systems for use in difficult childbirth cases, and electrocardiogram units which permit heart rate readings under conditions of exercise or stress.

The group will utilize products and technologies of all Beckman divisions, and will be supported by the production and scientific capabilities of the Scientific and Process Instruments Division.

New medical research electrode monitors tiny signals

A new research electrode that can measure electrical current from body tissues in millionths of a volt readings has been announced by Beckman Instruments, Inc.

Dr. Alan R. Kahn, medical director, said the new device is designed for use during surgery and in advanced research projects to monitor and record tiny electrical signals generated by brain, heart and muscle tissue.

Dr. Kahn said the electrode, which provides unusual measurement sensitivity and stability, will enable the researcher to learn more about the vital organs of the body and how they work. The device is expected to be especially useful in evaluating the body's reaction to drugs over extended periods.

The wick-like tip of the inch-long glass electrode carries minute electrical pulses from its point of contact through an electrolyte solution to a silver-silver chloride sensing element, which then transmits the signal to a recorder for readout on chart paper. The device is manufactured by Beckman's Physiological Measurements Group in Fullerton, California.

Trade shows

January 25-28: Eighteenth Annual Symposium on Modern Methods of Analytical Chemistry, Louisiana State University, Department of Chemistry. (Baton Rouge, Louisiana)

March 1-5: The 16th Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel. (Pittsburgh, Pennsylvania)

April 6-8: Midwest Chemical Exposition, Cobo Hall. (Detroit, Michigan)

April 10-14: Federation of American Societies for Experimental Biology (FASEB), Convention Hall. (Atlantic City, New Jersey)

Short courses

February 1-4: Third Annual Introductory Course in Gas Chromatography, Roosevelt University. (Chicago, Illinois)

April 19-23: Gas Chromatography Institute, Canisius College. (Buffalo, New York)

Dr. Alan R. Kahn, M.D., medical director for Beckman Instruments, Inc., inspects a new electrode designed for medical research. The device monitors and records tiny electrical signals generated by brain, heart, and muscle tissues.

Literature

New literature

772 TUBE FITTINGS OF TEFLON*
This six-page bulletin describes Beckman's Tube Fittings of Teflon for joining all common diameters of glass, plastic and metal tubing. Tubing systems using these fittings are leak-proof under pressures to 100 psig and temperatures to 100°C. Tube Fittings of Teflon are ideal for assembling permanent, semi-permanent or temporary tubing systems in the laboratory or pilot plant.

pH-4022-b BECKMAN CHLORIDE ION ANALYZER
This newly revised four-page bulletin describes the Beckman Chloride Ion Analyzer, which continuously and automatically determines the chloride ion concentration in aqueous solutions, over a range from 1.0 to 10,000 ppm. Applications include monitoring for chloride pollution in industrial wastes, and for salt content of finished and intermediate products during processing.

GC-4058 TRENDOMATIC PROCESS CHROMATOGRAPH SYSTEMS
This new four-page bulletin describes the recently-introduced TRENDOMATIC Series, a new "packaged system approach" to process gas chromatography. Designed for closed-loop control and trend recording, TRENDOMATIC provides a single stream, one or two component capability. The basic system consists of an E Analyzer, wall or panel mount 620 Programmer, and a miniature trend-recorder with Application Engineering. It is available in six system packages that will meet virtually any control requirement in gas chromatography.

7056 BECKMAN PLANCHET COUNTING SYSTEMS
This illustrated bulletin describes the LOWBETA II and the new WIDEBETA II Radioactivity Counting Systems. Both systems are low level counting instruments designed specifically for measurement of alpha and beta emitting samples. The new WIDEBETA II permits accurate counting at rates from a few counts per hour up to 1,000,000 counts per minute with an effective dead time of less than 0.5 microseconds. Also, a newly developed absorber insert system allows automatic printout of alpha/beta ratio and beta/beta ratio.

Application data sheet

NI-8081 PLANCHET COUNTING OF TRITIUM
This four-page application data sheet describes the measurement of tritium with Beckman Planchet Counting Systems. The problems of window and air absorption, sample self-absorption and windowless counting are described, as well as Beckman's screen window application which makes it possible to efficiently count tritium as a solid.

Technical reprints

REPRINT 6206
"Test Methods in Spectrophotometry: Stray-Light Determination." Richard E. Poulson; *Applied Optics;* Vol. 3—No. 1; January, 1964.

This paper describes methods and materials used in stray-light determination for the purpose of evaluating the performance of UV Spectrophotometers.

REPRINT 6215
"Use of Infrared Analyzer for Total Carbon Determination" by C. E. Van Hall and V. A. Stenger, *Water and Sewage Works,* June, 1964.

A discussion of the method employed by the Beckman Carbonaceous Analyzer in determining either the total carbon or the total organic carbon content of waste streams. The authors, both with the Special Services Laboratory of the Dow Chemical Company, describe the advantages and the limitations of the instrument and its application in waste treatment plants. Data is presented which indicates a significant correlation of total organic content with the results of both standard BOD and COD tests.

REPRINT 6216
"Rapid Determination of Percent Reduction of Iron Ore" by E. Price, *Engineering and Mining Journal,* June, 1964.

A comparison of three methods for determining the percent removal of oxygen from iron oxides—the more conventional methods which might be termed gravimetric and metallization, or a new method based on specific gravity. The new method is described in detail by the author, a member of the Research Division of the Allis Chalmers Manufacturing Company. Use of a Beckman Air Comparison Pycnometer helps to make the new procedure faster and easier than conventional methods.

*Teflon is a registered trade mark of Dupont.

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BROWN RECORDERS

	Model No.	Range	Inst. No.	Ser. No.
Stack No. 1	153X12V-W7-6K	0-50 MV	883278	5100-N
Stack No. 2	153X12V-W5-6K	0-50 MV	883276	5100-N
Hood Room No. 1	" "	0-50 MV	986192	5100
Hood Room No. 2	" "	0-50 MV	883277	5100-N
Glove Box	KY153X12-VH-II-(W6)-6-K	0-50 MV	T117981[illegible]01	5100-N
Spare Unit	Y153X12V-W7-(27)A3	0-50 MV	910657	6540

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Glove Box	KY153X12-VH-II-(W6)-6-K	0-50 MV	T1179810001	5100-N
Spare Unit	Y153X12V-W7-(27)A3	0-50 MV	910657	6540

J. Sech

Beckman®
instructions

BULLETIN 338-A
BECKMAN MODEL VL LOGARITHMIC MICRO-MICROAMMETER

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APRIL 1957 PROCESS INSTRUMENTS DIVISION PRINTED IN USA
BECKMAN INSTRUMENTS, INC. FULLERTON, CALIFORNIA

LIST OF ILLUSTRATIONS

Section 1.

INTRODUCTION

A. DESCRIPTION

The BECKMAN Model VL Logarithmic Micro-Microammeter measures currents in the range of 10^{-13} to 10^{-7} amperes. The entire range of current measurement is presented on a single meter scale for direct reading, with no range-switching requirements. This makes the instrument particularly useful in measuring widely varying signal currents such as those often encountered when working with ion chambers or photocells, or when measuring high-value resistors or insulators over a wide range of applied voltages. Such currents can be measured on a monitoring or continuous basis, with use of a standard recorder unit, but without need of scale-changing mechanisms.

The instrument accommodates any standard 50-millivolt potentiometer-type recorder; six-decade logarithmic chart paper is available for some types of recorders. The instrument also provides a 200-volt regulated voltage supply suitable for use with ion chambers. Full output signal voltage is made available at low impedance for use with auxiliary equipment such as control units.

B. SPECIFICATIONS

1. Power Supply requirements:

   a. Electrical - 60 cycle, 100-130 volts, 170 watts.

2. Operating conditions:

   a. Ambient temperature - 20 F to 114 F.

   b. Warm-up time -

      (1) Constant temperature oven - 30 minutes.

      (2) Amplifier - 2 to 4 minutes

3. Instrument characteristics:

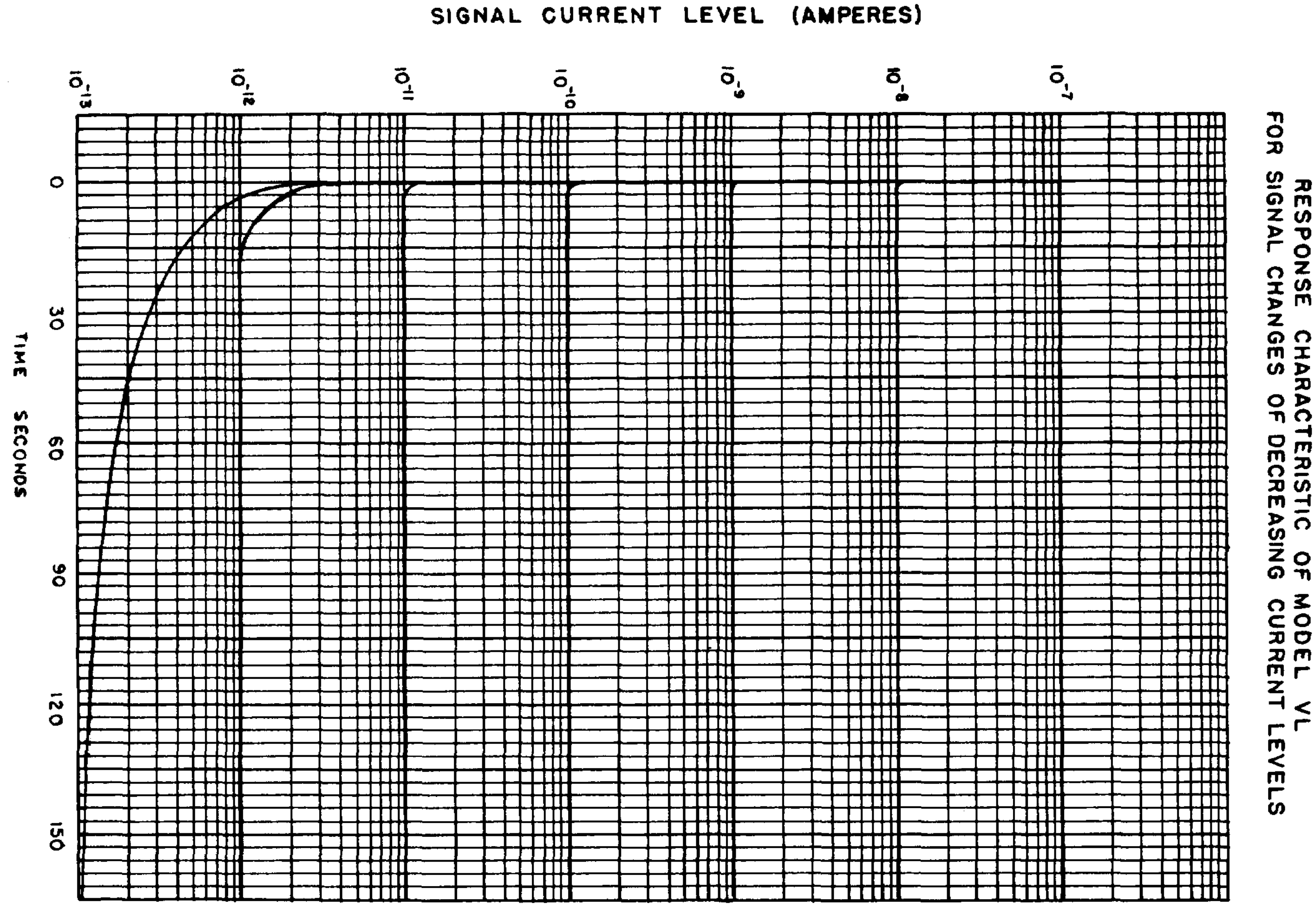
   a. Indicator - Milliammeter, 4 1/2-inch scale, divided into 6 logarithmic decades.

   b. Detection range - 10^{-13} to 10^{-7} amperes.

   c. Drift - 5% of decade per 24 hours after equilibration (equivalent to 1% meter displacement).

   d. Accuracy - See Figure 2.

   e. Response Time - See Figure 1.



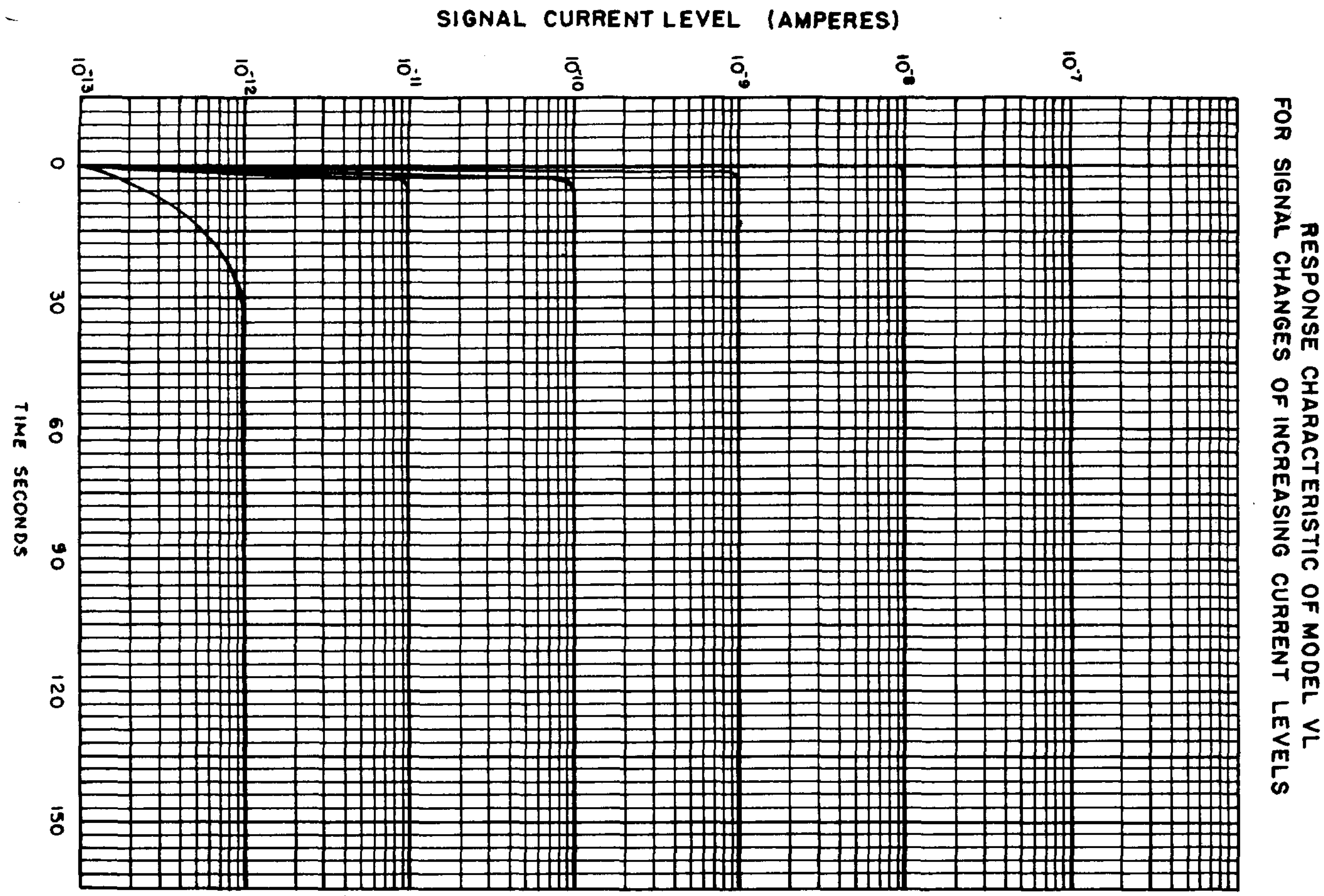


FIGURE 1. Characteristics of Model VL Response to Changes in Signal Level.

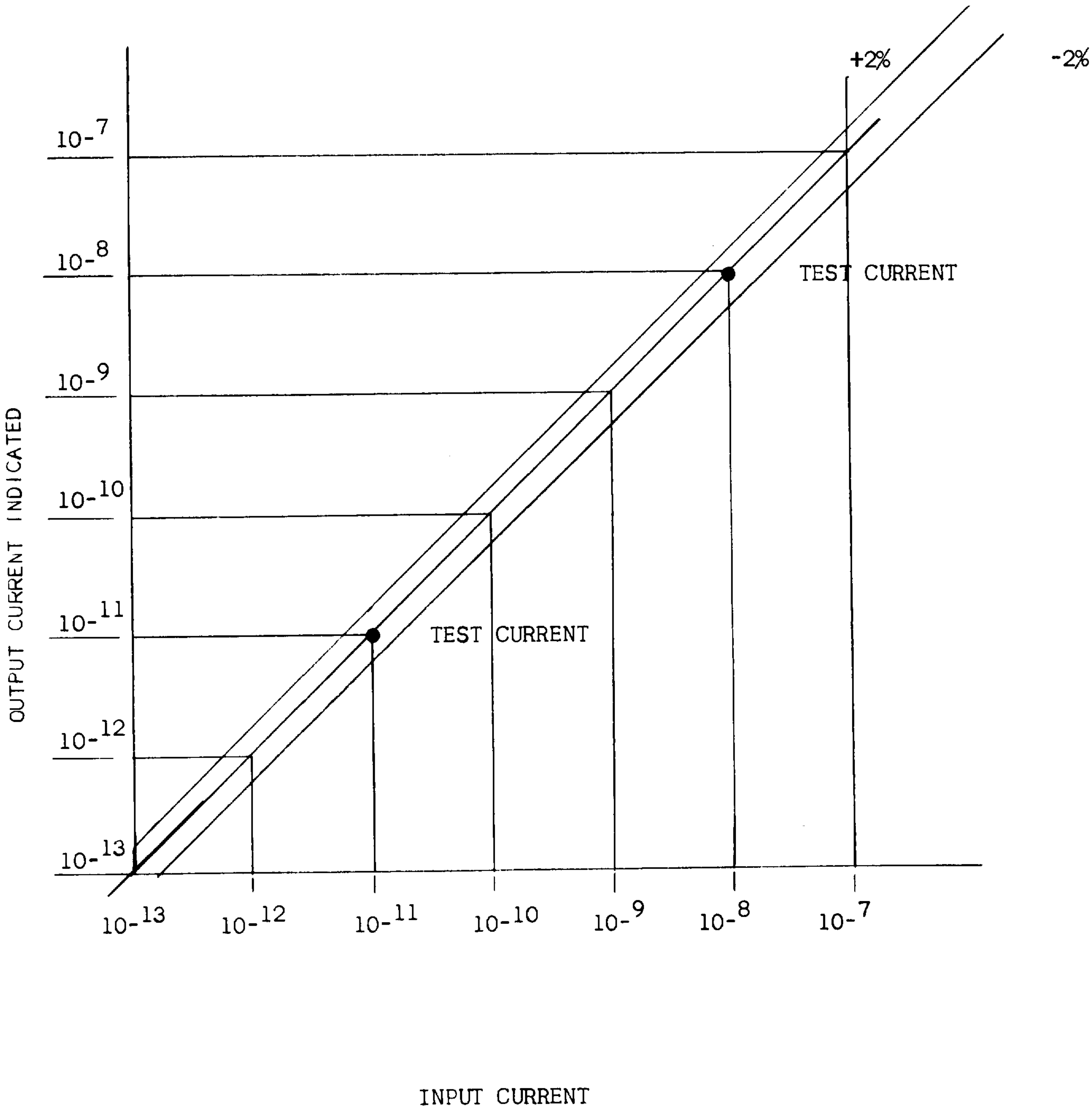


FIGURE 2. CHARACTERISTICS OF READING ERRORS

f. Chamber supply voltage - 200 volts with maximum drift rate of 100 microvolts/second.

4. Output connections:

a. Recorder, 50-millivolt, potentiometer-type.

b. Full output voltage suitable for operation of control equipment.

Section 2.

INSTALLATION

A. SPACE REQUIREMENTS

The rack-mounted Model VL requires a vertical space of 8 3/4 inches in a standard RETMA 19-inch rack. The chassis extends 10 1/4 inches behind the panel; a total of 15 inches is required to accomodate chassis, connectors and cables.

B. TERMINALS

1. Recorder Terminals (S8). These terminals are located on the rear of the chassis. One terminal is connected to chassis ground. The output impedance is 50 ohms.

2. Regulated B+ Terminal (S6). This terminal is located on the rear of the chassis. The potential of the regulated voltage source is about 200 volts; internal resistance is 2 megohms. The voltage supplied through this terminal is used as a polarizing voltage for ion chambers. Since an ion chamber represents a capacitance between the collectrode (connected to the input of the amplifier) and the polarizing electrode (connected to regulated B+), currents can be generated at the input of the amplifier by changes of voltage across the two electrodes. The important criterion of a voltage suitable for ion chamber work is not the dc regulation of the supply, but the rate of change of voltage across the chamber capacitance. The rate of change of voltage of this supply is less than 100 micro-volts per second. This will permit operation of chamber units with capacitances of less than 30 micro-microfarads and with induction currents of less than 10^{-14} amperes.

3. Input Terminal (S1). This is a standard coaxial chassis connector which requires an Amphenol 82-804 cable connector. The choice of input cable is important if the best performance is required. The cable must be well shielded, and the dielectric should be treated to prevent voltage or current generation between the conductor and the shield when the cable is moved, subjected to vibration, or exposed to changes in temperature. Installation should be made so that the cable will not be subjected to motion or rapid temperature change. For operation at low current levels, a cable is available from Amphenol in which the outside of the polyethylene dielectric is coated with colloidal carbon to reduce the generation of voltages and currents. Normally, no earth-to-chassis connection will be required. If, however, with the instrument connected to the current source, the indicating meter needle moves when a part of the system is touched with the hand, a check should be made to ensure adequate shielding of the cable and the current source. If earth grounding is necessary to correct for inadequate shielding, use only a single ground connection - do not connect both the instrument and the current source to ground.

C. MAKING CONNECTIONS

1. Cable for B+ Voltage. To connect the regulated B+ voltage terminal (S6) to an ionization chamber, use RG8/U, RG9/U, or RG10/U cable or equivalent.

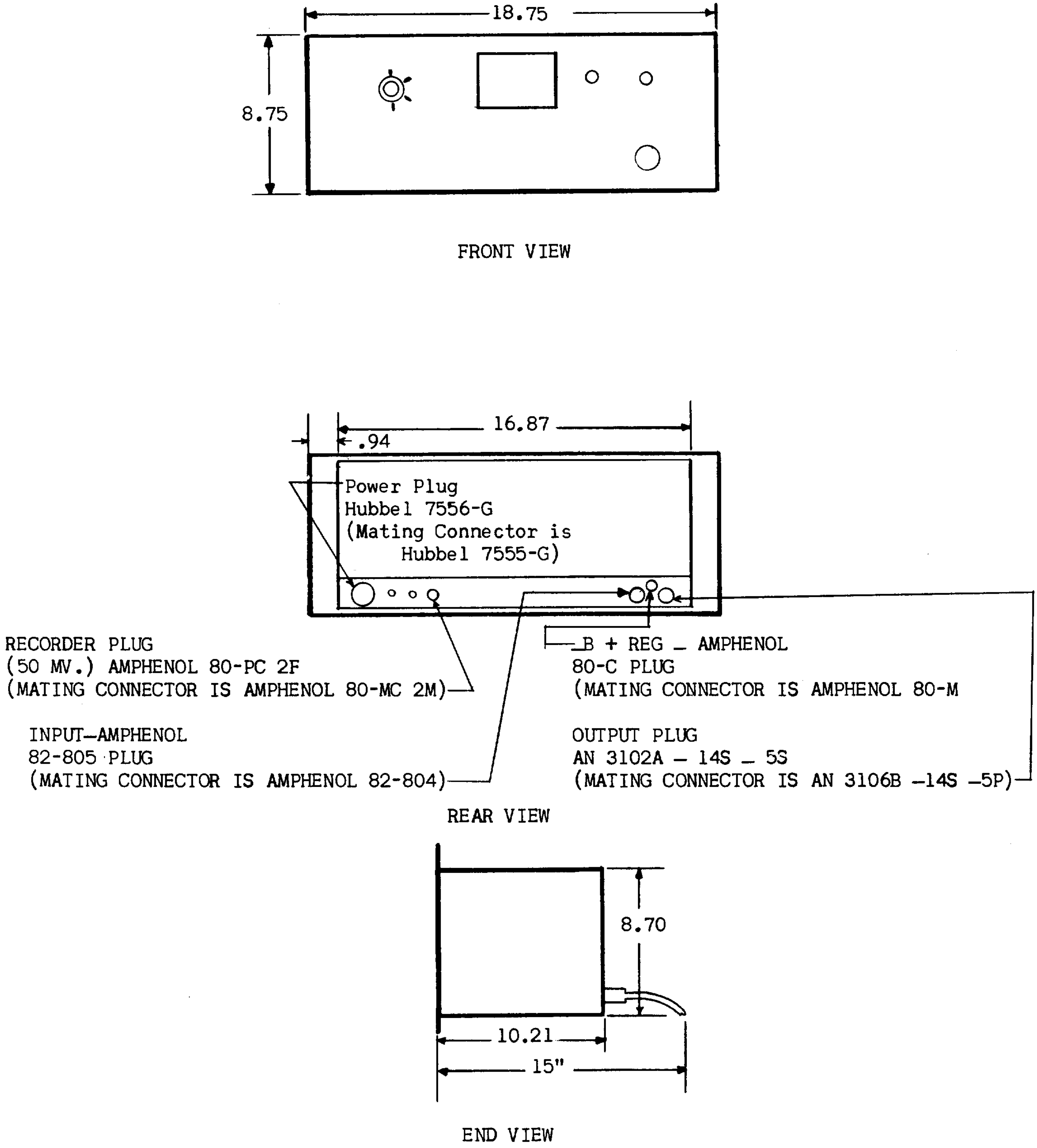


FIGURE 3. Mounting Dimensions

2. Cable for Recorder. To connect the recorder terminals (S8) to a recorder, use a two-conductor cable with at least 150-volt insulation.

3. Input Cable. Use Amphenol 21-467 with maximum length of 240 feet; or use Amphenol 21-537 cable with maximum length of 170 feet.

4. Connectors. The following table indicates the chassis terminal connectors and the mating cable connectors.

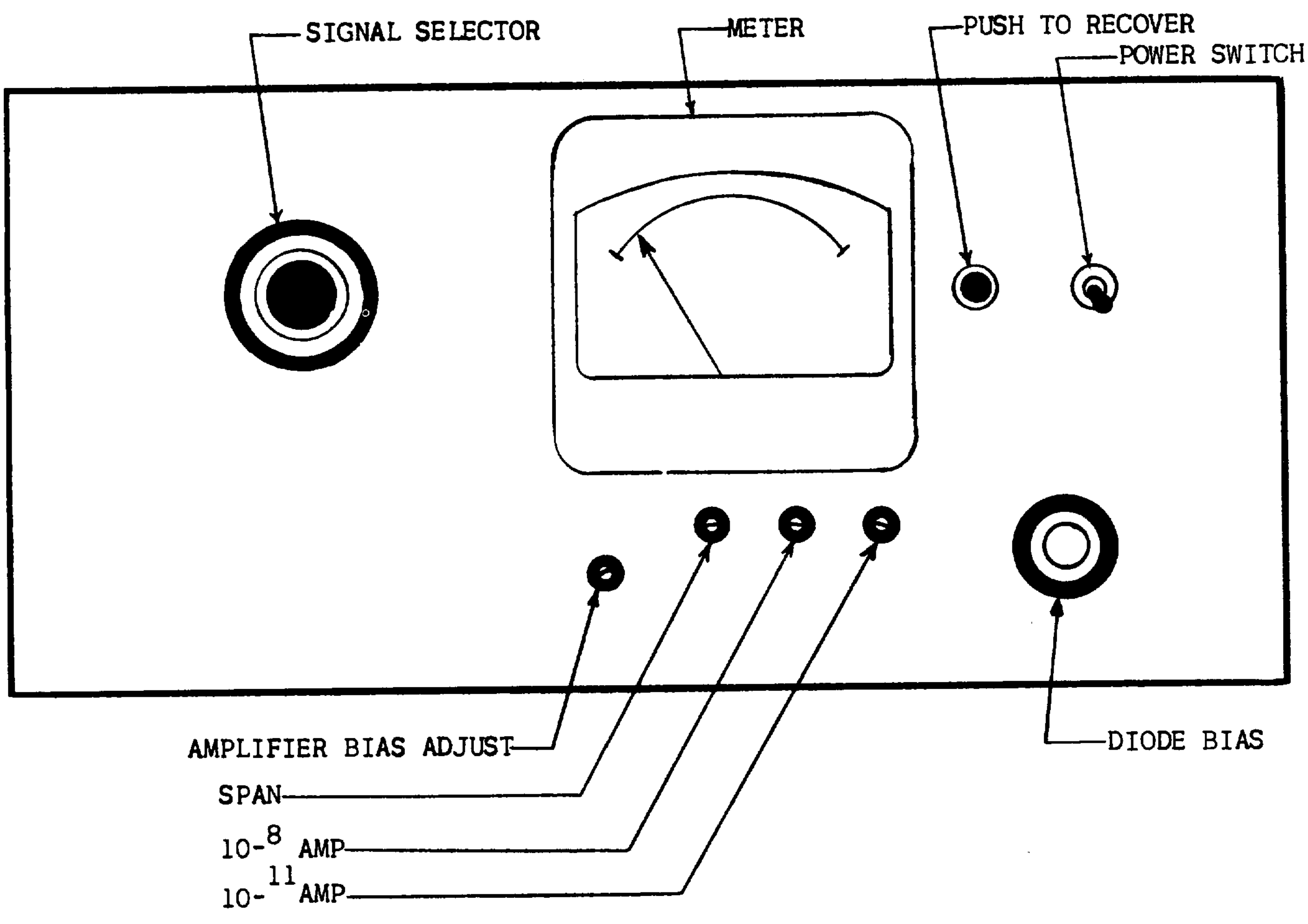


FIGURE 4. Controls, Model VL.

Section 3.

OPERATION

A. OPERATING CONTROLS

1. Power Switch. This toggle switch disconnects the instrument from the power line when it is in the OFF position.

NOTE

> The switch does not disconnect power from the thermo-regulated oven. This permits maintenance of oven operating temperature while instrument is turned off to keep the high-insulation components clean and moisture free. This reduces warm-up time of instrument.

2. Signal Selector Switch. This switch selects the signal to be connected to the amplifier as follows:

Position 1 - AMPLIFIER BIAS. The input of the amplifier is connected to ground for adjusting d-c amplifier bias. (See Section 3, Paragraph B, 1, Amplifier Bias Adjust).

Position 2 - 10^{-8} AMP. An internal standard current of 10^{-8} amperes is connected to the amplifier when adjusting for a correct reading.

Position 3 - 10^{-11} AMP. This is a second internal standard, of 10^{-11} amperes.

Position 4 - OPERATE. This position is used when a measurement is being made. Selecting this position conects the input to the amplifier.

3. Diode Bias. This control is used in the same manner as the zero control on a conventional amplifier, except that the meter needle is positioned to read a known current instead of zero. Two such test currents are provided. Though only one is necessary to perform zeroing function, two are needed for sensitivity adjustment. (See Section 3, Paragraph B, 2, Span Control).

4. Push to Recover. This push button is used to provide a positive transient at the input of the amplifier to counteract large transients which occur during switching. If a positive transient occurs, the amplifier will recover quickly; but if transient is negative, the amplifier may lose control and recovery will be slow (several minutes under some conditions). The positive transient thus produced by pushing this button compensates for most negative transients. Repeated use of the button will be necessary to compensate for more severe transients.

B. ADJUSTMENT AND MAINTENANCE CONTROLS.

The following controls are used for setting the instrument initially and for maintenance. They are located behind a removable cover on the instrument panel.

1. AMPLIFIER BIAS ADJUST. This control is used to set the bias on the input stage of the d-c amplifier associated with the diode detector. It permits the setting of the input potential within a few millivolts to minimize current leakage across the insulation of the input cable.

This adjustment is delicate, for the amplifier is without feedback and behaves like an amplifier with a gain of about 700. Because of this high amplifier gain, the meter needs only to indicate within three decades of the lower end of the scale.

2. Span Control. This control is essentially the sensitivity control of the instrument. It varies the feedback resistor so that the meter reads correctly for all current values. In an amplifier using a resistor as a current detector, the feedback resistor can be changed in value so that the meter will read full scale for a particular value of current (thus the instrument is made direct reading, and calibration charts are unnecessary). The function of the SPAN control is exactly the same; however, since the logarithmic scale has no zero, a different procedure must be used. Using two known currents, the span control is adjusted until the instrument indicates both currents correctly. The SPAN control interacts to a certain extent with the Diode Bias Control.

3. 10^{-8} AMP and 10^{-11} AMP. These controls are used to adjust the test currents. If known currents are applied to the input of the instrument, the instrument can be used as a null device and the internal test currents adjusted to their proper values.

C. OPERATING PROCEDURE

1. Warm-up

a. Set Power Switch to OFF.

b. Connect 115-volt, 60-cycle source to instrument. Wait 30 minutes for thermoregulated oven to reach thermal equilibrium. If the instrument is turned on immediately and operated, the operating procedure must be repeated after the oven has reached equilibrium.

c. Set Signal Selector Switch to 10^{-8} AMP and turn the Power Switch ON. Allow two to four minutes for instrument to warm up.

2. Making Initial Settings

a. Turn DIODE BIAS Control to bring meter to 10^{-8} amperes.

b. Remove cover for sub-panel controls by taking out the two knurled thumbscrews in the 2 x 7-inch plate below the indicator.

c. Adjust amplifier bias.

(1) Set Signal Selector Switch to AMPLIFIER BIAS.

(2) Turn AMPLIFIER BIAS ADJUST Control until meter indicates between 10^{-13} and 10^{-10} amperes. When instrument has first been turned on, it may

be difficult to obtain permanent adjustment. Even after the instrument has stabilized, the adjustment will require several seconds and the meter may wander over a range of a half decade.

(3) Readjust the AMPLIFIER BIAS ADJUST again after several hours of instrument operation, and again every few days as experience indicates.

d. Adjust diode bias and span.

(1) Turn Signal Selector Switch to 10^{-11} AMP.

(2) Turn DIODE BIAS Control to set meter needle at 10^{-13} amperes.

(3) Turn Signal Selector Switch to 10^{-8} AMP.

(4) Turn SPAN Control to set meter needle at 10^{-10} amperes.

(5) Turn DIODE BIAS Control to set meter needle at 10^{-8} amperes.

(6) Alternately set Signal Selector Switch at 10^{-11} AMP and 10^{-8} AMP. The meter should read the correct value when either of the two positions is selected.

(7) If there is a discrepancy in the readings it can be corrected by making small changes in the setting of the SPAN Control and subsequent resetting of the DIODE BIAS control to make the 10^{-8} ampere test current read correctly.

3. Operating Instrument

a. Connect the current source to be measured to the Input terminal.

b. Turn Signal Selector Switch to OPERATE.

c. Read measurement of input on meter.

d. If, during input switching operations, transients occur, producing an off-scale reading in the direction of very small current, momentarily depress the PUSH TO RECOVER Control. The meter needle should jump up-scale when the button is released, and then settle at the proper current value. If severe transients occur, more than one operation of the button may be necessary.

If transients occur at times other than when a switching operation is being performed, intermittent connections may be in the current source, or, more likely, shielding may be inadequate. As a final corrective measure, try connecting an earth ground to one part of the equipment.

D. OPERATING CHECK LIST

NOTE

The following procedure for operating the instrument is intended for use only after instrument has been installed, adjusted, and checked out.

1. Turn Power Switch OFF.

2. Connect instrument to 115-volt, 60-cycle power source. Allow 30 minutes for thermoregulated housing to reach constant temperature.

3. Connect current source to INPUT terminal.

4. Turn Signal Selector Switch to 10^{-8} AMP.

5. Turn Power Switch ON. The amplifier warm-up period is three minutes.

6. Adjust DIODE BIAS Control until meter indicates 10^{-8} amperes.

7. Set Signal Selector Switch to 10^{-11} AMP. Meter should indicate 10^{-11} amperes.

8. Turn Signal Selector Switch to OPERATE to measure input currents.

Section 4.

MAINTENANCE

A. EQUIPMENT

1. Calibrated current source--- delivering 10^{-11}, 10^{-10}, and 10^{-8} amperes. The BECKMAN 1500 Micro-Micro Current Source is recommended.

2. Student's potentiometer.

3. Strip-chart recorder--- with a sensitivity of 50 millivolts and a chart speed on one inch per minute.

4. Oscilloscope--- with vertical sensitivity of 25 millivolts per inch.

5. Voltmeter---with a sensitivity of 20,000 ohms per volt.

6. A small source of radioactivity and an ion chamber---arranged to produce a current of approximately 10^{-13} amperes.

7. Autotransformer---equipped with a voltmeter such as Variac or Varitran.

B. LOOP GAIN TEST

The loop gain is a measure of the forward gain of the amplifier with the feedback connection broken or otherwise made inoperative. The significance of this test is that it makes possible calculations regarding the effectiveness of the feedback loop in degenerating the input capacitance (cable capacitance, etc.) to reduce the time response of the instrument. Even through the signal current develops a voltage across the diode, the real signal that the amplifier produces is a voltage between the input and ground. The ratio of these two signals is the loop gain of the amplifier.

Since it is very difficult to measure the actual grid-to-ground voltage under signal conditions, use the following method consisting of steps 1, 2, and 3:

1. With the feedback connection inoperative, insert a variable voltage between input and ground as follows:

   a. Set the instrument for operation as instructed in Section 3.

   b. Leave the Signal Selector Switch in one of the test current positions.

   c. Disconnect the yellow lead from the negative meter terminal.

   d. Connect the output of a student's potentiometer or similar voltage source between chassis ground and the input terminal, with positive terminal of voltage source to input terminal.

   e. Adjust the voltage source to deliver zero voltage.

   f. Turn the Signal Selector Switch to OPERATE.

g. Adjust AMPLIFIER BIAS ADJUST until meter needle is off-scale to left.

h. Increase voltage from student's potentiometer until meter indicates 10^{-13} amperes; note the voltage.

i. Increase the voltage until the meter indicates 10^{-7} amperes; again note the voltage.

j. If the instrument drifts appreciably during the measurement, a more accurate measurement can be made by taking readings going upscale, then another pair of readings going downscale. If time consumed in taking each set of readings is about the same, the true reading will be the average of the two values obtained.

2. Measure the voltage necessary to drive the meter from zero to full scale: (It should be 1 to 1 1/2 millivolts.)

a. Disconnect student's potentiometer from input of instrument.

b. Reconnect yellow lead to negative terminal of meter.

c. Connect an accurate voltmeter with full-scale sensitivity of 1 to 3 volts, and an impedance of at least 50,000 ohms from the negative side of the output meter to chassis ground.

d. Connect positive lead from test meter to ground.

e. Set Signal Selector Switch to the 10^{-11} AMP position.

f. Turn DIODE BIAS Control until meter of VL indicates 10^{-13} amperes. The test meter should read zero.

g. If meter does not, the mechanical zero of the meter does not coincide with the electrical zero. Short the meter and adjust mechanical zero until the meter indicates 10^{-13} amperes. Unshort the meter.

h. With Signal Selector Switch in the 10^{-8} AMP position, turn DIODE BIAS Control until meter indicates 10^{-7} amperes. The test meter now indicates the full-scale output voltage.

3. Calculate the loop gain, using the following expression:

$$\frac{\text{Voltage Output}}{\text{Voltage Input}} = \text{Loop Gain}$$

The loop gain should be about 700. If it is less than 500, check the voltages through the amplifier against those marked in the circuit diagram. If tube trouble is suspected, the 12AT7 and the 6C4 tubes are most likely to be at fault.

C. CALIBRATING INTERNAL TEST CURRENTS.

1. Using Two Known Currents. The internal test currents can most easily be calibrated by the use of known currents as follows:

a. Connect a known current of 10^{-8} amperes to the input terminal of the instrument.

b. Use the DIODE BIAS control to set the meter to read 10^{-8} amperes.

c. Set Signal Selector Switch to 10^{-8} AMP.

d. Use 10^{-8} AMP Control to set meter to read 10^{-8} amperes. Now the 10^{-8} ampere internal current is calibrated.

e. To calibrate the 10^{-11} ampere internal current, perform a similar operation using a known current source of 10^{-11} amperes.

2. Using one Known Current. An alternate method for calibration requires only a single, known-current source. The actual value of the known current is not important other than it must be within the detection limits of the instrument.

To perform this alternate method, you will need a voltage divider with a 100-to-1 ratio and a high-value resistor which is linear with respect to applied voltage over the voltage range of 1 to 100 volts. The voltage divider is used to set the span. Figure 6 shows a suggested circuit. Voltage source should be at least 100 volts.

The voltage divider can be constructed of 1% wire wound resistors which are commercially available. The high resistor value should be such as to produce currents between 10^{-11} and 10^{-8} amperes for best results. A 10^{+10}-ohm resistor is indicated.

It can readily be seen that through operation of the switch the current to the instrument will vary by a factor of 100 or two decades. These two currents can be used to set the span of the instrument in the same manner as the internal test currents are used.

With equipment necessary, perform the alternate calibration method as follows:

a. Set the span. (See "Making Initial Settings" in Section 3, Paragraph C).

b. When the span has been set correctly, connect the known current source to the input terminal. (It is suggested that the value of the current be between 10^{-11} and 10^{-8} amperes for best results.)

c. Using the DIODE BIAS Control, set the meter to indicate the exact value of the known current. The instrument is now set to read currents correctly.

d. Set the Signal Selector Switch to 10^{-8} AMP; use the 10^{-8} AMP Control to set the meter to indicate correctly.

e. Set the Signal Selector Switch to 10^{-11} AMP; use the 10^{-11} AMP Control to set the meter to indicate correctly. The internal current sources are not calibrated.

D. POWER SUPPLY TEST

1. Connect an oscilloscope between ground and B+ or B-. Only a small amount of 120 cycle should be observed. The peak-to- peak voltage at these two points should be less than 2 millivolts at the B+ point and less than 75 millivolts at the B- point. No other noise or spikes should be present, except under some conditions when RF is introduced on the a-c supply. Even then, spikes of 25 to 50 millivolts peak-to-peak may not result in poor instrument performance.

2. Note ripple voltages. If they are higher than normal, amplifier loop gain may be low. The 12AT7 or the 35L6 tubes are most likely to be at fault. If the grid voltage is high the 35L6 tubes may have poor emission.

3. If the shunt resistor across the 35L6 tubes changes value materially, the amplifier regulation may be affected. To check the resistor value, turn instrument off, remove a tube (12AT7, for example) and check resistor with an ohmmeter. This is not a complete check, since the resistor trouble might appear only when heated. An open resistor should result in a high bias on the 35L6 tubes.

4. If the shunt resistor is found to be open, replace it, and check the 35L6 tubes on a tube tester. They could have been damaged during overload conditions.

5. If the B+ and B- voltages are noisy, the voltage reference tube (V5) may be noisy. Connect the oscilloscope between B+ and pin 7 of the 5651 tube base. The noise should appear here if the reference tube is at fault.

E. CHECKING CHAMBER SUPPLY VOLTAGE REGULATION

1. Check B+ terminal output. The voltage should be 200 (± 10) volts. Abnormal reading may indicate a poor 12AX7 tube or a drift in the value of the resistors producing grid bias for the two halves of the tube.

2. To measure regulation of this supply, obtain the following:

a. Polystyrene capacitor of 50 to 100 micro-microfarads with a leakage current of less than 10^{-14} amperes at 200 volts.

b. Signal current of 10^{-13} amperes. This may be obtained from an ion chamber and a small radium source. Use no cables.

c. In practice, it has been found that a small junction box (see Figure 5), when connected directly to the instrument INPUT connector, is useful.

3. With capacitor, signal current, and junction box on hand, proceed as follows:

a. Attach junction box to instrument INPUT connector.

b. Attach a small ion chamber to junction box.

c. Polarize chamber with a battery supply returned to instrument chassis ground.

d. Use small radium source to adjust chamber current to 10^{-13} amperes as read by the instrument.

e. Install the polystyrene capacitor in the junction box, connecting it between INPUT and the insulated pin jack. Close junction box.

f. Connect capacitor pin jack to positive terminal of a 200-volt battery supply.

g. Measure ion chamber current. Change in reading will be due to leakage currents in polystyrene capacitor.

h. Disconnect capacitor connector from 200-volt battery supply and connect it to ground. The instrument should again read the ion chamber current only. Some drift in reading may occur if the capacitor shows any dielectric soak.

i. Allow the soak currents to dissipate before taking a final reading.

j. If the leakage currents from the capacitor are less than 10^{-13} amperes, return capacitor lead to B+ REG connector and set instrument to read ion chamber current.

k. Observe meter for several minutes to note variations in readings. If variations are less than 10^{-14} amperes, the supply is sufficiently well regulated. A recorder would be convenient in making the observations in this step.

F. TROUBLE SHOOTING

1. The manner in which the instrument warms up may be significant in helping to spot trouble. In normal operation the warm-up sequence is as follows:

a. When the instrument is first turned on, only the rectifier tube is supplied with proper voltage; hence it will show red filaments first.

b. The diode activity produces raw B+ voltage across the load capacitor C1. All other tubes in the amplifier, including the series regulator tubes, are supplied with heater current from regulated B+.

c. While the series regulator tubes are cold, the heaters of the tubes are supplied current through the shunt resistor R5.

d. In normal operation, the resistor R5 supplies only half of the regulated current. Moreover, when the heaters of tubes are cold, the resistance of the heaters is lower than during normal operation, so initially the heaters are supplied with only a fraction of their rated current.

e. When the cathodes reach the temperature at which they start to emit, the series regulator tube passes a little plate current which supplies the other tubes with a little more heater current.

f. This process continues for two or three minutes until all the heaters are operating at nominal currents.

g. Normal progress can be followed by observing the neon tube NE2 associated with the plate of tube V6 and the reference tube V5.

h. About one minute after the instrument is turned on, the NE2 will light.

i. After another 3/4 minute, the voltage reference tube will light.

j. In 1/2 minute after the voltage reference tube has lighted, the full voltage will be attained at B+ and B-.

2. If the voltage reference tube lights when the instrument is first turned on, the heater string is broken and can be isolated as follows:

a. Check plug P3 and socket S3 for proper connection.

b. Inspect all tubes for heater continuity.

c. Disconnect P3 from S3 and test socket continuity between pins 5 and 6 with an ohmmeter; a reading of 600 to 800 ohms should be obtained, if resistance is not in this range, the 35L6 tubes are at fault.

d. Connect ohmmeter between socket pins 1 and 4. Reading of 250 to 350 ohms should be obtained. If reading is outside of this range, tube V3, V4, or V10 may be at fault.

e. Connect ohmmeter between pins 1 and 6 of plug P3. Resistance should be 150 to 200 ohms. This step inspects the heaters of tubes V6 and V9.

f. Make checks individually of heaters of the electrometer and diode tubes.

3. If it is necessary to operate the power supply as a separate unit, disconnect plug P3 and insert a 150-ohm, 5-watt resistor across socket pins 1 and 5.

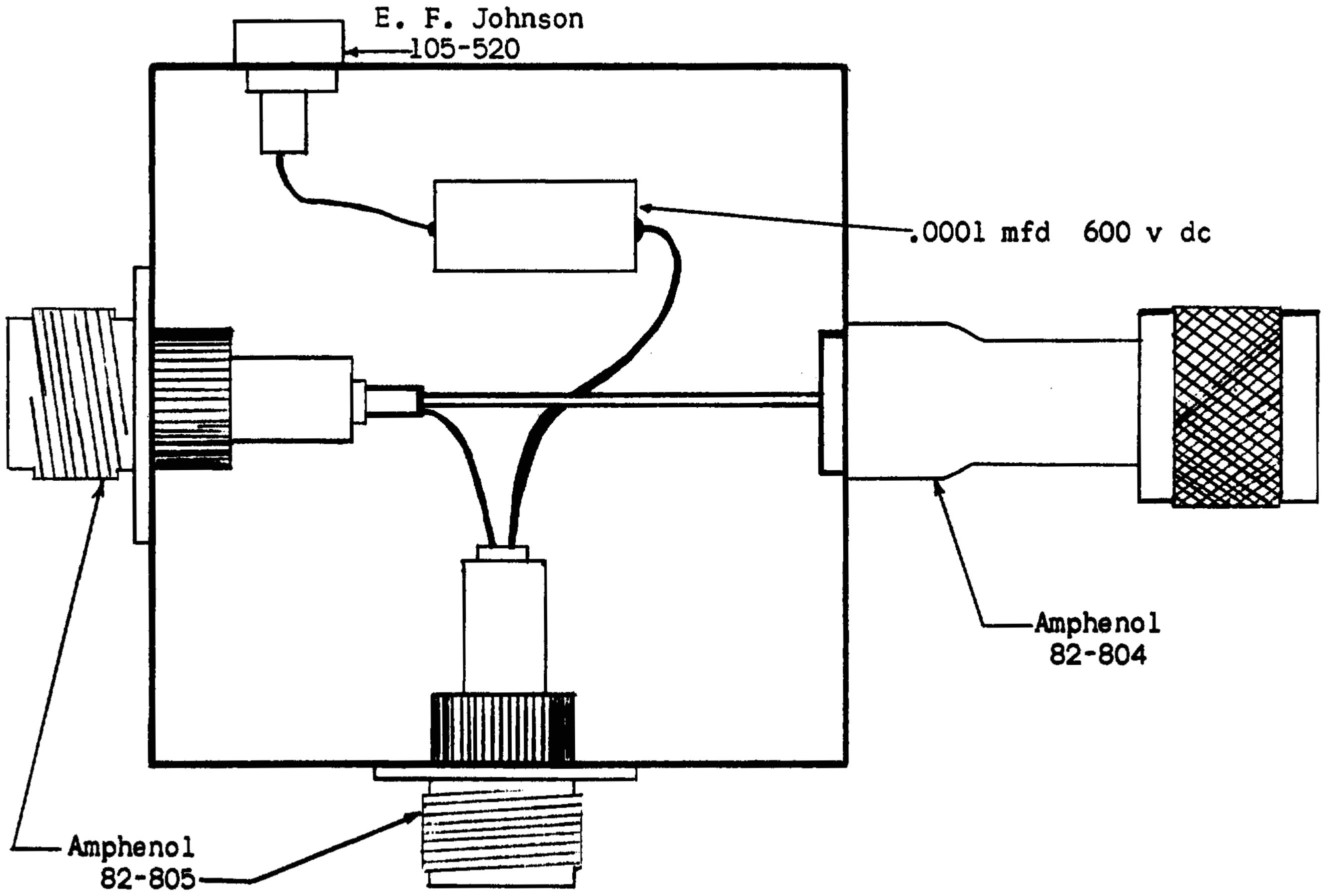


FIGURE 5. Junction Box for Check of Chamber Supply Voltage

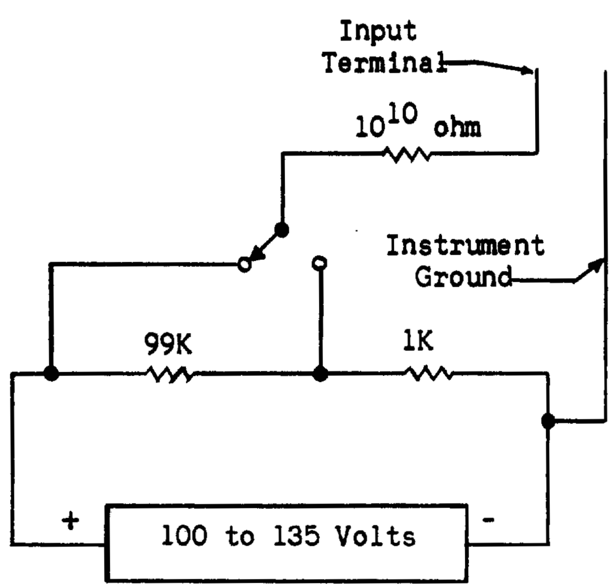


FIGURE 6. Circuit Diagram - Span Adjustment

Section 5.

THEORY OF THE INSTRUMENT

A. OPERATION OF THE CIRCUIT

Figure 7 is the basic circuit diagram which indicates the fundamental circuit configuration and shows the relationship of the controls in the circuit operation. The circuit is essentially a dc amplifier employing 100% negative feedback to stabilize the amplifier gain and to degenerate the input impedance in order that large input capacitances can be tolerated (such capacitances are most often represented by long input cables) without seriously affecting the response time of the device. Conventional micro-microammeters employ high-value input resistors to develop a voltage from the signal current. As a result, practical wide-range instruments use elaborate sensitivity-changing systems to permit satisfactory measurements over a wide range of input current values.

A logarithmic diode is used at the input instead of the high-value resistor. The diode is operated under such conditions that the voltage developed across it is proportional to the logarithm of the current passing through the diode. The diode is operated in this instrument in such a manner that the diode potential changes 0.15 volt for each decade change in the current passing through the diode. Figure 6 shows the diode connected to the input of the amplifier so that the input signal current must pass through the diode. The voltage at the plate of the logarithmic diode detector is impressed on the amplifier. The output voltage is fed back to the cathode of the logarithmic diode detector in such a manner as to make the amplifier gain unity. The feedback resistor is comprised of the SPAN resistor and the resistance of the meter. The SPAN resistor is a sensitivity adjustment. The meterscale is divided into six decades; thus, if the increment of voltage change across the diode per decade change of signal current is 0.15 volt, the SPAN control is adjusted to produce $6 \times 0.15 = 0.90$ volt across the enitre feedback element when the meter reads full scale.

Since a logarithmic element can have no zero, the diode must develop a voltage across it for any particular current level of operation. When the meter current is zero (and indicating 10^{-13} amperes), the diode has a voltage across it corresponding to a current level of 10^{-13} amperes. It is desirable to maintain the input at ground potential to reduce leakage currents across insulators and cable dielectric. It is also advantageous to return the feedback to ground for convenience in the use of auxiliary control and indicating equipment, and to reduce a-c pickup. Both of these objectives may be reached by inserting a potential drop (in the form of Resistor R3) between the feedback point and the cathode of the diode. A variable-current generator comprising the DIODE BIAS control R1 and resistor R2 is connected to R3 in such a manner that the voltage developed across R3 is exactly equal and opposite in polarity to the voltage developed across the diode by a singal current of 10^{-13} amperes. Since the diode does develop a definite voltage drop from a given input signal, zero adjustment of the amplifier itself must be made with the diode removed from the circuit. This is done by grounding the input terminal, which prevents the feedback from having any influence on the input of the amplifier. When the input is grounded, the amplifier is adjusted until the output meter current is zero (needle indicating 10^{-13} amperes). When the input is disconnected from ground, the amplifier maintains the input at ground potential by applying the output signal to the cathode of the detector. When the input is grounded while adjusting the amplifier bias, the amplifier behaves like a high-gain amplifier with a gain of about 700 and has a full scale sensitivity of about 1.3 millivolts. Consequently, the adjustment is somewhat difficult, but the residual error is small when the input is ungrounded. Suppose that the meter reads 1/3 full scale before ungrounding the input this corresponds to a voltage across the feedback elements of 0.3 volts; then, if the amplifier has a gain of 700, the input will be found at a potential of 0.3/700, or 0.43 millivolt, from ground when the feedback is reconnected.

The use of the screen-voltage adjustment as a bias control, instead of the conventional cathode-type bias control, is possible because of the type of electrometer tube used in this circuit has an extremely low screen mμ; the use of the control in this position has the further advantage of reducing the current through the slider contact on the control potentiometer to a few microamperes. As this is a feedback amplifier, the input is maintained at constant potential when signal is applied to the input by virtue of the amplifier's ability to do so. In this case the forward gain of the amplifier is about 700, so the change in input potential with respect to ground is equal to the generated output voltage divided by the gain of the amplifier or for full scale meter deflection (0.90 volt), 0.90/700, or 0.0013 volt.

1. Details of the Input Circuit and the Switching. The input circuit is contained within a thermoregulated housing in order to stabilize the temperature-sensitive elements and to provide adequate protection against moisture for the high-insulation components of the circuit. The Signal Selector Switch serves to connect the input of the circuit to ground, to either of two internal current source, or to the input terminal. The switch is designed in such a manner that poles not connected to the input of the circuit are returned to ground. By this means, the internal current generators are maintained under constant conditions and all contacts of the switch are maintained at ground potential, thus materially reducing the leakage currents across the switch insulators, as well as eliminating insulator soak effects.

The internal current standards are produced by impressing suitable voltages across resistors whose values are 3×10^8 and 3×10^{11} ohms. The nominal voltage across these resistors is 3.0 volts; these voltages are made adjustable for exact calibration against external standards.

The transient-control circuit consists of a neon tube connected to the input and returned to ground through a 15-megohm resistor. A 100 micro-microfarad polystyrene capacitor is connected from the junction of these two elements to -35 volts through a 22-megohm resistor. A button on the front panel is a normally-closed switch which connects the near end of the 22-megohm resistor to B+. Thus, in the non-operating condition, the far end of the neon tube is at ground potential so that current leakage across the base of the tube is kept at a minimum, and the capacitor is discharged through the 15-megohm and 22-megohm resistors and assumes B- voltage (-35 volts). The two resistors act as a voltage divider which maintains the voltage across the neon tube below the firing potential. When the panel control is released, the far end of the capacitor is connected to B+ again. Thus 120 volts appears across the neon tube. Since this is well above the firing potential, the tube fires, transferring a portion of the condenser charge to the input capacitance of the amplifier. This charge tends to make the input of the amplifier positive, thus introducing a transient which is easily handled by the amplifier. A second

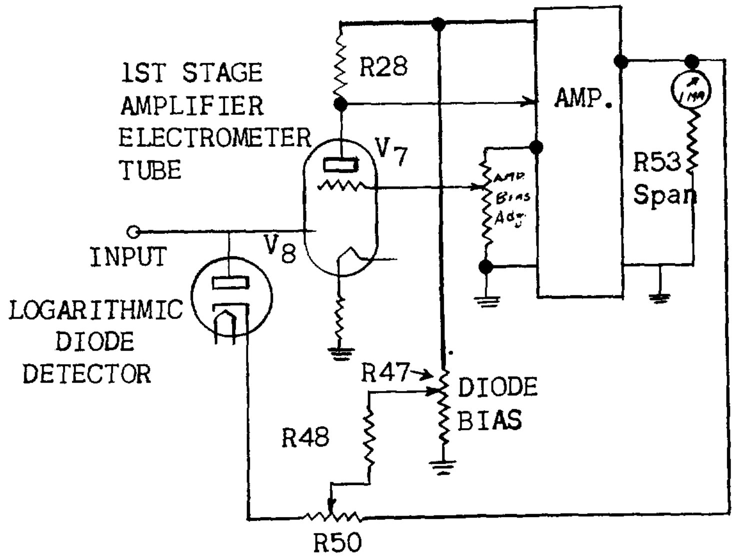


FIGURE 7. Basic Circuit Diagram

neon tube serves to illuminate the electrode of the first neon tube to insure proper firing. A one-megohm resistor limits the current to the diode, preventing overloads. The far end of the one megohm resistor is connected to ground through a 100 micro-microfarad polystyrene capacitor. This capacitor is in essence a cable simulator which tends to make the amplifier performance independent of added cable capacitance. The diode is shunted by a 50 micro-microfarad capacitor to reduce noise and to stabilize the circuit against transients.

B. THE DIODE DETECTOR

The didode is a Raytheon CK5704 cathode-type tube with a heater rating of 6.3 volts and 150 milliamperes. In this application, the heater is operated at about 2.0 volts and 80 milliamperes. The important criterion for satisfactory performance is not the heater power but the temperature of the cathode. It can be shown theoretically that the cathode temperature determines the slope of the logarithmic characteristic of the device. It has been determined experimentally that the best slope for operation over the range of detection encompassed by this instrument corresponds to a decade increment of 0.15 volt. This means that if the current level is changed by a factor of ten, the voltage across the diode will change by 0.15 volt.

It is important that the cathode be maintained at constant temperature; not only will the decade increment change with cathode temperature changes, but the diode bias for a given current level will change. Indeed, the latter factor is the more important, for a 10% change in the heater current is equivalent to a diode bias change of 40% of a decade. The heater current is obtained from a bleeder across the regulated B voltage supply.

The logarithmic relationship between the current and voltage in the diode detector is due to the fact that the energies of the electrons emitted from the hot cathode surface have Gaussian distribution. If the plate of such a diode is maintained at a fixed voltage negative with respect to the cathode, these electrons emitted from the cathode with energies exceeding the plate-to-cathode voltage will succeed in overcoming the retarding influence of this voltage and reach the plate. Those electrons with less energy will return to the cathode. If the plate-to-cathode potential is reduced, more of the electrons emitted from the cathode will have sufficient energy to reach the plate; hence, the plate current will increase.

The change in voltage necessary to increase or decrease the plate current tenfold is the decade increment of voltage.

If, instead of controlling the voltage across the diode, we connect the diode to a high-impedance current generator requiring the diode to supply electrons, the diode will adjust the potential between its plate and cathode until the resultant electron flow from cathode to plate meets the demand of the current generator. The voltage across the diode is unique for a given current. If the demand of the current generator changes, then the diode will adjust itself to a new plate-to-cathode potential. Hence, the voltage across the diode is a direct measure of the current flowing through the diode.

If the plate potential were made positive with respect to the cathode, it might be expected that the plate voltage-plate current relation would follow Child's Law. However, this is not the case, for the work function of the cathode surface can be considered as a retarding force on the electrons trying to escape from the cathode surface in just the same manner as a negative potential applied to the plate. This results in the diode behaving in a logarithmic fashion until the plate assumes a positive potential equal to that of the work function of the cathode surface.

The work function of the cathode surface is another variable which will require consideration. It turns out that changes in the work function are responsible for bias drift. The work function is dependent on the material (specifically the surface of the material) and also in part on the history of the treatment of the material. If new diodes are placed in a circuit where the work function of the surface can be measured, the work function can be observed to 'age' in a somewhat predictable manner. During the first week, the change in work function may be several tenths of a volt. (Bear in mind that the full scale voltage sensitivity of the instrument is 0.9 volt.) At the end of three weeks' aging, the rate of change will have leveled off to a value of the order of one to five tenths of a millivolt per day (0.1% of full scale per day). It is important that aged diodes be used to insure low drift characteristics in the amplifier performance.

C. THE FEEDBACK AMPLIFIER

The input tube of the amplifier is a subminiature electrometer tube type CK5886, manufactured by Raytheon. It is operated as a tetrode with a screen voltage of about 4 1/2 volts and a plate potential of 12 volts. The grid bias is fixed at 3.0 volts and a screen voltage adjustment serves as bias control. In this circuit, the grid current is less than 10-14 amperes. The second stage amplifier is a 12AT7 tube operated as a non-inverting voltage amplifier exhibiting a gain of about 20. Coupling to the output stage is achieved through a neon tube which drops the d-c level of the signal without loss of gain. A 6C4 tube used as the output tube is operated as a cathode follower with a gain of about 0.6. The output signal appears between cathode and ground. The full output signal is applied to the cathode of the diode detector with a polarity opposite that of the signal across the diode. Since the diode impedance is a function of the input signal, the amplifier is required to operate over a wide range of input impedances. In order to stabilize the loop for a broad range of frequencies, a special filter section is used between the 1st and 2nd amplifier stages. The network is designed to produce 45° of phase shift over a wide band of frequencies.

D. THE POWER SUPPLY

The power supply is designed to supply 150 milliamperes of regulated current at about 120 volts. Chassis ground is effected at such a point on the main bleeder that the supply produces a positive 85 volts with respect to the chassis and a negative 35 volts. The high current of the supply is to meet the demands of the diode detector heater, for the heater current must be well regulated to insure good performance. The main bleeder across the supply is comprised of the heaters of all the tubes used in the instrument with the single exception of the rectifier tube. Hence, all the tubes of the instrument are operated under ideal conditions which should result in long service life. Since the power transformer is a regulating transformer, the rectifier tube also is operated under nearly ideal conditions. The power supply regulating amplifier is essentially a three-stage amplifier using a 5651 tube as a voltage reference. The gain of the amplifier, excluding the series regulating tubes, is about 2000. The series regulator is a pair of 35L6 tubes connected in parallel. A shunt resistor across the regulating tubes nominally provides half the current for the supply. The choice of the point on the bleeder for ground provides the best possible regulation for the positive side of the voltage supply; all the critical components are located in this part of the supply. The ripple observed on the B+ voltage is less than 2 millivolts peak-to-peak. The negative supply may have as high as 75 millivolts of ripple.

A second regulated voltage is designed to furnish 200 volts suitable for polarization of ion chambers to be used with the instrument. The amplifier consists of a two-stage amplifier a (12AX7 tube) with a gain of about 2500; regulated B+ of the power amplifier is used as the voltage reference. An output filter on the amplifier further controls the regulation of the output voltage. The internal resistance of the supply is ten megohms. The degree of regulation of the supply can be defined as the rate of change of voltage at the output terminal. Since an ion chamber represents a capacitance coupled from the high-voltage element to the input of the amplifier, and the minimum detectable voltage is known, then the regulation of the polarizing voltage can be determined by application of the relation

$$\frac{I}{C} = \frac{dV}{dT}$$

If the chamber is assumed to have an inner-electrode capacitance of 35 micro-microfarads and the maximum induced current to be tolerated is 10^{-14} amperes, then the maximum rate of change of voltage that can be tolerated for the polarizing voltage is 300 microvolts per second. This supply is designed to produce variations of less than 100 microvolts per second. It must be remembered that the dc regulation of supply is not that good.

Section 6.

PARTS LIST

Symbol	Description	BECKMAN Part
R1, 3	51 ohms, ±5%, 1 w, AB GB	7528
R2, 4	68 ohms, ±5%, 1 w, AB GB	7527
R5	2,500 ohms, 20 w, Mallory 2HJ2500	7526
R6, 7	51,000 ohms, ±5%, 1/2 w, AB EB	15067
R8	36,000 ohms, ±5%, 1/2 w, AB EB	7543
R9	47,000 ohms, ±5%, 1/2 w, AB EB	15064
R10, 35	1 megohm, ±5%, 1/2w, AB EB	3180-15
R11	2 megohms, ±5%, 1/2 w, AB EB	2209
R12	15,000 ohms, ±5%, 1 w, AB GB	6270-564-8
R13, 21	100,000 ohms, ±5%, 1/2 w, AB EB	15074
R14	9.1 megohms, ±5%, 1/2 w, AB EB	8856
R15, 19	5.6 megohms, ±5%, 1/2 w, AB EB	8851
R16, 37	0.24 megohms, ±5%, 1/2 w, AB EB	3180-13
R17	27,000 ohms, ±5%, 1/2 w, AB EB	15085
R18	8.2 megohms, ±10%, 1/2 w, AB EB	8860
R20	10 megohms, ±5%, 1/2 w, AB EB	8154
R22	4.3 megohms, ±5%, 1/2 w, AB EB	8151
R23	0.91 megohm, ±5%, 1/2 w, AB EB	8147
R24	180,000 ohms, ±5%, 1/2 w, AB EB	15081
R25	50 ohms, ±0.5 ohm)	7531
R26	500 ohms, ±20 ohms)	
R27	10 ohms, ± 1 ohm)	7552
R38	48 ohms, ± 4 ohms)	
R28, 39	22 megohms, ±5%, 1/2 w, AB EB	8852
R29, 30	20,000 ohms, ±5%, 1/2 w, AB EB	15057
R31, 32	0.33 megohm, ±10%, 1/2 w, AB EB	8104
R33	10,000 ohms, ±5%, 1/2 w, AB EB	15052
R34	24,000 ohms, ±5%, 1/2 w, AB EB	7933
R36	15 megohms, ±10%, 1/2 w, AB EB	8153
R40	300 megohms, ±10%, RPC type HBF	5630
R41	330,000 megohms, ±5%, Victoreen Hi-Meg	5623
R42, 43	Potentiometer, 5,000 ohms, Clarostat 43-5000	7520
R44, 45	100 ohms, ±10%, 50 w, Ohmite	9841
R46	100 ohms, ±10%, 1/2 w, IRC BW-1/2	9061
R47	Potentiometer, 20,000 ohms, Helipot 20,000 AZ	680-4
R48	100,000 ohms, ± 3%, 1/2 w, Welwyn	7628
R49, 50	2,000 ohms, ±5%, 1 w, IRC BW-1	7568
R51	36,000 ohms, ± 5%, 1 w, AB GB	6270-556-11
R52	7,500 ohms, ±5%, 1/2 w, AB EB	5563
R53	Potentiometer, 1000 ohms, Clarostat	7529
R54	Potentiometer, 20,000 ohms, Helipot	7530
R55	82,000 ohms, ± 10%, 1/2 w, AB EB	8098
R56	12.5 ohms, ±5%, 1/2 w, IRC BW-1/2	7629
R_S	Selected (to shunt meter M1 to 1.0±.005 ma)	
C1	20 x 20 mfd, Mallory FP 234	10069
C2	0.0047 mfd, ±20%, 600 v, molded paper, Sprague 73 P 47206	15023

Symbol	Description	BECKMAN Part
C3	0.047 mfd, ±20%, 600 v, molded paper Sprague 73 P 4736	15029
C4	0.022 mfd, ±20%, 600 v, molded paper, Sprague 73 P 22306	15026
C5, 15	20 x 20 mfd, Mallory FP 234	10069
C6, 7	0.0022 mfd, ±20T, 600 v, molded paper Sprague 73 P 22206	15021
C8	1 mfd, 600 v, Tobe Oilmite OM-601	9886
C9	0.068 mfd, ±20%, 600 v, molded paper, Sprague 73 P 68306	313
C10	0.012 mfd, ±10%, 600 v, molded paper, Sprague 73 P 12306	13118
C11	0.0025 mfd, +30% — 10%, 600 v, paper, Sprague 2256-AG	6270-509
C12	500 mmfd, 500 v, mica Sprague 1FM-35	10893
C13	100 mmfd, ±5%, 500 v, mica, Cornell-Dubilier 5R-5T1	8133
C14, 18	100 mmfd, ±20%, 600v, polystyrene	5596
C16	50 mmfd, ±20%, 600 v, polystyrene	7560
C17	0.01 mfd, ±20%, 300 v, mica, Cornell-Dubilier 1DL-3S1	9062
C19	50 mmfd, ±5%, 500 v, mica, Cornell-Dubilier 5R-5Q25	8132
V1, 2	Tube, 35L6, RCA	6270-8
V3, 6	Tube, 12AT7, RCA	7523
V4	Tube, 12AU6, RCA	7524
V5	Tube, 5651, RCA	173
V7	Tube, CK5886, Raytheon	7875-0
V8	Tube, CK5704, Raytheon, processed	7525
V9	Tube, 6C4, RCA	13361
V10	Tube, 12AX7, RCA	15093
V11	Tube, 5AW4 CBS	7627
M1	Meter	7511
T1	Transformer (with matched condenser CT)	7513
P2	Plug with leads	7569
P3	Plug with leads	7555
P4	Plug, 2-prong, Jones P302AB	7538
P5	Plug, Jones P302CCT	9055-0
P9	Plug, 3-prong	4536
S1	Socket, Amphenol 82-805	5614
S2	Socket, 9-pin miniature, Cince 13481	7269
S3	Socket, 7-pin miniature, Cinch 56F12865	12052
S4	Socket, Jones S302CCT	7539
S5	Socket, 2-prong Jones S302AB	5611
S6	Socket, Amphenol 80C	9093
S7	Socket, 5-prong, AN 3102A-14S-5S	5629
S8	Socket, Amphenol 80-PC2F	4586
TR1	Thermoregulator, 58°C, normally closed, Edison Type S1-1A	1036
SW1	Switch, rotary, Oak	7515
SW2	Switch, DPST, Arrow H&H 80600	2313
SW3	Switch, normally closed, Grayhill 4002	7521
F1,F2	Fuse, 3 amp	516
NE2	Lamp Neon	7522

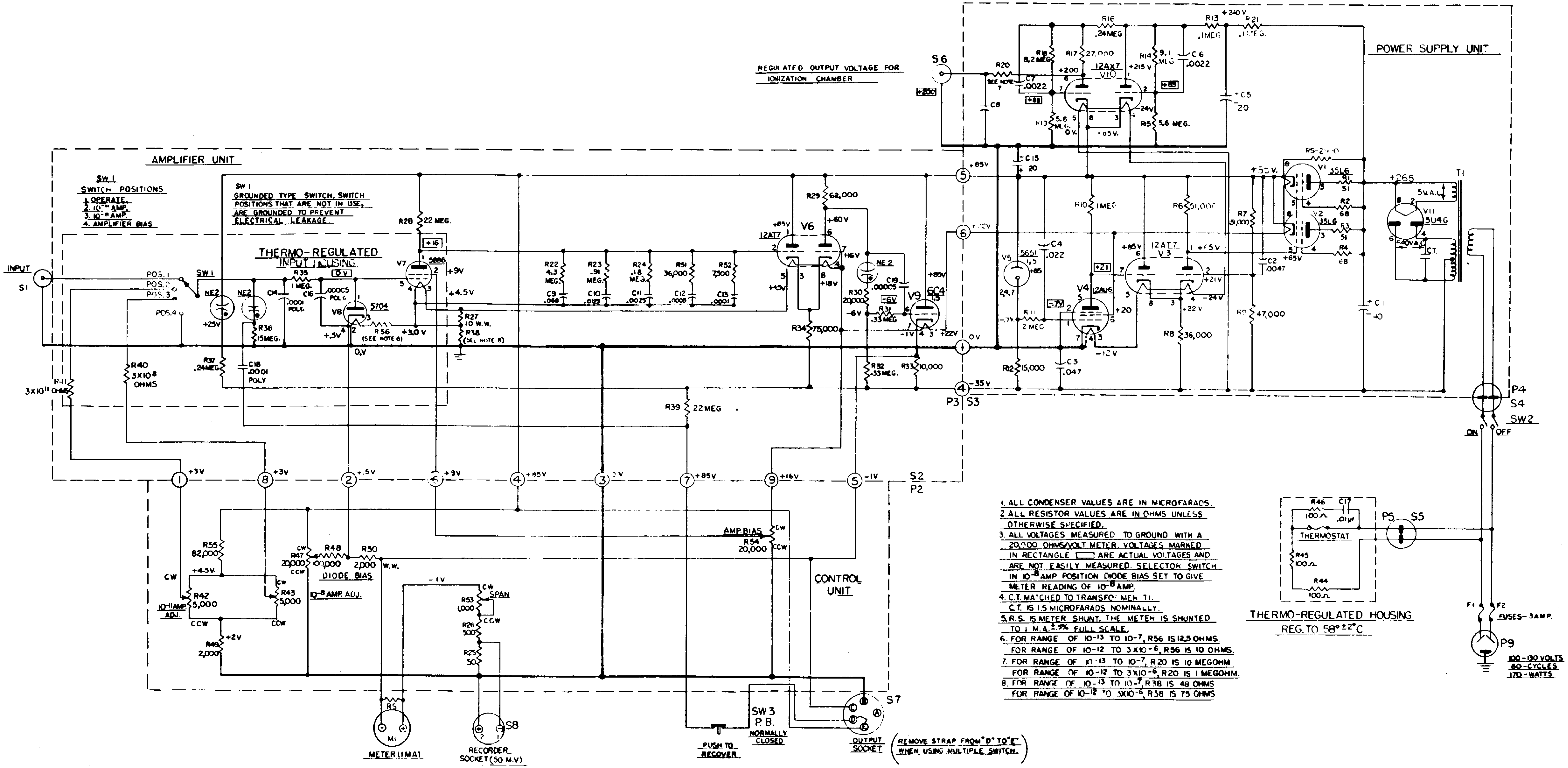


FIGURE 8. Circuit Diagram, Model VL.

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874-9399

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Beckman Instruments, Inc.

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BECKMAN
Instruments

INSTRUCTION MANUAL

BECKMAN MODEL V MICRO-MICROAMMETER

OPERATING PROCEDURE

Without the 1710 Multiple Switch:

1. Turn Power Switch OFF.

2. Connect instrument to 115-volt, 60 cycle power source. Allow 30 minutes for isothermal shield to reach temperature equilibrium.

3. Turn Operational Switch to MANUAL.

4. Connect Current source to INPUT terminal.

5. Check mechanical zero of meter.

6. Set Selector Switch to ZERO.

7. Turn Power Switch ON. Amplifier warm-up period is 3 to 5 minutes.

8. Adjust meter to zero with ZERO control.

9. Turn Selector Switch to desired range (black figures).

10. Read signal value from meter.

With the 1710 Multiple Switch:

1. Turn Power Switch OFF.

2. Connect instrument to 115-volt, 60 cycle power source. Allow 30 minutes for isothermal shield to reach temperature equilibrium.

3. Make 1710 Switch and B+ connections.

4. Turn Operational Switch to AUTOMATIC.

5. Check mechanical zero of meter.

6. Set Selector Switch at ZERO. Turn Power Switch ON. Amplifier warm-up period is 3 to 5 minutes.

7. Adjust meter to zero with ZERO CONTROL.

8. Set Selector Switch to desired Input Resistor position (see paragraph I C 2 and Table I of this manual and Instruction Manual for 1710 Multiple Switch).

9. See Instruction Manual, 1710 Multiple Switch, for measurement of signal currents.

BECKMAN INSTRUCTION MANUAL

MODEL V MICRO-MICROAMMETER

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Beckman Division, BECKMAN INSTRUMENTS, INC. • Fullerton, California

CHICAGO, ILLINOIS • MOUNTAINSIDE, NEW JERSEY

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LIST OF ILLUSTRATIONS

SECTION I

OPERATION

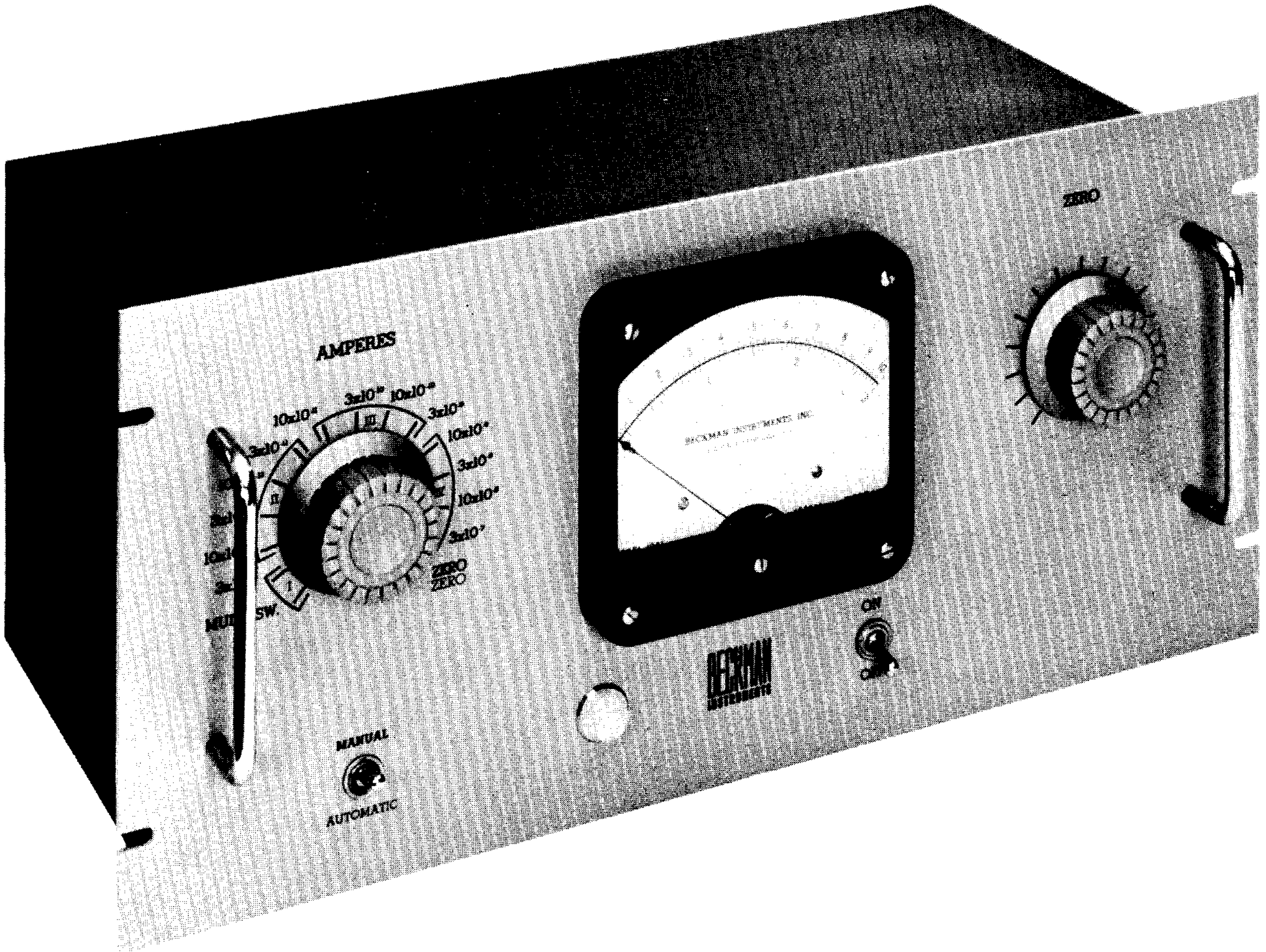


Figure 1. Model V Micro-Microammeter

A. DESCRIPTION

The Beckman Model V Micro-Microammeter is a sensitive current measuring instrument with a vibrating capacitance modulator. Thirteen measuring ranges from 0.3 micro-microamperes to 0.3 microamperes are available.

Many of the highly desirable features of the instrument, including high response speed and accuracy, are due to the degenerative lowering of the input impedance in the more sensitive ranges to a small fraction (1/1000 to 1/6000) of the value of the input resistor used. This is accomplished in such a way that, with proper adjustment, the voltage between the conductor and the shield on the input cable will never exceed 2 mv plus the contact potential in any current range. The use of a vibrating capacitor and an a-c amplifier eliminates the first stage grid current and zero drift inherent in straight d-c amplifiers.

When positive current from an external source flows through the input circuit it tends to increase its potential. The amplifier output to the feedback circuit keeps the feedback end of the input resistors (R_r, Figure 3) sufficiently negative to bring the input circuit quickly to equilibrium potential.

B. SPECIFICATIONS

1. Input Power: 60 cycles, 103-127 volts, 100 watts.

2. Detection Range: 3×10^{-13} to 3×10^{-7} amperes.

3. Indicator: 200 microamperes, 4½-inch scale.

4. Ambient Temperature Requirements: 20°F. to 115°F.

5. Warm-up Time:
   Amplifier: 3 to 5 minutes
   Isothermal Shield: 30 minutes

6. Zero Shift: Less than 2 millivolts in 24 hours.

7. Chamber Supply Voltage: 210 volts with maximum drift rate of 30 millivolts per second.

8. Output Connections:
   a. Recorder: 50 millivolts potentiometer type
   b. Multiple Switch: Beckman 1710 Multiple Switch

9. Accuracy: ± 5% on all ranges.

10. Time Constant:

	Input to Ground Capacitance (Cable and Detector)	
Range	None	1500 μμf
3×10^{-13}	1 second	4 seconds
10×10^{-13} to 3×10^{-11}	0.9	1.4
1×10^{-11} to 3×10^{-7}	0.12	0.12

11. Output Noise: On 3×10^{-13} ampere range;
    Less than 3% with no input capacitance
    Less than 8% with 5000μμf input capacitance

C. OPERATING CONTROLS

1. POWER SWITCH

This toggle switch disconnects the instrument, with the exception of the isothermal shield, from line voltage when in the OFF position. CAUTION: This switch must be OFF whenever the outer case is removed because of the danger of the high voltage present in the chassis.

2. SELECTOR SWITCH

This control, marked AMPERES, is used to select the desired range. When using the Model V alone (without a Beckman 1710 Automatic Multiple Switch), the Selector Switch should be in the position of the desired amperes range (black figures).

When using a 1710 Switch without plug-in resistors, the Model V Selector Switch should be on any one of the points in a group (red figures) which provides four ampere ranges, the particular range within the group being selected by the four sensitivity switches on the 1710 Switch. See Table I.

When using a 1710 Switch with plug-in resistors (which shunt the Model V input resistor), the Model V Selector Switch is on a group number (red figures) and the Model V input resistor in the circuit is listed in Table I. The current sensitivity or plug-in resistor value is calculated from the following equation:

$$R_p = \frac{R_v E_f}{I_f R_v - E_f}, \text{ in which}$$

E_f = Feedback or full scale voltage* in volts

I_f = Full scale current in amperes

R_e = Effective input resistance (R_v and R_p in parallel) in ohms

R_v = Model V input resistor in ohms

R_p = Plug-in resistor in ohms

*Selected by 1710 Switch sensitivity switch as indicated in Table I.

If no plug-in resistor is used in one or more channels of the 1710 Switch, the full-scale current I_f may be read directly from Table I, or calculated from $I_f = \frac{E_f}{R_v}$, a reduction of the above equation when R_p equals infinity.

Table I applies to all four ion-chamber stations simultaneously. All four ion-chamber currents must be within a 30 to 1 ratio; if the four currents do not fall within this 30 to 1 ratio, then plug-in resistors must be installed in the 1710 Switch to permit measurements on the chambers not within the 30 to 1 limit. The installation of such plug-in resistors can only lower the sensitivity and can never be used to increase it. The installation of a plug-in resistor increases the absolute magnitude of a full scale reading, e.g., from 3×10^{-13} amperes to 3×10^{-12} or 3×10^{-11} amperes.

3. OPERATIONAL SWITCH

This toggle switch, marked MANUAL and AUTOMATIC, is turned to the latter position when the instrument is used with a 1710 Multiple Switch. When the instrument is used without a 1710 Multiple Switch, the toggle switch must be in the MANUAL position.

4. ZERO CONTROL

Used to bring the meter needle to zero on the meter scale initially and in subsequent corrections for needle drift.

5. INDICATING LIGHT

Lights a few seconds after the instrument is turned on, indicating that the B+ supply is operating. If it does not light with the Power Switch in the ON position, the B supply circuit of the instrument is not functioning properly and should be checked.

6. METER

Indicates the magnitude of the current under measurement. Two meter styles are available; one calibrated in percent and the other with two scales of 3 units and 10 units, full scale, respectively. Full scale deflection on both meters represents a current equal to the setting of the Selector Switch. Intermediate readings are fractions of the current indicated by the Selector Switch. For example, a reading of 30 on the percent scale with the Selector Switch set on 3×10^{-11} amps would show 0.9×10^{-11} amps of input current. A reading of 1.5 on the lower scale of the dual scale meter with the Selector Switch set on 3×10^{-11} amps would represent 1.5×10^{-11} amps of input current.

7. RECORDER TERMINALS

These terminals are used to connect a potentiometer-type recorder or controller having a range of 50 mv. NO OTHER CONNECTIONS SHOULD BE MADE TO THESE TERMINALS. The recorder should have uniform chart gradations, with the left side corresponding to zero voltage input to the potentiometer. It is important that no temperature sensitive element, such as a cold-junction temperature compensator, be connected to the potentiometer circuit.

8. REGULATED B+ TERMINAL

Marked B+ REG, this coaxial fitting has an internal resistance of 1 megohm and is used to supply a precisely-regulated potential of 210 volts, with respect to ground, to polarize an ionization chamber. B+ variation, for ionization chambers, shall be less than 0.3 millivolts when the line voltage changes from 103 to 127 volts ac. Use only shielded cable for this connection. Cable shield must be grounded only to the coaxial fitting.

9. MULTIPLE SWITCH SOCKET

This socket, marked MULT SW, permits the use of a 1710 Multiple Switch. The socket provides the feedback voltage circuit and return circuit for the input resistors in the 1710 Switch. See instruction manual supplied with the 1710 Multiple Switch.

10. INPUT TERMINAL

This connection, denoted INPUT 1, is a standard coaxial socket for an Amphenol 82-805 fitting. The input cable is not furnished, but a standard shielded coaxial cable and fitting is required. The shielding of the input cable and jack is of extreme importance and should not be neglected when connecting a current source to the Model V. If a well-shielded cable is used, a chassis-to-earth ground will not normally be required. If touching the instrument causes the meter needle to move, the input or B+ cable shielding is faulty.

A more sensitive test for faulty shielding can be performed with an oscilloscope connected to OSC terminal. If waveform changes when instrument is touched, shielding is faulty. If a chassis-to-earth ground is utilized to correct for faulty shielding, it should be connected only to the GND terminal on the Model V or to the wire provided on the main power cable. Under no circumstances should both the instrument and the ion-chamber be individually connected to earth ground.

11. FEEDBACK TERMINAL

This terminal, marked FB, is used in checking the voltage sensitivity as described under MAINTENANCE.

12 GND AND OSC TERMINALS

These terminals are used for circuit testing. The vacuum tube voltmeter and oscilloscope used in circuit testing are both connected to these terminals.

OPERATING PROCEDURE

Without the 1710 Multiple Switch:

1. Turn Power Switch OFF.
2. Connect instrument to 115-volt, 60 cycle power source. Allow 30 minutes for isothermal shield to reach temperature equilibrium.
3. Turn Operational Switch to MANUAL.
4. Connect Current source to INPUT terminal.
5. Check mechanical zero of meter.

Table I. Full-Scale Current in Amperes

Selector Switch on Model V Group (in red)	Input Resistor Model V (ohms)	Sensitivity Switch Position on 1710 Switch A (0.1v)**	B (0.3v)**	C (1.0v)**	D (3.0v)**
I	3.33×10^{11}	$0\text{-}3 \times 10^{-13}$	$0\text{-}9 \times 10^{-13}$	$0\text{-}3 \times 10^{-12}$	$0\text{-}9 \times 10^{-12}$
II	1.0×10^{11}	$0\text{-}10 \times 10^{-13}$	$0\text{-}3 \times 10^{-12}$	$0\text{-}10 \times 10^{-12}$	$0\text{-}3 \times 10^{-11}$
III	1.0×10^{9}	$0\text{-}10 \times 10^{-11}$	$0\text{-}3 \times 10^{-10}$	$0\text{-}10 \times 10^{-10}$	$0\text{-}3 \times 10^{-9}$
IV	1.0×10^{7}	$0\text{-}10 \times 10^{-9}$	$0\text{-}3 \times 10^{-8}$	$0\text{-}10 \times 10^{-8}$	$0\text{-}3 \times 10^{-7}$

**Feedback and full-scale voltage

6. Set Selector Switch to ZERO.

7. Turn Power Switch ON. Amplifier warm-up period is 3 to 5 minutes.

8. Adjust meter to zero with ZERO control.

9. Turn Selector Switch to desired range (black figures).

10. Read signal value from meter.

With the 1710 Multiple Switch:

1. Turn Power Switch OFF.

2. Connect instrument to 115-volt, 60 cycle power source. Allow 30 minutes for isothermal shield to reach temperature equilibrium.

3. Make 1710 Switch and B+ connections.

4. Turn Operational Switch to AUTOMATIC.

5. Check mechanical zero of meter.

6. Set Selector Switch at ZERO. Turn Power Switch ON. Amplifier warm-up period is 3 to 5 minutes.

7. Adjust meter to zero with ZERO CONTROL.

8. Set Selector Switch to desired Input Resistor position (see paragraph I C 2 and Table I of this manual and Instruction Manual for 1710 Multiple Switch).

9. See Instruction Manual, 1710 Multiple Switch, for measurement of signal currents.

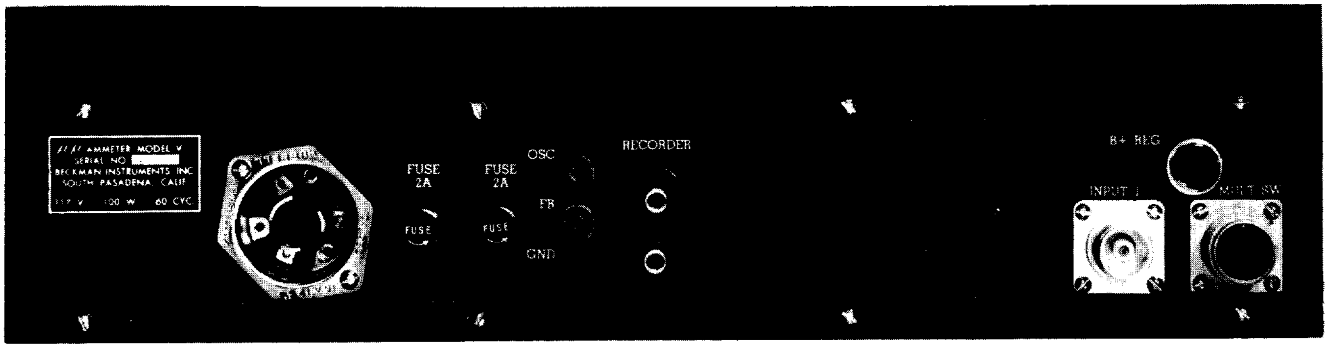


Figure 2. Rear Panel View, Model V

SECTION II

MAINTENANCE

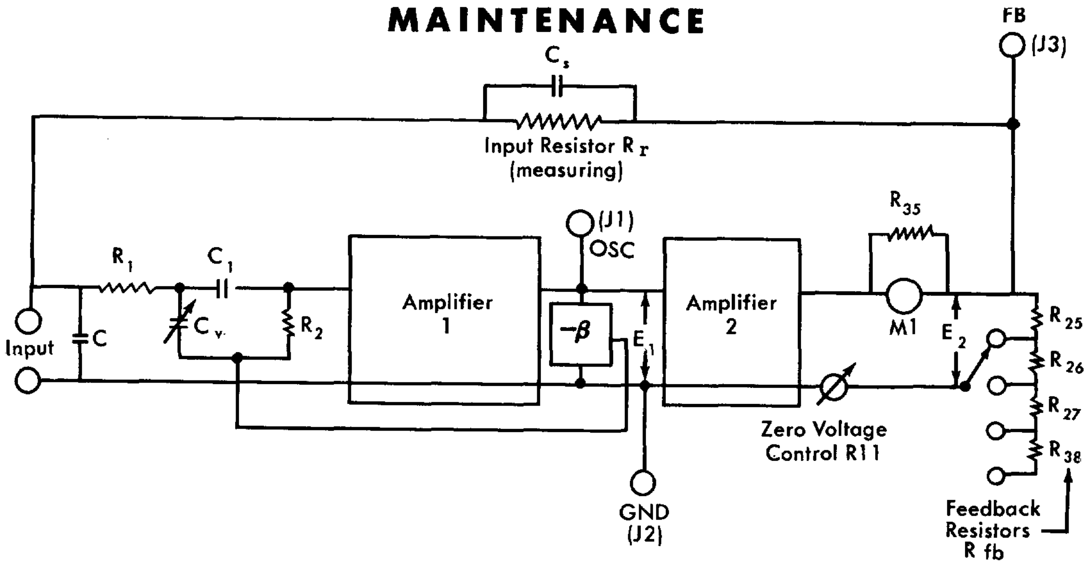


Figure 3. Simplified Schematic Diagram Model V Circuit

A. CIRCUIT OPERATION

The Model V Micro-Microammeter is a very sensitive current-measuring instrument.The signal current flows through a high value resistor (see Figure 3), and the resultant voltage is measured by an electrometer amplifier. In order to achieve rapid response to small signals in the presence of large input capacitance, e.g., cable capacitance, negative voltage feedback is used. The feedback connection is such that the potential input across the signal terminals of the instrument is maintained constant. Thus, the instrument behaves as a classical ammeter. The actual potential level of the input terminals has been chosen as ground to minimize the effect of insulation leakage currents on the measurements.

The circuit is an electronic servo, in which the amplifier strives to maintain the input at ground potential in spite of the magnitude of voltage developed across the input resistor by the signal current. The amplifier unit is designed to compare the input potential with ground potential and to react to any error signal by producing a driving voltage at the bottom end of the high-value resistor with proper sense to return the input to ground level. The ability of the amplifier to counteract the error signal is determined by the magnitude of the open loop gain. The compensating voltage applied to the input also serves to indicate the input signal magnitude.

In the Model V Micro-Microammeter, the dc error voltage signal is first converted into an ac signal by a vibrating capacitor (C , Figure 3). This ac signal is amplified, then rectified synchronously (to preserve dc polarity sense). The resultant dc voltage is applied to the bottom of the input resistor to complete the servo loop.

1. VIBRATING REED

Consider a variable capacitor with no voltage across it; if the capacitance of the unit is changed by moving the plates farther apart, the voltage across the unit will remain at zero. If, however, the capacitor is charged to 1.0 volt in the closed position and the source of charging voltage removed, the voltage across the capacitor increases as the plates are moved apart. ($Q = CE$, where Q is the charge, C is the capacitance, and E is the voltage.) Q, the charge, is held constant by removing the voltage source; hence, if C charging, then E must change also. See Figure 4. Since the voltage across the capacitor varies inversely with the capacitance of the unit, let the distance between the condenser plates vary in some regular manner and observe the voltage across the unit. See Figure 5. The farther the plates are apart, the higher the voltage; the closer the plates, the lower the voltage.

The actual voltage which can be obtained from such a system is limited by the practical maximum and minimum capacitances that can be achieved. The total maximum and minimum capacitances of the system are the important quantities. In any real system, shunt capacitance and stray capacitance must be considered. For example, suppose a variable capacitor is used with a maximum capacitance of 75 $\mu\mu$f and a minimum capacitance of 25$\mu\mu$f. Figure 6 shows that if the capacitor is charged to 1.0 volt in the closed position, 2 volts peak-to-peak ac can be obtained from the system. However, if a fixed capacitor of 75 $\mu\mu$f is connected across the system as shown in Figure 7, only 0.5 volt peak-to-peak will be obtained.

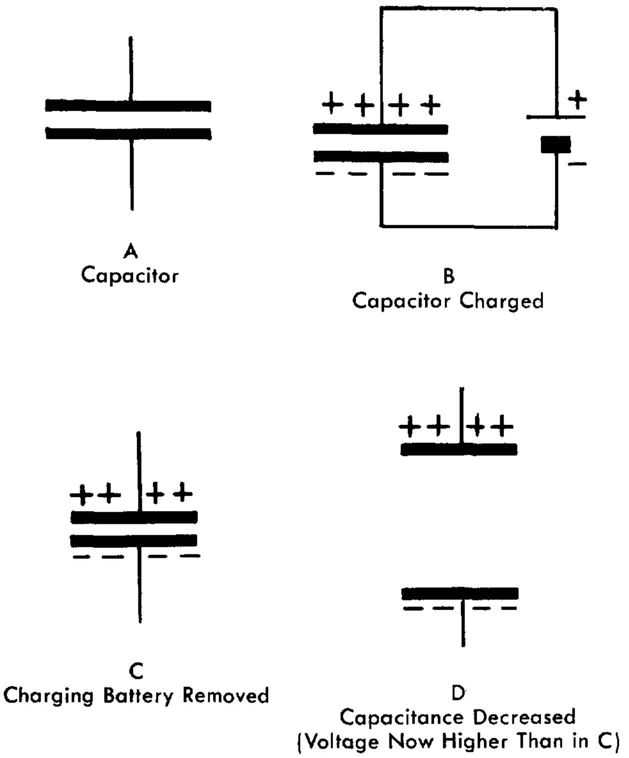


Figure 4. Principle of a Variable Capacitor

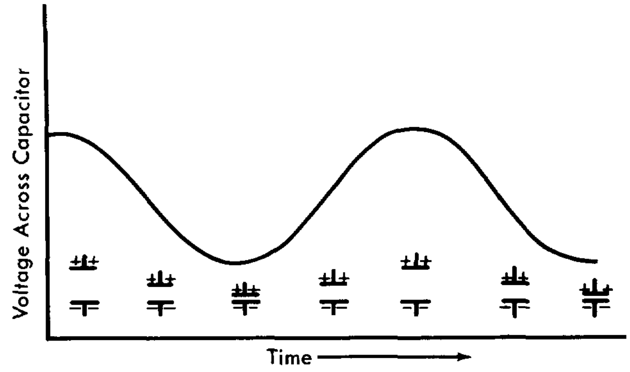


Figure 5. Change in Voltage with Change in Capacitance

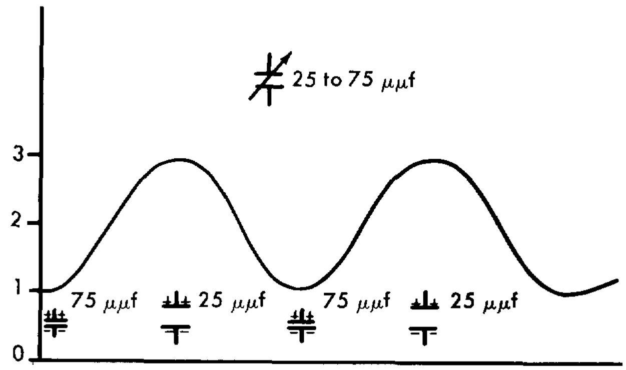


Figure 6. Voltage Relationship in a Charged Variable Capacitor

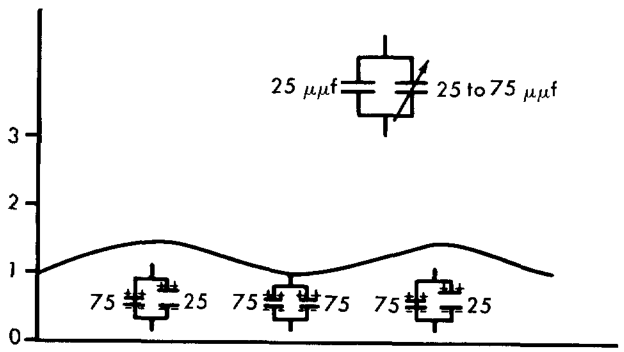


Figure 7. Voltage Relationship in a Charged System

2. CONTACT POTENTIAL

In a real capacitor, there always exists a potential between the plates, even if the leads to the capacitor unit are carefully shorted. At the surface of all metals there exists a characteristic potential barrier which prevents the escape of electrons out of the body of the metal into free space. In some metals this barrier is small; these metals or alloys are used in phototubes. (The barrier can be considered as a battery in series with the surface of the metal.)

If a capacitor is constructed with metals which have identical contact potentials, then the potential difference between the two surfaces would be zero if the leads to the capacitor were shorted. Where it is desired to construct two surfaces with no potential difference, extreme care must be taken. The surfaces should be made of the same kind of metal, and preferably from the same piece of metal. The metal chosen should be thoroughly cleaned and kept clean. Even with these precautions, it is not always possible to reduce the contact potentials to zero; the surface characteristics can be changed drastically by adsorption, abrasion, chemical changes, physical change of state, etc.

The 'residual' contact potential of the Beckman Vibrode is reduced to a few millivolts and will not be greater than 20 millivolts. Change of reed contact potential results in 'zero drift' in the instrument. The 'drift' of the contact potential will be less than 2 millivolts per day and will have a wandering characteristic, i.e., the drift will not be unidirectional.

The Beckman Vibrode is a variable capacitor which is sealed in a glass envelope and varied by the application of a 120-cycle magnetic field. The capacitor is hence vibrated at a frequency of 120 cycles. The 120-cycle magnetic field is derived from a coil driven from a 60-cycle power line.

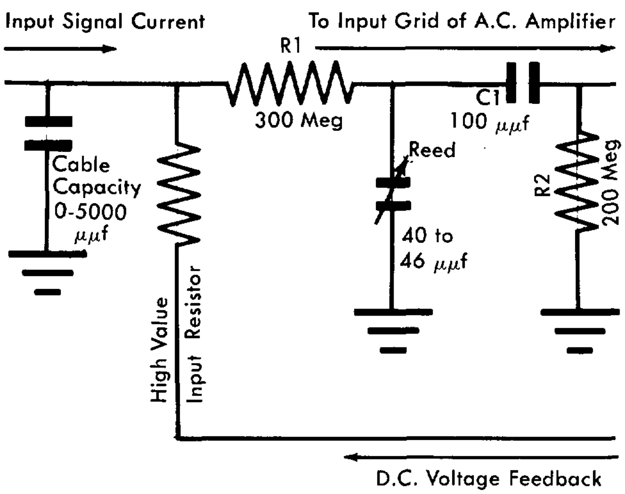


Figure 8. Error-Sensing Circuit

Figure 8 shows the error-sensing circuit of the Model V. The 300-megohm resistor R1 serves to isolate the reed capacitance from the large cable capacitance so that maximum ac voltage will be developed across the reed. Resistor R2 and Capacitor C1 serve to couple the reed ac-wise to the amplifier and yet isolate the reed from the bias potential of the input tube of the amplifier.

At 120 cycles, the impedance of the reed is about 30 megohms, the impedance of the coupling capacitor C1 about 10 megohms, and the impedance of the cable capacitance about 200,000 ohms; the efficiency of the conversion is limited chiefly by the reed itself. This system differs from the first example used in that the charging voltage is applied to the system continuously. As a result, the maximum ac voltage that can be obtained has a peak-to-peak value of twice the dc voltage. The conversion efficiency of the modulator unit is about 10%.

3. AMPLIFIER 1

The modulated 120-cycle signal is fed into Amplifier 1. This is a three-stage, ac amplifier with negative voltage feedback to stabilize the amplifier gain. The first two stages are subminiature tubes with filament current supplied from regulated B+.

A frequency response correction network is employed in the feedback line to the bottom of the reed to improve the transient response of the amplifier.

It is not convenient to measure the gain of the amplifier itself, so in testing the instrument, the gain of the circuit from the input through Amplifier 1 is measured. This measurement includes the modulator unit. Gains of about 3000 are usually observed for Amplifier 1. Gains of less than 750 necessitate correction.

4. AMPLIFIER 2

This amplifier consists of a power amplifier stage which receives the output signal of Amplifier 1 and a synchronous rectifier demodulator to convert the amplified ac to dc. This is followed by a smoothing

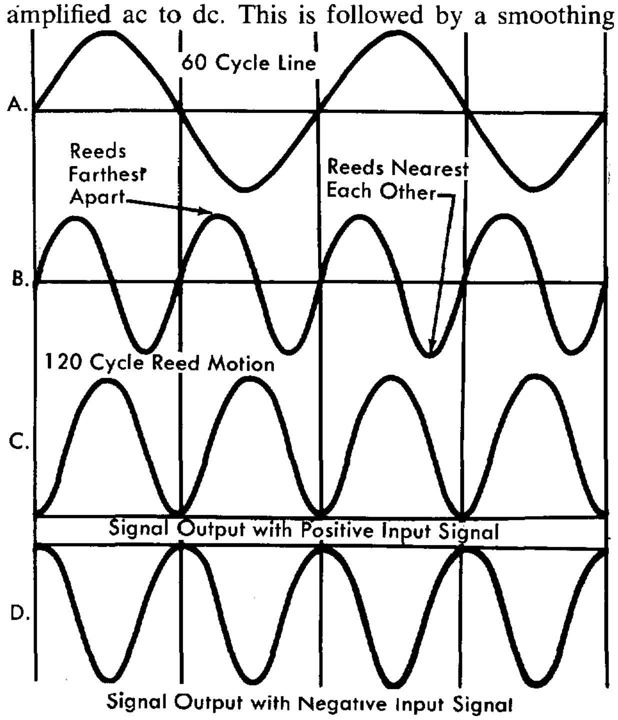


Figure 9. Modulator Signal Phase

filter network. The resultant output is fed back to the input of the instrument to degenerate the input impedance. The current in the dc modulated signal is also used to drive the ouput meter.

5. PHASE RELATIONS

Figure 9 shows the phase and frequency relationships in the reed modulator unit. (A) is the 60-cycle line that is applied to the reed drive coil. This results in a 120-cycle reed motion (B), because the reed plates repel each other each time a magnetic field is generated by the coil current. The reeds repel each other regardless of the direction of the field. The reeds will be farthest apart when the driving coil current is highest, and closest together when the current is zero.

When a charging voltage is applied to the modulator as in the circuit of Figure 8, the highest part of ac voltage generated will be when the reeds are farthest apart. (C) and (D) of Figure 9 show that when a positive signal is applied, the phase of the generated ac signal is in phase with the 120-cycle reed motion, and that when a negative dc signal input is used, the generated ac signal is 180° out of phase with the reed motion. Thus, the polarity of the input can be determined by comparing the phase of the amplified signal with a signal known to be in phase with the reed motion.

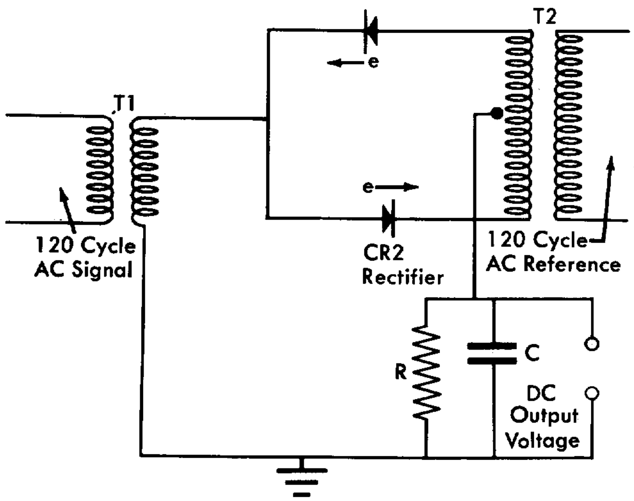
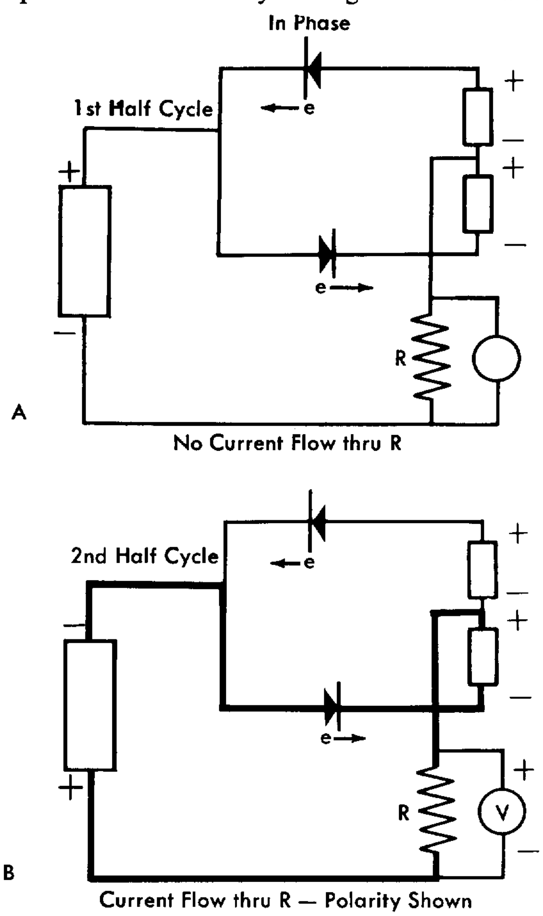


Figure 10. Synchronous Demodulator Circuit

6. SYNCHRONOUS RECTIFIER DEMODULATOR

Consider the circuit in Figure 10. At each rectifier, an arrow indicates the direction of electron flow. The amplifier signal from the reed modulator is applied through transformer T1. A 120-cycle reference signal is applied through T2. This signal, obtained from the 120-cycle ripple on the unregulated power supply, is in phase with the 120-cycle magnetic field that drives



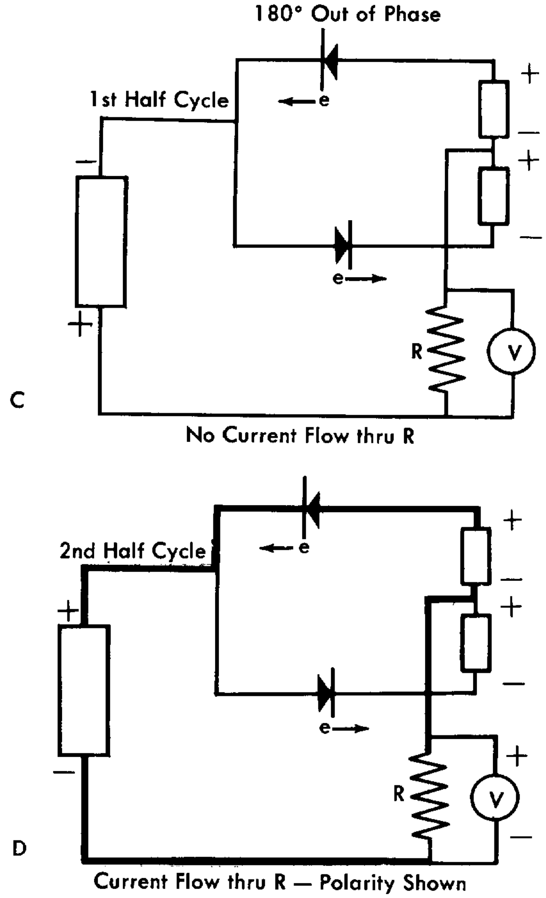


Figure 11. Current Flow in Demodulator

the reed. It has been shown that the phase of the signal from the reed modulator depends on the polarity of the dc charging voltage applied to the reed modulator. The ac 120-cycle reference signal must be at least twice as large as any expected dc signal developed across the input resistor detector.

The circuits of Figure 11 show the current flow through the demodulator circuit under the various conditions. Note that current flows in the circuit for only one part of the cycle. The boxes represent the transformer secondaries with polarity indicated. In (B) and (D) the heavy lines indicate the current flow.

In (B) and (D), current also flows through the other rectifiers; however, the actual voltages on the individual rectifiers are such that unequal currents pass through the rectifiers. (The heavy lines indicate the larger current.) Under conditions of no signal, the two rectifiers pass equal currents; hence they produce no net current in the external resistor.

In actual practice, resistors are placed in series with each rectifier to limit the current and also to equalize the rectifier impedances to prevent "one-sidedness." A large capacitor is placed across the external resistor to smooth the rectified voltage suitably for feeding back to the input of the instrument.

7. FEEDBACK CIRCUIT

The filtered voltage signal developed across the feedback resistors (R38, R27, R26, R25) is isolated from circuit potentials by transformer coupling. Thus, both ends of the feedback resistor must be returned to the circuit. The reference end of the resistor is returned through the zero control, which allows adjustment of the feedback potential in relation to ground to compensate for the contact potential of the vibrating reed modulator.

The other end of the feedback resistor is applied to the low impedance end of the input resistors. This feedback voltage must be well filtered to insure that no ac voltages can appear at the input of the instrument without attenuation, at least by gain of the overall amplifier. The alternating current of 60 cycles and the 120-cycle modulator frequency are to be especially discriminated. Each input resistor has a specially-designed filter network associated with it to insure sufficient discrimination at the input. For this reason also, any signal source used with the instrument must be carefully designed to eliminate ac pickup voltages from appearing at the input of the instrument.

8. REGULATED POWER SUPPLY AMPLIFIER

The amplifier consists of an RCA 5651 Voltage Reference Tube and a three-stage, direct-coupled amplifier which controls a series regulator tube; current feedback is employed through the bleeder string. The first two stages of the amplifier are subminiature tubes with filamentary cathodes heated by the bleeder string current. The input grid of the amplifier is also coupled through capacitor C13 directly to B^+ to improve the regulation to power line transients. R54, a 35,000-ohm resistor, shunts the current regulator tube and carries half the current under nominal line conditions. The output tube of the amplifier uses two neon tubes in the cathode return to avoid cathode degeneration of the signal.

The regulated B^+ is used to provide polarizing voltage for ionization chambers. R51 and C27 provide additional filtering for this purpose.

B. TESTING EQUIPMENT

The following equipment will be required to test the operation of the Model V.

1 Model 250 Simpson Analyzer or equivalent

1 Oscilloscope, 2" diameter or larger, 1 volt rms/in. minimum vertical sensitivity, 60 cps horizontal sweep

1 Recorder, 0-50 millivolts range

1 Vacuum tube voltmeter, calibrated 0-5 volts ac

1 Voltage Source to supply 0-50 millivolts

1 Voltage and Current Source to supply the following required values (available as Beckman 1500 $\mu\mu$ Current Source):

- 10 volts ± 0.5 percent
- 3 volts ± 0.5 percent
- 1 volt ± 0.5 percent
- 0.3 volt ± 0.5 percent
- 0.1 volt ± 0.5 percent
- 0.0005 volt ± 5 percent

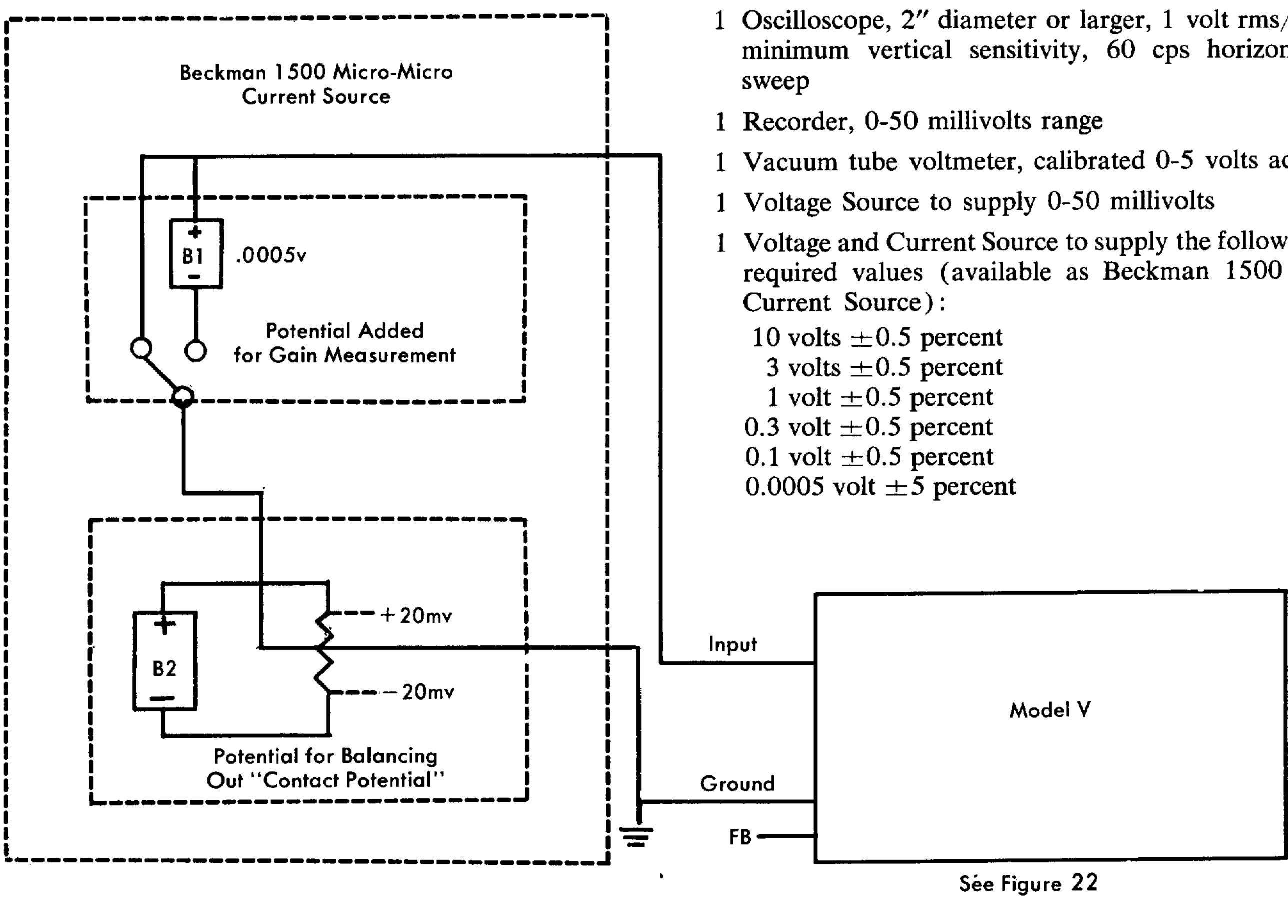


Figure 12. Amplifier Gain Measurement Diagram

3×10^{-13} to 3×10^{-7} amperes as shown in column one, Table II. These current values should be ±2 percent for accurate checks.

Using these instruments the following tests can be made on the Model V.

1. Loop gain test: To check the over-all gain in the two amplifiers.
2. Gain of Amplifier 1
3. Gain of Amplifier 2
4. Vibrating capacitor efficiency
5. Voltage calibration on all scales
6. Current calibration on all scales
7. Response time on all scales
8. Power supply output noise level

C. MEASURING AMPLIFIER GAIN

1. Connect the variable voltage source (0-50 mv) in series with the calibrated voltage source. Adjust the calibrated voltage source to deliver 0.0005 volts.

2. Connect the two voltage sources to the instrument through the INPUT jack. Turn the variable source ON and leave the calibrated source turned OFF.

3. Connect the vacuum tube voltmeter and the oscilloscope to test points OSC and GND.

4. Set the Selector Switch on the Model V to the 3×10^{-11} ampere position. Turn the Operational Switch to MANUAL.

5. Adjust the variable voltage source until the meter needle on the Model V reads zero. This voltage is the contact potential and should be 20 mv or less.

6. Turn ON the calibrated (0.0005 volts) voltage source.

7. Read E (see Figure 3) on the vacuum tube voltmeter and E on the lower scale of the Model V Meter. With the Selector Switch set at 3×10^{-11}, full scale is 3 volts.

8. Reading these two voltages, the following specifications are given to indicate proper operation of the main circuit components.

a. Over-all loop gain

$\text{Gain} = E_2/E_{in} \geqq 1500$

If the over-all loop gain is less than 1500 as shown by this test, proceed to check the gain of Amplifiers 1 and 2.

b. Gain of Amplifier 1

$\text{Gain} = E_1/E_{in} = E\ /0.0005$

$= 2000\, E_1 \geqq 600$

If the gain of Amplifier 1 is less than 600, consult the wiring diagram (Figure 22) and check the circuit for Amplifier 1.

When the over-all loop gain is low and the gain of Amplifier 1 is correct, check the gain of Amplifier 2.

c. Gain of Amplifier 2

$\text{Gain} = E_2/E_1 \geqq 2.5$

If the gain of Amplifier 2 as found by this test is less than 2.5, consult the wiring diagram (Figure 22) and check the circuit for Amplifier 2. Occasionally low gain in this stage is caused by the vibrating capacitor being out of phase with the demodulator; if so, replace vibrating capacitor. Also check C15 and C9. See Figure 22.

d. Response Time: Over-all loop gain of less than 1500, as determined in Paragraph above, may result in increased response time, over-damped response, or impaired accuracy. As the over-all loop gain drops, these effects will occur in the above order. The specification of loop gain of 1500 insures a time constant of 4 seconds or less on the 3×10^{-13} scale. A gain of 1500 on 3×10^{-11} scale is approximately equivalent to a gain of 500 on the 3×10^{-13} scale.

$$T = R_{in} C_s + \frac{R_{in}(C_i + C_c)}{A}$$

where T = Time constant in seconds (effective)

R_r = input resistor (See Table II)

A = Over-all loop gain

C_i = Internal input to ground capacitance (See Table II)

C_c = Input cable capacitance

C_s = Built-in shunt capacitance (See Table II)

E_i = Voltage output of Amplifier 1 measured between Oscilloscope Jack J1 and ground with an a-c vacuum-tube voltmeter

E_2 = Voltage sensitivity of Model V. See Table II, column headed Volts Full Scale

E_{in} = Voltage impressed on input to Model V (from input to ground, which opens the feedback loop) for calibration of loop gain only.

For example: Using the 3×10^{-13} scale

$R_v = 3.33 \times 10^{11}$

$C_c = 5000\ \mu\mu f$

$C_i = 30\ \mu\mu f$

$C_s = 3\ \mu\mu f$

A = 500 (This corresponds to a gain of 1500 on the 3×10^{-13} scale)

$$T = 3 \times 10^{11} \left[3 \times 10^{-12} + \frac{5030 \times 10^{-12}}{500} \right]$$

$$= 0.9 + 3 = 3.9 \text{ sec}$$

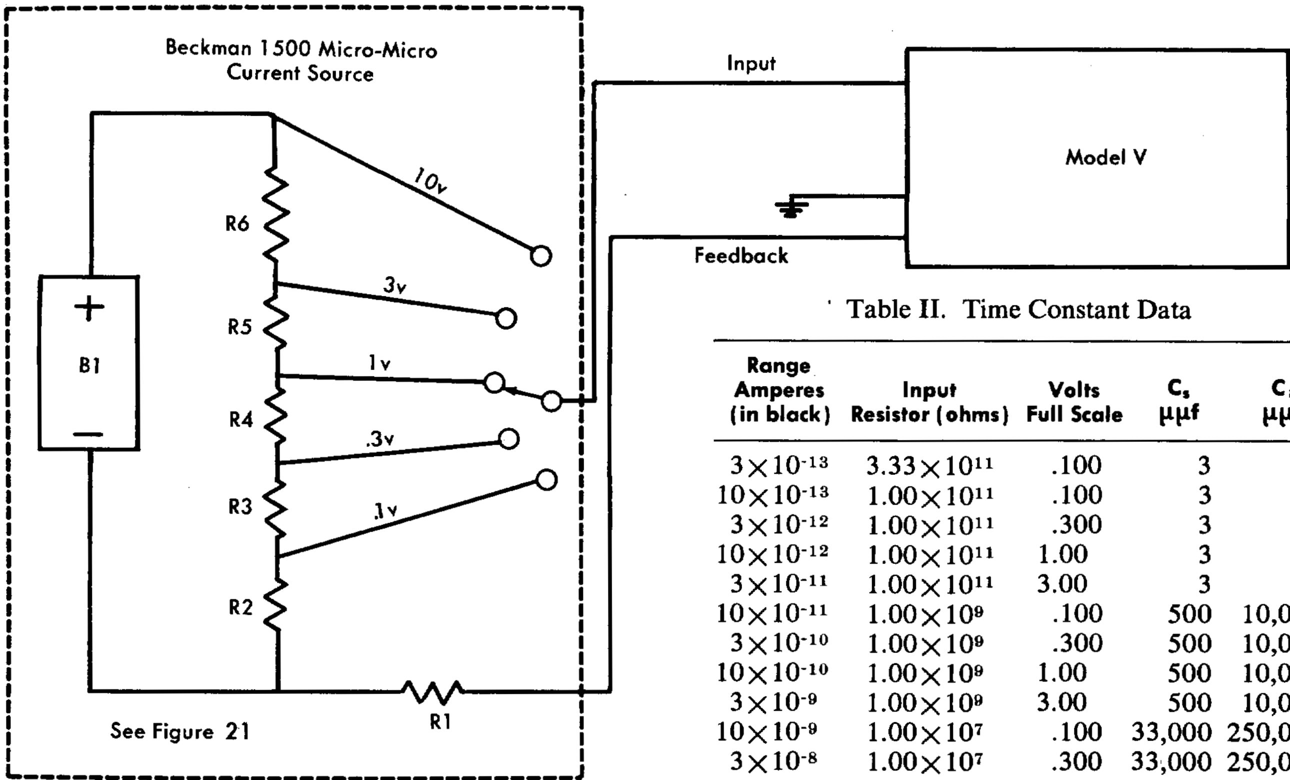


Figure 13. Voltage Calibration Diagram

Table II. Time Constant Data

Range Amperes (in black)	Input Resistor (ohms)	Volts Full Scale	C_s μμf	C_i μμf
3×10^{-13}	3.33×10^{11}	.100	3	30
10×10^{-13}	1.00×10^{11}	.100	3	30
3×10^{-12}	1.00×10^{11}	.300	3	30
10×10^{-12}	1.00×10^{11}	1.00	3	30
3×10^{-11}	1.00×10^{11}	3.00	3	30
10×10^{-11}	1.00×10^{9}	.100	500	10,000
3×10^{-10}	1.00×10^{9}	.300	500	10,000
10×10^{-10}	1.00×10^{9}	1.00	500	10,000
3×10^{-9}	1.00×10^{9}	3.00	500	10,000
10×10^{-9}	1.00×10^{7}	.100	33,000	250,000
3×10^{-8}	1.00×10^{7}	.300	33,000	250,000
10×10^{-8}	1.00×10^{7}	1.00	33,000	250,000
3×10^{-7}	1.00×10^{7}	3.00	33,000	250,000

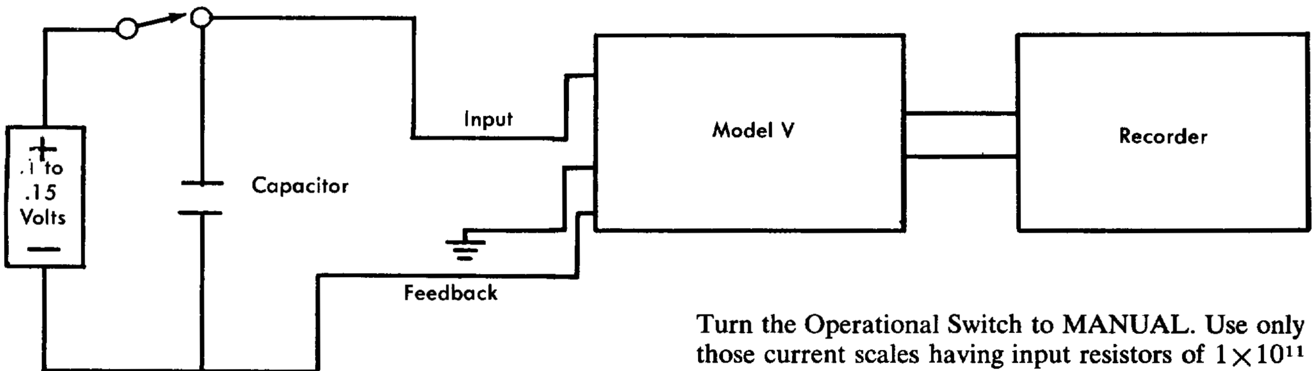


Figure 14. Current Calibration Diagram

D. VOLTAGE CALIBRATION

The voltage calibration can be checked by applying a known calibrated voltage between the INPUT and FB (Feedback) terminals. Turn the Selector Switch to the current scale corresponding to the desired voltage range as shown in Table II.

10×10^{-13} ampere scale corresponds to .1 volt full scale on the Model V meter (M1)

3×10^{-12} ampere scale corresponds to .3 volt full scale on the Model V meter (M1)

10×10^{-12} ampere scale corresponds to 1 volt full scale on the Model V meter (M1)

3×10^{-11} ampere scale corresponds to 3 volts full scale on the Model V meter (M1)

Turn the Operational Switch to MANUAL. Use only those current scales having input resistors of 1×10^{11} ohms. If the voltage registered on the Model V Meter is not within acceptable limits (1.5 percent) proceed to test Amplifiers 1 and 2 as outlined above. If this test has already been made, check condenser C24 (50 μf) for leakage or a short circuit. The instrument will tend to read high if this condenser is faulty. If these checks are all satisfactory the feedback resistors R25, R26, R27 and R38 should be investigated. The feedback resistors R25, R26, R27 and R38 can be checked by measuring them with a Wheatstone bridge. Before measuring, disconnect the Model V meter (M1) to avoid damaging it with the high currents in the bridge. See the Parts List in this manual for values and tolerances of the feedback resistors. Inspect resistor R35 by measuring with a micro-ammeter the current through the meter and the resistor when the Model V is in operating order and the Power Switch is ON.

REVISION SHEET

BULLETIN 271-D

$10{,}000\ M\Omega$

$3\ MV$

$I = \frac{3 \cdot 10^{-3}}{10^{10}} = 3 \cdot 10^{-13}$

$= .3 \cdot 10^{-12}$

1. Page 2. Paragraph B 7 should read:

   7. Chamber Supply Voltage: 210 volts with maximum drift rate of 0.3 millivolts per second.

2. Page 5, Column 1, third paragraph. First sentence should end: "...(C_V, Figure 3)."

3. Page 6, Figure 7. Fixed condenser at the top of the illustration should be labeled "75 μμf" instead of "25 μμf."

4. Page 7, Figure 9 B. Sine wave should be shifted 90° forward, so that it is in phase with wave in Figure 9 C.

5. Page 8, Figure 11 B. Polarity signs should be reversed on voltmeter in lower right corner.

6. Page 10, paragraph C 7. First sentence should read:

   7. Read E_1 (see Figure 3) on the vacuum tube voltmeter and E_2 on the lower scale of the Model V Meter.

7. Page 10, paragraph C 8 a. After "...the gain of Amplifiers 1 and 2.", add: "Usually, the loop gain will be from 3000 to 6000."

8. Page 19. See revised circuit diagram, Figure 22.

E. CURRENT CALIBRATION

The current calibration can be determined by supplying a known current to the instrument, from the Beckman 1500 $\mu\mu$ Current Source, for example. In this case the current source must have an internal resistance at least equal to the input resistance R_r (Figure 3) of the Model V. The input resistor used for each current scale is shown in Table II.

The current calibration CANNOT be found by measuring the resistance between the INPUT and GND terminals, even with the instrument disconnected from the line, because the input resistance under these circumstances is shunted by the insulation leakage resistance.

If the voltage calibration is correct but the current calibration is low, the circuit should be checked for moisture or insulation leaks on the high value resistors.

Another method of current calibration follows.

Capacitor Discharge Method for Calculating Values of Input Resistors: The values of the input resistance for the four highest current ranges can be measured on a Wheatstone bridge. The value for the nine lower current ranges can be determined by measuring the time constant of the resistor in conjunction with a known low-leakage capacitor.

1. Connect a condenser of sufficient capacitance between the INPUT and FB terminals to give a product of $R_r \times c = 100$ seconds (at least). A condenser with polystyrene dielectric may be used if it has been found to have a leakage resistance over 500 times the value of the input resistor being tested. Use a .1 mfd capacitor for calibrating the 10^9-ohm resistor (R41). Use a .001 mfd capacitor for measuring the 10^{11}-ohm resistor (R42 and R43 in parallel), and for the 3.33×10^{11}-ohm resistor (R43). Protect the capacitor and input leads from external fields by shielding.

2. Make the meter adjustments as usual, with the Selector Switch set to the correct position to select the resistor to be measured (see Table II), and the Operational Switch set at MANUAL.

3. Connect the capacitor and determine if the dielectric absorption currents are negligible. This may be accomplished by discharging the condenser to 0 volts, and observing by the Model V meter the ability of the condenser to remain at 0 volts. Some condensers will act like voltage generators, remaining a few millivolts on either side of 0.

4. Charge the condenser with an external battery to a voltage between .10 and .15 volt on scale 3×10^{-13}, scale 10×10^{-13}, and scale 10×10^{-11}

5. Allow the condenser to discharge through the input resistor, measuring the number of seconds required for the meter needle to go from 10.0 to 3.67.

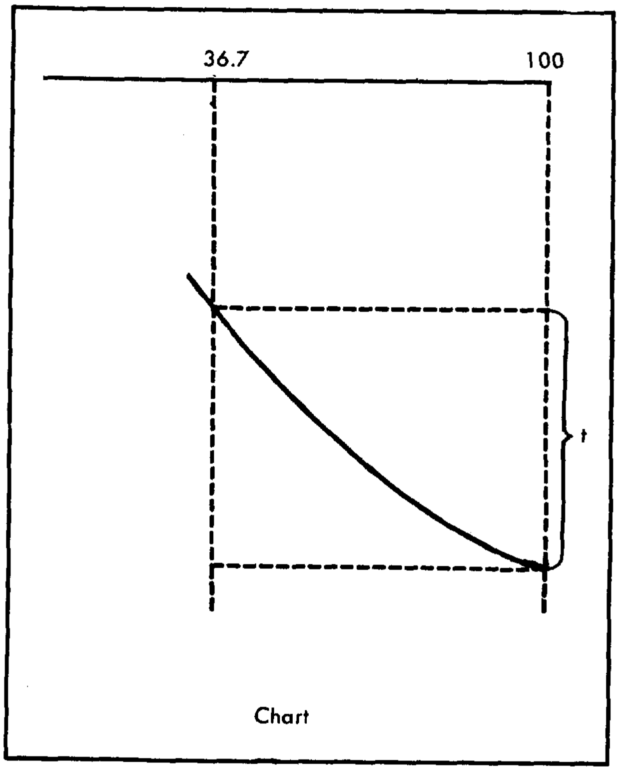


Figure 15. Capacitor-Discharge Method, Using a Recorder to Measure Time of Discharge

6. Divide the figure obtained in Step 5 by the condenser capacitance in thousands of micro-microfarads to find the value of the input resistor in thousands of megohms. The use of a recorder will greatly facilitate this test, and will also increase the precision. See Figure 14 for details of connections for using a recorder. The strip chart recorder will produce a chart similar to that shown in Figure 15. Use the time t to solve the equation

$R = \frac{t}{C}$, where R = value of resistor in thousands of megohms

t = time in seconds

C = capacitance in micro-microfarads

F. OUTPUT NOISE

The following test should be performed over a period of at least 3 hours with the Model V connected to a recording unit.

1. Disconnect the instrument from line voltage and remove the dust cover by unscrewing the four bolts located above the rear panel.

2. Remove the metal plate located on the underside of the instrument below the INPUT and MULT SW outlets. This provides access to INPUT 1 and B+ REG.

3. Connect a 50 $\mu\mu$f polystyrene dielectric capacitor (Fast No. A9157BA) between INPUT 1 and B+ REG and solder connections. Make the connection at this point to take advantage of the shielding provided by the Model V chassis. Replace metal plate and dust cover. If the condenser is connected between INPUT 1 and B+ REG externally, it must be mounted in a metal box to shield it from stray radiation and other sources of noise. The 50 $\mu\mu$f condenser simulates a very large ion chamber for test purposes.

4. Set the Selector Switch on the 3×10^{-13} scale and the Operational Switch on MANUAL. Connect the instrument to line voltage and turn the Power Switch ON. The noise level, as indicated by needle fluctuation, should be less than ±5 percent.

5. If the noise level exceeds ±5 percent, the power supply regulation may be faulty. It can be checked by suddenly changing the line voltage from 103 volts ac to 127 volts ac. If the needle kick for this shift in line voltage is less than 10 percent on the meter scale, the power regulation is functioning properly. If the noise level is above 5 percent and power supply regulation is not at fault, replacing the 5651 Tube may reduce the noise level.

The waveforms shown in Figures 16 through 19 are typical but their amplitudes will vary from capacitor to capacitor as a function of the uniformity of contact potential distribution on the surfaces. The most uniform surfaces will produce the least residual signal. Typical capacitors at maximum drive will produce .5 to .7 volt rms at the OSC terminal.

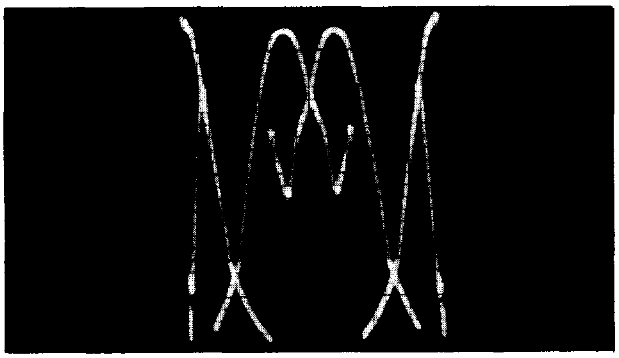


Figure 16. Pattern of Vibrating Capacitor Shorted at Several Places

The oscilloscope patterns in Figures 16 and 17 are typical of those of a shorted vibrating capacitor. Although a shorted vibrating capacitor can appear in several ways, it will usually appear as shown in Figure 16, which indicates a short in several places in the cycle. Figure 17 shows the pattern of a vibrating capacitor shorted only at the extreme ends of the cycle.

The pattern in Figure 18 shows an overloaded signal condition. If the load at the input is reduced or eliminated, the pattern should regain its normal appearance; if it does not, the feedback system is inoperative.

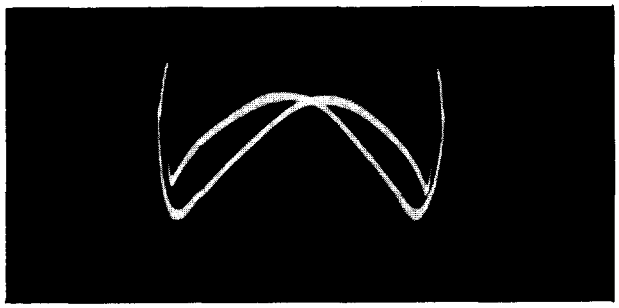


Figure 17. Pattern of Vibrating Capacitor Shorted Only at the Ends of the Cycle

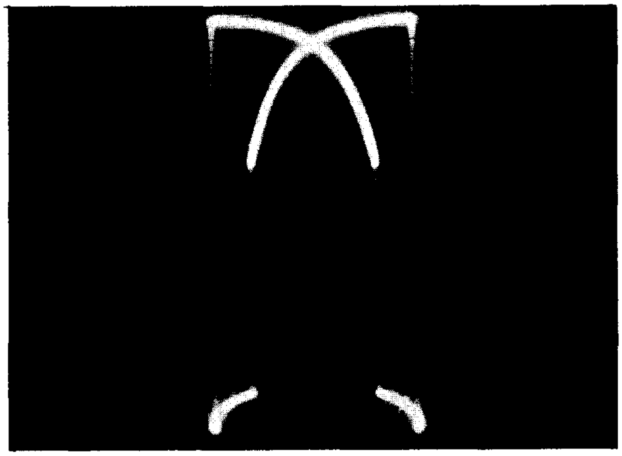


Figure 18. Overloaded Signal Condition

The appearance of a good vibrating capacitor is shown in Figure 19. Here the pattern is almost flat with little harmonic content.

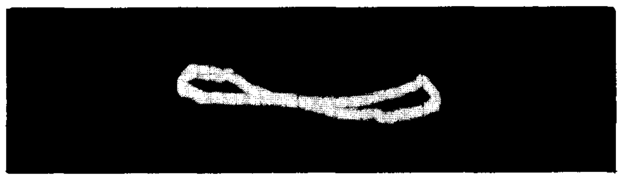


Figure 19. Normally-Operating Vibrating Capacitor

Electronic Tubes: If it is necessary to remove electronic tubes, DO NOT handle tubes or wiring until the Power Switch is turned OFF. When handling the CK 533 AX tubes, hold them by the leads or the top of the envelope, never by the pressed end of the envelope. Be sure that not over 15 milliamperes passes through the filaments of the CK533AX tubes. The V3 (12AU7), V4, V7 (6AQ5) and V8 (6X4) tubes can be checked on a standard tube tester; however, such tests are not necessarily conclusive on V1, V2, V6 and V9 (CK533AX) tubes. All tubes are used as supplied by the manufacturer; in replacing tubes, no selection is required. Actual trial replacement should be made first in cases of suspected faulty tubes. A set of spare tubes is located inside the instrument dust cover.

G. TROUBLE-SHOOTING

Following are some symptoms of malfunctions, with indications of probable sources of trouble in each case.

1. Erratic operation of the Meter (ripple over 1 mv on B+ as seen with an oscilloscope).

a. May be caused by failure of the Regulated Power Supply to control B+ voltage properly, due to:

(1) Defective neon lamps (NE51).

(2) Open filament in tube V1, V2, V9, V6, V3B, or V7.

(3) Open resistor in filament string (R3, 10, 9, 33, 32, 34).

(4) ~~R54 open~~

b. May be caused by noise in the Regulated Power Supply due to:

(1) Intermittent noise in Resistors R3, 10, 9, 33, 32, 34.

(2) Noisy V5 (5651).

(3) Microphonic V9 or V6 (CK533AX).

2. Low Loop Gain – may be due to:

a. Defective Vibrode C_v.

b. Improper phasing of Demodulator T2. Correct by selecting C15 for maximum voltage across T2.

c. Defective (open) C9 or C26.

d. Defective CR1 or CR2 (1N34).

e. Shorted transformer T1 or T2.

3. Zero offset over 2%. To measure Zero offset, proceed as follows:

With no signal on the Input, and the Selector Switch at ZERO, adjust the meter needle to zero with the Zero control. Now turn the Selector Switch to 3×10^{-13}. The meter needle should return to a point within $\pm2\%$ of scale zero. If it does not, the cause may be one of the following:

a. Defective Capacitor C1.

b. Defective insulation of Switch SW1.

c. Charge built up on input plug (P3) by friction with mating plug. Charge will dissipate in several hours.

4. Temperature of thermoregulated housing too high or too low. Should be 58 $\pm2°$ C. Adjust thermostat with a strong magnet by turning the adjusting bar, or replace the thermostat if contacts are defective.

5. Excessive noise when Selector Switch is in 3×10^{-13} position may be caused by:

a. Defective Vibrode C_v.

b. Microphonic input tube V1.

6. Meter will not read full scale on 3×10^{-11}, 3×10^{-9}, or 3×10^{-7} range. Probable causes are:

a. Improper phasing of Demodulator T2. Correct by selecting C15 for maximum voltage across T2.

b. Defective 1N34 (CR1, 2).

c. Shorted turn in Transformer T1 or T2.

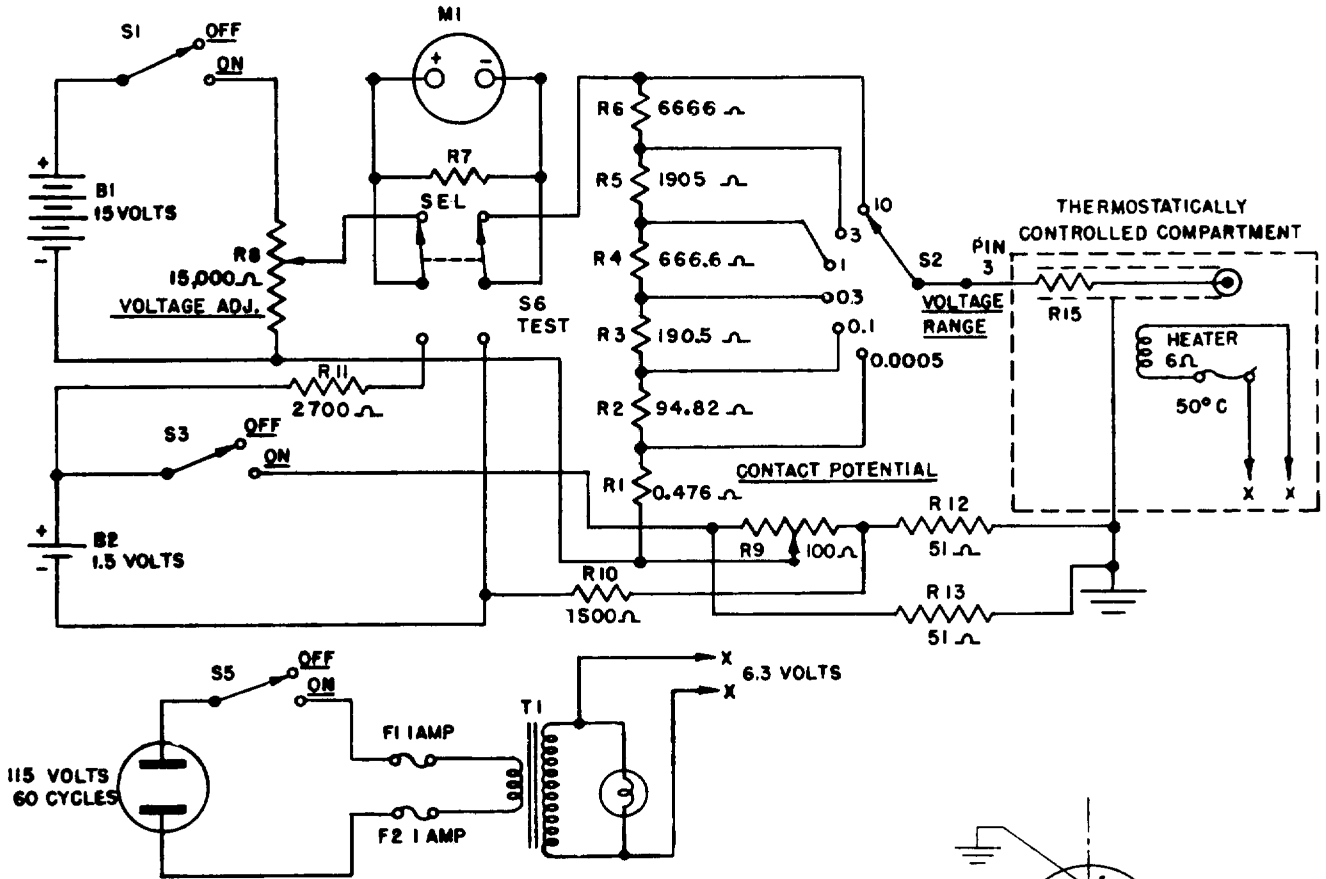
d. Defective Capacitor C12.

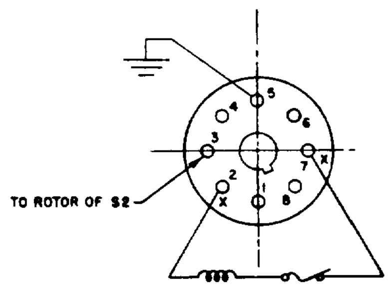
7. Meter needle does not zero: may be caused by:

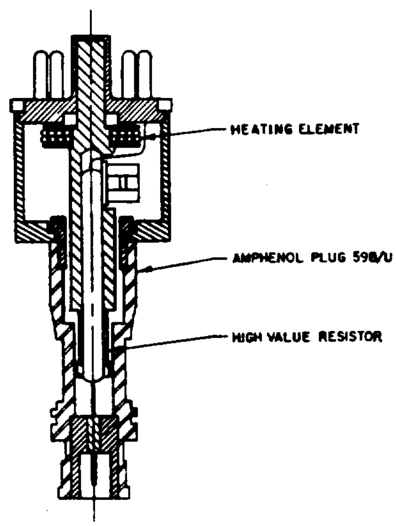
a. Open Zero control R11.

b. Open filament in tube V1, 2, 9 or 6.

c. Open resistor in filament circuit – R3, 10, 9, 33, 32, 34.







R 7 USED TO SHUNT METER (M1) TO 1.05 MA.

MOD V RANGE SWITCH	MOD. V. CURRENT		
	METER ADJ VOLTS	VOLTAGE RANGE	CURRENT RESISTOR R15
3×10^{-13}	3	0.1	10^{11} Ω
10×10^{-13}	10	0.1	10^{11} Ω
3×10^{-12}	10	0.3	10^{11} Ω
10×10^{-12}	10	1.0	10^{11} Ω
3×10^{-11}	10	3.0	10^{11} Ω
10×10^{-11}	10	10.0	10^{11} Ω
3×10^{-10}	10	0.3	10^{9} Ω
10×10^{-10}	10	1.0	10^{9} Ω
3×10^{-9}	10	3.0	10^{9} Ω
10×10^{-9}	10	0.1	10^{7} Ω
3×10^{-8}	10	0.3	10^{7} Ω
10×10^{-8}	10	1.0	10^{7} Ω
3×10^{-7}	10	3.0	10^{7} Ω
FOR LOOP GAIN MEASUREMENTS			
3×10^{-11}	.0005	3	0

Figure 20. Schematic Wiring Diagram of Special Calibrating Equipment

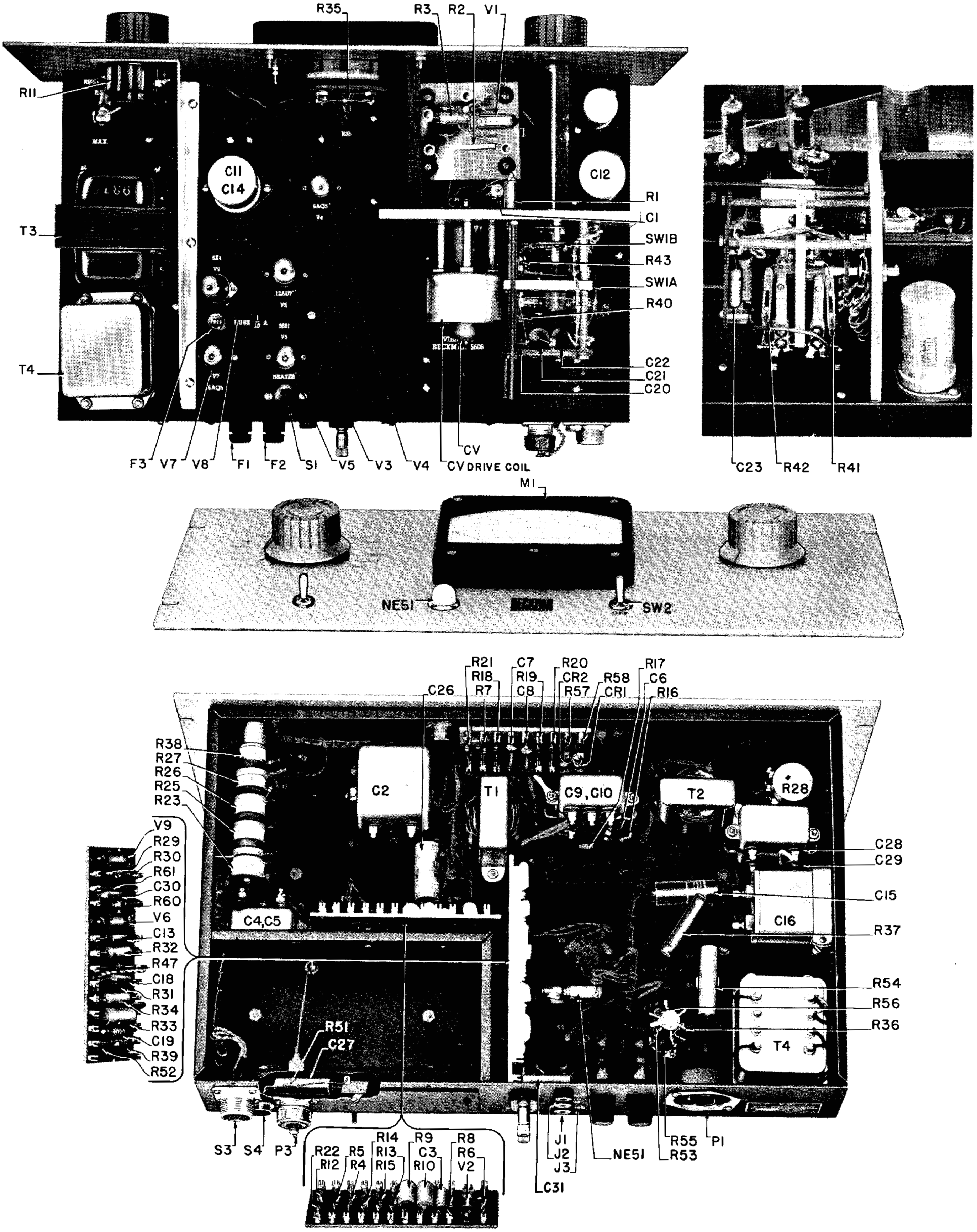
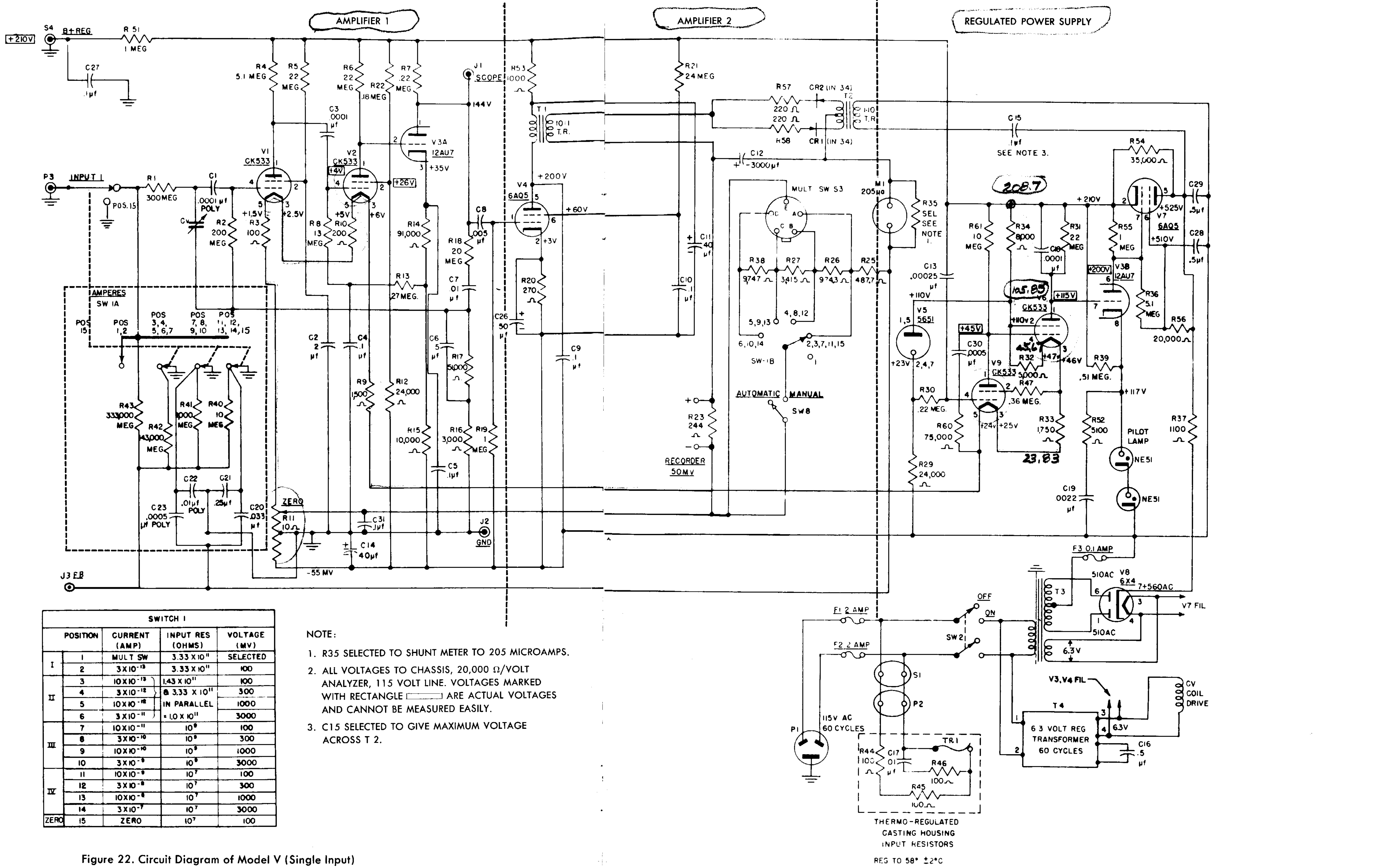


Figure 21. Views of Model V Chassis

PARTS LIST

Symbol	Description	Beckman Part
R1	300 Meg, ±10% RPC Type HBF	5630
R2	200 Meg, ±10%, 1 watt, S.S. White	6270-494
R3	100 ohms, ±5%, Sprague 5 NIT	4068
R4, 36	5.1 Meg, ±5%, ½ watt, AB EB	10624
R5, 6, 31	22 Meg, ±10%, ½ watt, AB EB	8853
R7, 30	.22 Meg, ±10%, ½ watt, AB EB	8102
R8	13 Meg, ±5%, ½ watt, AB EB	5659
R9	1,500 ohms, ±5%, Sprague, Type 5 NIT	4066
R10	200 ohms, ±5%, Sprague, Type 5 NIT	4067
R11	Potentiometer, 10 ohms, Helipot C.T. No. 10 CZ	5566
R12, 29	24,000 ohms, ±10%, ½ watt, AB EB	7933
R13	.27 Meg, ±10%, ½ watt, AB EB	8103
R14	91,000 ohms, ±5%, ½ watt, AB EB	15073
R15	10,000 ohms, ±5%, ½ watt, AB EB	15052
R16	3,000 ohms, ±5%, ½ watt, AB EB	8845
R17	51,000 ohms, ±5%, ½ watt, AB EB	15067
R18	20 Meg, ±5%, ½ watt, AB EB	2208
R19, 51, 55	1 Meg, ±10%, ½ watt, AB EB	8148
R20	270 ohms, ±10%, ½ watt, AB EB	8070
R21	.24 Meg, ±5%, ½ watt, AB EB	3180-13
R22	.18 Meg, ±5%, ½ watt, AB EB	15081
R23	244 ohms, ± 5 ohms	5664
R24	Not used	
R25	487.7 ohms, ± 1 ohm	5642
R26	974.3 ohms, ± 2 ohms	5642
R27	3415 ohms, ± 7 ohms	5642
R28	Not used	
R32	5,000 ohms, ±5%, 5 watt, Dale Prod, RS-5	1430
R33	1,750 ohms, ±5%, 5 watt, Dale Prod, RS-5	1429
R34	8,000 ohms, ±5%, 5 watt, Dale Prod, RS-5	1428
R35	Selected (used to shunt meter M-1 to 205 microamps.)	
R37	1,100 ohms, ±5%, 10 watt, Mallory, Type 1HJ vitreous enamel	8840
R38	9747 ohms, ± 25 ohms	5642
R39	.51 Meg, ±5%, ½ watt, AB EB	9092
R40	10 Meg, ±1%, Wilkor Type CPI, 1 watt, w/Vinylite sleeving	5626
R41	1,000 Meg, ±5% at 3 v and 58° C, Type EBF or Victoreen	5625
R42	143,000 Meg, ±5%, 3 v and 58° C, Type HBM or Victoreen	5624
R43	333,000 Meg, ±5% at 3 v and 58° C, Type HBM or Victoreen	5623
R44, 45	100 ohms, ±10%, 50 watt, Ohmite	9841
R46	100 ohms, ±10%, ½ watt, IRC, Type BW-½	9061
R47	.36 Meg, ±5%, ½ watt, AB EB	1102
R48, 49, 50	Not used	
R52	5,100 ohms, ±5%, ½ watt, AB EB	8123
R53	1,000 ohms, ±5%, ½ watt, AB EB	15038
R54	35,000 ohms, ±5%, 10 watt, Sprague	6270-233
R56	20,000 ohms, ±5%, 1 watt, AB GB	6270-564-14
R57, 58	220 ohms, ±10%, ½ watt, AB EB	8069
R59	Not used	
R60	75,000 ohms, ±5%, ½ watt, AB EB	8775
R61	10 Meg, ±10%, ½ watt, AB EB	11180
C_v	Vibrode	5606

Symbol	Description	Beckman Part
C1	.0001 mfd, 600 v, Polystyrene, ±20%	5596
C2	2 mfd, 400 v, Mallory No. CB-406	5617
C3	.0001 mfd, 400 v, Polystyrene, ±10%, Solar No. SDP-4-.0001	12058
C4, 5	.1 + .1 mfd, Mallory No. CBD-602	5619
C6	.5 mfd, Mallory No. CB-404	5618
C7	.01 mfd, 600 v, paper, ±20%, Sprague No. 73P 10306	15024
C8	.005 mfd, 600 v, paper, +30 −10%, Sprague No. 256-AG	6270-453
C9, 10	.1 + .1 mfd, Mallory No. CBD-602	5619
C11, 14	40 mfd, 450 v, electrolytic, Mallory No. FP-238	144
C12	3,000 mfd, 10 v, Mallory No. WP-032	5621
C13	.00025, 600 v, Polystyrene, ±20%, Fast A7877FJ	6270-348
C15	.1 mfd, paper, ± 20%, Sprague No. 73P 10406	13370
C16	Supplied with transformer T4	5615
C17	.01 mfd, 300 v, mica (low loss case), ±20% Cornell-Dubilier No. IDL-3S1	9062
C18	.0001 mfd, 500 v, mica, ±20%, Cornell-Dubilier No. SW-5T1	2191
C19	.0022 mfd, 600 v, molded paper, ±20%, Sprague No. 73P 22206	15028
C20	.033 mfd, 600 v, paper, ±20%, Sprague No. 73P 33306	13370
C21	.25 mfd, 400 v, paper, Mallory No. PT 4025	4651
C22	.01 mfd, 600 v, polystyrene, ±20%, Fast No. A7878 CJ	9039
C23	.0005 mfd, 600 v, polystyrene, ±20%, Fast No. A6290 FJ	9029
C24, 25	Not used	
C26	50 mfd, 25 v, Mallory No. TC-29	5559
C27	.1 mfd, paper, ±20%, Sprague No. 73P 10406	13370
C28, 29	.5 mfd, 600 v, Mallory CB No. 604	5564
C30	.0005 mfd, 500 v, mica, Sprague No. 1 FM-35	10893
C31	.1 mfd, 600 v, paper, ±20%, Sprague No. 73P 10406	13370
V1, 2, 6, 9	CK 533, Raytheon	12524
V3	12AU7, RCA	12015
V4, 7	6AQ5, RCA	12014
V5	5651, RCA	173
V8	6X4, RCA	12013
CR1, 2	1N34, Sylvania	738
M1	Meter	5536
T1, 2	Transformer (demodulator)	5616
T3	Transformer, Power	5592
T4	Transformer, Regulating 6.3 Volt Sola No. 301002 Type 12	5615
P1	Connector base, flush, male, Hubbell No. 7556G	4536
P2	Plug, Jones No. P-302-CCT	5612
P3	Plug, Amphenol No. 82-805 Teflon	5614
S1	Socket, Jones No. S-302AB	5611
S2	Not used	
S3	Socket, AN 3102A-14S-5S	5629
S4	Socket, Amphenol No. 80C	9093
J1, 3	Tip-Jack, E. F. Johnson 105-520 Red	5627
J2	Tip-Jack, E. F. Johnson 105-521 Black	5628
SW1	Switch, Selector	5676
SW2	DPST Toggle Switch, 12A, 125V, Arrow H.&H. No. 82143	2313
SW8	DPST Toggle Switch, 6A, 125V, Cutler-Hammer No. 8370K7	1918
F1, 2	Fuse, 2 amp. SloBlo Littelfuse 313002	9017
F3	Fuse, 0.1 amp. Littelfuse 313100	9842
TR1	Thermostat, adjusted to 58° C	1036



SWITCH I				
POSITION		CURRENT (AMP)	INPUT RES (OHMS)	VOLTAGE (MV)
I	1	MULT SW	3.33×10^{11}	SELECTED
	2	3×10^{-13}	3.33×10^{11}	100
II	3	10×10^{-13}	1.43×10^{11}	100
	4	3×10^{-12}	& 3.33×10^{11}	300
	5	10×10^{-12}	IN PARALLEL	1000
	6	3×10^{-11}	$= 1.0 \times 10^{11}$	3000
III	7	10×10^{-11}	10^{9}	100
	8	3×10^{-10}	10^{9}	300
	9	10×10^{-10}	10^{9}	1000
	10	3×10^{-9}	10^{9}	3000
IV	11	10×10^{-9}	10^{7}	100
	12	3×10^{-8}	10^{7}	300
	13	10×10^{-8}	10^{7}	1000
	14	3×10^{-7}	10^{7}	3000
ZERO	15	ZERO	10^{7}	100

NOTE:

1. R35 SELECTED TO SHUNT METER TO 205 MICROAMPS.
2. ALL VOLTAGES TO CHASSIS, 20,000 Ω/VOLT ANALYZER, 115 VOLT LINE. VOLTAGES MARKED WITH RECTANGLE ▭ ARE ACTUAL VOLTAGES AND CANNOT BE MEASURED EASILY.
3. C15 SELECTED TO GIVE MAXIMUM VOLTAGE ACROSS T 2.

Figure 22. Circuit Diagram of Model V (Single Input)

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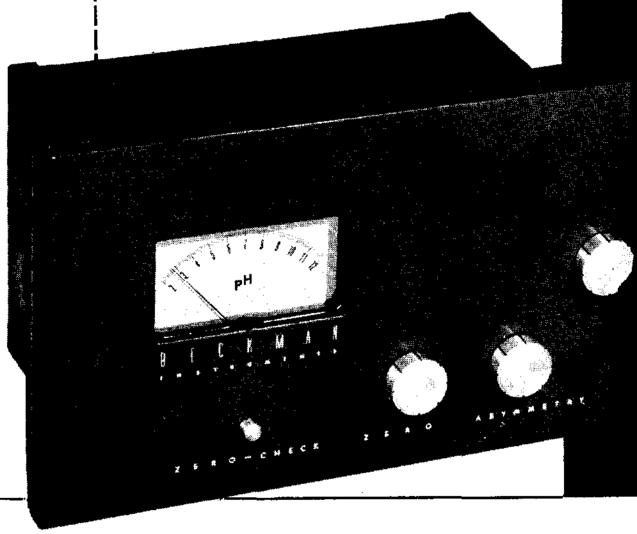
—A Husky New Addition to America's Most Distinguished Family of



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