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SANDIA LABORATORY

Branch of

LOS ALAMOS SCIENTIFIC LABORATORY

UNIVERSITY OF CALIFORNIA

HIGH POTENTIAL TESTER MK II MOD 0

R. A. Richards, SLE-6

May 10, 1949

Report No. SLMS-94

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HIGH POTENTIAL TESTER MK II MOD 0

(I). PURPOSE

The High Potential Tester (HPT) Mk II Mod 0 is a high-voltage power supply designed for use in testing the high-voltage breakdown characteristics of the insulation in the various high-voltage components and cables used with the Mk III Mod 0, Mk III Mod 1, and Mk IV Mod 0 FM bombs. It is also used as a source of high voltage in calibrating the Peak Reading Voltmeter (PRVM) Mk I Mod 2.

The HPT may be used as a source of high voltage for other applications provided its current and voltage limits are observed. It is normally used in the laboratory.

(II). DESCRIPTION

The overall dimensions of the HPT are 19 X 12-1/4 X 10 inches; it contains a front panel 19 X 12-1/8 X 3/16 inches and a chassis 17 X 10 X 3 inches. The HPT without cables weighs approximately 43 pounds. The unit plus carrying case weighs 185 pounds, and the weight of the unit, carrying case, and shipping chest (total shipping weight) is 335 pounds.

The power input requirement is 117.5 volts a-c at 0.5 amperes, 60 cps. The required output voltage is 0-11 kv d-c, the output current is 0-10 milliamperes, the maximum available voltage is 15 kv, and the maximum available current is no more than 15 milliamperes.

A schemetic diagram of the HPT Mk II Mod 0 (dwg. 5Y-15083-C1) and photographs of the front, top, and bottom views of the HPT are attached to this report.

(III). PRINCIPLES OF OPERATION

The functions of the major components of the HPT are outlined below. The components are segregated into (A) those components mounted on the front panel, (B) those mounted above the chassis, (C) those mounted below the chassis, and (D) other major components.

(A). Components Mounted on the Front Panel

(1). Line power switch S-102, marked LINE POWER, provides control over the 117.5-volt a-c supply.

(2). Line fuses F-101 and F-102 are in the 117.5-volt a-c input circuit. These fuses are in holders with screw caps which permit their replacement from the front of the panel.

(3). Amber indicator lamp I-101, marked FILAMENT, normally comes ON when the line power switch is operated to ON.

(4). Green indicator lamp I-102, marked READY, comes ON about one-half minute after the line power switch is operated to ON.

(5). High-voltage output control T-103, marked HV INCREASE, provides continuous adjustment of the high-voltage output.

(6). Snap-action switch S-103, associated with and mounted on the rear of the high-voltage output control, T-103, is part of the safety system which prevents premature high-voltage output.

(7). Red indicator lamp I-103, marked HIGH VOLTAGE, comes ON when voltage exists at the high-voltage output terminals.

(8). High-voltage output voltmeter M-101, marked VOLTAGE, indicates the magnitude of the voltage at the high-voltage output terminals.

(9). High-voltage output milliammeter M-102, marked CURRENT, indicates the magnitude of the current being furnished to the external load connected to the high-voltage output terminals.

(10). Negative high-voltage output jack J-102, marked DANGER HIGH VOLTAGE, is the negative high-voltage output terminal.

(11). Positive high-voltage output jack J-103, marked GROUND, is the positive high-voltage output terminal and is connected directly to the HPT chassis.

(B). Components Mounted above the Chassis

(1). High-voltage output transformer T-102 provides high-voltage alternating current to the high-voltage rectifier system.

(2). High-voltage rectifier tube filament transformer T-101 provides filament power to the high-voltage rectifier tube, V-101.

(3). High-voltage rectifier tube V-101 provides half-wave rectification for the high-voltage rectifier system. V-101 is an 8013-A high-vacuum rectifier tube.

(4). High-voltage capacitors C-101 and C-102 serve as filter capacitors in the high-voltage rectifier system output.

(5). Time delay relay unit K-101 allows the filament of the high-voltage rectifier tube, V-101, about 30 seconds to become warm before the high voltage can be applied.

(6). High-voltage output relay K-103 is provided to transfer the negative high-voltage output terminal connection from the negative output of the high-voltage rectifier system to the high-voltage output load discharge resistor, R-104, when the high-voltage output control knob is turned to OFF.

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(7). Lock-in relay K-102 is part of the safety system preventing premature high-voltage output.

(8). High-voltage output load-discharge resistor R-104 is provided for discharging externally connected capacitive loads with limited discharge current when the high-voltage output control knob is turned to OFF.

(9). High-voltage voltmeter multiplier resistors R-105, R-106, and R-107, together with resistors R-108 through R-112, which are mounted below the chassis, comprise the high-voltage multiplier resistor for the high-voltage voltmeter, M-101.

(C). Components Mounted below the Chassis

(1). Chassis-cabinet interlock snap-action switch S-101 is provided to break the 117.5-volt a-c input circuit automatically when the HPT is separated from its cabinet.

(2). High-voltage output load-limiting resistor R-103 is a one-megohm resistor connected in series with the negative side of the high-voltage rectifier system output for limiting the maximum short-circuit output current to less than 15 milliamperes.

(3). High-voltage output voltmeter multiplier resistors R-108 through R-112, together with resistors R-105, R-106, and R-107, which are mounted above the chassis, comprise the high-voltage multiplier resistor for the high-voltage voltmeter, M-101.

(4). High-voltage output milliammeter shunt resistor R-102 shunts most of the HPT load current around the high-voltage output milliammeter, M-102, and provides a path to ground if the meter circuit should open.

(5). Filter resistor, R-101, is part of the smoothing filter of the high-voltage ouput rectifier system.

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(D). Other Major Components

(1). Cable CT-102 connects the HPT to its proper 117.5-volt a-c power source.

(2). Cable CT-112 provides the ground (positive) high-voltage output connection to equipment or components under test.

(3). Cable CT-113 provides the negative high-voltage output connection to equipment or components under test and is equipped with a specially protected probe.

(4). Ground straps (wire mesh) are provided for making low-resistance connections to an earth ground from the HPT.

(5). A binding post, marked GROUND, is mounted at the lower right of the front panel for connecting a conducting ground strap from the chassis to a good earth ground such as a ground rod or water pipe. (Air pipes and gas pipes are not satisfactory grounds.)

NOTE: It is also necessary that the chassis of equipment under test with the HPT be grounded to a good earth ground.

(IV). THEORY OF OPERATION

(A). General Description of Operation

The HPT Mk II Mod 0 provides a source of relatively high-voltage d-c power and has a manually-controlled adjustable output ranging from 0-15 kilovolts and a maximum short-circuit output current limit of not more than 15 milliamperes at its maximum output setting.

This high-voltage output is obtained by stepping up the 117.5-volt a-c line voltage by means of high-voltage output transformer T-102 and rectifying this voltage with half-wave high-voltage rectifier tube V-101 (Type 8013-A

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high-vacuum rectifier tube). The high-voltage pulsating direct current from the rectifier is filtered with a capacity-resistor pi-type filter system to provide relatively smooth high-voltage d-c power at the output terminals under normal operating conditions. The positive side of the high-voltage rectifier system output of the HPT is connected directly to the HPT chassis.

In use the HPT is connected by means of output cables CT-112 and CT-113 to the equipment under test. The high voltage is then turned on and raised to the required test value, after which the current indication is checked for an excessive reading or other characteristics peculiar to the particular equipment under test, as described in the test instructions. At the completion of any test the high-voltage output control knob should always be turned to the OFF position before removing the output cables.

(B). Controls and Indicators

The indicator lamps give the operator the following information about the operating conditions of the HPT:

(1). The amber FILAMENT indicator lamp, I-101, comes on when voltage is applied to the filament of the high-voltage rectifier tube, V-101, at the time that line power switch S-102 is operated to ON to provide 117.5-volt a-c line power to the HPT.

(2). The green READY indicator lamp, I-102, comes on about 30 seconds after the amber FILAMENT indicator lamp comes on. It informs the operator that the filament of the high-voltage rectifier tube, V-101, has had sufficient time to heat and that the 117.5-volt a-c line voltage is available to the high-voltage rectifier system.

(3). The red HIGH VOLTAGE indicator lamp, I-103, comes on when the high-voltage output control knob is turned from its OFF position to

any high-voltage output position, informing the operator that high voltage exists at the output terminals of the HPT.

The high-voltage output control, T-103, marked HV INCREASE, provides continuous adjustment of the high-voltage output. The knob for this control is near the center of the front panel.

The high-voltage output voltmeter, M-101, marked VOLTAGE, indicates the magnitude of the voltage at the high-voltage output terminals.

The high-voltage output milliammeter, M-102, marked CURRENT, indicates the magnitude of the current being furnished to the external load connected to the HPT.

(C). Connecting Cables

Cable CT-102 connects the HPT to a source of 117.5-volt alternating current.

Special high-voltage insulated cables, CT-112 and CT-113 connect the high-voltage output of the HPT to the equipment being tested.

Heavy wire-mesh ground straps are provided for the protection of the operating personnel.

(D). Safety Features

The high-voltage output relay, K-103, transfers the negative high-voltage output terminal connection and any externally connected load from the output of the high-voltage rectifier system to the high-voltage output load discharge resistor, R-104, when the high-voltage output control knob is turned in a counterclockwise direction to its OFF position. Thus the possibility of a residual charge in the rectifier system appearing at the output terminals after the HPT has supposedly been turned OFF is greatly

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reduced. Also any capacitances in externally connected loads will automatically be discharged when the high-voltage output control knob is turned to OFF.

Snap-action switch S-101 breaks the 117.5-volt a-c input circuit automatically when the HPT is separated from its cabinet.

The high-voltage output control interlock system prevents premature appearance of high voltage at the output terminals. The 117.5-volt a-c supply to the high-voltage output transformer, T-102, is controlled by contacts on lock-in relay K-102, which close when the relay is energized. This relay is provided with lock-in contacts which maintain the current supply to the relay coil once it is energized. Lock-in relay K-102 is initially energized by contacts on snap-action switch S-103 when the high-voltage output control knob is turned fully counter-clockwise to its OFF position. Thus had the high-voltage output control knob been left ON at the time the a-c line power switch, S-102, was operated to ON, high-voltage would not have appeared unintentionally at the high-voltage output terminals. An interruption of the line power will cause lock-in relay K-102 to become de-energized, necessitating returning the high-voltage output control knob to the OFF position to re-energize it.

A one-megohm load-limiting resistor is incorporated in the high-voltage output circuit of the HPT, in series with the negative side of the high-voltage rectifier system and the negative high-voltage terminal. This resistor limits the output current to less than 15 milliamperes under all normal conditions, including short-circuiting of the output.

Fuses are provided in the 117.5-volt a-c input circuit to protect the HPT against overload currents as a result of possible component break-downs.

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(V). OPERATING PROCEDURE

(A). Preliminary Preparation for Using the HPT

(1). Observe the SAFETY PRECAUTIONS outlined in Section VI.

(2). Operate the a-c line switch, S-102, to OFF.

(3). Rotate the knob of the high-voltage output control T-103, counterclockwise to its OFF position.

(4). Check the reading on voltmeter M-101.

INDICATION: Meter M-101 should read zero volts.

(5). Check indicator lamps I-101, I-102, and I-103.

INDICATION: All lamps should be OFF.

(6). Connect a ground strap from the binding post, marked GROUND, at the lower right of the front panel to an actual earth ground such as a water pipe or ground rod.

NOTE: This earth ground is a safety precaution to prevent the chassis of the HPT from acquiring a high potential relative to surrounding grounded objects (including the a-c power line) which would expose personnel to dangerous potentials. Do not use gas pipes or air lines as grounds.

(7). Connect cable CT-112 to jack J-103 and to the proper portion of the frame or circuit of the equipment under test. Jack J-103 is the positive high-voltage output terminal of the HPT. It is connected directly to the HPT chassis and thence to ground by means of a ground strap.

NOTE: This cable provides the ground return path for the HPT high-voltage output circuit. If this path is opened during operation of the HPT, the chassis of the equipment under test will acquire a high potential relative to ground unless another ground return path has been provided in the form of a separate ground strap connection. Therefore it is absolutely necessary that the ground side of the equipment under test as well as the HPT be provided with good ground strap connections to an earth ground.

(8). Connect cable CT-113 to jack J-102 and thence to the equipment under test, as described in the HPT test procedure for that particular piece of equipment. Jack J-102 is the negative high-voltage output terminal of the HPT.

(9). Check line power switch S-102 and the high-voltage output control, T-103, to be sure that they are OFF.

INDICATION: Both controls should be OFF.

(10). Connect the HPT to the a-c line by means of cable CT-102, which should first be plugged into connector J-102 at the rear of the HPT chassis; its other end should then be plugged into a 117.5-volt a-c outlet receptacle. The HPT is now ready for use.

(B). HPT Test Procedure

(1). Perform the preliminary steps outlined in Section V-A.

(2). Operate the line power switch, S-102, to ON.

INDICATION: The amber FILAMENT indicator lamp, I-101, should come ON.

(3). Wait about 30 seconds, during which time the green READY indicator lamp, I-102, should come ON.

INDICATION: The green READY indicator lamp, I-102, should come ON.

(4). The HPT is now ready to provide high voltage at its output terminals.

(5). To obtain high voltage rotate the knob of the high-voltage output control, T-103, slowly in a clockwise direction.

INDICATION: As the high-voltage output control knob leaves its OFF position, the red HIGH VOLTAGE lamp, I-103, should come ON. The high-voltage output voltmeter should now indicate the presence of high voltage at the high-voltage output terminals of the HPT, the exact amount depending upon the amount of clockwise rotation of the control knob, which is rotated until the desired output is indicated on the high-voltage output voltmeter.

(6). To remove the high-voltage output (and incidentally to connect a 30,000-ohm resistor across the high-voltage output terminals) rotate the high-voltage output control knob in a counterclockwise direction to its OFF position.

INDICATION: The red HIGH VOLTAGE indicator lamp should go OFF. The high-voltage output voltmeter should indicate zero volts.

(7). In an emergency the a-c line switch can be operated to OFF, automatically grounding (through 30,000 ohms) the high-voltage output as well as removing the high-voltage source. The same result may be accomplished by disconnecting a-c supply cable CT-102 from the 117.5-volt a-c outlet receptacle.

(8). If both cable CT-112 and the ground strap become disconnected from the HPT during operation and the negative high-voltage output cable is still connected to the equipment to be tested, it is probable that the full high-voltage will appear between the HPT chassis and ground. Therefore, in the event of loss of ground connections to the HPT, avoid contacting the chassis with the body until the a-c power source has been removed or the negative high-voltage output connecting cable CT-113 (or CT-113A) has been disconnected from the equipment being tested.

(VI). SAFETY PRECAUTIONS

(A). Operational Instructions

The operator should become completely familiar with the operational instructions and principles of the HPT, including all safety precautions.

(B). Ground Connections

Ground strap connections, in particular, should be watched. These connections are <u>essential</u> to safe operation of the HPT.

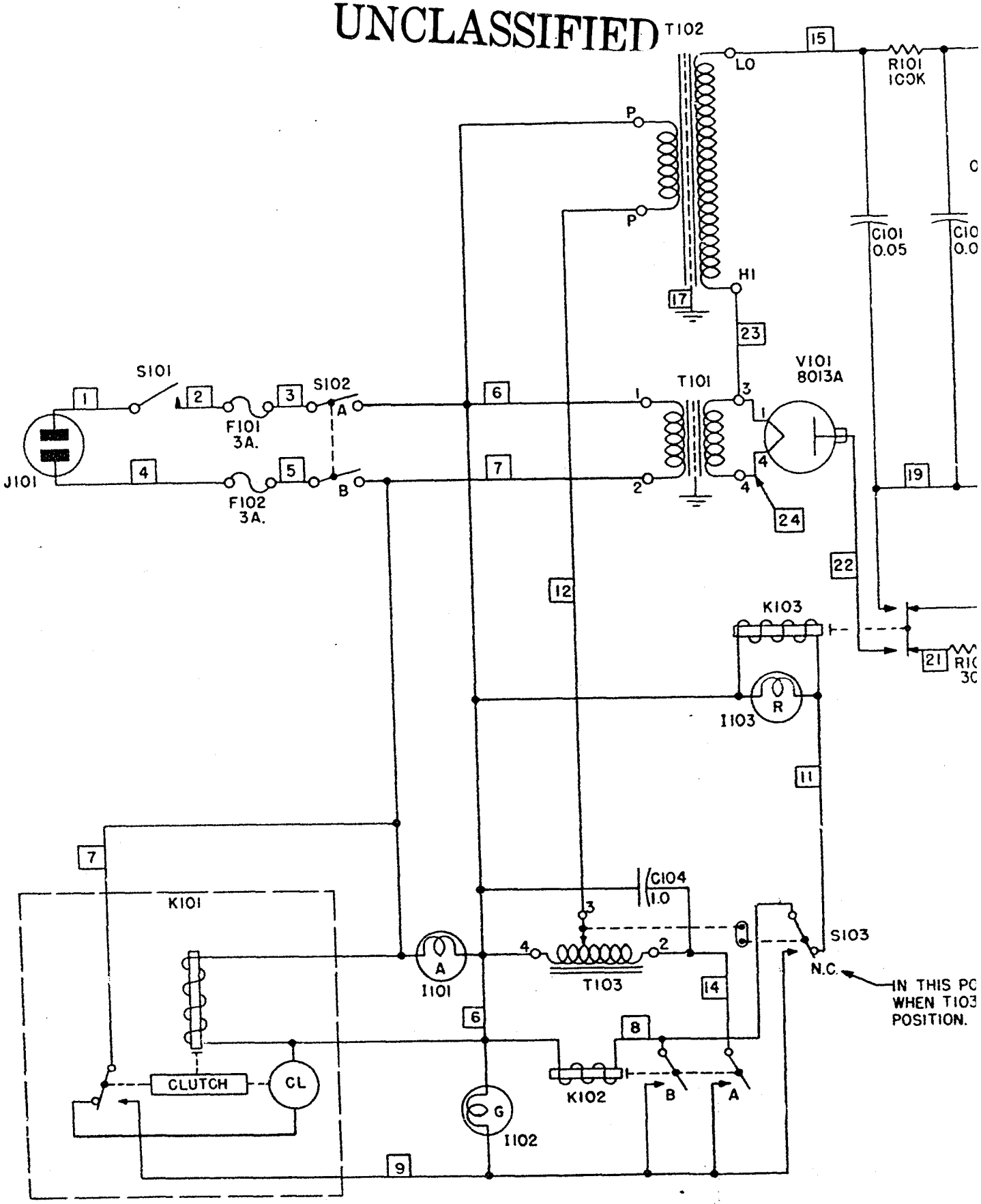
(C). Proximity Limits

Great care should be exercised to maintain adequate air-gap distances between conductors having high potential differences. It should be remembered that high potentials

will cause air gaps to arc over if an air gap is too short for the potential involved.

Report by _____
R. A. Richards, SLE-6

Approved by _____
E. L. Deeter
Division Leader, SLE-6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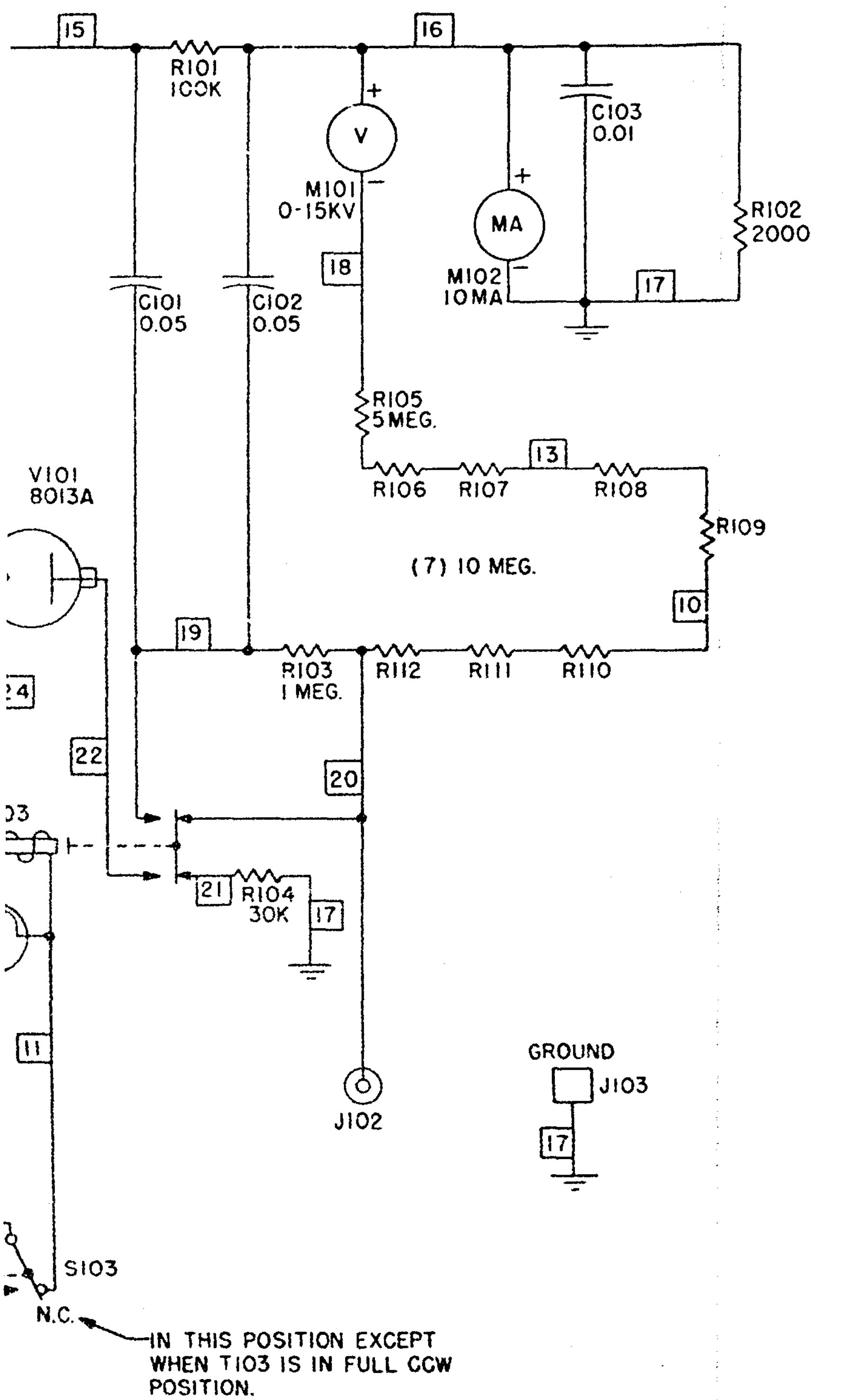

BILL OF MATERIAL

PART NO.	Q'TY	PER	DESCRIPTION
C101	1		CAPAC. 0.05 ±10%, 20KV. PAPER
C102	1		CAPAC. 0.05 ±10%, 20KV. PAPER
C103	1		CAPAC. 0.01 ±10% 300V. MICA
F101	1		FUSE, 3A. 250V. TYPE 4AG (SB)
F102	1		FUSE, 3A. 250V. TYPE 4AG (SB)
I101			
THRU	3		LAMP, 6W. 115V. #6S6DC
I103			
J101	1		CONN. A.C. FLUSH MOUNTING
J102	1		CONN. RECP. AN3102-18-16ST
J103	1		CONN. RECP. BANANA TYPE
K101	1		RELAY, TIME DELAY, 10 SEC.
K102	1		RELAY, 115V. 60∿ DPDT
K103	1		RELAY, HI. VOLT. 115V. 60∿
M101	1		METER, 0-200μA DC. SCALE 0-15KV.
M102	1		METER, 0-10 MA DC.
R101	1		RESISTOR, 100K, ±10%, 50W. W.W.
R102	1		RESISTOR, 2000, ±10%, 1/2W. COMP.
R103	1		RESISTOR, 1 MEG. ±5%, 22W. COMP.
R104	1		RESISTOR, 30K, ±10% 12W. COMP.
R105	1		RESISTOR, 5 MEG. ±1%. 5W. COMP.
R106			
THRU	7		RESISTOR, 10 MEG. ±1%. 5W COMP.
R112			
S101	1		SWITCH, SENS. SPDT, PLUNGER
S102	1		SWITCH, TOGGLE, DPST
S103	1		SWITCH, SENS. SPDT, LEAF
T101	1		TRANS. FIL. 50:1, 115V. 60∿ 17VA.
T102	1		TRANS. PLATE, 1:100, 135V. 60∿ 170VA
T103	1		TRANS. AUTO. 115V. 60∿ 862VA.
V101	1		TUBE, RECTIFIER, JAN8013A
C104	1		CAPAC. 1.0 MFD ±10% 600V. PAPER

REVISIONS

REV LTR	CHANGED ITEM WAS	DATE	CHANGED BY	CHKD
A	M101 WAS 200MA.	1-10-49	N. Holder	

TOLERANCE UNLESS OTHERWISE NOTED: FRACTIONAL, DECIMAL, ANGULAR

	SIGNATURE	DATE	GROUP NO. REPRESENT	DATE
ORIGINATED				
DRAWN	N. Holder	10-10-48		
CHECKED				
PROJ ENG	[illegible]	1-6-49		
APPROVED	R.V. Saley	1-6-49		

TOTAL SHEETS | SCALE

TITLE: HIGH POTENTIAL TESTER MK. II, MOD. 0 ASSEMBLY-SCHEMATIC TEST EQUIPMENT

DRAWING NO. 5Y15083C1 | SHEET SIZE | PART NO.

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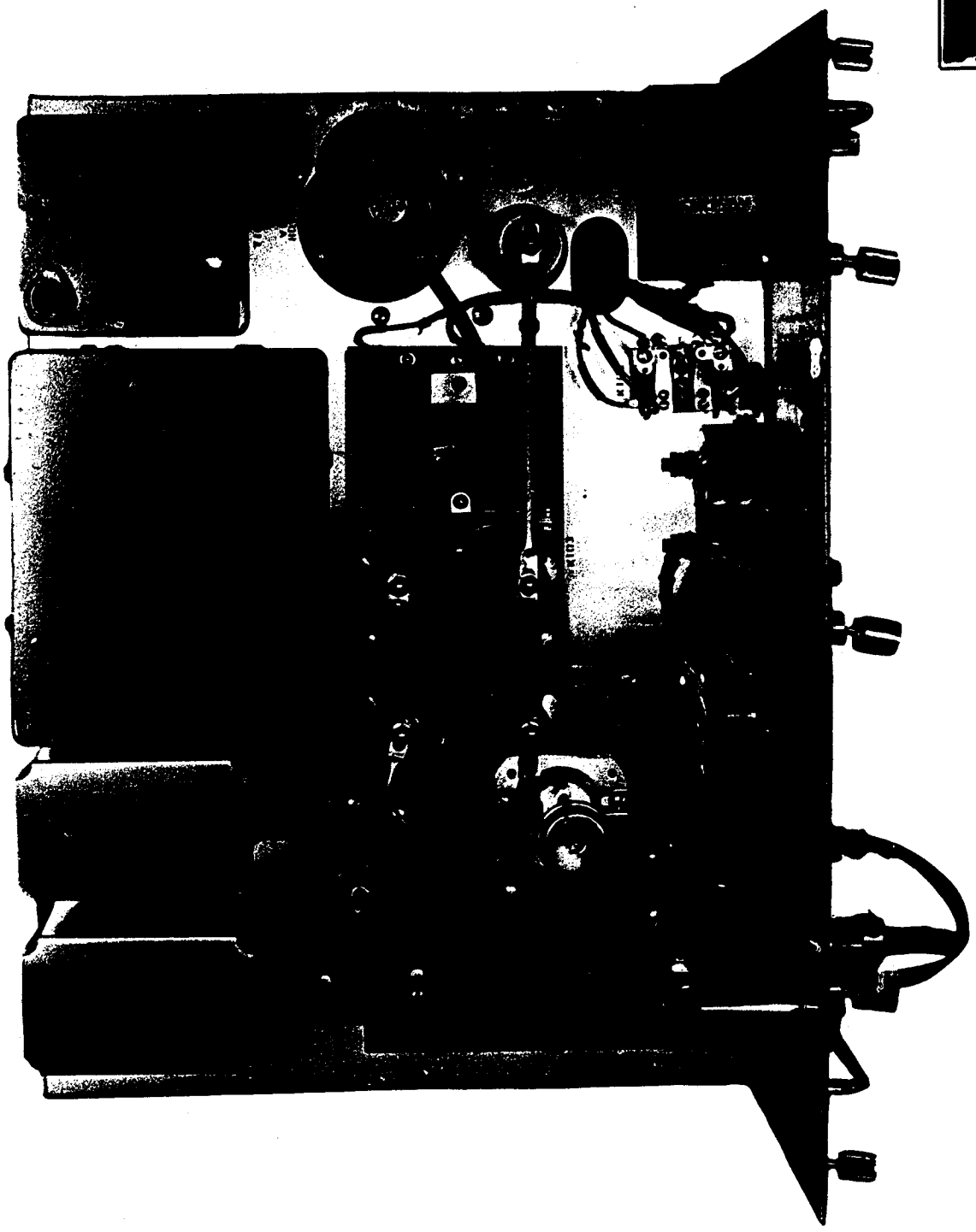

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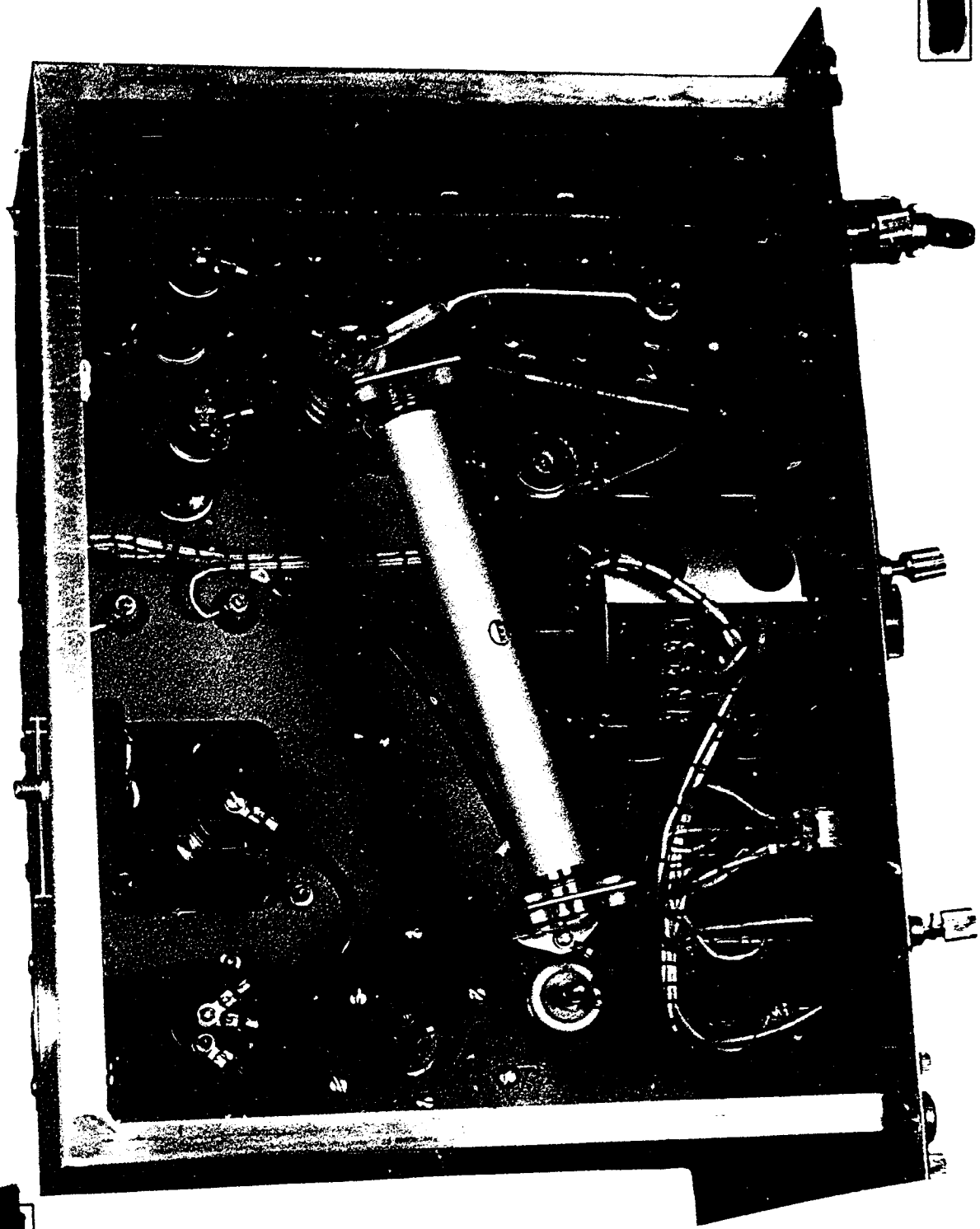

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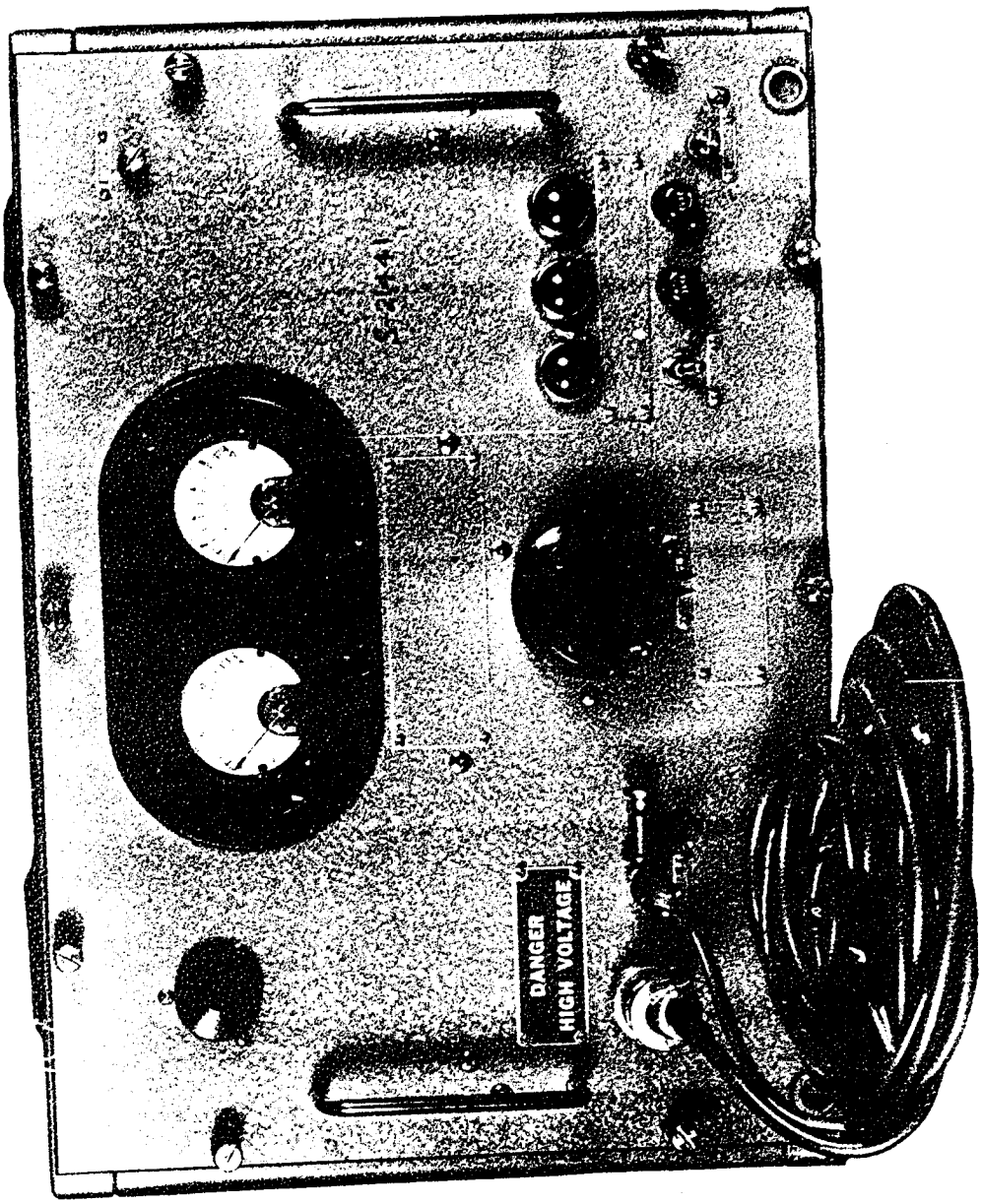

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Errata Sheet 1
March 30, 1950

TO: Distribution List of SLMS-94

FROM: Division 2146

SUBJECT: ERRATA SHEET FOR SLMS-94

On p 7 step 4 should read: Protective resistor R-102 is connected in parallel with the high-voltage output milliammeter M-102 to provide a conductive path to ground in case the meter circuit should accidentally become opened.

Step 5 should read: Milliammeter protective capacitor C-103 is connected in parallel with high-voltage output milliammeter M-102 to absorb excessive surges occurring at the time of breakdown of any external component undergoing tests.

Step 6 should read: Filter resistor R-101 is part of the smoothing filter of the high-voltage output rectifier system.

These corrections have been approved by R. A. Richards, 1215.