



INSTRUCTION BOOK  
*for*  
NAVY MODEL OZ-1

RADIO TUBE TEST EQUIPMENT

NAVSHIPS 900, 346 - IB

110 Volt

60 Cycle

Single Phase

RESTRICTED

(For Official Use Only)

MANUFACTURED BY

THE HICKOK ELECTRICAL INSTRUMENT COMPANY

10514 DUPONT AVENUE • CLEVELAND, OHIO

FOR

U. S. NAVY DEPARTMENT

BUREAU OF SHIPS



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CONTRACT NX<sub>55</sub> - 33175

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WARNING

THIS EQUIPMENT EMPLOYES VOLTAGES WHICH ARE DANGEROUS AND MAY BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION SHOULD BE EXERCISED WHEN WORKING WITH THE EQUIPMENT.

Since the use of high voltages which are dangerous to human life is necessary to the successful operation of the equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by the operating personnel during the adjustment and operation of the equipment.

Be sure that the equipment has been disconnected from power source before removing case.

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

KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person be permitted to reach within or in any manner gain access to the enclosure with power supply line switches to the equipment closed; or to approach or handle any portion of the equipment which is supplied with power, or to connect any apparatus external to

the enclosure to circuits within the equipment; or to apply voltages to the equipment for testing purposes while any portion of the shielding or enclosure is removed or open. Wherever feasible in testing circuits, check for continuity and resistance rather than directly checking voltage at various points.

DON'T SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO BUREAU OF SHIPS MANUAL OF ENGINEERING INSTRUCTIONS, CHAPTER 31 (MIMEOGRAPHED FORM) OR SUBSEQUENT REVISIONS THEREOF ON THE SUBJECT OF "RADIO - SAFETY PRECAUTIONS TO BE OBSERVED."

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

\*\*\*\*\*

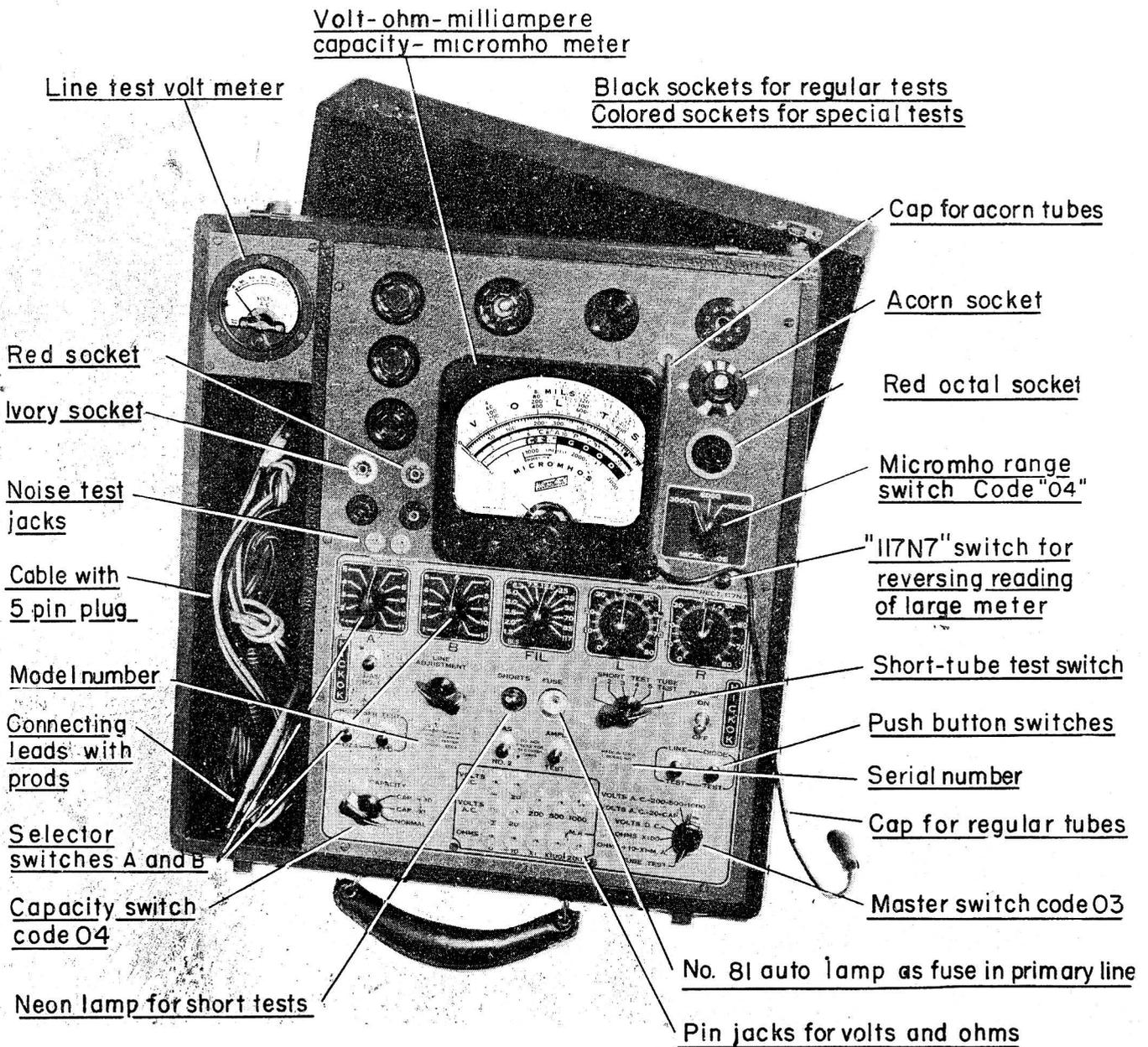


FIGURE 1 - NAVY MODEL OZ-1 MULTI-TESTER (Top View)

## SECTION I

## INTRODUCTION

1. This instruction book is issued as the general basic publication for the equipment involved.
2. This Bureau of Ships publication contains instructions for Operation, Maintenance, and Overhaul of the Navy Model OZ-1 MULTI-TESTER, manufactured to the Bureau of Ships Specification No. RE-13A 811 B by the Hickok Electrical Instrument Company, Cleveland, Ohio.

\* \* \* \* \*

## SECTION II

## DESCRIPTION, OPERATION, AND ADJUSTMENT

1. GENERAL DESCRIPTION

(a) THIS INSTRUMENT IS TO BE OPERATED FROM 60 CYCLES, 110-130 VOLT POWER SOURCE.

2. TYPES OF TUBES INVOLVED

(a) Two rectifier tubes, an 83 mercury vapor type and a \*5W4 high vacuum type, are used to supply plate and grid voltages. These tubes are included as part of the instrument.

(b) Two #6H6 diode tubes are used in the rectifying system of the A.C. voltmeter instead of the usual copper oxide rectifiers. This avoids burn outs which are frequently experienced when copper oxide rectifiers are used. The 6H6 tubes are matched at the factory. Failure of the 6H6 Tubes is very rare.

\* - Types 5W4G, 5W4GT or 5Y3GT can be substituted for the type 5W4 tube.

# - 6H6GT can be substituted for the type 6H6 diode tubes.

3. FUNCTIONS OF THE VARIOUS CONTROLS:

(a) The selectors "A" and "B" control connections to the socket contacts.

(b) The center switch in the top row controls the filament voltage.

(c) The potentiometer "L" controls

the sensitivity of the micromho meter. This knob is always set at 60 (Gm) when reading micromhos. The micromho switch to the right of the large meter selects the micromho scale to be read. When set on 3000 the meter scale is read 0-3000 as printed on the scale. When set on 6000 the scale is read 0-6000, etc.

(d) The figures on the tube data chart under the heading "L" are to be used for setting the "L" knob when it is desirable to have the readings show in the RED - GREEN sector of the meter scale. WHEN USING THE RED - GREEN SCALE THE MICROMHO SWITCH IS ALWAYS SET ON 3000.

(e) The potentiometer "R" controls the "C" bias on the grid of the tube under test. A change in "C" bias causes a change in mutual conductance. The "R" settings as given in the tube data chart are the same whether using the micromho scale or the RED - GREEN scale.

(f) The Short Test - Tube Test switch is used in checking tubes for shorts or leakages. Turn the switch successively through the positions 1 - 2 - 3 - 4 - 5 while watching the neon lamp. If the neon lamp burns continuously in any one of the five positions the tube contains a "short". An instantaneous flash of the lamp as the switch is turned is to be disregarded. This is caused by the charging of a condenser in the cir-

cuit. Intermittent shorts can be detected by tapping the tube with the finger while the switch is being turned. If the tube is free from shorts, turn the switch to "Tube Test" position for Quality test. See "Noise Test". The short test lamp is a 1/4 watt, 110 volt, candelabra base neon signal lamp made by the General Electric Company, - G.E. Type T4-1/2 Bulb, NE-45. This lamp will last indefinitely unless broken.

NOTE: On account of cross connections and taps within some of the later tubes the neon short lamp will glow on certain positions of the short switch. Special notation is made in the right hand column of the data chart opposite these tubes.

(g) The Fuse Lamp is a standard #81 auto bulb.

(h) Line Adjustment. Standard voltages on the tube elements are secured by means of the "Line Adjustment" knob. A special line voltage meter is mounted in the upper left corner of the cabinet. Insert the tube in the socket and adjust the knob until the pointer of the small meter is exactly over the red line on the meter scale. This meter will also read the exact voltage of the power source when the "Line Test" button is pressed.

(i) The ON-OFF switch is for turning the power On or Off.

(j) There are two buttons marked "Rectifier Test". The one marked "STD." (standard) is for all filament or heater type rectifier tubes. The button marked "OZ4" is used when testing gaseous cold cathode rectifier tubes such as OZ3-OZ4. Rectifier tubes should read in the GREEN sector of the scale if satisfactory. Separate tests are made for each plate of full wave rectifier tubes.

(k) The button marked "Ampl. Test" is used more than any other. On the tube data chart the symbol "AMPL" under the heading of Notations, means that this button is to be pressed for a meter reading.

(l) Gas Test. A tube can be checked for gas content as follows: Set the "L" potentiometer on Gm. Set the micromho range switch on 3000. Hold down the Gas No.1 button and

adjust the "R" knob until the large meter reads 100 micromhos. Continue to hold down Gas No. 1 and press Gas No.2 button. If the micromho meter moves more than one scale division up the scale the tube contains too much gas. Some tubes such as the #45 and #71A cannot be brought down to 100 micromhos by turning the "R" knob. In that case turn "R" to 82 and test for gas. Some tubes develop gas after being heated for a period of time. If a tube is suspected allow it to heat for a few minutes.

(m) Diode Test. The Diode Test button is to be pressed when testing a diode element of a tube. This places a low voltage on the element as recommended by the tube manufacturers. DO NOT PRESS AMPL. TEST OR RECTIFIER TEST BUTTON when testing a diode element as the high voltage applied will paralyze the delicate cathode.

(n) Colored sockets (red and ivory) are provided for certain tubes. The word "Red" or "Ivor" following the tube type number in the tube data book signifies that the tube is to be inserted in the appropriate colored socket. The black sockets are to be used for all ordinary tests.

(o) When operating as a Tube Tester, the master switch in the lower right hand corner of the control panel is set on TUBE TEST. The capacity switch is set on NORMAL at all times except when measuring capacity.

#### 4. VOLTS, OHMS, CAPACITY, MILLIAMPERES, DECIBELS AND INDUCTANCE.

(a) The analyzer section of the Navy Model OZ-1 MULTI-TESTER is entirely independent of the tube test section but employs the same indicating meter. The rectifying elements used in this tester when measuring A. C. voltages are type 6H6 diode tubes instead of the usual copper oxide rectifiers. In the tube test position of the master switch, the heaters of the diode tubes are not connected. On ohms and volts, the heaters of the diode tubes are connected in the circuit. It requires approximately 10 seconds for the diodes to reach normal operating temperature. An entirely new circuit is employed in the analyzer section of the Navy Model OZ-1 which avoids the disad-

vantages of copper oxide rectifiers, at the same time securing a linear scale for A. C. volts.

(b) In the lower center of the tube tester panel there are three rows of pin jacks. The top row is used in measuring D.C. volts. The middle row is used in measuring A.C. volts and the bottom row is used in measuring ohms and milliamperes.

#### VOLTS D.C.

(c) Set the master switch on Volts D.C. The pin jack in the top row at the left is negative. The ranges secured are 0-20, 0-200, 0-500 and 0-1000 volts. The pin jacks numbered 200, 500 and 1000 are common to both D.C. and A.C. volts. The meter resistance is 1000 ohms per volt on both the D.C. and the A.C. ranges.

#### VOLTS A.C.

(d) The power must be turned on for A. C. volts in order to heat the 6H6 diode tubes. Set the capacity switch on NORMAL. The pin jack to the left of the middle row marked plus-minus  $\pm$  is the common terminal. When using the 20 volt range, the master switch is set on Volts A. C. 20.

When using the A.C. voltage range 200 or higher, the master switch is set on Volts A. C. 200 - 500 - 1000.

#### OHMS

(e) Ohms are measured in three overlapping ranges, the center scale readings of which are respectively 30, 300 and 30,000 ohms. The scale on the meter is read directly when the master switch is set on Ohms X1 and the connecting leads are placed in the corresponding pin jacks. To measure lower resistance, move the connector lead from the pin jack marked X1 to the pin jack marked  $\div 10$ . Then the center scale reading of the meter is 30 ohms. In this position, resistance as low as 1/10 ohm can be estimated. The third range of the ohmmeter multiplies the scale by 100. In this range, the center reading of the scale is 30,000 ohms. The connecting leads are placed in the corresponding pin jacks. In this position, resistance as high as 5 megohms can be measured. 5

megohms is the mark on the meter scale midway between 20,000 and INF. To operate, throw the master switch to the range desired. The pointer of the meter will move to the end of the "Ohms" scale marked infinity (INF). By means of the "Line Adjustment" knob bring the pointer of the meter exactly over the "INF" mark. Resistance is then determined by connecting the flexible lead wires to the resistor being measured and noting the reading of the meter on the ohms scale.

#### TO CHECK LEAKAGE OF ELECTROLYTIC CAPACITORS

(f) Set the master switch on OHMS X 100. Adjust the meter to "INF". Place one connecting lead in the pin jack marked "OHMS 0" and the other lead in the pin jack marked "OHMS X 100". The pin jack marked "0" is to be connected to the negative terminal of the electrolytic capacitor, the X 100 jack is connected to the positive terminal. When connection is made to the electrolytic capacitor, the pointer of the meter will drop back about half-scale then gradually rise to about 2 megohms if the capacitor leakage is normal. If the capacitor is OK for leakage, check for capacity as explained in the following paragraph.

#### CAPACITY

(g) .01. Set the master switch on Volts A.C. 20 CAP.

.02. Adjust the small line test meter to the red line by means of the line adjustment knob.

.03. Place the connecting leads in the pin jacks marked "Capacity". For electrolytic capacitors, set the capacity switch on CAP.X1. Capacity can then be read directly in microfarads on the scale of the meter. In checking smaller capacitors, set the capacity switch on CAP.+10. The scale reading is then, of course, divided by 10.

.04. NOTE: Set Fil. Switch on "OFF": when checking capacity.

#### INDUCTANCE

(h) .01. In measuring the inductance of choke coils, place the

connecting leads in the pin jacks marked "CAPACITY". Adjust the meter to red line as for capacity, see paragraph (g) .02 above. Set the capacity switch on Capacity + 10. Connect the ends of the leads to the terminals of the choke and read the capacity scale on the meter.

.02. EXAMPLE - If the meter reads .4 microfarads, divide this into 7.04 which gives 17.6 henries. In like manner, when measuring chokes of any size divide the reading in microfarads into 7.04 which will give the result in henries.

.03. Conversion table for Inductance Values.

CAPACITY READING M. F.	INDUCTANCE HENRIES.
.1	70.4
.2	35.2
.3	23.4
.4	17.6
.5	14.1
.6	11.7
.7	10.1
.8	8.8
.9	7.8
1.0	7.0

ACCURACY OF NAVY MODEL OZ-1  
MULTI-TESTER

(1) The Navy Model OZ-1 MULTI-TESTER on a percentage of full scale angular deflection is accurate as follows:

Volts - A.C.- 5%	Ohms - 5%
Volts - D.C.- 3%	Capacity - 5%
Milliamperes- 3%	

MILLIAMPERES D.C.

IN MEASURING MILLIAMPERES, BE SURE TO TURN THE OFF-ON SWITCH TO "OFF" POSITION.

(j) To measure D.C. milliamperes, set the master switch on Ohms + 10. There are two scales available, for D. C. milliamperes, namely, 0-20 and 0-200. To use the 0-20 scale, the pin jack marked "Ohms 0" is the negative terminal. The pin jack marked Ohms + 10 is the positive terminal. The capacity switch must be set on Normal. Milliamperes are read on the voltmeter scale numbered 0-20. To use the 0-200 milliamperes scale, the pin jack marked "Ohms 0" is the negative terminal and the pin jack marked "MA-200" is the positive terminal. Milliamperes in this case are read on the voltmeter scale numbered 0-200.

DECIBELS

(k) (.01) The term "Decibel" is relative and the point selected for comparison, zero decibels, can be any level of power. However, it has been agreed that zero decibels shall be represented by the power expended by 1.73 volts across a resistance of 500 ohms, or 6 milliwatts. This voltage is the A. C. component, and must be measured by a meter that does not respond to direct current, if direct current is present. This is true of the 0-20 volts A. C. range of the Navy Model OZ-1 MULTI-TESTER.

A good way, when aligning receivers, is to:

(.02) Disconnect the voice coil of the speaker.

(.03) In parallel with the primary of the regular audio transformer connect an audio transformer with an multi-tapped secondary. The multi-tapped transformer should have about 3000 turns in the primary. The turn ratio of each tap should be known.

(.04) The ratio to be used can be determined from the following formula:

$$T = \sqrt{\frac{R}{500}} \quad \text{Where: } T = \text{turn ratio} \\ R = \text{plate resistance of power tube.}$$

(.05) Example 1: - Power tube is a single #45. Then R is 2000 ohms, and -

$$T = \sqrt{\frac{2000}{500}} = 2 = \text{turn ratio}$$

(.06) Example 2: - Power tubes are two #45's in push pull. Then R is 4000 ohms, and

$$T = \sqrt{\frac{4000}{500}} = 2.83 = \text{turn ratio}$$

(.07) When the proper turn ratio has been determined connect a resistance of 500 ohms across the taps of the transformer which are nearest to the computed ratio. These ratios are not critical so if the computed ratios were 2.83, connection could be made to the 3:1 ratio taps, etc.

(.08) Connect the 0-20 range of the A. C. voltmeter across the

500 ohm resistor. The decibel output of the receiver is found by consulting the Conversion Table for Decibels, which is printed below.

CONVERSION TABLE FOR DECIBELS

DECIBELS	VOLTS ACROSS 500 OHMS	RELATIVE LOUDNESS AT 400 CYCLES WITH SAME SIGNAL
10	.55	48.
9	.61	51.
8	.69	54.
7	.77	58.
6	.87	63.
5	.97	67.
4	1.09	73.
3	1.23	79.
2	1.38	85.
-1	1.54	92.
0	1.73	100.
+1	1.94	108.
2	2.18	117.
3	2.45	128.
4	2.75	139.
5	3.08	150.
6	3.46	168.
7	3.88	186.
8	4.35	207.
9	4.88	230.
10	5.47	256.
11	6.12	285.
12	6.89	314.
13	7.74	351.
14	8.68	388.
15	9.74	432.
16	10.93	482.
17	12.26	535.
18	13.76	593.
19	15.44	658.
20	17.32	730.
21	19.43	805.

The sensitivity of the human ear varies with frequency, also with different sound levels. As an average, an increase of 24 decibels in power will produce a sound that appears to be 10 times as loud as the original sound.

#### 5. TO CHECK HIGH RESISTANCE:

RESISTORS FROM 2 TO 25 MEGOHMS MAY BE CHECKED AS FOLLOWS:

(a) Be sure that the resistor is not connected in parallel with another resistor, condenser, etc.

(b) Make Line Adjustment the same as for tube testing. See paragraph 3 (h), page 2.

(c) Set Master Switch on Volts A.C. 200.

(d) Set Selector A on 1, Selector B on 6.

(e) Furnished with the Navy Model OZ-1 MULTI-TESTER is a special test cable. One end of the cable is equipped with a 5 pin plug. The black wire terminates in a pin tip. The red wire terminates in an alligator clip.

(f) Insert the plug in the 5 pin socket. Insert the pin tip in the plus-minus (+) pin jack.

(g) Connect the alligator clip to one terminal of the resistor to be measured. Insert one of the voltmeter leads in the 200 V. pin jack and hold the prod on the other terminal of the resistor to be measured.

(h) Press the OZ4 Rectifier Test button and note the reading of the voltmeter on the 0-200 volt scale. The value of the resistor is found in the table below:

<u>RESISTANCE IN MEGOHMS</u>	<u>VOLTMETER READING ON 200 VOLT SCALE</u>
2.	28.
2.5	22.
3.	18.
4.	14.5
5.	12.
6.	10.
7.	8.5
8.	7.5
9.	6.5
10.	6.
12.	5.
15.	3.5
20.	2.5
25.	2.

#### HUM IN FILTER SYSTEM

#### 6. HUM VOLTAGE IN THE FILTER SYSTEM CAN BE MEASURED AS FOLLOWS:

(a) Disconnect the antenna and ground wires.

(b) Turn down the volume control.

(c) Turn on the power.

(d) Connect the 0-20 volt A. C. range of the Navy Model OZ-1 MULTI-TESTER from plate to cathode of any socket in which it is desired to check hum.

(e) The meter reads ripple volts directly. Disregard the swing of the pointer as connection is first made. The 0-20 A.C. voltage range does not respond to direct current.

7. TO CHECK SMALL CAPACITORS:

Capacitors from .0001 to .05 M.F. may be checked as follows:

(1) Make Line Adjustment the same as for tube testing. See paragraph 3 (h), page 2.

(2) Set the master switch on A.C. Volts 200.

(3) Set the Selector A on 1, Selector B on 6.

(4) Furnished with the Navy Model OZ-1 MULTI-TESTER is a special cable. One end of this cable is equipped with a 5 pin plug. The black wire terminates in a-pin tip. The red wire terminates in an alligator clip.

(5) Insert the plug in the 5 pin socket. Insert the pin tip in the plus-minus (+) pin jack.

(6) Connect the alligator clip to one terminal of the capacitor to be measured. Insert one of the voltmeter leads in the 200 V. pin jack and hold the prod on the other terminal of the capacitor.

(7) Press button marked Rectifier Test, STD. and note the reading of the voltmeter. The value of the capacitor is found in the table below.

CAPACITY IN M. F.	VOLTMETER READING ON 200 VOLT SCALE
.0001	1.5 Volts
.0002	3. "
.00025	3.5 "
.0005	7. "
.001	13. "
.002	25. "
.003	37. "
.004	49. "
.005	59. "
.006	70. "
.007	79. "
.008	85. "
.009	92. "
.01	99. "
.015	125. "
.02	139. "
.025	147. "
.03	153. "
.035	156. "
.04	160. "
.05	162. "

(8) By pressing AMPL Test button the meter will show directly the leakage current of paper capacitors. The point 200 (on the 1000 volt scale) indicates 200 microamperes; the point 100 indicates 100 microamperes, etc.

LOCATING SHORTED ELEMENTS: In the following table, (X) under any SHORT-TUBE TEST switch position indicates that neon lamp burns in that position.

SHORT-TUBE TEST SWITCH POSITION

Kind of Short	1	2	3	4	5
FIL. - CATHODE				X	X
FIL. - GRID			X	X	X
FIL. - PLATE	X	X	X		
FIL. - SCREEN		X	X	X	X
CATHODE - GRID			X		
GRID - PLATE	X	X		X	X
GRID - SCREEN		X			
PLATE - SCREEN	X			X	X
CAP - FIL.	X	X	X	X	
CAP - GRID	X	X			X
CAP - CATHODE	X	X	X		X
CAP - SCREEN	X				X
CAP - PLATE				X	
SHELL - FIL.	X				
SHELL - PLATE		X	X		
SHELL - GRID	X		X	X	X
SHELL - SCREEN	X	X	X	X	X
SHELL - CATHODE	X			X	X
SHELL - CAP		X	X	X	

BALLAST TUBES

NOTE: WHEN TESTING BALLAST TUBES ALWAYS SET THE FILAMENT SWITCH ON "BLST" POSITION. SHORT-TUBE TEST SWITCH IS NOT TURNED TO TUBE TEST POSITION.

INSTRUCTIONS FOR TESTING "BALLAST TUBES" IN THE NAVY MODEL OZ-1 MULTI-TESTER.

In the following table of settings, an "X" under any SHORT-TUBE TEST switch position indicates that the neon lamp will light in that position with Selectors "A" and "B" set as shown following the tube type number. Certain ballast tubes have complicated internal connections, such as the K36H, have three selector settings for complete test.

Noisy ballast tubes are detected by using the Noise Test, the same as for other tubes. Tap the tube with fingers while making test. (See Noise Test, below.)

NOISE TEST

The two jacks just above the left top of the control panel are provided for the noise test. By connecting these jacks to the antenna and ground posts of any radio receiver, loud crashes of static will issue from the loud speaker, if the tube under test contains loose, jangling elements, when the tube is tapped by the finger as the SHORT-TUBE TEST switch is turned. Intermittent contacts too brief for the neon lamp to detect may be detected in this way. The r.f. stages of the radio receiver will not pass the 60 cycle hum which is present in the short test circuit of the Navy Model OZ-1 MULTI-TESTER.

8. BALLAST TUBES

TUBE TYPE	SELECTOR		SHORT-TUBE TEST SWITCH POSITION				
	A	B	1	2	3	4	5
1A1-1B1-1C1-1E1-1F1-1G1-1J1-1K1-1L1-1N1-1P1-1Q1-1R1G-1S1G-1T1G-1U1G-1V1-1Y1-1Z1-2.....	1	1	X	X	X	X	
2UR224.....	3	1	X	X	X	X	X
2LR212.....	{ 2 3	{ 12 2	X X	X X	X X	X X	X X
3.....	1	1	X	X	X	X	
03G.....	1	1				X	X
4-5.....	1	I	X	X	X	X	
6-133.....	1	1				X	X
6-6AA.....	1	1	X	X	X	X	
7-8-9.....	1	1	X	X	X	X	
10A - 10AG.....	1	1				X	X
10AB.....	1	1	X	X	X	X	
K17B - M17C - B M17C.....	3	1	X	X	X	X	X
M17HG - M17H.....	{ 4 5 7	{ 4 1 12	X X X	X X X	X X X		X X X
K23B - K23C - KX23B - KX30C.....	3	1	X	X	X	X	X
M30H.....	{ 4 5 7	{ 4 1 12	X X X	X X X	X X X		X X X
30A - K30A.....	1	1				X	X
K30D.....	{ 3 3	{ 1 12	X X	X X	X X	X X	X X
33A - 33AG.....	1	1				X	X
K34B.....	3	1	X	X	X	X	X

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NAVY MODEL OZ-1 MULTI-TESTER  
BALLAST TUBES - Continued

TUBE TYPE	SELECTOR		SHORT-TUBE TEST SWITCH POSITION				
	A	B	1	2	3	4	5
36A.....	1	1				X	X
K36B-BK36B-L36B-M36C-BM-36C-L36C-KX36C.....	3	1	X	X	X	X	X
KX36A.....	1	1	X	X	X	X	
36D - L36D.....	{ 3 3	1 12	X X	X X	X X	X X	X X
L36DJ.....	{ 4 7 8	2 5 12	X X X	X X X	X X X	X X X	X X X
K36H - M36H - M36HG.....	{ 4 5 7	4 1 12	X X X	X X X	X X X		X X X
L40S1 - L40S2.....	{ 2 3 4	1 12 4	X X X	X X X	X X X	X X X	X X X
42A.....	1	1				X	X
42A1.....	1	1				X	
42A2 - 42B2.....	7	1	X	X	X	X	X
K42B-L42B-M42B-KX42B-LX42B-L42BX-K42C-L42C-M42C	3	1	X	X	X	X	X
BK42D - K42D - L42D.....	{ 3 3	1 12	X X	X X	X X	X X	X X
LX42D - L42DX.....	1 1	2 7	X X	X X	X X	X X	X X
K42E - L42E.....	3	1	X	X	X	X	X
L42F.....	1	2	X	X	X		X
42HA - K42HJ - M42H - M42HG.....	{ 4 5 7	4 1 12	X X X	X X X	X X X		X X X
KX42C.....	3	1	X	X	X	X	X
L42S1.....	{ 2 3 4	1 12 4	X X X	X X X	X X X	X X X	X X X
49A - 49AJ - K49AJ.....	1	1				X	X
KX49A.....	3	1	X	X	X	X	X
49A1.....	1	1				X	
49A2 - 49B2.....	7	1	X	X	X	X	X
K49B-L49B-M49B-BM49B-K49C-L49C-M49C-BM49C-BK49C-K49E-L49E.....	3	1	X	X	X	X	X
K49D - BK49D - L49D.....	{ 3 3	1 12	X X	X X	X X	X X	X X
L49F.....	1	2	X	X	X		X
M49H - M49HG.....	{ 4 5 7	4 1 12	X X X	X X X	X X X		X X X
KZ49B - KZ49C.....	1	1	X	X	X	X	X

NAVY MODEL OZ-1 MULTI-TESTER  
BALLAST TUBES - Continued

TUBE TYPE	SELECTOR		SHORT-TUBE TEST SWITCH POSITION				
	A	B	1	2	3	4	5
K49BJ - L49BJ.....	{ 7 8	1 12	X X	X X	X X	X X	X X
L49S2.....	{ 2 3 4	1 12 4	X X X	X X X	X X X	X X X	X X X
49AJ - K49AJ.....	1	1	X	X	X	X	X
KX49B - LX49B - LX49C.....	3	1	X	X	X	X	X
L49DJ.....	{ 4 7 8	2 5 12	X X X	X X X	X X X	X X X	X X X
L49S3.....	{ 2 3 4	1 12 4	X X X	X X X	X X X	X X X	X X X
50A2.....	3	1	X	X	X	X	X
50A2MG - 50B2.....	1	1	X	X	X	X	X
50X3.....	1	1	X	X	X	X	
K52H - M52H.....	{ 4 5 7	4 1 12	X X X	X X X	X X X		X X X
K54B.....	3	1	X	X	X	X	X
55A - K55A.....	1	1				X	X
55A1.....	1	1				X	
KX55A.....	1	1	X	X	X	X	
55B-K55B-M55B-EM55B-L55BG-LX55B.....	3	1	X	X	X	X	X
55A2 - 55B2.....	7	1	X	X	X	X	X
K55C - L55C - KX55C.....	3	1	X	X	X	X	X
K55CP.....	{ 4 1 1	12 11 9	X X X	X X X	X X X	X X X	X X X
K55D - L55D.....	{ 3 3	1 12	X X	X X	X X	X X	X X
L55E - M55E.....	3	1	X	X	X	X	X
L55F - M55F - BL55F.....	1	2	X	X	X		X
K55H - M55H - M55HG.....	{ 4 5 7	4 1 12	X X X	X X X	X X X		X X X
L55S1 - L55S2.....	{ 2 3 4	1 12 4	X X X	X X X	X X X	X X X	X X X
60R30G.....	3	1	X	X	X	X	X
64.23.....	1	1				X	
67A.....	1	1				X	
K67B - L67B.....	3	1	X	X	X	X	X
L73B - K74B - L74B - CX74C.....	3	1	X	X	X	X	X

NAVY MODEL OZ-1 MULTI-TESTER  
BALLAST TUBES - Concluded

TUBE TYPE	SELECTOR		SHORT-TUBE TEST SWITCH POSITION				
	A	B	1	2	3	4	5
80A.....	1	1				X	X
K79B - K80B - M80B - K80C - KX80B - L80B.....	3	1	X	X	X	X	X
K80F.....	1	2	X	X	X		X
KX87B - LX87B - L90B.....	3	1	X	X	X	X	X
K90F - M90F - K92F - M92F.....	1	2	X	X	X		X
92A.....	1	1				X	X
L92B - 95K2.....	3	1	X	X	X	X	X
L99D.....	{ 3 3	1 12	X X	X X	X X	X X	X X
100R8.....	3	1	X	X	X	X	X
120R.....	1	1	X	X	X	X	
120R8 - 135K1.....	3	1	X	X	X	X	X
135K1A.....	{ 7 8	1 12	X X	X X	X X	X X	X X
140L4 - 140L8 - 140R4 - 140R8.....	3	1	X	X	X	X	X
140R.....	1	1	X	X	X	X	
140L44 - 140R44.....	{ 1 1	2 7	X X	X X	X X	X X	X X
165L4 - 165L8 - 165R4 - 165R8.....	3	1	X	X	X	X	X
165R.....	1	1	X	X	X	X	
165L44 - 165R44.....	{ 1 1	2 7	X X	X X	X X	X X	X X
185L4 - 185L8 - 185R4 - 185R8.....	3	1	X	X	X	X	X
185R.....	1	1	X	X	X	X	
185L44 - 185R44.....	{ 1 1	2 7	X X	X X	X X	X X	X X
200R - 250R.....	1	1	X	X	X	X	
250R8 - 290L4.....	3	1	X	X	X	X	X
300R4 - 320R4.....	3	1	X	X	X	X	X
340.....	1	1	X	X	X	X	
808-1.....	{ 7 8	1 12	X X	X X	X X	X X	X X
E14980 - W43357 - W45788 - 3613.....	3	1	X	X	X	X	X
3334 - 3334A.....	{ 3 3	1 12	X X	X X	X X	X X	X X
8593 - 8598 - 8601 - 8664.....	3	1	X	X	X	X	X
3ER248.....	{ 4 7 8	2 5 12	X X X	X X X	X X X	X X X	X X X
3CR241.....	{ 3 3	1 12	X X	X X	X X	X X	X

## SECTION III - MAINTENANCE

## I. CHART ON PROBABLE TROUBLES

TROUBLE	PROBABLE CAUSE	REMEDY
No reading	Not turned ON	Turn toggle switch to ON
	Faulty line cord or outlet socket	Examine cord, plug and test power socket
	"Short" switch is on one of the "Short" positions	Turn "Short" switch to "Tube Test" position
	Burned out fuse	Check fuse lamp
	Faulty contact in tube socket	Examine socket - See that contacts are clean
Erratic Reading	Faulty #83 Tube in tester	Check the #83 tube for emission. The two plates should give equal emission
	Faulty contact in one of the push button switches	See that push button switch contacts are clean and are making proper contacts
	Burnt out "R" potentiometer	Examine pot for broken or burnt wire
	#83 or #5Y3GT tube not securely in socket	Insert tubes firmly if loose
Incorrect Reading	"Master" switch set on incorrect position see photograph	Set master switch correctly Read instructions
	"Short" switch set on incorrect position	Set "Short" switch correctly
	"Capacity" switch set incorrectly	Set capacity switch correctly
	A, B, FIL, L, R, controls set incorrectly	Consult data book and set controls as indicated
	Line Adjustment knob set incorrectly	Turn knob until small meter reads exactly at red line on scale
	Micromho Range switch set incorrectly	Set on suitable range for tube being tested
	Pointer of meter touches scale	Remove meter from instrument and adjust pointer with fine tweezers
	Tube in wrong socket	Consult data book
	Broken wire in top grid connector	Check for continuity
	Broken voltmeter leads	Check for continuity

## PARTS LIST FOR NAVY MODEL OZ-1 MULTI-TESTER

ITEM NO.	HICKOK PART NO.	DESCRIPTION	QUAN.	SOURCE	MAKERS PART NO.
1	3145-8.....	Cabinet, Portable.....	1	Hickok El. Inst. Co.	
2	20800-1.....	Transformer.....	1	Hickok El. Inst. Co.	
3	440-010.....	Meter, Micromho.....	1	Hickok El. Inst. Co.	
4	570-005.....	Meter, Line Volts.....	1	Hickok El. Inst. Co.	
5	19912-6.....	Switch, Selector A.....	1	Oak Mfg. Co.....	13000-H4
6	19912-8.....	Switch, Selector B.....	1	Oak Mfg. Co.....	13070-H5
7	19912-1.....	Switch, Filament Volts...	1	P. R. Mallory Co....	SPO-27890
8	19912-5.....	Switch, Short-Tube Test..	1	Oak Mfg. Co.....	12782-H5
9	19912-3.....	Switch, Master.....	1	Oak Mfg. Co.....	9778-H3
10	19912-4.....	Switch, Capacity.....	1	P. R. Mallory Co....	3123-Y-206931
11	19912-4.....	Switch, Micromho.....	1	P. R. Mallory Co....	3123-Y-206931
12	20875-28.....	Vacuum Tube #83.....	1	R. C. A. Mfg. Co....	#83
13	20875-6.....	Vacuum Tube #5Y3GT.....	1	R. C. A. Mfg. Co....	#5Y3GT
14	20875-11.....	Vacuum Tube #6H6.....	2	R. C. A. Mfg. Co....	#6H6
15	19350-9.....	Sockets, 4 pin.....	2	American Phenolic Corp.....	S-4
16	19350-11.....	Sockets, 5 pin.....	1	American Phenolic Corp.....	S-5
17	19350-13.....	Sockets, 6 pin.....	1	American Phenolic Corp.....	S-6
18	19350-15.....	Sockets, 7 pin.....	1	American Phenolic Corp.....	78-7CD
19	19350-19.....	Sockets, 8 pin Octal....	5	American Phenolic Corp.....	S-8
20	19350-17.....	Sockets, 8 pin Loktal...	1	American Phenolic Corp.....	78-8L
21	19350-7.....	Sockets, Bantam...	1	American Phenolic Corp.....	78-6H
22	19350-3-Blk...	Sockets, Miniature	3	American Phenolic Corp.....	78-7P
22	19350-4-Red...				
22	19350-5-Ivor..				
23	19350-6.....	Sockets, "Acorn"...	1	Alden Products Co.	455V-2 Acorn
24	10300-1.....	Jacks, pin.....	17	Hugh Eby.....	#52 Red
25	3105-15.....	Capacitors, 0.5 M.F.....	2	Aerovox Co.....	ZB-4033P-400V.15%
26	3105-19.....	Capacitors, 0.1 M.F.....	1	Aerovox Co.....	ZB-4027D-400V.20%
27	3095-8.....	Capacitors, .0005 MF....	3	Aerovox Co.....	Type 5 - 400V.20%
28	12270-1.....	Neon Lamp 1/4 Watt.....	1	Gen. Elect. Co.....	NE45
29	19350-2.....	Socket, Candelabra.....	1	Drake Mfg. Co.....	414L-CH
30	19350-1.....	Socket, Bayonet.....	1	Drake Mfg. Co.....	614L-CH
31	12270-2.....	Lamp, Auto #81.....	1	Tungsol Lamp Works	#81
32	19910-3.....	Push Switch Line Test...	1	Hickok El. Inst. Co.	
33	19910-6.....	Push Switch OZ4.....	1	Hickok El. Inst. Co.	
34	19910-7.....	Push Switch Gas No.1....	1	Hickok El. Inst. Co.	
35	19910-1.....	Push Switch Gas No.2....	1	Hickok El. Inst. Co.	
36	19910-8.....	Push Switch AMPL.....	1	Hickok El. Inst. Co.	
37	19910-2.....	Push Switch DIODE.....	1	Hickok El. Inst. Co.	
38	19910-3.....	Push Switch 117N7.....	1	Hickok El. Inst. Co.	
39	19910-4.....	Push Switch Rectifier Std.....	1	Hickok El. Inst. Co.	
40	19911-4.....	Switch, Power ON-OFF.....	1	Arrow Hart & Hegeman.....	#20994
41	3675-1.....	Line Cord.....	1	Lowell Ins. Wire Co.....	8 ft. A.C. Cord set, #18, 1/64-POSJ, QK, spring action prongs on rubber plug. 1377-2A
42	18575-12.....	Resistor, "R1" 1800 ohm.	1	Ohmite Co.....	
43	18550-2.....	Resistor, "R2" 1250 ohms	1	Continental Carbon Co.....	1250 $\Omega$ -1 watt-wire term 20%
44	18550-28.....	Resistor, "R3" 15,000 ohms.....	1	Continental Carbon Co.....	15,000 $\Omega$ -1 watt-wire term 10%
45	16925-4.....	Resistor, "R4" 150 ohms.	1	P. R. Mallory Co....	Dual Pot. #33505
45	16925-4.....	Resistor, "R5" 150 ohms.			
46	18575-13.....	Resistor, "R6" 6000 ohms.	1	Ohmite Co.....	6000 $\Omega$ Brown Dev 10 watt 5%
47	16925-10.....	Resistor, "R7" 3000 ohms.	1	Utah Products Co..	Potent #16174-A
48	18450-30.....	Resistor, "R8" 180,000 ohms.....	1	Continental Carbon Co.....	180,000 $\Omega$ -1/4 watt-wire term. 15%
49	18670-407.....	Resistor, "R9" 18 ohms...	1	Hickok El. Inst. Co.	Medium Spool 18 $\Omega$ -1%
50	18450-19.....	Resistor, "R10" 100,000 ohms.....	1	Continental Carbon Co.....	100,000 $\Omega$ -1/4 watt-wire term. 20%
51	18525-33.....	Resistor, "R11" 5000 ohms	1	Continental Carbon Co.....	5000 $\Omega$ -1/2 watt-wire term. 20%

## PARTS LIST FOR NAVY MODEL OZ-1 MULTI-TESTER

ITEM NO.	HICKOK PART NO.	DESCRIPTION	QUAN.	SOURCE	MAKERS PART NO.
52	18575-18.....	Resistor "R12" 50 ohms..	1	Ohmite Co.....	3003A-2 Section
53	18750-2.....	Resistor "R13" 50 ohms..			
54	18525-70.....	Rheostat "R31" 200 ohms.	1	Ohmite Co.....	2878-3SC
		Resistor "R14" 500,000 ohms.....	1	I.R.C.Co.....	Matched Set #19
55	18525-69.....	Resistor "R15" 300,000 ohms.....	1	I.R.C.Co.....	Matched Set #18
56	18525-66.....	Resistor "R16" 180,000 ohms.....	1	I.R.C.Co.....	Matched Set #15
57	18525-46.....	Resistor "R17" 22,000 ohms.....	1	I.R.C.Co.....	Matched Set #11
58	18525-45.....	Resistor "R18" 20,000 ohms.....	1	I.R.C.Co.....	Matched Set #10
59	18525-45.....	Resistor "R19" 20,000 ohms.....	1	I.R.C.Co.....	Matched Set #10
60	18525-67.....	Resistor "R20" 195,000 ohms.....	1	I.R.C.Co.....	Matched Set #16
61	18525-54.....	Resistor "R21" 41,000 ohms.....	1	I.R.C.Co.....	Matched Set #12
62	18525-65.....	Resistor "R22" 110,000 ohms.....	1	I.R.C.Co.....	Matched Set #14
63	18575-14.....	Resistor "R23" 6300 ohms	1	Ohmite Co.....	6300 $\Omega$ Brown Devil 10 Watt 5%
64	18679-15.....	Resistor "R24" 280 ohms.	1	Hickok El.Inst.Co.	Double Spool 280-380 $\Omega$
		Resistor "R25" 380 ohms.			
65	18600-313....	Resistor "R26" 62 ohms..	1	Hickok El.Inst.Co.	Large Slate 25 watt 62 $\Omega$
66	18670-424....	Resistor "R27" 600 ohms.	1	Hickok El.Inst.Co.	Medium Spool, 600 $\Omega$
67	18670-438....	Resistor "R28" 5700 ohms	1	Hickok El.Inst.Co.	Medium Spool, 5700 $\Omega$
68	18679-14.....	Resistor "R29" 31 ohms..	1	Hickok El.Inst.Co.	Double Spool, 31-3.2 $\Omega$
69	18525-68.....	Resistor "R30" 3.2 ohms.			
70	18670-418....	Resistor "R32".....	1	I.R.C.Co.....	Matched Set #17
		Calibrating Resistor, 150 ohms.....	1	Hickok El.Inst.Co.	Medium Spool, 150 $\Omega$
71	18670-411....	Calibrating Resistor, 40 ohms.....	1	Hickok El.Inst.Co.	Medium Spook, 40 $\Omega$
72	12450-8.....	Cable with 5 pin plug...	1	Hickok El.Inst.Co.	
73	12450-13.....	Connecting Leads with Prods, 4 ft.long.....	1		
			Pair	Hickok El.Inst.Co.	
74	3200-4.....	Book of Tube Data.....	1	Hickok El.Inst.Co.	
75	2490-14.....	Book of Instructions for Navy Model OZ-1 MULTI-TESTER	1	Hickok El.Inst.Co.	
76	11505-3.....	Bar Knobs.....	10	Kurz-Kasch Co.....	S-292-IL
77	12450-21.....	Grid Lead & Clip.....	1	Mueller Elect.Co..	45 GR
78	12450-10.....	Grid Lead & Cap. Miniature.....	1	Mueller Elect.Co..	#88
79	2920-1.....	Push Buttons for Push Switches.....	8	Hickok El.Inst.Co.	#1638 Medium

## INDEX TO MANUFACTURERS

Manufacturer	Address
1. Hickok Electrical Instrument Co.	Cleveland, Ohio
2. R.C.A. Mfg. Co.	Harrison, N.J.
3. Tungsol Mfg. Co.	Newark, N.J.
4. General Electric Supply Co.	Cleveland, Ohio
5. Kurz-Kasch Co.	Dayton, Ohio
6. Rocto Molded Products Co.	Cincinnati, Ohio
7. Utah Products Co.	Chicago, Ill.
8. P.R. Mallory Co.	Indianapolis, Indiana
9. Lowell Insulated Wire Co.	Lowell, Mass.
10. American Phenolic Co.	Chicago, Ill.
11. Alden Products Co.	Brockton, Mass.
12. Ohmite Mfg. Co.	Chicago, Ill.
13. Continental Carbon Co.	Cleveland, Ohio
14. Cornell-Dubilier Co.	South Plainfield, N.J.
15. Mueller Electric Co.	Cleveland, Ohio
16. Drake Mfg. Co.	Chicago, Ill.
17. Arrow Hart & Hegeman	Hartford, Conn.
18. Oak Mfg. Co.	Chicago, Ill.
19. Hugh Eby Co.	Philadelphia, Pa.
20. International Resistance Co.	Philadelphia, Pa.

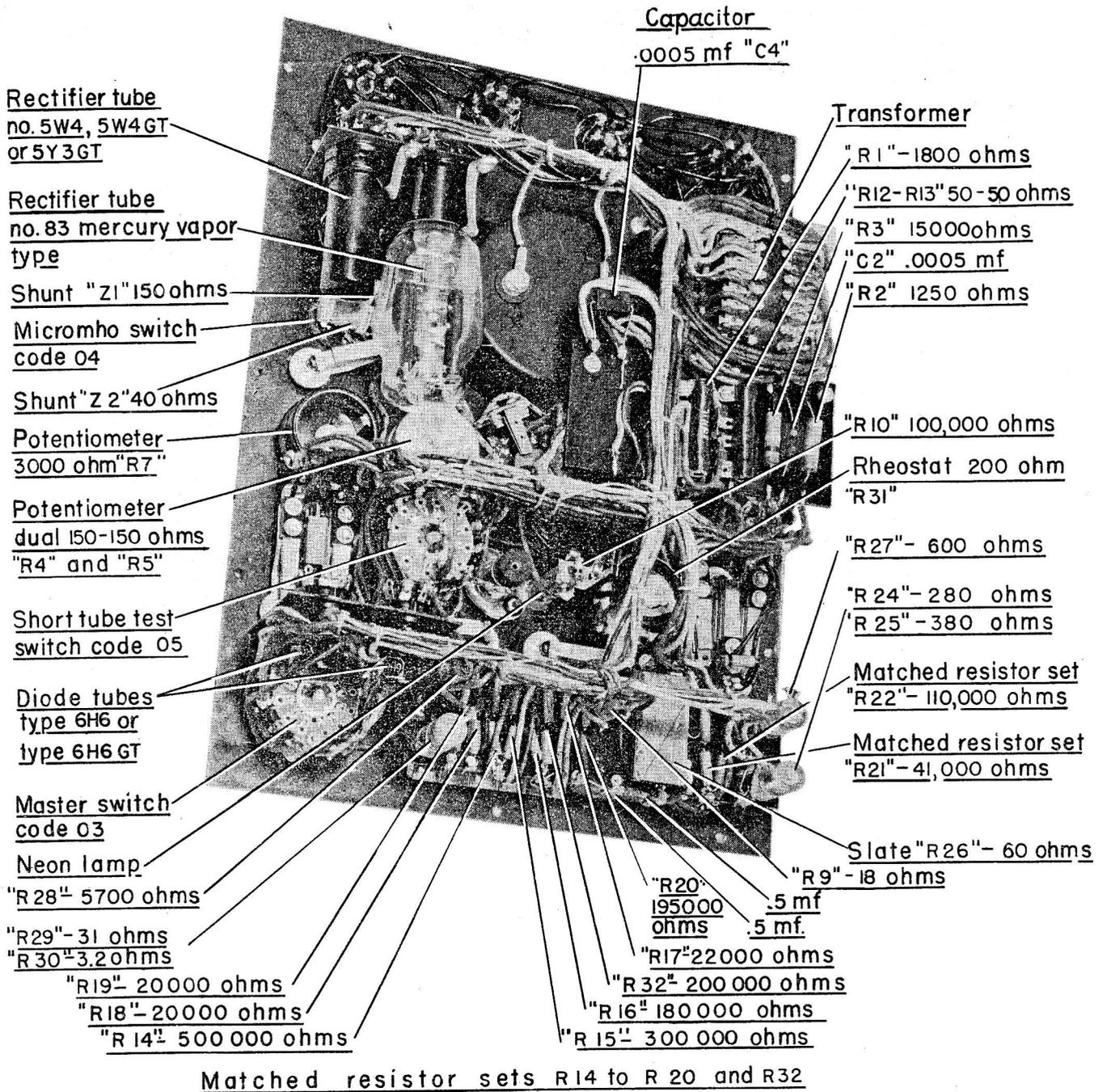


FIGURE 2 - NAVY MODEL OZ-1 MULTI TESTER (Bottom View)

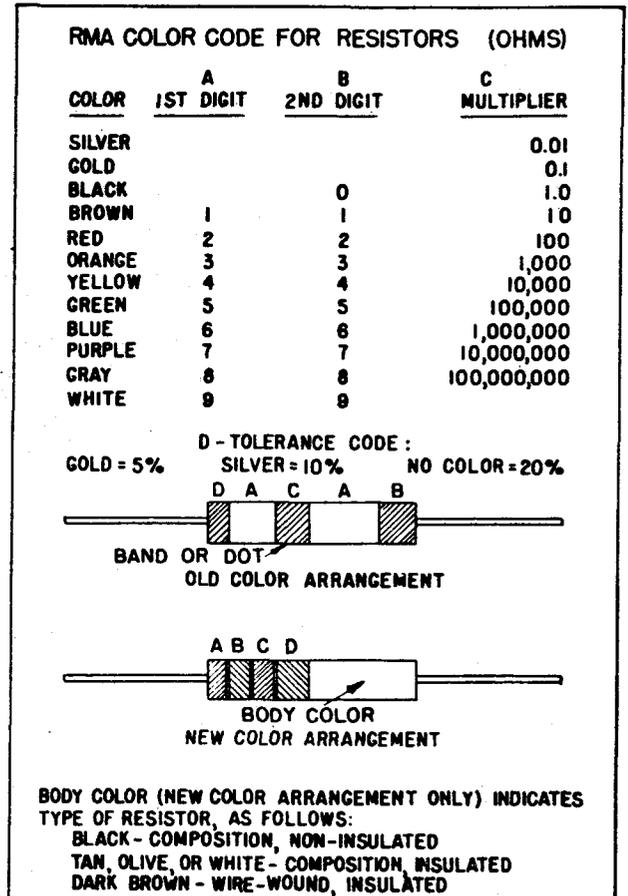
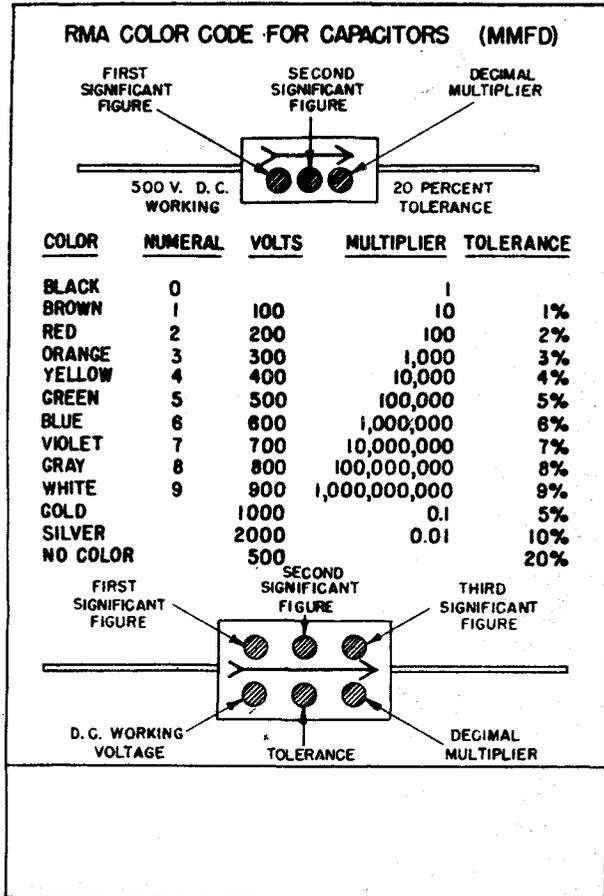


FIGURE 4 - COLOR CODES

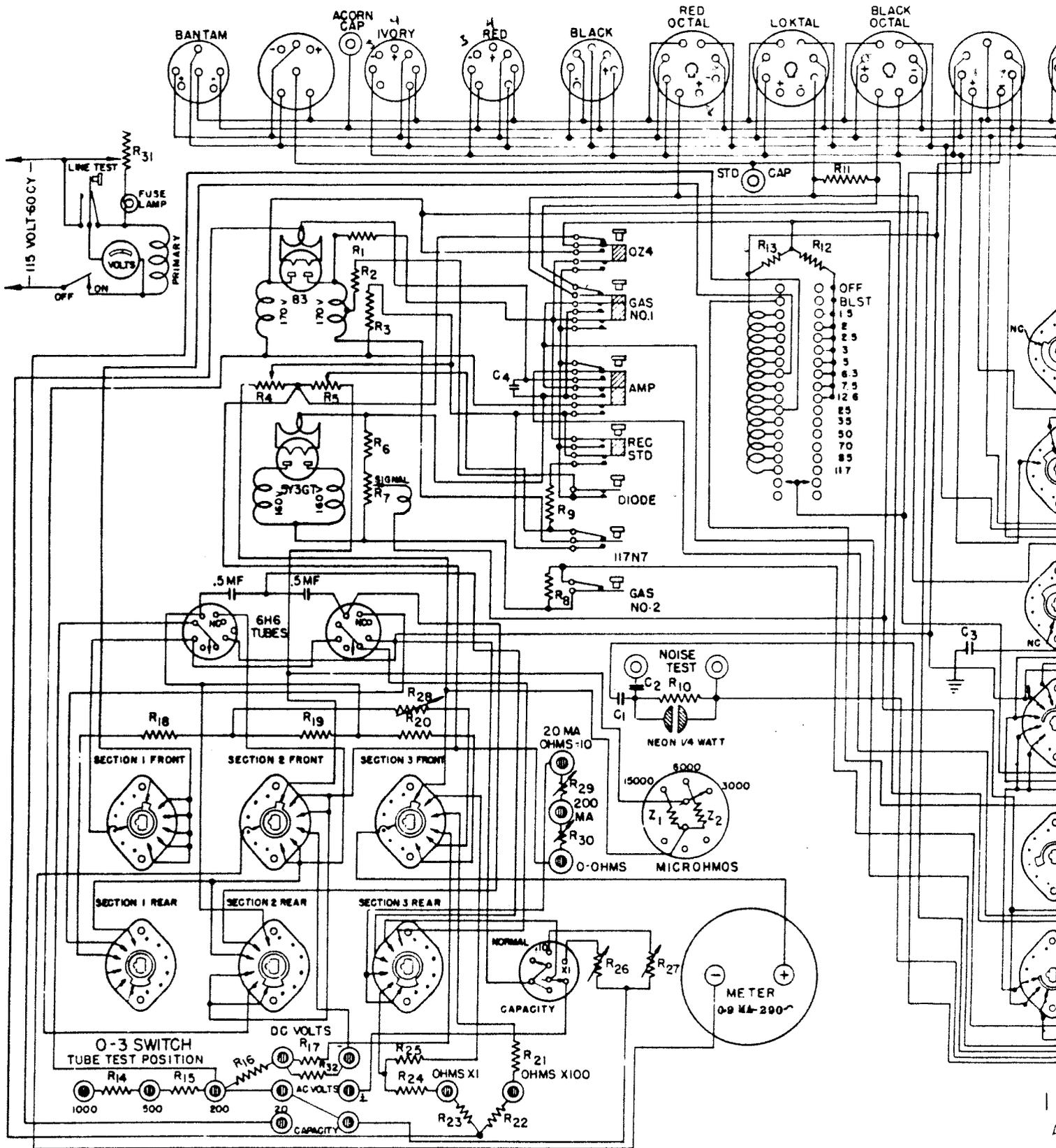


FIGURE 3 - Wir

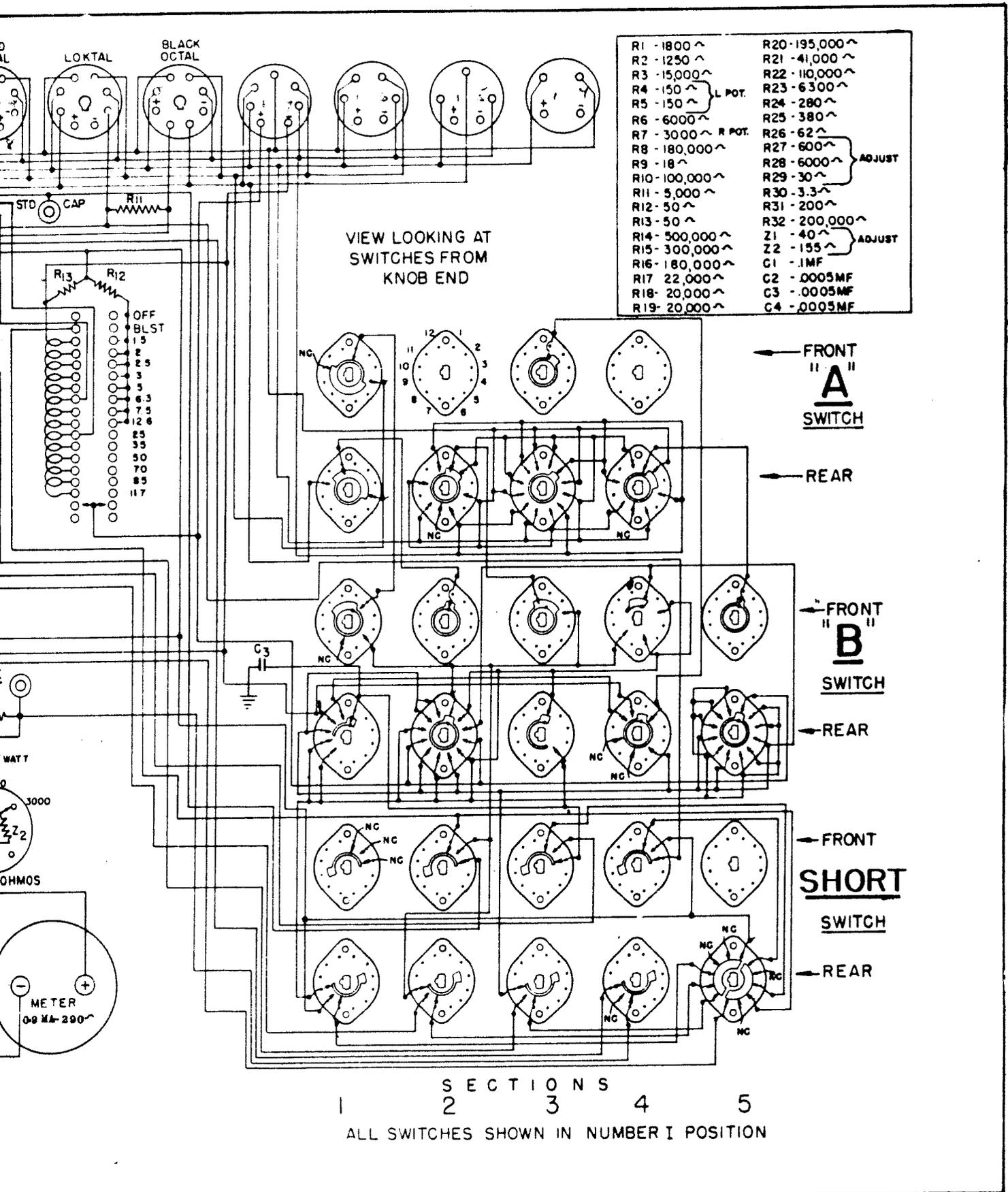


FIGURE 3 - Wiring Diagram for Navy Model OZ-1 MULTI-TESTER