

THE SUPREME MASTER
RADIO DIAGNOMETER

OPERATING DATA

SUPREME INSTRUMENTS CORPORATION
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THE SUPREME MASTER
RADIO DIAGNOMETER

The Supreme Master Diagnometer incorporates, in one compact unit all of the essential radio testing facilities heretofore required of a multiplicity of servicing devices. The five major testing functions of this new tester are listed as follows:

- (1) Analyzer.
- (2) Ohmmeter.
- (3) Capacity Tester.
- (4) Oscillator.
- (5) Tube Tester.

The order in which these major testing functions is listed above will be followed in the following pages which outline the various applications of the tester for practical radio servicing requirements. Other applications of the tester will become obvious to the user from time to time. It is believed that every application of the tester outlined herein is easily understood by the average radiomen who is familiar with the fundamental principles of radio servicing technique, but the Service and Engineering Departments of the Supreme Instruments Corporation will gladly answer any inquiry relating to the operation of the tester. Each inquiry should include a detailed description of the attempted tests and of the reactions thereto; and every inquiry should mention the serial number of the tester which is engraved (but not whitened) in the tester panel.

ACCURACY. A new circuit is employed for compensating or minimizing the effects of temperature and other variations of the full-wave instrument rectifier unit and for utilizing a single rugged D. C. Meter for both A. C. and D. C. measurements on a single scale without the confusion of the usual "offset" scales. The shunt and multiplier resistors are selected within an accuracy tolerance of 1/2%. The A. C. functions of every tester are individually calibrated for 60-cycle power supply unless ordered for some other frequency. All potential measurements have a sensitivity resistance of 1,000-ohms-per-volt.

THE OHMMETER AND ANALYSIS GRID SHIFT BATTERY. A battery of three 1.5-volt flashlight cells (Eveready No. 935, or equivalent) should be obtained, locally, and inserted in the small battery compartment so that the positive brass terminals of each cell is towards the outside etched battery plate. The battery should be replaced when it depreciates to such an extent that the meter needle cannot be adjusted to full-scale deflection for any range of the ohmmeter functions.

POINT-TO-POINT TESTS. By reason of their knowledge of electrical fundamentals, most radiomen are familiar with the method of connecting calls on telephone switchboards whereby any telephone subscriber can be easily connected with any other subscriber. The principles of the flexibility of the telephone switchboard are incorporated in the miniature terminal arrangement of this tester, so that any range of the multimeter may be applied across any pair of the eight analyzer cable circuits or in series with any of those circuits except the filament or heater circuit, or any of the meter and analytical circuits can be connected externally to other apparatuses for innumerable testing combinations. Such flexibility in the application of a tester could not be obtained by any principle of construction other than the point-to-point arrangement. The rapidity with which the fundamental tests of radio servicing may be performed with this tester appeals to the practical radioman who

sees in this tester a device which covers the entire field of testing requirements, ranging from the simple plate current analysis to the more detailed individual unit testing procedure which requires the use of test probes with all types of testers.

TUBE TERMINALS. The standardizing committees of the Radio Manufacturers Association have recently established a standard system for numerically-designating tube and socket terminals. These terminal numbers are shown around the sockets on the panel of this tester, and it will be noted that the numbers conform to a clockwise sequence beginning with the Number "1" grid terminal nearest the conventional plate terminal which will, in the future, be designated as the Number "2" terminal and the terminals numbered "3" and "4" are the filament or heater terminals on all types of tubes, regardless of the total number of terminals. A 4-pin tube has no number "5" terminal which represents the conventional cathode in practically all tubes which have more than four terminals. The terminals numbered "6" and "7" are applicable to tubes which have more than five base terminals. The conventional control grid terminal is designated as the "TOP CAP" and abbreviated "T. C." in the new RMA standards, and is so marked on the panel of this tester. The "TOP CAP" pin jack above the "AC-DC" tumbler switch on the tester panel is connected directly through the analyzing cable to the lug which terminates the short flexible insulated conductor at the top of the analyzing plug. It is believed that it is preferable to have this lug connected through a flexible lead so as to enable connections with various lengths of "top cap" tubes, as such connections are often difficult to effect when the lug is rigidly attached to the analyzing plug. The terminals corresponding to the numbered positions of the "SELECTOR 1" and "SELECTOR 2" rotary switches are connected to correspondingly-numbered contacts of the terminal tube sockets and to corresponding terminals of the analyzing plug or of the analyzing plug adapters.

PRELIMINARY TESTS. In view of the fact that the plate current of a tube is the result of practically all of the electrical factors involved in the circuits leading to the tube, a normal plate current value is fairly conclusive evidence that the circuits leading to the tube are performing their normal functions. It is therefore, usually sufficient, in the preliminary analysis of a radio, to measure only the plate current of each tube, in turn, until a tube is encountered in which the plate current is incorrect, when other readings for that tube may be taken in an effort to isolate the defect in the circuit leading to the tube in which the incorrect plate current is observed. An abnormally high plate current reading usually suggests (1) an open grid circuit, (2) a shorted or leaky bypass capacitor across the grid biasing resistor in the cathode circuit, (3) a leaky capacitor coupling the grid of the tube to a positive plate of the preceding stage, or (4) an excessively gaseous tube when resistance-coupled to the preceding stage. A low plate current indication usually suggests (1) a leaky plate bypass capacitor, or (2) a leaky screen bypass capacitor. No plate current usually suggests (1) an open grid bias resistor in the cathode (or filament) circuit, (2) a shorted plate bypass capacitor, (3) a shorted screen grid bypass capacitor, (4) an open plate circuit, or (5) an open screen grid circuit. There are other possible causes of incorrect plate current values, but those enumerated are the most usual. The use of high resistance coupling circuits in modern radios introduces errors in practically all voltage measurements, because of the multiplier effects of the resistors in the coupling circuits of such radios. Furthermore, potential measurements will vary with different ranges of ordinary service voltmeters applied to high resistance circuits, so that the voltage readings published by a radio manufacturer may be found quite different by the radioman when analyzing with a voltmeter of the same sensitivity but of a different range from that used by the radio manufacturer. Such differences are much less likely to exist in milliammeter indications, and these factors make it advisable to rely more upon plate current and less upon voltage readings for indications of amplifier circuit conditions.

This procedure of preliminary analysis by means of plate current indications, only, saves time and is usually sufficient for all practical servicing purposes. Plate current measurements with this tester are accomplished in the following manner:

- i. Complete all connections to the radio under test with all tubes in the proper sockets for normal operations.
- ii. Remove all test lead conductors from the tester panel, and set the "TUBE TEST SELECTOR" and "FIL-HTR. SELECTOR" control knobs to the "ANALYSIS" position.
- iii. With the radio turned "Off," remove a tube from the radio, place the tube in the proper tester socket, and connect the top terminal of the tube, if any, to the "TOP CAP" pin jack above the "AC-DC" tumbler switch on the tester panel.
- iv. Insert the analyzing plug into the vacant radio tube socket and complete the radio "TOP CAP" terminal connection, if any, to the lug at the top of the analyzing plug, and turn the radio "On." As the tubes attain their normal operating temperature, adjust the volume and tuning controls of the radio for normal response to broadcast signals or to whatever positions may be recommended by the radio manufacturer for circuit analysis.
- v. Set the "METER RANGES" control knob to the "250- 25-250" position so as to connect the proper multimeter shunt for the 250-milliampere range.
- vi. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "AC-DC" tumbler switch to the "D. C." position, set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position, and set the "OPEN, CIRCUIT INSERT" tumbler switch to the closed or "CIRCUIT INSERT" position.
- vii. Set the "SELECTOR 1, CURRENT" rotary switch to the position that corresponds to the plate terminal of the tube, and depress the "ANALYSIS, MILS." switch button. The plate current value will then be indicated on the multimeter. Release the push button.

It is usually advisable to first observe the plate current reading on the 250-mil. range, after which the "METER RANGES" control may be rotated clockwise for a suitable lower range. The above procedure may be continued, without changing the settings, from tube to tube until the plate current measurements have been made for all of the tubes in the radio; or until a tube is encountered in which there is an indication of incorrect plate current value, in which case the radioman should undertake a more detailed analysis in an effort to isolate the cause of the incorrect plate current condition by potential and resistance measurements as outlined in these instructions. The "SPR" position of the "SELECTOR 1" and "SELECTOR 2" rotary switches are reserved as spare settings for future developments.

TUBE TESTING. When a radio is in its normal operating condition, the use of the analyzing unit of this tester for testing the tubes in the radio tube sockets constitutes an excellent means for the detection of weak and/or noisy tubes. It is very often found that after tubes have been in use for a long period of time, a rattling or raspy noise will be omitted from the loud speaker when the tubes are very lightly thumper or tapped with a pencil or other small object, although

the tubes may be indicated as satisfactorily operable by the usual meter tests. It is, therefore, advisable to clean the tube pins and socket contacts and gently thump or tap each tube during the regular tests, preferably while the tube is in the analyzer socket and held away from the radio so that any noises observed may be definitely assigned to the tube rather than the vibrations of some loose part in the radio chassis. An exception may be observed in the case of detector tubes which will produce a ringing musical sound in the loudspeaker when the tube is thumped or tapped. A ringing musical sound may be natural, but a raspy or rattling sound is not generally natural, and the experienced radioman soon learns the difference between natural and unnatural sounds accompanying the test procedure. The logical explanation for the benefit of the customer is that tubes with vibratory noises may respond to the loudspeaker vibrations and distort the reception; and that if the noises are caused by loose elements, short circuits may develop which might harm other parts of the radio. Tube test readings of amplifier tubes are obtained with this tester as a logical step following the measurement of plate current as described in the preceding paragraph, and is accomplished by connecting the self-contained battery of the tester into the input grid of the tube in which the plate current is being observed. In the types 26 and 27 tubes, the number "1" terminal corresponds to the input grid, and the following tube testing procedure is recommended;

- i. After observing the plate current reading, release the "ANALYSIS, MILS." push button.
- ii. Set the "SELECTOR 2, BIAS" control knob to the No. "1" position, and depress the "ANALYSIS, MILS." switch button.
- iii. While observing the multimeter indication of the plate current value, depress the "ANALYSIS, GRID SHIFT" switch button for observing the change in the plate current, and release both push buttons.

In the types 24 and 35 tubes the input grid is connected to the "top cap" terminal, and the battery should be connected to the "T. C." pin jacks instead of to the number "1" pin jacks by rotating the "SELECTOR 2, BIAS" control knob to the "T. C." position before depressing the "ANALYSIS, GRID SHIFT" switch button. Similarly, the terminals numbered "6" or "7" may represent the input grids of the other types of tubes, and the radioman must determine from radio service notes or commercial tube data charts the functions of the terminals of the tubes and circuits encountered in service. It is the amount of the change in the plate current which indicates the extent to which the input grid controls the plate current output which corresponds to the amplifying ability of the tube. An amplifier tube in which the plate current remains unchanged when the battery is connected to the input grid circuit will not amplify signals and should generally be replaced. Because of the variations in different radio circuits, definite discard limits cannot be defined, and the radioman must use his own good judgment, based on his experience, in determining when tubes should be discarded. Additional data on tube testing will be found in the discussion relating to the A. C. tube testing oscillator functions of this tester.

POTENTIAL MEASUREMENTS. After proceeding with the preliminary procedure of plate current measurements and tube testing until a tube socket is encountered in which the tube is passing incorrect plate current, and in which the replacement of the tube does not correct this condition, it is advisable to resort to more specific tests for the purpose of isolating the circuit which is defective. For this purpose the following procedure is recommended:

- i. Remove all test conductors from the tester panel.

- ii. Set the "METER RANGES" control knob to the "250-25-250" position so as to connect the proper multimeter multiplier resistor for the 250-volt range.
- iii. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "AC-DC" tumbler switch to the "D. C." position and set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- iv. Set the "SELECTOR 1" control knob to the No. "5" position, or to whatever other position which corresponds to the cathode element of the tube which is being analyzed.
- v. Rotate the "SELECTOR 2" control knob to each position, in turn, and depress the "ANALYSIS, VOLTS" switch button at each setting for observing the multimeter indication of the potentials between the respective settings of these two "SELECTOR" settings.

A lower or higher potential-measuring range of the multimeter may be obtained by changing the setting of the "METER RANGES" control knob. When any of the potential measurements involve A. C. instead of D. C. values, the "AC-DC" tumbler switch should be thrown to the "A. C." position. The potential readings obtained by the above procedure should be compared with those published for the radio involved in the tests in an effort to determine which circuit contains the defect causing incorrect plate current values. After determining the defective circuit, the ohmmeter should be utilized for locating the defective part. This procedure is described in connection with the use of the ohmmeter in resistance analysis. In the following paragraphs, some typical and representative potential analyses will be described.

FULL-WAVE 4-PIN RECTIFIER CIRCUITS. The following procedure is recommended for the analysis of full-wave rectifier tube circuits which are transformer supplied:

- i. Remove all test conductors from the tester panel.
- ii. Set the "METER RANGES" control knob to the "1,000" volts position so as to connect the proper multimeter multiplier resistor for the 1,000-volt range.
- iii. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "AC-DC" tumbler switch to the "AC" position, and set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- iv. With the radio turned "Off," remove the tube from the radio, place the tube in the proper tester socket, and insert the analyzer plug into the vacant radio socket. Turn the radio "On."
- v. For the first plate potential measurement, set the "SELECTOR 1" control knob to the No. "3" position, set the "SELECTOR 2" control to the No. "1" position, and depress the "ANALYSIS, VOLTS" switch button. Observe the multimeter reading and release the switch button.
- vi. For the second plate potential measurement, rotate the "CONTROL 2" knob from the No. "1" position to the No. "2" position, and depress the "ANALYSIS, VOLTS" switch button. Observe the multimeter reading and release the switch button.

- vii. For the filament potential measurement, set the "METER RANGES" control knob to the "10-50M-1.0" position, rotate the "SELECTOR 2" control knob from the No. "2" position to the No. "4" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the switch button.
- viii. Turn the radio "Off." replace the tube in the radio socket, and remove all connectors from the tester panel.
- ix. The test readings obtained by the above procedure may be compared with those specified by the radio manufacturers concerned.

The primary function of the above test is to determine whether or not some of the turns of one side of the secondary plate winding of the power transformer are shorted. Since these windings carry the highest potentials of the transformer, they are usually the first windings to break down. It should be remembered that short-circuited windings in any transformer result in an oversaturation of the iron core with resultant overheating and lowered output potentials.

TRIODE TUBE CIRCUIT TESTS. A Triode tube is any amplifier tube with four or five terminals in which the input grid is connected to the base terminal Numbered "1." The following test procedure is recommended:

- i. Remove all test conductors from the tester panel.
- ii. Set the "METER RANGES" control knob to the "250-25-250" position so as to connect the proper multimeter multiplier resistor for the 250-volt range.
- iii. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "AC-DC" tumbler switch to the "DC" position, and set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- iv. Remove the tube from the radio and insert the analyzer plug into the vacant radio socket. Turn the radio "On."
- v. For the plate potential measurement, set the "SELECTOR 1" control to the No. "5" position when analyzing 5-pin triode tube circuits, or to the No. "4" position when analyzing 4-pin triode tube circuits.
- vi. Set the "SELECTOR 2" control to the No. "2" position, depress the "ANALYSIS, VOLTS" switch button, and observe the meter reading. Release the switch button.
- vii. For the cathode potential measurement of 5-pin triode tube circuits, rotate the "SELECTOR 2" control to the No. "3" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the button.
- viii. For the grid potential measurement, rotate the "SELECTOR 2" control knob to the No. "1" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the switch button.
- ix. For the filament or heater potential measurement, set the "AC-DC"

tumbler switch to the proper position, rotate the "SELECTOR 1" control to the No. "4" position, rotate the "SELECTOR 2" control to the No. "3" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the switch button.

- x. Turn the radio " Off" and replace the tube in the radio tube socket.
- xi. The test readings obtained by the above procedure may be compared with those specified by the radio and tube manufacturers concerned.

"TOP CAP" TUBE CIRCUIT TESTS. In the normal use of the screen grid tubes, such as the types 24 and 35, a small negative potential is applied to the top cap of the tube which is generally called the "control grid" connection, while a positive potential ranging between $1/3$ and $1/2$ of the plate potential, is connected to the grid prong of the tube base. The following procedure should be followed in testing screen grid tube circuits, or other circuits which involve tubes with "top cap" terminals:

- i. Remove all test conductors from the tester panel.
- ii. Set the "METER RANGES" control knob to the "250-25-250" position, so as to connect the proper multimeter multiplier resistor for the 250-volt range.
- iii. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "AC-DC" tumbler switch to the "DC" position, and set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- iv. For the plate potential measurement, set the "SELECTOR 1" control knob to the No. "5" position (or to the No. "4" position if the tube does not have a separate cathode terminal), set the "METER RANGES" control knob to the "250-25-250" position, rotate the "SELECTOR 2" control knob to the No. "2" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter readings, release the button.
- v. For the screen potential measurement, rotate the "SELECTOR 2" control knob to the No. "1" position and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the switch button.
- vi. For the cathode potential measurement of heater types of tubes, rotate the "SELECTOR 2" control knob to the No. "3" position and depress the "ANALYSIS, VOLTS" switch button. After observing the meter reading, release the button.
- vii. For the input grid potential measurement, rotate the "SELECTOR 2" control knob to the "T. C." position, reset the "METER RANGES" control if necessary and depress the "ANALYSIS, VOLTS" switch button after observing the meter reading. If this grid of the radio tube socket being analysed is resistance-coupled to the preceding stage, a more accurate reading of the applied control grid potential will be indicated by temporarily connecting a test conductor between the "TC" pin jack and the "grid return" which is usually the grounded chassis of the radio. After observing the meter reading, release the switch button.

- viii. For the filament or heater potential measurement, set the "AC-DC" tumbler switch at the proper position, rotate the "SELECTOR 1" control to the No. "4" position, rotate the "SELECTOR 2" control to the No. "3" position, and depress the "ANALYSIS, VOLTS" switch button. After observing the meter readings, release the switch button.
- ix. For the screen current measurement, set the "METER RANGES" control knob to the "2.5-5M-0.1" position, set the "OPEN, CIRCUIT INSERT" tumbler switch to the closed or "CIRCUIT INSERT" position, and set the "SELECTOR 1" control knob to the No. "1" position, and depress the "ANALYSIS, MILS." switch button. After observing the current reading on the multimeter, release the switch button.
- x. Turn the radio "Off" and replace the tube in the radio socket.
- xi. The test readings obtained by the above procedure may be compared with those specified by the radio and tube manufacturers concerned.

RESISTANCE ANALYSES. For general radio analysis, it is recommended that the plate current indications be relied upon as having primary importance, because correct plate current values almost invariably indicate correct potentials applied to the tube sockets. Whenever a socket is encountered during a general analysis in which the plate current fluctuates or is radically low or high, it is then advisable to concentrate the investigation at that socket in an effort to determine the cause of the radical plate current. This investigation may lead to the use of the ohmmeter functions of the tester for point-to-point tests of the component elements of the circuits of the socket. Before undertaking such tests, the radio must be disconnected from the power supply outlet. The resistance analysis may be made between the pin jack terminals of the analyzer cable circuits, or from these terminals to the chassis or other reference points without removing the analyzing plug from the socket in which the circuit defect apparently exists. Resistance analyses should not be made in lieu of the usual current and potential analyses because some types of resistors change in resistance values when operating under their normal loads. Furthermore, it is generally advisable to disconnect resistors from parallel circuits in order to test them, whereas current and potential values can be analyzed without disturbing normally permanent connections.

LOW OHMMETER RANGE. The lowest range of the ohmmeter functions of this tester are calibrated on the tube testing milliammeter, and this range is available from the two "0-500 ohms" pin jack terminals. This range is adjusted by setting the "TUBE TEST, OHMMETER" tumbler switch to the "OHMMETER" position and rotating the "OHMMETER ADJUSTMENT" control knob for a full scale reading of the tube testing milliammeter. The "ZERO OHMS" pearl switch button should not be depressed, and test conductors should not be connected between the "0-500 ohms" pin jacks during the adjustment for the low range.

HIGH OHMMETER RANGES. The higher ranges of the Ohmmeter functions are calibrated on the multimeter, selected by the "METER RANGES" rotary switch, and are available from the two "0-25 MEG. OHMS" pin jack terminals. The higher ohmmeter ranges are adjusted by setting the "OHMMETER, MULTIMETER" tumbler switch to the "OHMMETER" position, the "OHMMETER, TUBE TEST" tumbler switch to the "TUBE TEST" position and by rotating the "OHMMETER, ADJUSTER" control knob for a full scale deflection of the multimeter while depressing the "ZERO OHMS" pearl

switch button. The markings of the "OHMS" range of the multimeter are direct for the 0/5,000-ohm range, should be multiplied by 10 by adding a zero. for the 0/50,000 ohm range, should be multiplied by 100 by adding two zeros for the 0/5-megohm range, and by 5,000-by adding three zeros and multiplying by 5 for the 0/25-megohm range.

The power supply for the 5-megohm and 25-megohm ranges is obtained by connecting the Diagonometer to a convenient A. C. power supply outlet, placing a type '83 tube in the socket designated on the panel for this purpose and setting the "OSCILLATOR, TUBE TEST" tumbler switch to the "TUBE TEST" position.

RECTIFIER RESISTANCE ANALYSES. The most common defect of rectifier circuits which utilize the types 80, 81, 82 and 83 rectifier tubes is represented by short-circuited filter capacitor sections. This condition is usually evidenced by heavy rectifier plate current values. When this defect is suspected during the analysis of the rectifier socket, the radioman should proceed as follows:

- i. Turn the radio "Off," and set the "SELECTOR 1" control knob to the No. "2" position.
- ii. Set the "SELECTOR 2" control knob to the No. "3" position.
- iii. Set the "METER RANGES" control knob for the desired "OHMS" range.
- iv. Depress the "ANALYSIS, OHMS" switch button, and observe the meter reading.
- v. After observing the meter readings, release the button.

If the resistance reading is considerably less than 10,000 ohms, a shorted paper filter capacitor section or a defective electrolytic capacitor should generally be suspected.

AMPLIFIER PLATE AND SCREEN RESISTANCE ANALYSES. The resistance of any amplifier plate circuit can be measured from the plate contact at the tube socket to one of the filament contacts of the rectifier tube socket, or to the plate contact of another amplifier or detector tube to which the same plate potential is applied as that which is specified for the plate circuit of the socket under test. With the analyzing plug in an amplifier tube socket, the following procedure is recommended for plate circuit resistance measurements:

- i. Turn the radio "Off."
- ii. Set the "METER RANGES" control knob to the desired "OHMS" range.
- iii. Rotate the "SELECTOR 1" control knob to the No. "5" position, (or to the No. "4" position if the tube does not have an independent cathode).
- iv. Rotate the "SELECTOR 2" control knob to the different positions corresponding to the terminal arrangement of the socket under analysis, depressing the "ANALYSIS, OHMS" switch button for each setting so as to observe the meter reading of the resistance between the settings of the two "SELECTOR" control knobs.

If the plate circuit resistance appears to be normal for a good tube in which the plate current is considerably lower than the specific value, it is recommended that the resistance between the pin jack that corresponds to the plate terminal of the tube and the No. "5" pin jack (or to the No. "4" pin jack if the tube does not

have an independent cathode) be measured for the purpose of determining whether or not the defective condition is caused by a short-circuited plate bypass capacitor. A procedure similar to that described above may be followed for the measurement of screen grid circuit resistance values from the pin jack that corresponds to screen grid terminal of the tube, or for resistance measurements of other circuits to which positive potentials are applied through resistors from the filament circuit of rectifiers.

AMPLIFIER CATHODE RESISTANCE ANALYSES. In the earlier types of 4-pin triode tubes for use in A. C. power supplied radios, such as types 26, 71A, and 45, the filament performs the functions of a cathode element, and is usually connected to the chassis or to the negative side of the filter system through a resistor across which the negative input grid potential is developed by the plate current of the tube. In the later types of amplifier tubes with more than five base pins, a separate cathode element is heated by the filament and terminates at a cathode pin which usually corresponds to the No. "5" pin. Resistance measurements of cathode circuits should usually be made with external test lead conductors, testing between the No. "5" contact of the socket and the chassis of the radio or to one of the plate contacts of the rectifier sockets of the radio. In some radios the volume control constitutes a part or all of the cathode resistance for some of the tubes. If the cathode resistance is considerably less than the specified value, the bypass capacitor across the cathode resistor may be short-circuited or very "leaky;" this condition will tend to reduce the negative input grid potential with a resultant high plate current value.

INPUT GRID CIRCUIT RESISTANCE ANALYSES. In the latest types of tubes, the No. "1," "T. C.," No. "6," or No. "7" terminals connect to input grids, and the radio-man must determine from service data pertaining to radios which utilize these tubes the terminals which connect to the input grids. The circuit diagrams of such radios are helpful in determining the points between which the resistance values of the input grid circuits should be measured. Input grid circuits carry practically no direct current, wide variations in the resistance values may have negligible effect upon the plate current, but considerable effect upon the amplification of signals. For example, it was found that the transformer secondary windings of the first audio transformer of a Model 70 Majestic radio had increased in resistance value to 40,000 ohms without changing the input grid potential or the plate current of the type 26 first audio tube; but the signal strength of the radio was considerably reduced.

CAPACITOR LEAKAGE TESTS. While the higher ranges of the ohmmeter may be used for measuring the leakage resistance of paper capacitors, the leakages which can be detected in this manner are so far in excess of the permissible leakages for paper capacitors that the use of higher potentials is recommended for such leakage tests. The Radio Manufacturers Association recommends that the insulation resistance of fixed paper capacitors should not be less than 500 megohm microfarads, at a capacitor temperature of 68 degrees Fahrenheit, the test being made by raising to a direct potential of 250 volts a completely discharged capacitor and maintaining this potential for 3 minutes before insulation resistance is measured. These conditions can generally be sufficiently approximated in practical service procedure by utilizing the 250-volt DC potential of the tester, in the following manner:

- i. Connect the tester to a convenient A. C. power supply outlet, and insert a type 83 tube in the socket designated for this purpose on the tester panel.
- ii. Throw the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position.

- iii. Set the "AC-DC" tumbler switch to the "DC" position.
- iv. Set the "METER RANGES" control knob to the "250-25-250" position.
- v. Set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- vi. Set the "OSCILLATOR, TUBE TEST" tumbler switch to the "TUBE TEST" position.
- vii. Set the "CAPACITY, TUBE TEST" tumbler switch to the "TUBE TEST" position.
- viii. Connect a short conductor between the "POWER OUTPUT" and the "MULTIMETER COMMON" pin jacks.
- ix. Connect the "POWER OUTPUT" pin jack to one terminal of the capacitor under test, and to the other capacitor terminal connect "0-1,000 VOLTS" pin jack.

When the potential is applied, a good capacitor will take a charge through the meter which will indicate the charge by a maximum reading at the instant the connection is made, the reading decreasing to zero as the charge is completed. The instantaneous maximum reading varies with the capacities of capacitors under test. The failure of the meter to make any response to the charging potential would indicate an "Open" capacitor, or a capacitor of a capacity too low to accommodate a discernible charge with the applied potential. A shorted capacitor will be indicated by reading on the meter of the full voltage of the D. C. power supply. A capacitor with a resistance leakage will be indicated by the failure of the meter needle to complete its decrease to the zero position. Paper capacitors which have any discernable leakage should be discarded, as it is likely to break down at any time.

A. C. LINE VOLTAGE MEASUREMENTS.

- i. Set the "AC-DC" tumbler switch to the "AC" position and set the "OHMS METER MULTIMETER" tumbler switch to the "MULTIMETER" position.
- ii. Depress the "LINE VOLTS" switch button. (Observe the reading on the 250-volt scale of the Multimeter).

CAPACITY MEASUREMENTS. Because of the possibility of "blowing" the fuse located beneath the tester panel when attempting to measure the capacity of a shorted capacitor, it is recommended that every capacitor be subjected to the leakage test outlined in the preceding paragraphs before undertaking a measurement of the capacity. No attempt should be made to perform such measurements on capacitors which are connected to grounded radios or circuits. This test is not applicable to electrolytic capacitors, which require special circuits for capacity measurements. For capacity measurements with this tester, the following procedure should be followed:

- i. Set the "AC-DC" tumbler switch to the "AC" position, and set the "OSCILLATOR, TUBE TEST" tumbler switch to the "TUBE TEST" position.
- ii. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position, and set the "METER RANGES" rotary switch to the desired "CAPACITY, MFDS." range.

- iii. Set the "CAPACITY, TUBE TEST" tumbler switch to the "CAPACITY" position.
- iv. Set the "OUTPUT, VOLTMETER" tumbler switch to the "VOLTMETER" position.
- v. Connect the tester to a convenient A. C. power supply outlet.
- vi. Connect the unknown capacitor between the two "CAPACITY" pin jacks, and observe the capacity reading on the multimeter.
- vii. After observing the capacitive value, disconnect the power supply system, and remove all connections to the tester.

All capacitive values should be read on the "100" scale of the meter; the readings should be divided by 10 for the "10-MFD." range, divided by 100 for the "1.0-MFD." range and by 1,000 for the "0.1-MFD." range. If the tester is designed on special order for some power frequency other than 60 cycles, the frequency for which the tester is designed should be applied instead of a power supply of 60 cycles.

MISCELLANEOUS CONNECTIONS. By reason of the fact that all of the analytical circuits, except the filament or heater circuits No. "3" and "4" may be broken by setting the "OPEN, CIRCUIT INSERT" tumbler switch to the "OPEN" position, any device, such as headphones, loudspeakers, etc., may be connected to the two "CIRCUIT INSERT" pin jack terminals for insertion in any of the analytical circuits corresponding to the settings of the "SELECTOR 2" control. All of the analytical circuits terminate at correspondingly numbered pin jack terminals on the lower right hand margin of the tester panel, and any of the potentials of the radio sockets are available at these pin jack terminals. The A. C. and D. C. 2.5-ampere measuring range is available between the two "2.5 AMPS." pin jacks while depressing the "2.5 AMPS." pearl push button.

THE OSCILLATOR AND OUTPUT MEASUREMENTS. In order to dispense with the use of a calibration chart or a graph with a tuning curve, the oscillator of this tester is designed for tap switch tuning. The available frequency settings of the rotary "OSCILLATOR FREQUENCY" switch cover more than 95% of all of the superheterodyne radios in use. The fact that the modulation of most D. C. operated oscillators is about 30%, whereas the modulation of an A. C. operated oscillator is practically 100% makes the oscillator of this tester ideal for adjustments of modern radios in which the blasting effect of strong signals is minimized by volume level circuits which are most efficient when operating with signals from a 100% modulated broadcast station. If strong r. f. signals are applied to a sensitive radio of this type by an unmodulated oscillator it is possible to overload the detector with r. f. energy without having any appreciable loudspeaker output of a. f. energy. In some radios, an overloading of the above mentioned circuits with r. f. energy may result in two maxima or peaks of the radio output and in broad tuning when the modulation is considerably less than 100%. It is, therefore, obvious that the loudspeaker output is greatly dependent upon the percentage of the modulation of the input r. f. signals. The procedure for the operation of the oscillator for output measurements is very simple and is outlined as follows:

- i. Set the "OSCILLATOR, TUBE TEST" tumbler switch to the "OSCILLATOR" position, and attach the tester to a convenient power outlet.
- ii. Insert the black dummy antenna pin plug into the "GND." pin jack of the tester oscillator.

- iii. Insert the dummy antenna pin plug into the "ANT." pin jack of the tester oscillator.
- iv. Attach the "A" dummy antenna clip to the "ANTENNA" binding post of the radio, or to a contact point specified by the radio manufacturer.
- v. Attach the remaining dummy antenna clip to the "GROUND" of the radio.
- vi. Set the "MULTIMETER" tumbler switch to the "MULTIMETER" position, set the "OPEN, CIRCUIT INSERT" tumbler switch to the "CIRCUIT INSERT" position, and set the "OUTPUT, VOLTMETER" tumbler switch to the "OUTPUT" position.
- vii. With the radio turned "OFF," remove a power output tube from the radio, place the tube in the proper tester socket, and connect the top cap, if any, of the tube to the "TOP CAP" pin jack on the tester panel.
- viii. Insert the analyzing plug into the vacant radio tube socket and complete the radio top cap terminal connections, if any, to the lug at the top of the analyzing plug, and turn the radio "ON."
- ix. Set the "SELECTOR 1" control knob to the No. "3" position (or to the No "5" position if the power tube has an independent cathode element).
- x. Set the "SELECTOR 2" control knob to the position that corresponds to the plate terminal of output tubes.
- xi. Set the "METER RANGES" control knob to the "250-25-250" position, or the control may be rotated clockwise for a suitable lower range.
- xii. Set the rotary "OSCILLATOR FREQUENCY" switch for the desired frequency, tune the radio to the oscillator, adjust the radio volume and tester "OUTPUT CONTROL" for the desired signal strength, and proceed with the radio re-adjustments in accordance with the procedure outlined by radio manufacturers for such adjustments.

Failure to hear the signals indicated by the meter would suggest a defective output transformer or defective speaker circuits. If desired, a range lower than the "250" volts range may be used when necessary for better readability. The "POLICE" tuning range is calibrated at 1,875 kilocycles (160 meters) unless the tester is ordered calibrated at some other frequency in the 160-meter band. The 80-meter, 40-meter and 20-meter short wave bands are coverable by the 2nd, 3rd and 4th harmonics, respectively, of the 160-meter "POLICE" band. It is generally advantageous to keep records of the output readings of various radios for comparative and reference purposes in future adjustments. The oscillator and output meter constitutes an ideal method for comparative tube testing with operative radios. This method of tube testing is accomplished by observing the effect on the output meter readings resulting from the replacement of questionable tubes with new tubes. Tubes tested by this method are usually designated as "set tested" tubes. This method of testing is also ideal for detecting fading conditions within the radio or tubes, and is being practiced by many leading radio service engineers as a result of the recommendations of some of the leading tube manufacturers.

A. C. TUBE TESTING. In addition to the provisions for (1) testing tubes from the sockets of operative radios and (2) by means of an oscillator and output meter, this tester is provided with facilities for testing tubes with A. C. power supply by the usual "Grid shift" transconductance (or mutual conductance) principle. The meter of this tester is provided with a "LOAD" classification which permits the user to definitely "load" each amplifier tube before depressing the "TUBE TEST" push button switch for determining the amplification quality of the tube. This "LOAD" adjustment automatically compensates variations in the cathode emissivity of amplifier tubes, and adjusts the tester circuit to power supply variations, within normal limits, by practically the same principles as those utilized in conventional ohmmeters for adjusting ohmmeters to battery potential depreciation.

RECTIFIER TUBES. The principles discussed in the preceding paragraph are applicable to amplifier types of tubes. Rectifier types are tested in this tester, by the well known emission test principles. Practical radiomen are aware of the fact that a somewhat wider tolerance is permitted in the classification of rectifier tubes, so no adjustment is provided in this tester for compensating power supply variations when using the tester for the purpose of classifying rectifier tubes. It will be noted that the "TUBE TEST" push button switch does not affect the test of rectifier tubes; this is natural, as such tubes do not have controlling grid elements. The "TUBE TEST" push button switch is associated with the conventional transconductance test of amplifier types of tubes. The following general procedure is recommended for testing rectifier types of tubes:

- i. Attach the tester to a convenient A. C. power supply outlet, and set the "CAPACITY, TUBE TEST" and "OSCILLATOR, TUBE TEST" tumbler switches to the "TUBE TEST" position.
- ii. Set the "OHMMETER, TUBE TEST" tumbler switch to the "TUBE TEST" position.
- iii. Set the "CAPACITY, TUBE TEST" tumbler switch to the "TUBE TEST" position, and locate the tube in the 1st column of the Tube Testing Table.
- iv. Set the "FIL-HTR. SELECTOR" rotary switch to the potential marking indicated in the 2nd column.
- v. Set the "TUBE TEST SELECTOR" to the position indicated in the 3rd column.
- vi. Set the "TUBE TEST CONTROL #1" to the position indicated in the 4th column.
- vii. Set the "TUBE TEST CONTROL #2" to the position indicated in the 5th column.
- viii. Place the tube in the proper tester socket; after the tube attains its normal operating temperature, observe the meter indications of the tube condition.

AMPLIFIER TUBES. All tubes which have controlling grid elements for varying output plate currents with varying input A. C. potentials are considered as amplifier tubes for the purpose of this tester. The following testing procedure is recommended:

- i. Attach the tester to a convenient A. C. power supply outlet, and set the "CAPACITY, TUBE TEST" and "OSCILLATOR, TUBE TEST" tumbler switches to the "TUBE TEST" position.
- ii. Set the "OHMMETER, TUBE TEST" tumbler switch to the "TUBE TEST" position.
- iii. Set the "CAPACITY, TUBE TEST" tumbler switch to the "TUBE TEST" position, and locate the tube in the 1st column of the Tube Testing Table.
- iv. Set the "FIL-HTR SELECTOR" rotary switch to the potential marking indicated in the 2nd column of the Tube Testing Table.
- v. Set the "TUBE TEST SELECTOR" to the position indicated in the 3rd column of the Tube Testing Table.
- vi. Set the "TUBE TEST CONTROL #1" to the position indicated in the 4th column of the Tube Testing Table.
- vii. Set the "TUBE TEST CONTROL #2" to its Zero position. The 5th column of the Tube Testing Table is blank for amplifier types of tubes.
- viii. Place the amplifier tube in the proper tester socket; after the amplifier tube attains its normal operating temperature, adjust the "TUBE TEST CONTROL #2" for an upright meter pointer indication of full "LOAD." This re-adjustment should not be made when testing rectifier tubes.
- ix. Depress the "TUBE TEST" push button switch, observe the meter indication of the tube condition, and release the "TUBE TEST" push button switch. The operation of this switch is not necessary when testing rectifier tubes.

CATHODE HEATER LEAKAGE TEST. The rasping noise sometimes emitted from radio speakers is generally caused by intermittent cathode heater leakage of indirectly heated type of tubes. The effect of this tube defect varies with different types of radio circuits being most noticeable where the cathode circuit or biasing resistance is used in the volume control circuit with heater circuit grounded.

The testing procedure for heater type tubes is the same as outlined in the above paragraph that pertains to filament type of amplifier tubes with the exception of the use of the "CATHODE HEATER LEAKAGE" switch for determining shorts between cathode and heater elements of indirectly heated types of tubes. This test is accomplished in the following manner:

- i. Set the "OHMMETER, MULTIMETER" tumbler switch to the "MULTIMETER" position.
- ii. Set the "A.C., D.C." tumbler switch to the "AC" position.
- iii. Depress the "CATHODE HEATER LEAKAGE" push button switch, and observe the multimeter indication. (A short or leakage between the cathode and heater elements of tubes will be indicated by approximately full scale deflection of the multimeter needle.)

NEUTRALIZING AND A. V. C. ADAPTERS. The Supreme Neutralizing and A. V. C. Adapters are indispensable for those who are equipped with an oscillator or who utilize the signals from a nearby broadcasting station for re-neutralizing adjustments, or for tuning capacitor re-adjustments in A. V. C. radios in which the manufacturers

MASTER DIAGNOMETER
PACKING LIST

Effective March 7, 1934

Accessories included in original Master Diagonometer shipments.

Quantity: Included:	Stock : Number:	Description	:Packer's :Check
1	: 6349	: Adapter, small 7-hole plug to 4-pin	: <input checked="" type="checkbox"/>
1	: 6348	: Adapter, small 7-hole plug to 5-pin	: <input checked="" type="checkbox"/>
1	: 6347	: Adapter, small 7-hole plug to 6-pin	: <input type="checkbox"/>
1	: 6346	: Adapter, small 7-hole plug to large 7-pin	: <input checked="" type="checkbox"/>
1	: 6344	: Cable, 9-wire Analyzing with #6343 and #6397 plugs : : 48"	: <input checked="" type="checkbox"/>
1	: 6052	: Cable, 2-wire with Female plug #58, 72"	: <input checked="" type="checkbox"/>
1	: 1112	: Connector, 15" Top Cap	: <input checked="" type="checkbox"/>
1	: 6025	: Cable, shielded Antenna, 50"	: <input checked="" type="checkbox"/>
1	: 6402	: Chart, Tube Testing	: <input type="checkbox"/>
1	: 1111-B:	: Connector, 50" Black Test Probe	: <input checked="" type="checkbox"/>
1	: 1111-R:	: Connector, 50" Red Test Probe	: <input checked="" type="checkbox"/>
1	: 6135	: Connector 27" pin plug	: <input checked="" type="checkbox"/>
1	: 6404	: Data, Operating	: <input type="checkbox"/>
1	: 6288	: Sample Analysis Chart	: <input type="checkbox"/>
1	:	: Accessories Order Form & Registration	: <input type="checkbox"/>

The above list of items was checked by the undersigned who is responsible for the completion of this package.

..... (Signed)

*The serial number of this tester is engraved (but not waxed) in the panel and should always be mentioned in all correspondence pertaining to the tester.

SUPREME INSTRUMENTS CORPORATION
GREENWOOD, MISSISSIPPI
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