SUPREME

Radio Diagnometer

Radio Manual

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SUPREME INSTRUMENTS CORPORATION

Greenwood, Miss.,

U. S. A.

THE SUPREME INSTRUMENTS CORPORATION

acknowledges its indebtedness for the splendid work done in the compilation of this Manual, by its author,

Mr. Floyd Fausett,

who, backed by many years of experience in radio servicing and having used a Supreme Radio Diagnometer, almost since its inception, in his own service work, is peculiarly fitted for the task.

His understanding of the service man's problems, and his actual use of the instrument in the service field, has enabled him to present this Manual in a manner that is sure to be appreciated by all users of the Supreme Diagnometer and by service men generally.

PREFACE

In the rapid development of radio, it is but natural that the attention of the industry has been centered on sales promotion and the mass production of receiving sets, to meet the demand that the warranted popularity of radio has created, but too little thought has, thus far, been given to the equally important factor of service.

The entire industry has come to recognize that, with the constantly expanding production of receiving sets, ever widening markets must be created, which can only be accomplished thru still further popularizing radio. Unquestionably, this can best be attained through the enthusiastic satisfaction of present users, which depends entirely upon obtaining for them the maximum and most pleasurable results from the sets now in operation.

The future of the radio industry is therefore, largely dependent upon the development of such system of radio servicing as will guarantee such results to the radio public. Unless such results can be attained, the full rewards for the sales effort and engineering ingenuity employed in the distribution and production of receiving sets, cannot be realized. Obviously, therefore, the development of a truly efficient service is equally important with the production of better receiving sets; and the successful distribution of the latter, and the growth of the industry, will be largely controlled by the character of service rendered.

It is in recognition of this vital need that the Supreme Instruments Corporation was brought into being. Heretofore, there has been no organization concentrating its attention on the production of such apparatus as would develop the type of service that is so sorely needed. It is true that various simple meter combinations, of very limited range and capacity, have, from time to time, been offered by manufacturers, predominately interested in other types of apparatus, as an incidental item to their major production, but there has not been the concentrated research, study, and analysis necessary to the development of truly efficient radio service.

It is the belief of the founders of the Supreme Instruments Corporation that, with the present tremendous volume of radio distribution and its probable continued expansion, there is not only room for an organization dealing exclusively with servicing, but, that such an organization is absolutely essential to the maximum development of radio potentialities.

In response to this need, this corporation is concentrating its efforts upon the production of such equipment and apparatus as will facilitate the solution of radio servicing problems, and through producing more pleasurable results from the receiving sets in use, contribute its full share to the growth of the radio industry. Its sole function is to meet the needs of radio service. All the thought and attention of its capable engineering and research departments are centered on this one problem and it is not surprising, therefore, that, in the comparatively brief period of its existence, its products have come to be recognized as affording the only practical, convenient means of making those thorough and scientific analyses that form the basis of truly efficient radio service.

TABLE OF CONTENTS

INTRODUCTION

SUPREME DIAGNOMETERS are designed to meet the ever growing needs of radio service by placing in the hands of the service man a compact, convenient instrument, in portable form, that is capable of making all of the tests and analyses that are so helpful, and in many instances absolutely essential, to the performance of truly efficient service.

The SUPREME DIAGNOMETER is the only apparatus now available in portable, convenient form by which the thorough scientific analyses can be made that are so essential to the character of service that the continued growth of the radio industry demands. It must not be confused with the ordinary meter combinations generally known as "Set-Testers." While, naturally, it provides all the readings that can be made by such testers, it goes very much farther, being in fact a portable laboratory, with all of the range and possibilities of the most complete and expensive laboratory equipment.

Naturally, in a laboratory apparatus of this kind it is impossible to enumerate all of the various uses to which the equipment may be applied and while an attempt will be made in this manual to fully cover all of the more important tests and analyses and those in more general use, the flexibility of the instrument is such that the user, with greater familiarity with the apparatus, will constantly find new uses for it; in fact, it is difficult to conceive of any problem or situation in radio that may arise that cannot be quickly and satisfactorily met with this marvelous equipment.

Obviously, it is not practical to include within a service manual of this type a complete treatise on radio service, although a sincere effort has been made to provide much information other than that relating to the actual operation of the instrument, which will prove helpful to the user. There will be found contained in this manual, complete descriptions of many of the more important receiving sets, and it is planned to issue supplements from time to time, enlarging on the information contained herein and keeping this manual abreast with the rapid developments in radio. It is for this purpose that this manual is printed in loose leaf form.

In placing the SUPREME DIAGNOMETER in the hands of the service man, there has been made available the most complete and efficient radio testing and analyzing equipment that money can buy or engineering ingenuity create. It must be borne in mind, however, that no mechanical arrangement, marvelous though it may be, can wholly supplant human intelligence and knowledge and naturally the success attained in the field of radio servicing will be largely governed by the knowledge and intelligence of the individual user and the consideration given to the problems in hand. All users are urged to continuously and closely apply themselves to the problems of radio servicing and to secure a thorough knowledge of the principles underlying the theory of radio circuits and related apparatus. The same careful study should be made of the operation of the SUPREME DIAGNOMETER; the instructions contained herein should be closely observed and the user should thoroughly familiarize himself with the operation of the instrument.

With this preparation, backed by a reasonable knowledge of radio, the SUPREME DIAGNOMETER will prove a great asset to any service man. He will find that he can not only do much more efficient work, but that he can do vastly more of it because of the time saved as compared with the former "Guess work," "Hit and miss" methods. Through this increase in his productive capacity, the service man can command a wage more in keeping with the technical knowledge his occupation demands and at the same time the cost of such service to the public can be reduced, while in addition thereto, there is the incomparable satisfaction that comes from the knowledge of a task well performed.

The manufacturers of SUPREME DIAGNOMETERS do not consider that their obligation to the users of their instruments ceases with the sale and delivery of the equipment. Instead, they feel that such purchase marks the beginning of a mutuality of interest and it is their desire to develop such effective co-operation with their users as will promote their respective well-being to the utmost.

Every possible effort is made to maintain at all times a correct list of users so that data and information can be submitted to them from time to time, that will perhaps be helpful in the solution of problems that confront them. Should repairs or adjustments at any time be necessary, such service is performed with the utmost dispatch and everything possible is done to minimize the inconvenience and delay that is caused by such unfortunate experiences. This question is discussed more fully elsewhere in this manual.

Through the Supreme Service League, which is also presented in greater detail elsewhere herein, the dealer or service man is offered an opportunity, through co-operative effort, to build a prestige in his chosen field that will pay big dividends in a financial way.

This manual is presented in the hope that it will be of material aid to the service man. Its compilation has been no easy task and represents a very substantial financial outlay. No expense has been spared in its preparation. The information contained herein is dependable and thoroughly proved by painstaking care. It is hoped that it will fulfill its mission to improve the character of radio service and thereby contribute substantially to the maximum growth of the radio industry. It may be truthfully said that the future of radio is in the hands of the service man and depends upon the quality of service rendered.

The manufacturers of SUPREME DIAGNOMETERS feel that the interest of every individual user of their instruments is their interest, and assurances are given that they will strive earnestly to see that maximum results are obtained from the equipment they sell and that they will lend every possible aid in the development and promotion of the business interests of their users.

Chapter I.

THE SUPREME DIAGNOMETER.

General Description. — The SUPREME DIAGNOMETER is a complete portable laboratory, comprising all necessary meters and equipment for testing both alternating and direct current radio sets and tubes. It is designed especially for the up-to-date radio man, enabling him to make every conceivable test that might be encountered in radio servicing. It is equipped with an ammeter-milliameter and voltmeters with a system of multi-contact switches which provides a means for testing the various types of tubes and ascertaining all desired electrical values in the operation of A.C. and D.C. radios. Contained within the instrument as a part of the power plant is a step-down transformer with a tapped secondary for utilizing the ordinary house lighting current to provide the various voltages required for testing the numerous types of tubes. The unit is also provided with a tube rejuvenator operating from the same step-down transformer, providing a means for rejuvenating tubes of the thoriated-filament type. Current is supplied by this transformer for an oscillator, giving the "Oscillation test" on various types of tubes under the actual operating conditions, independent of a radio. This oscillator, modulated by the alternating current, provides a signal for the aligning of condensers and calibration and neutralizing purposes. Connecting cables, plugs, tube sockets and adapters are provided to facilitate the testing of the various tubes and circuits. Non-thermionic rectifier tubes may be tested by comparing the output with the normal for the type in question.

Frequency Terms. — All tables and data contained herein are based on the use of 60 cycle A.C. current, but operators of specially-built 25-cycle Diagnometers will have no difficulty in interpreting these tables and data to meet the operating characteristics of their instruments. In view of the tendency towards designating the assignments of broadcasting stations in frequencies instead of wave-lengths, and the corresponding tendency towards the calibration of radio receivers in kilocycles, the references within this manual to tuning positions are in terms of kilocycles only. It is a simple problem of arithmetic to divide 300,000 by the frequency (in kilocycles) to obtain the approximate wave length (in meters); as the velocity of radio signals is the same as that of light, about 300,000 kilometers (186,000 miles) per second, and this velocity constant is the product of the frequency (in kilocycles) and wave length (in meters).

Electrical Protection. — In most electrical measuring instruments the meters employed are generally the most expensive, delicate and sensitive apparatus contained therein. While voltmeters are protected by their component resistances within their scale limit, current measuring meters, especially milliameters, are generally at the mercy of the operators of the apparatus. SUPREME DIAGNOMETERS are equipped with the finest service meters obtainable, and these meters are surrounded with every possible protection consistent with their proper performance. The problem of protecting the SUPREME milliameter has been given more study than any other problem involved in the manufacture of SUPREME DIAGNOMETERS.

When the SUPREME DIAGNOMETER is powered from the alternating current line, protection to the milliameter and other sensitive apparatus against over load current, such as might be encountered by the inadvertent placing of a shorted-element tube in one of the sockets, is accomplished by the use of a protective resistor in series with one side of the alternating current supply to the instrument, the current carrying capacity of the prescribed resistor being such that it limits the current supply to that required by the SUPREME DIAGNOMETER for the various tests it is designed to accommodate. This current limitation can be provided either with a 100-watt Mazda lamp or a 100-ohm resistor at the option of the operator. The 100-watt Mazda lamp offers the advantage of providing instant and visible evidence of a shorted tube. All tables contained herein are based on the use of the 100-watt Mazda lamp, from which there will be a slight variation in event the 100-ohm resistor is used.

CAUTION.—DO NOT USE ANY LIMITING DEVICE OTHER THAN THAT PRESCRIBED, AS A HIGHER VALUE OF RESISTOR WILL RENDER TABLES CONTAINED HEREIN INACCURATE AND LOWER VALUE RESISTOR WILL ENDANGER THE MILLIAMETER.

Either of these prescribed resistors will protect the milliameter and circuits only when the SUPREME DIAGNOMETER is supplied with power from the A.C. line. When power is supplied from external batteries, there is no protection to the milliameter against shorted tubes, which is one of the reasons for recommending that tube testing with the SUPREME DIAGNOMETER be accomplished with the tube testing circuits powered from the alterating current line.

A protective relay which shunts the meter when the current reaches 140 mils is embodied in the Model 400-B to protect the milliameter against shorted tubes. This relay is included as additional protection and while it will doubtless prove effective in almost every instance its operation cannot be guaranteed and it is therefore recommended that testing with power supplied from external batteries be resorted to only when A.C. current is not available.

When the SUPREME DIAGNOMETER alterating current connector cord is connected to a line socket, the analyzing plug and all connected leads and jacks must be kept clear of all other apparatus which may be grounded or connected to either side of any alternating current supply system. This will prevent the possibility of shunting an alternating current line potential into the instrument apparatus around the protective resistor. Failure to diligently observe this simple precaution may incur serious damage to the apparatus.

Switching Systems. — SUPREME DIAGNOMETERS have multi-pole jack switches designed to be operated with master plungers. This insures longer life and more positive contact and minimizes the possibility of anyone of the governing switches being placed in wrong setting during any test. Each instrument is supplied with four master plungers, one with a special grooved-shank for use in the double-action rejuvenator switches, and three with straight shanks for operating all other jack switches.

Some of the earlier SUPREME DIAGNOMETER models were designed with push button switches, and these models do not require master plungers. In reference to switches in the following pages of this manual, a closed switch will mean a jack switch with its corresponding plunger inserted or a button switch with its button depressed.

Before making any test one should be sure that all switches are open. When making a test only the necessary switches should be closed. All switches should be opened after every test. This is an instrument of multi-circuits with multi-voltages, and while all possible protective arrangements are included in the design of the instrument, these simple precautions in the operation of switches SHOULD BE CAREFULLY OBSERVED in order not to subject the apparatus to unnecessary electrical strain.

The Use of Multi-Scale Meters.—Multi-scale meters are employed in SUPREME DIAGNOMETERS in order to accommodate the requirements of portability and a little practice on the part of those who are not already familiar with multi-scale meters will enable them to read these meters as easily as they can single-scale meters.

The simple principles involved are applicable to all multi-scale meters. In this section a typical three-scale voltmeter with 0-10, 0-50, and 0-300 scales, having corresponding 10-scale, 50-scale and 300-scale governing switches will be discussed.

Closing the "10 scale" switch automatically brings a corresponding meter resistance into the circuits involved, the value of which is such that whatever voltage, under 10 volts, is applied to the meter circuit will deflect the meter needle a distance over the meter dial in proportion to the voltage applied, 10 volts giving a full-scale deflection, 5 volts a half-scale deflection, and so on. In other words, the "0" to "10" graduations, only, are used, ignoring all other graduations on the meter dial while using the meter with the "10 scale" switch closed.

Closing the "50 scale" switch automatically brings a corresponding meter resistance into the circuits involved, the value of which is such that whatever voltage, under 50 volts, is applied to the meter circuit will deflect the meter needle a distance over the meter dial in proportion to the voltage applied, 50 volts giving a full-scale deflection, 25 volts a half-scale deflection, and so on. In other words, the "0" to "50" graduations, only, are used, ignoring all other graduations on the meter dial while using the meter with the "50 scale" switch closed.

Similarly, the "0" to "300" graduations, only, are observed when applying voltages under 300 volts through the "300 scale" switch.

In using the meters of the SUPREME DIAGNOMETER, use only the D.C. meters for reading direct (or pulsating) voltages and currents; and use only the A.C. meter for reading alternating current voltages.

Accuracy of Meters. — In a voltmeter very high resistance is desirable so that it may practically stop the flow of current and indicate the effect of the voltage or pressure acting upon its terminals. A poor voltmeter of low resistance would allow so much current to pass through itself that this load would reduce the voltage in the measured circuit far below the value which it would be without the voltmeter across the circuit.

It may be observed, in using multi-scale meters, that there is a slight lack of co-ordination when comparing the readings of the different scales. For instance, a ten volt reading on one scale may show a slightly different reading on another scale of the same meter. This does not indicate a defective meter, but may be due to the tolerance permitted in precision meters, which is based on full scale deflection. In voltmeters where current is limited, some or possibly all of this variation may be due to the greater current required to deflect the meter over the wider range of the lower scale. It must be remembered that it requires current to actuate the movement of the meter. The more closely the limited current approaches the value of the current necessary for the operation of the meter, the greater the inaccuracy of the meter will be. This applies to reading C-bias voltages where the bias is obtained by the voltage drop across a resistor.

A general rule, easy for the less technical man to remember, is to use the lowest scale that will accommodate the potential to be measured when the device to be measured is rated as a comparatively "low voltage—heavy current" type; and use the highest scale that will afford a discernable reading when the device to be measured is known to be a comparatively ''high voltage—low current'' device. For the more technical man, the rule is to choose the scale which will accommodate the voltage to be read and which will also introduce a current-resistance drop within the device to be measured such that the error occasioned by the drop will most nearly approximate the probable variation from accuracy tolerated by the meter manufacturer in the movement calibration as applied to the scale chosen.

Chapter II.

SPECIAL SUPREME FEATURES

The Major Features. — The adaptability of the SUPREME DIAGNOMETER is such that new uses and servicing features are discovered and published from time to time as new radio apparatus and servicing problems are developed. This manual, however, deals with the following Major Supreme Diagnometer Servicing Features:

(1) Tube Tester
(2) Modulated Radiator
(3) Resonance Indicator
(4) Neutralizer
(5) Analyzer
(6) Continuity Tester
(7) Rejuvenator
(8) External Use of Meters

The Power Plant. — The Power Plant consists of the A. C. Connector Cord with the prescribed protective resistor and series socket, the "A.C. Line" switch, a radio-frequency by-passing unit, the 110-volt 60-cycle primary winding and the 1.5, 2.5, 3.3, 5.0, 7.5, and 15.0-volt taps of the secondary winding of a power transformer, with a multi-contact selector system for connecting any one of these secondary voltages to the filament contacts of the "Tube Testing Sockets," automatically combining the transformer windings into a specially-arranged auto-transformer and completing the plate and grid circuits of the "Tube Testing Sockets" to the oscillator coil pin jacks while opening up the Power Plant from all other parts of the instrument.

The Power Plant should be used only when supplied with alternating current through the prescribed protective resistor. It is used in furnishing power to the Continuity Tester circuits; and, in combination with the oscillator coil, an alternating current-driven and modulated oscillator is formed which is described below as the Modulated Radiator. The Supreme Power Plant is not adaptable, however, for supplying power to operate any radio.

The "A. C. Line" switch may be closed whenever it is desired to observe line voltage variations during any test based on specified line voltages. Only one of the secondary voltage switches should be closed simultaneously in the Power Plant switching system, as more than one closed switch will short circuit part of the secondary winding, causing an inaccurate test and possible harm to the power transformer.

The alternating current supply cord with its series protective resistor socket should not be subjected to such use and handling as might damage the insulation of its connections at the series socket, which might result in shunting the protective resistor and rendering it inoperative. It is recommended that Supreme Diagnotricians subject the operation of the protective resistor to a test before inserting the oscillator coil in its pin jacks and before closing any switches other than the "A. C. Line" switch. A simple test is to connect the Supreme Diagnometer to the alternating current supply, using the regular series socket supply cord with the protective resistor removed and its socket vacant. No line voltage should then be indicated on the A. C. voltmeter with the "A. C. Line" switch closed. A reading on the A. C. voltmeter would indicate that the series socket is shorted, and the short circuit must be corrected before proceeding with any test involving the use of the Power Plant. If the A. C. voltmeter indicates no voltage with the "A. C. Line" switch closed, the protective resistor may be inserted in its socket. The A. C. voltmeter should then indicate the alternating current supply voltage, and the operator may then proceed with any Power Plant test.

The Supreme Modulated Radiator.—The oscillator feature of the Supreme Diagnometer is designed to meet the needs of radio men for a portable oscillator capable of providing oscillation tests on practically all types of tubes, as well as furnishing modulated radio-frequency signals for the synchronizing and calibration of tuning condensers, neutralizing of radio-frequency circuits, and through its modulated wave for checking up the performance of a radio under actual receiving conditions.

The oscillator circuit, which includes the milliameter and the "Tube Testing Sockets," is completed by placing the Radiator coil in its prescribed position. This coil should not be used in any tests other than those involving the use of the Modulated Radiator. The oscillator circuits are designed to operate with power supplied from:

(1) The A. C. Line through the Power Plant; or
(2) Batteries through external test leads.

When the oscillator is powered from the A. C. line, modulation at the frequency of the applied potential is accomplished in the radiated harmonics. If all of the potentials supplied to the oscillator circuit are direct (i. e., neither alternating or pulsating, as with batteries), "click" modulation may be had by manipulation of the oscillation switch, which is shunted across the grid or secondary winding of the oscillator coil and across the tuning condenser.

The mil-ameter is in the common plate circuit of the "Tube Testing Sockets" and indicates the self-rectified plate current of any tube placed in either of these sockets. This current reading may include additional plate current drain induced by the feed-back of the oscillatory circuit. Positive protection to this meter from over-load current is afforded when the Supreme Radiator is supplied from the Power Plant utilizing the prescribed protective resistor in series with the A. C. Line Connector Cord. This method of supply should always be utilized whenever alternating current supply, of the potential and frequency for which the Supreme Diagnometer is designed, is available.

The value of whatever oscillation current may be induced in addition to the normal plate current flowing in the plate circuit may be determined by closing the oscillation switch and subtracting the reading obtained with the switch closed from the reading obtained with the switch open. This difference is proportional to the audible strength of the radio-frequency harmonic signals radiated from the Modulated Radiator. Any tube designed with filaments for alternating or direct current heating, if capable of oscillatnig, will perform satisfactorily in the Modulated Radiator. With the Modulated Radiator in operation in close proximity to a radio, with a tube in one of the "Tube Testing Sockets" showing good oscillation on the milliameter, inability to tune in the Radiator signals with the radio would indicate something defective in the radio or its accessories. The following types of tubes are named approximately in the order of their respective merits as oscillation generators in the Supreme Radiator: '12-A, '71-A, '50, '45, '26, '00-A, '10, '01-A, and '27.

The Power Plant method of supplying power to the Modulated Radiator for generating oscillatory currents is such that constant circuit values, and potentials with a fixed relation to the power supply potential, are provided for tube testing, while signals are radiated in harmonics over the broadcast band for other purposes. Using the Modulated Radiator is simply a matter of choosing a harmonic the frequency of which meets the requirements of the test to be performed. For the calibration of tuning dials, or for checking dials already calibrated, and for a general check-up on the operating characteristics of a radio, all of the radiated harmonics may be used. If for any reason, it is desired to increase the audible strength of the radiated signal in a radio, the Supreme Diagnometer may be provided with a better oscillator tube, moved closer to the radio, or both.

The Supreme Resonance Indicator. — The Meter Resonance Indicator utilizes the Modulated Radiator for setting up radio-frequency signals to which a radio, the tuning condensers of which are to be synchronized, may be tuned. The A. C. voltmeter of any model of the Supreme Diagnometer may be connected to the loudspeaker output terminals of the radio so as to measure the alternating or pulsating component of the amplified output signal of the radio. The strength of this component, other factors being equal, is governed by the degree of alignment of the tuning condensers, and the process of synchronizing consists of adjusting the alignment of each tuning condenser until a maximum reading is indicated on the A. C. voltmeter. When all of the tuning condensers are in resonance with the Modulated Radiator signal the maximum meter reading will be attained.

In addition to the foregoing method, the Model 400-B Supreme Diagnometer incorporates a special thermo-couple meter-driving device, so coupled as to give a comparative indication of the strength of the output signal of a radio. The Supreme Radiator may be employed to set up the modulated radio-frequency signal which is amplified by the radio and inductively fed through the thermo-couple to the D. C. voltmeter movement. The process of synchronizing consists of adjusting each tuning condenser until a maximum reading is indicated on the D. C. voltmeter dial.

The Supreme Analyzer. — The analyzing circuits of the Supreme Diagnometer, collectively termed the Analyzer, consist of the Analyzer plug and its connecting multi-wire cable with its plate connection in series with the ammeter-milliameter and the plate contact of the "Load Socket," all other wires of the cable terminating at their corresponding contacts at the "Load Socket," which is also a part of the Analyzer apparatus. The Analyzer includes the necessary switches for connecting the voltmeter across the cable leads for obtaining the various voltage readings necessary in radio tube-socket analyzing. It is not necessary to use the oscillator coil in analyzing.

The Analyzer may be used for all tube-socket analyzing. Plugging the Analyzer plug into the tube socket of a radio-frequency or detector stage of a radio will detune the stage during the test, due to the added capacity, inductance, and resistance of the Analyzer circuits, so that whatever signals may be heard before plugging into the socket may be weakened or eliminated during the test. This does not, however, affect the test nor indicate any defect in the radio or in the Supreme Diagnometer.

Closing the "D. C. Fil." switch combines the Analyzer with the Rejuvenator for the simultaneous rejuvenation of more tubes than can be accommodated in the Supreme tube sockets.

The Supreme Rejuvenator. — The Rejuvenator utilizes the primary winding and the 3.3, 7.5, 10.3, and 15.0-volt secondary taps of the power transformer which, for this operation, is not connected as an auto-transformer; and includes the 3-volt and the 5-volt double action multi-contact Rejuvenator switches, either of which is fully closed to supply the desired "flashing" voltage and placed in its semi-closed (notched) position to apply the desired "aging" voltage to the "Tube Testing Sockets."

The 10.3 and 3.3 voltages are the "flashing" and "aging" voltages respectively, controlled by the 3-volt Rejuvenator switch, and the 15.0 and 7.5 are the corresponding voltages of the 5-volt Rejuvenator switch. No meter is brought into action with the Rejuvenator unless it is desired to observe the A. C. Line voltage during rejuvenation.

The Rejuvenator may be combined with the Analyzer by closing the "D. C. Fil." switch for the simultaneous rejuvenation of ten or twelve tubes in a bank of sockets the filament contacts of which are connected in parallel, as in an ordinary D. C. Filament type of radio with its ground and power supply leads disconnected and all filament control resistances shunted. The Rejuvenator-Analyzer combination must not be used for the rejuvenation of tubes in radios designed for A. C. filament tubes, as these radios usually employ center-tapped resistances across the filament supply leads which might be damaged by the rejuvenation potentials.

The Supreme Continuity Tester. — The Direct (pulsating) Current continuity test is accomplished by utilizing the Power Plant to supply filament and plate potentials to an '81, or other heavy plate current type of tube, in one of the tube testing sockets, with the oscillator coil removed and two insulated-handle test leads connected to the two plate (left) pin jacks ordinarily occupied by the coil. The milliameter, being in the plate circuits, indicates continuity of the plate circuit of which, in this test, the two test leads are a part.

In using the Supreme Continuity Tester, care must be taken not to undertake the test on any apparatus which is grounded or connected to either side of the A. C. Line, whether or not the apparatus to be tested is in electrical operation.

Chapter III.

SUPREME TUBE TESTING

Tube testing with the SUPREME DIAGNOMETER is accomplished by subjecting the tube to an oscillation test in the oscillatory circuit of the SUPREME Modulated Radiator, which should preferably be powered through the SUPREME power plant supplied with alternating current through the prescribed protective resistor. This method provides an oscillating circuit, having constant values of inductance, capacity and resistance with quantitive electrical values of fixed relation to the power supply. This method gives accurate tabulation of simple tube characteristics for comparing the merits of tubes and the milliameter of the SUPREME DIAGNOMETER is fully protected against shorted tubes by either of the prescribed protective resistors. Directions for testing tubes by the latter-named method are included in this manual, but it is expected that they will be used only where alternating current is not available as a source of power supply.

The Oscillation Test. — The average practical radio man does not usually enter into a detailed study of tube characteristic curves, involving the relations between plate impedance, mutual conductance, and amplification factors, but he knows that a small change in grid voltage or grid bias should effect a large change in plate current, and that a good tube should respond in this manner over a wide range of grid voltage variation. Tube-checkers other than the SUPREME provide only one grid change affording two plate current readings of a tube under test.

The SUPREME oscillation test utilizes the principle of the feed-back from plate to grid, so phased as to produce sustained oscillations, which are, in any tube, to a great extent governed by all of the inherent characteristics of a tube, including element capacity and extent of filament exhaustion. When a tube is placed in an oscillatory circuit the amplitudes of plate currents induced increases plate current amplitudes, which in turn causes still greater plate current amplitude. This building-up process continues until the grid builds up to an effective voltage for self-sustained oscillation. At this point the oscillations are maintained at a constant amplitude providing that the power voltage is constant. Thus it is seen that the "Oscillation test" is the most simple test for the comparative merit of tubes. This test will also detect defective tubes and break them down. In comparing the oscillation test with other tests of tubes it will be found that two tubes may show practically the same response to one or two small grid changes but show entirely different characteristics under an oscillation test. This feature clearly establishes the value of the oscillation test.

Supreme Comparison Tube Tables. — Included in this manual are tables compiled from plate current and plate oscillation current readings obtained from testing tubes of known-standard average characteristics with the SUPREME Modulated Radiator supplied with the line voltages as indicated in the tables. These tables may be used as standards of comparisons, the service man determining for himself about what percentage of variation from these standards he should tolerate for the class of servicing he is undertaking. It should be remembered, however, that when the emmission or the oscillating qualities of a tube fall off appreciably it usually continues to do so at a fairly rapid rate. This is especially true of thoriated-filament tubes.

Matching Tubes. — It is a well-known fact that tubes, even when new, are not entirely uniform in characteristics and tubes which have undergone extended service are usually far from uniform. A comparison of tubes to an average standard of oscillation and emission readings affords a method of tube matching which cannot be excelled for a practical radio man. Tubes used in radio frequency and in the intermediate frequency stages of a radio should be tubes of good average or normal characteristics, and all such tubes should be matched as closely as possible. Sometimes a tube, through use, will become more radio-active than a tube fresh from the package. The normal plate current of such tubes may be the same as a new tube, but it is more sensitive in an oscillating circuit, and is therefore, an improved radio amplifier or detector tube. Detector tubes should show good or above average readings while average or slightly below average tubes are suitable for audio stages, irrespective of oscillation matching. The power tubes used in push-pull amplifying stages should be matched so as not to introduce distortion to the audio frequency amplifier system.

Tubes Requiring Special Couplings. — Some of the 3-element and 4-element tubes are built for special methods of coupling in radio circuits, and may not show oscillation in Models 100A, 400A and 99A. For these tubes emission readings are given in the tables. Oscillation tests can be made with Model 400-B.

Special Detectors. — The 200-A or 300-A, type of tube is an alkalin gas detector and in testing it, it is necessary to allow the tube upward of three minutes to generate maximum ionized gas. This tube should be used only when the radio is designed with its detector grid return to negative filament.

Semi-Power Tubes. — The '12-A type of tubes has a moderate plate resistance. It is an excellent oscillator and should be preferred for use in the SUPREME Modulated Radiator when it is desired to broadcast modulated radio frequency harmonics for test purposes. The type '12 is practically the same as the '12-A, except that the '12 has a one-half ampere filament. The '12-A tube is an excellent detector in radios which have a detector grid return to positive filament.

Five-Element General Purpose Tubes. — The '27 tube should be subjected to careful tests as "Flashers" and "Oxygen generators" must be discarded if a radio utilizing these tubes is to function properly. Oxygen within the tube is indicated by a purple glow during operation.

Heavy Current Tubes. — In testing these tubes it is advisable to throw the milliameter to the highest scale until after the tube has been inserted in the test socket and lighted, as some tubes may have a much greater current output than normal. If this does not occur immediately after the tube has been lighted the meter may be thrown back to a lower scale.

Rectifiers, Thermionic. — Standard comparative plate current readings of these high voltage filament types of rectifiers are shown in the tables. Tests of these tubes should be of short duration so as not to disturb the filament structure. When testing these tubes it will be noticed that the output at first recedes and then gradually gains. The test value of maximum output will be reached in approximately one minute. Gas in these tubes will be indicated by a purplish glow during the test and will show high current readings. When this condition exists or low emission is shown such tubes should be discarded.

Helium Rectifiers. — No provision is made for testing these tubes in SUPREME sockets as the best test for these tubes is to measure the output voltage under load with these tubes in the devices in which they are used. Low or intermittent voltage indicates a weak tube, provided, of course, the device in which it is used is not defective. The output voltage can be determined with external connecting leads through the SUPREME D. C. voltmeter pin jacks, or the analyzer may be used for reading the output voltage from the last audio socket of a radio supplied by the Helium tube rectifier device.

Tungar Bulbs. — These are low voltage rectifiers and the only test necessary is to connect the SUPREME ammeter in series with the trickle charger output under load through the external pin jacks. The output reading is usually stamped on the charger. It will be noted that when the tube is new, it will dim slightly when the battery leads are connected to the charger. If the tube is old or weak, it will grow brighter when the charging begins.

Voltage Regulator, '74 Type.—The voltage regulator or "glow tube" acts somewhat as a variable load to absorb the surplus current output of an eliminator. It maintains the output at 90 volts within certain limits. If the voltage across the tube becomes less than 125 volts the tube will cease to function and "go out." The plate and negative filament terminals are connected by a strap in the base of the tube which is sometimes used to complete the primary circuit of the power transformer. This is done to prevent operation of the device unless the tube is in place. It is possible that sometimes this strap may be broken and it can be tested for continuity. It is also possible that the tube may short circuit the output of the eliminator if the elements should touch. The discharge current through the tube flows from the grid to the positive filament terminals and cannot be measured in any of the SUPREME DIAGNOMETER sockets. These tubes sometimes become noisy due to a high frequency arc, the ionized gas across the elements, which will usually start with a slow "put," gradually increasing to a high note.

Ballast Tubes. — The '76 or '86 type of ballast tube is connected in series with the primary of the power transformer. It keeps the current constant under a wide range of voltage. The voltage drop across these tubes can be measured with the SUPREME A. C. voltmeter and should be the difference between 65 volts and the house line voltage. In other words, the tube keeps the voltage across the primary of the transformer at approximately 65 volts, regardless of the line voltage. The '76 and '86 types differ only in "operating current," the '76 being rated at about 1.7 amperes and the '86 being rated at 2.05 amperes.

Noisy Tubes. — Microphonic noise is caused by vibration of some of the parts in the detector tube or in the audio amplifier tubes. The detector is the usual offender in this respect. The grid, plate or the filament of the offending tube may be insecurely fastened so that the vibration of the sound waves from the loud speaker is sufficient to make these parts vibrate inside the tube. This changes the distance between the grid and the plate or filament so that the plate current must follow the rapid vibrations. The plate current changes are amplified by the following stages and the vibrations are reproduced in the speaker with great volume. The permanent remedy is to use a tube that is better constructed, or to use cushion sockets or cushion tube bases. The noise may sometimes be prevented by moving the loud speaker into a different position with relation to the receiver. If it is impossible to use cushion sockets, the microphonic defects may be prevented by the use of various "Howl Arrestors" which are devices on the market for the purpose of holding the tube against rapid vibration. It is not necessary that the tube and its elements remain perfectly still, only that they do not vibrate at frequencies within the audible range.

A buzzing noise, is sometimes emitted from the loud speaker, and indicates a noisy tube. This trouble is probably more frequently found in the heater types of tubes and the offending tube can best be detected by a process of elimination in actual operation in a radio.

Screen Grid Tubes. '22 and '24 Types. — These tubes can be tested with the SUPREME Modulated Radiator, but none of the SUPREME DIAGNOMETER Models prior to the Model 400-B are adaptable for complete analytical or continuity tests from radio sockets utilizing screen grid tubes. Such tests can, however, be made with Model 400-B.

Overhead Heater Type Tubes.—The Model 400-B SUPREME DIAGNOMETER provides both Radiator-power plant and analytical tests on tubes, the filament terminals of which are connected at the top. Models 99A, 100-A and 400-A do not permit complete analytical tests on radios using these tubes.

Tube Rejuvenation. — The following extracts from page 23 of the Cunningham Tube Data Book need no elaboration:

"The following types of tubes have thoriated-tungsten filament and may be reactivated when necessary: C-299 and CX-299, CX-220, CX-300, CX-301-A, CX-340, CX-371, CX-371-A and CX-310. This filament is not of the coated type, the thorium contents being distributed throughout the body of the tungsten wire. In the final factory process, a uniform layer of atomic thorium is built up on the surface of the filament, this layer being responsible for the high emission efficiency of the thoriated filament. When this tube is in use this surface layer of thorium very gradually evaporates, but fresh thorium is continuously supplied at the same rate from the interior of the filament. This process continues very smoothly, maintaining a uniformly active service condition throughout the life of the tube provided that the filament voltages do not increase more than 10% above the rated value. When subjected to a voltage overload, this balance between surface evaporation and restoration is upset, the active thorium surface is destroyed and the filament emission rapidly decreases. In operation the tendency is to further increase the filament voltage, thus further overloading the tube until no emission is obtained. The tube filament is then said to be 'paralyzed,' but can be restored by reactivation.

"The end of normal life of the thoriated tungsten filament results from the exhaustion of the thorium content and is indicated by a decrease in filament emission instead of actual failure or burn out of the filament with other types of filament material. If the tube will not return to normal after reactivation treatment, it is proof that the tube has either served its normal life or has been so heavily overloaded that the thorium content has been exhausted, or the vacuum impaired."

The reactivation possibilities of a thoriated filament tube with filament rating of 5 volts may be judged, with a fair degree of accuracy, by the SUPREME oscillation and emission tests. If the test shows no oscillation and very slight emission readings it is an indication that the tube has probably been overloaded or "paralyzed," and it can be improved by rejuvenation. The method of coupling in the SUPREME oscillating circuits of Models 99A, 100A and 400A does not accommodate the requirements for oscillation in the 3-volt tubes, and their rejuvenating possibilities must be judged from emission tests with these instruments. The Model 400B provides oscillation tests of these tubes. Under average working conditions, 3-volt tubes are more frequently "paralyzed" than 5-volt tubes. Tubes which are worn out or exhausted will be indicated by very low or no oscillation and low or no emission readings. A tube after successful rejuvenation should show average emission readings. Refer to "Directions for Rejuvenating" in another section of this manual.

CHAPTER IV

ALIGNING OF CONDENSERS.

Problems Involved.—The advent of the single-dial control receiver emphasized the need of the precision alignment of condensers. The constructional problems involved primarily concern the manufacturing engineer, but the problem of maintaining the synchronous relation between tuning units, and especially that of ganged tuning condensers, is a problem for the radio service man in the field.

Importance of Matched Units. — There still remain in use many of the first multi-dial radio-frequency and neutrodyne types of radios. Those who are familiar with the operation of these types of reçeivers have noticed that the tuning dials maintain their settings fairly close to one another for all stations, the greatest variation from the average setting of the dial being noticed in the dial which controls the first tuned radio-frequency stage, this variation being generally proportional to the variation of the antenna specifications from those specifications best suited to the operation of the radio. By observing the latter variation a radio man could usually tell a customer whether or not his aerial was too short or too long.

If a three dial receiver, having the proper antenna, be tuned to a broadcasting station on one side of its tuning range, at settings of 9, 10, and 11 for example, the average setting would be 10. The "9" and "11" dials could be released from their shafts and reset at "10" without disturbing the alignment of the condensers. Then the condensers and dials would be synchronized at resonance. If the dials were rotated to the opposite side of the tuning range, another station might be tuned in to maximum strength, but it would probably be found that the settings were not the same on all three dials, and the variation from the average setting of the dials would be an index to the variation from exact matching of the inductances and capacities involved in the tuning units. If the same units were utilized in the construction of a single-dial receiver a loss of tuning efficiency would result, as the receiver would afford accurate ganged condenser alignment at only one setting within its tuning range and as this frequency is departed from, the resonant points of the tuned circuits become farther apart.

Mechanical Adjustments. — Various methods for automatically or manually compensating for antenna variations are generally incorporated in single-dial-control radios, and these do not usually present any servicing problem; but many ingenious methods have been developed to handle the problem of compensating for the difference in the units of the several tuned stages of a radio. It is generally a problem for the service man to maintain the adjustment designed to compensate for the variation in the condenser units. The generally adopted method of building the single-dial-control radio is to use fixed inductances and variable capacities; i. e., to use coils that are not adjustable and tune them with variable condensers. Tuning condensers are usually provided with mechanical means of adjusting their electrical synchronism with one another. This may consist of set-screw adjustments on common shafts or on belt-driven pulleys, small adjustable vernier condensers, adjustments of lever drives, or the bending of condenser plate segments. Whatever the mechanical method prescribed, it is usually described by the radio manufacturer in his service literature, which should be consulted in all cases.

Audible Resonance Indication. — If any of the ganged-tuning condensers of a radio are completely out of synchronism, no signal will pass through the radio. A slight variation in the alignment will result in weaker signals and broader tuning. The degree of synchronism of tuning condensers cannot be determined by tube-socket analysis, and must be determined by tuning each unit to a generator of modulated radio-frequency signals, observing whether or not there is any variation between the units controlled by the master tuning control. The Supreme Modulated Radiator and the Supreme Meter Resonance Indication methods afford excellent means for detecting any variation from accurate alignment, and for the re-alignment of the tuning condensers where necessary. The routine involved will be discussed in Chapter VI.

For the average simply-constructed single-dial-tuning-control radio, comprising not more than three ganged-tuning-condensers, an audible method of indicating resonance may be preferred by many service men because of their greater familiarity with this method. This method has been recommended by some radio manufacturers, and has been in more or less general use. For the condenser alignment of such radios by this method, one of the radio-frequency harmonics of the SUPREME Modulated Radiator, utilizing a '12-A or other good oscillating tube, of a frequency between 1000 and 1500 kilocycles, or within whatever other frequency range may be recommended by the radio manufacturer, should be tuned in on the radio and all tuning condensers set for maximum signal strength on the same signal. All units should then be in close approximate resonance over the whole tuning range.

Meter Resonance Indication. — It is well-known fact that the ear affords less appreciation of quantitive values than does the eye, and a visual method of indicating resonance, other things being equal, is to be preferred to any audible method.

The D. C. Voltmeter of the Model 400-B SUPREME DIAGNOMETER indicates the strength of any output signal of a radio when connected through a self-contained thermo-couple and specially-designed transformer to the loudspeaker terminals of the radio. The SUPREME Modulated Radiator may be used, in the manner described above, for setting up a signal to which the radio to be synchronized may be tuned. Since the strength of the output signal increases as resonance within the radio is approached, the meter will show an increased reading as each of the tuned circuits of the radio is brought to resonance, the maximum reading being attained when all of the circuits are in resonance.

The A. C. voltmeter of all models of the SUPREME DIAGNOMETER may be used for indicating ganged-tuning condenser alignment by measuring the alternating or pulsating component of the output signal of any radio. This component, other factors being equal, is governed by the synchronous relation of the tuning condensers of the radio. The reading on the A. C. voltmeter approaches maximum as resonance is approached. The Modulated Radiator may be used for setting up the signal to be amplified by the radio for output measurement.

Calibrating. — At the present time the majority of radio receivers in use are equipped with tuning dials arbitrarily numbered from 0 to 100. Other more recent radio dials are calibrated in wave lengths, some in kilocycles, and some use a combination of frequency and wave-length calibration. Most radio users consult the schedules of radio programs in the daily newspapers where stations are listed with their corresponding frequency assignment, and the radio user frequently wants to listen to a program from a station which he has not previously "logged" and can see no connection between "KXYZ (1250-239.9)" and his "0-100" dial.

Dialing Charts. — Many of the instruction books supplied with radios, and many commercial call books contain directions for preparing a dialing chart for any radio. However, very few radio users ever undertake the drawing up of a dialing chart, as many people look upon a graph or chart as a complicated piece of mathematical abstraction.

An accurately made dialing chart is very useful in systematic tuning, and the customer is impressed with the knowledge and ability of a radio man who can chart the dialing of his radio, "When no program was on the air."

The SUPREME Radiator harmonics are useful when utilized to set up and correct dials already calibrated, as the dials sometimes slip from their proper relation to the tuning condensers, and an inaccurately calibrated dial is more confusing to the average radio user than would be the case had he first familiarized and contented himself with "hit and miss" arbitrary tuning. "Twenty per inch" cross section sheets are very useful in plotting dial calibration charts.

SUPREME DIAGNOTRICIANS may obtain an approximate calibration of their Modulated Radiators by tuning the harmonics in on any radio which has its dial accurately calibrated, making up a chart from the radio dial setting of the harmonics.

Preparation of Dialing Charts. — Knowing the frequencies and the relative strength of the harmonics radiated by the SUPREME Radiator, it is a simple matter to tune them in with the radio, one by one, beginning with the strongest, and record the radio dialing of each one tuned in. These settings can be plotted and connected with a line or curve, on a dialing chart, which is easily made up by using 100 horizontal dimensions of a sheet if "20-per-inch" cross-section paper to represent the "0 to 100" readings of the dial and using 95 of the vertical dimensions to represent the 95 10-kilocycle channels of the 550-1500 kilocycle broadcast band.

Straight Line Frequency Types. — In plotting a dial setting-frequency dialing chart for a radio, it will be found that the charted points will, when joined, form a straight line only when the tuning condensers employed in the radio are of the "Straight-line-frequency" tuning type, which evenly spaces the frequency assignment of broadcasting stations all the way across the dial. In other words, the same number of station channels are between 0 and 10 on a "0 to 100" dial as between 90 and 100 on the same dial.

Two other types of tuning condensers are known as the "Straight-line-wave-length" type and the "Straight-line capacity" type, the curve of either of which would be steep at the lower radio dial settings, the "Straight-line-capacity" curve being the steeper of the two.

Hence, it is seen that it is very important that all units composing the tuning stages of a single-dial-control radio be as perfectly matched as possible, and that this synchronism be maintained in service in order to minimize the loss of tuning efficiency.

Various methods for automatically and successfully compensating for antenna variations are generally incorporated in single-control receivers and these do not usually present any servicing problem.

When a condenser is used for the higher frequencies, its plates are generally well out of mesh and a capacity near the minimum is used. A change of the internal capacity of the grid and filament of the tube will give a larger effect on higher frequencies and changing of a tube may upset the balance of the stage in which such change is made. This trouble is sometimes minimized by the manufacturer using a condenser of such a capacity that its plates are still fairly well in mesh when tuned to the highest frequency of the broadcast band.

Chapter V

NEUTRALIZING.

Definition. — Neutralizing is a method of balancing to provide a second feed-back between various other external circuits through connections outside the tube. This second feed-back is arranged so that energy passing through it is equal in amount to the tube feed-back but is opposite in phase or polarity. The effect of the tube feed-back is then exactly balanced by the external feed-back. The result of combining the two feed-backs is to destroy the effect of both so that regeneration and oscillation are prevented.

Causes of Oscillations. — In almost all radio-frequency amplifying systems there is present some inherent regeneration caused by coupling in some form between the plate and grid circuits, even though the circuits be designed as non-regenerative circuits. Regeneration is the action by which a part of the energy from the plate circuit of a tube is fed back in frequency phase into the grid circuit of the same tube. The plate circuit energy is added to the energy already in the grid circuit. If this regeneration were practically controllable in a radio it would be an added advantage in tuning, as it allows an exceedingly weak signal to be built up until it is as effective as a powerful signal. Regeneration also greatly increases the sensitivity and selectivity of a radio. It is practically impossible, however, to control regeneration over a wide tuning range, with a single control. Regeneration breaks into oscillation when enough plate current energy has been fed back to overcome the effective grid circuit resistance; the power fed back then being sufficient to maintain oscillation without the help of incoming signals. The feed-back increases as the tuning frequency is increased. When a tube is oscillating it is a generator of continuous wave radio-frequency signals, and a receiver with any of its radio-frequency tubes acting as a generator will not satisfactorily reproduce incoming signals, but on the contrary may radiate its own signals from the antenna and cause interference with neighboring radios.

Tube Capacity Feed-Back.—In the well-designed radio in which the various units, such as condensers, radio-frequency transformers, and the connecting leads, composing the radio-frequency stages are properly matched and shielded, or placed in the proper electrical relation to each other, practically all regeneration is introduced by capacity coupling between the plate and grid within the tube. It is a well-known fact that the elements of a radio tube form an electro-static system, each element acting as one plate of a small condenser. The capacity between grid and filament, and plate and filament, do not affect the performance of a tube at audio-frequencies, and have almost a negligible effect at radio-frequencies, except where the minimum tuning capacity is almost as low as the grid-filament capacity of the tube, where the latter affects the tuning almost as much as the minimum tuning capacity, contributing to broader tuning at the higher frequencies of such a radio. The capacity between grid and plate is larger and has a very marked effect on the performance of a tube as a radio-frequency amplifier, resulting in coupling between the input and the output circuits which causes a feed-back of energy to the input circuit, or with certain circuit adjustments, an absorption of energy from the input circuit. The inter-electrode capacity differs with different types of tubes, and may differ slightly in tubes of the same type. The '99 type of tube is chosen as the radio-frequency amplifier in some radios because it has a small plate-to-grid capacity and is, consequently, easier to stabilize. There are several methods of stabilizing circuits so that they will not oscillate, the most familiar of these being covered in the following discussion.

"Losser" Stabilizing Methods. — The first method to be widely used consisted of having the grid return variable by a potentiometer so that a variable positive potential might be placed on the grid. The grid would then draw current and lower the resistance between grid and filament, increasing the effective resistance of the tuned circuit. The chief objections are the heavy plate current taken by the tube when the grid is positive and the added dampening of the tuned circuit. Another and better method utilizes a fixed resistor of from 100 ohms and up, placed in the grid leads. This resistance causes a decrease in amplification, which is more pronounced at the higher frequencies; an advantageous feature, since the feed-back increases with frequency. This method does not avoid broadening of tuning due to the added dampening of the circuit. The selectivity of a radio is lessened by increasing the amount of effective resistance in a tuned circuit. The advantages of this method are very dependent upon the selection of resistances of proper value. A third method of securing stable operation is to insert a resistor, which may be variable for the purpose of controlling the volume, in the plate supply lead, thus lowering the effective plate voltage. This method has several advantages, one being the saving in plate current effected when the volume control is adjusted to powerful signals; another, the smaller increase in dampening of the resonant circuit, which results in sharper tuning.

Counter-Phasing Methods. — A neutralizing method that is highly regarded by radio engineers, and one which is much used, is to neutralize the tube capacity by adding another capacity, in the form of a small fixed or variable neutralizing condenser, commonly called a "neutrodon," connected in such a manner that a neutralizing circuit is formed across the plate and grid circuits of the tube for the purpose of generating oscillations which are equal in strength, but opposite in phase, to the oscillations caused by inter-electrode capacity of the tube. There are three well-known means of accomplishing this: the Rice method, the Roberts method and the Hazeltine method. While the connections for these three methods are not quite alike, the method of adjusting neutrodons for neutralization is practically the same.

The Roberts method employs a special winding in the following radio-frequency transformer which is of the same inductance as the primary, but wound in the opposite direction so that the neutralizing voltages taken from it are of opposite phase to the voltages passing back from the primary through the plate into the grid circuits by way of the tube capacity. In the Rice method the center of the input coil is grounded and the input voltage applied to the tube is one-half of that developed across the tuned circuit, so that some reduction in sensitivity may be expected when this circuit is used. The end of the input coil opposite the grid is connected to the plate through the neutrodon. The Hazeltine method employs a neutralizing circuit from the grid through the neutrodon to a tapped position on the secondary winding on the following stage. Any one of these methods is nearly independent of frequency over the range now occupied in broadcast transmission.

Neutrodon Adjustments. — When the neutralizing circuits of radios are out of balance, it will generally be found that one or more of the radio-frequency tubes will break into oscillation, causing squeals of varying pitch to be emitted from the loud-speaker as the tuning dial is moved over the higher frequencies. The best method for assuring proper neutralization of radios provided with adjustable neutrodons is to adjust the neutrodons for the maximum degree of balance. Radios which utilize either the Rice, Roberts, or Hazeltine methods for radio-frequency amplifier neutralization usually employ neutrodons which are variable and made accessible for service adjustments. When the correct setting of the neutrodon condensers is determined, they need not be changed unless one of the original tubes in the radio-frequency or detector stages is replaced by a tube of different internal capacity, in which case the neutrodons should be re-adjusted. This is a very simple operation in well-balanced radios. Capacity impedance to oscillatory current decreases as the frequency increases. Sets should be neutralized tuned to a frequency of 1000 to 1500 kilocycles, depending on the manufacturer's recommendation.

Chapter VI

SUPREME SERVICING AND ANALYZING INSTRUCTIONS

Scope of Discussion. — Radio servicing is the term generally understood to include all of the servicing processes necessary in determining the continuity and electrical values of all of the circuits and apparatus involved in the proper performance of a radio.

Special servicing features involved in efficient radio service have been discussed in the preceding chapters of this manual. In this chapter the arrangement of the discussion will follow the procedure which should generally be followed in the routine of analyzing the circuits and apparatus of the average radio. The routine should, of course, be modified to meet the requirements of whatever servicing problems may be encountered during the course of the servicing analysis.

The instructions contained in this chapter apply to all models of the SUPREME DIAGNOMETER, unless specifically excepted. All references to panel operations on the Model 100-A apply also to the Model 80-A.

The first step in servicing should be a preliminary inspection of the operating characteristics of the radio, and as this can best be done by actually tuning the radio to signals, if the radio is not completely inoperative, it is advisable to put the Modulated Radiator in operation. After a preliminary examination of the radio, the next step should be the testing of the tubes used in the radio, which is also accomplished with the Modulated Radiator circuits, preferably powered through the Power Plant.

Putting the Power Plant in Operation. — Where Alternating current power, of the potential and frequency for which the SUPREME DIAGNOMETER is designed, is available, the following procedure puts the Power Plant in operation for powering the Modulated Radiator for a test of the tuning characteristics of a radio, for the testing of tubes, and for other purposes:

1. Remove the oscillator coil from its pin jack position.
2. Open all switches on the panel of the SUPREME DIAGNOMETER.
3. Clear the analyzing plug and all jacks of the SUPREME DIAGNOMETER from contact with any electrical conductors which might short circuit any of the jack switches, or which might be grounded or directly connected to the common alternating current system. This will avoid the possibility of shunting power supply around the protective resistor.

4. Remove the prescribed protective resistor from its series-socket of the A. C. connector cord.
5. Connect the SUPREME DIAGNOMETER to a convenient A. C. supply socket, using the A. C. connector cord with its series-socket vacant.
6. Close the "A.C. Line" switch. If the A. C. voltmeter shows any reading, the series-socket is shorted, and the deficiency must be corrected before proceeding with any test.
7. If the A. C. voltmeter shows no reading, replace the protective resistor in its series-socket of the A. C. supply connector cord. The A. C. line voltage should then be indicated on the A. C. voltmeter. This switch may remain closed so that line-voltage fluctuations may be observed. A shorted tube, or other short circuit within the circuits supplied with the Power Plant will be indicated by a radical drop of the voltmeter reading.

Putting the Modulated Radiator in Operation. — With the Power Plant in operation, the following steps complete the set-up of the Modulated Radiator for a check-up of the pick-up characteristics of a radio, for tube testing, and for other purposes:

1. Insert the oscillator coil, with its label to the front, in its prescribed position.
2. If using Model 400-B, throw the "UX-Heater" switch to its "Heater" position.
3. Place a good oscillating tube in one of the "Tube Testing Sockets." If using Model 400-A, use special overhead heater-filament adapter when using a tube of this type; on all other models, use special clip-pin plug leads for connecting the filament contacts of these tubes to their corresponding pin-jacks on the instrument panel. When using a screen grid tube on any SUPREME DIAGNOMETR, use a clip-pin plug lead for connecting the top control grid contact to the screen grid" pin jack on the instrument panel.
4. If using Model 400-B, throw the biasing toggle switch to the position for maximum oscillation.
5. Leave the ammeter-milliammeter scale switch in position for readings on the highest available scale of the meter.
6. Close the Power Plant switch, the voltage marking of which corresponds to the filament specification of the tube which has been placed in one of the "Tube Testing Sockets."
7. When using screen grid tubes with the Model 400-B, close the "Test S. G. Tubes" switch momentarily for obtaining plate readings of the tube.
8. The plate current, which includes whatever additional current which may be induced by the oscillatory circuit, will then be indicated on the mil-ameter.

9. If the current reading does not exceed the next lower scale limit, the mil-ameter scale switch should be closed to the position for readings on the next lower scale. Observe the value of the current.

10. Close the oscillation switch and observe the plate current reading with the tube not in an oscillating condition. The audible strength of the radiated signal will generally be in proportion to the difference in the current readings obtained.

Operating Modulated Radiator With Batteries.—Where alternating current power supply of the potential and frequency for which the SUPREME DIAGNOMETER is designed is not available, the oscillatory circuits of the Modulated Radiator may be powered with batteries, the hook-up procedure being as follows:

1. When using Model 400-B;

(a) Connect the common positive (DC) external pin jack of the SUPREME DIAGNOMETER to the positive terminal of a battery the voltage of which is regulated to meet the filament voltage specification of the tube to be placed in either of the "Tube Testing Sockets."

(b) Connect the "—10" DC external pin jack to the negative terminal of the filament supply battery.

(c) Connect the "External mil-ameter positive" pin jack to the positive terminal of a 45-volt "B" battery.

(d) Join the negative terminal of the 45-volt "B" battery to the positive terminal of the filament battery.

(e) Close the "DC Fil." switch of the SUPREME DIAGNOMETER for observing the filament voltage.

(f) Insert the oscillator coil in its prescribed position.

(g) Place a tube in one of the "Tube Testing Sockets."

2. When using the Model 400-A;

(a) Connect the common positive external meter pin jack of the SUPREME DIAGNOMETER to the positive terminal of a battery suitable for supplying filament current for the tubes to be placed in either of "The Tube Testing Sockets."

(b) Connect the "30-ohm" external pin jack to the negative terminal of the filament supply battery.

(c) Connect the "External Mil-Ameter Positive" pin jack to the positive terminal of a 45-volt "B" battery.

(d) Join the negative terminal of the 45-volt "B" battery to the positive terminal of the filament battery.

(e) Close the "D. C. Fil." switch of the SUPREME DIAGNOMETER.

(f) Adjust the filament voltage, using the 30-ohm rheostat, to that specified for the tube to be placed in one of the "Tube Testing Sockets."

(g) Insert the oscillator coil in its prescribed position.

(h) Place a tube in one of the "Tube Testing Sockets."

3. When using the Model 99-A;

(a) Connect the common positive meter pin jack of the SUPREME DIAGNOMETER to the positive terminal of a battery the voltage of which is regulated to meet the filament voltage specification of the tube to be placed in either of the "Tube Testing Sockets."

(b) Connect the "—10" meter pin jack to the negative terminal of the filament supply battery.

(c) Connect the "External Mil-Ameter Positive" pin jack to the positive terminal of a 45-volt "B" battery.

(d) Join the negative terminal of the 45-volt "B" battery to the positive terminal of the filament battery.

(e) Close the "D. C. Fil." switch to read the "A" battery potential.

(f) Insert the oscillator coil in its prescribed position.

(g) Place a tube in one of the "Tube Testing Sockets."

4. When using the Model 100-A;

(a) Plug the oscillator coil in jacks "0-0-1-2."

(b) Connect coil jack No. 2 to the negative terminal of a battery the voltage of which meets the filament voltage specification of the tubes to be placed in Socket No. 17.

(c) Connect jack No. 15 to the positive terminal of a 45-volt "B" battery.

(d) Connect the negative terminal of the filament battery to the negative terminal of the "B" battery.

(e) Connect the positive terminal of the "A" battery to pin jack No. 16.

(f) Close the Filament switch No. 19 by partially removing its actuating plunger.

(g) Adjust the "A" potential, using the 30-ohm rheostat, to that specified for the tube to be placed in Socket No. 17.

(h) Place a tube in Socket No. 17.

5. "Click" modulation may be had by manipulation of the oscillation switch on all models of the SUPREME DIAGNOMETER.

Using the Modulated Radiator for Tube Testing.—Tube testing is probably the most important phase of radio servicing, and every test or analysis of any radio should be preceded by a test of the tubes used in the radio with whatever replacements and re-arrangements of the tubes may be required for the best operation of the radio. With the Modulated Radiator in operation, the following procedure is necessary to accomplish tube testing:

1. If the Radiator is powered with alternating current, close the "A. C. Line" switch and observe the line voltage reading on the A. C. voltmeter. All "Tube Testing Tables" are graduated on line voltage readings; and on the use of a 45-volt "B" battery where alternating current supply is not available.
2. Place the tube to be tested in one of the "Tube Testing Sockets." If using Model 400-A, use special overhead heater-filament adapter when testing a tube of this type. On any other model, use the special clip-pin plug leads for connecting the filament contacts of these tubes to their corresponding pin jacks on the instrument panel. When testing a screen grid tube on any model SUPREME DIAGNOMETER, use a clip-pin plug lead for connecting the top control grid contact of the tube to the "screen grid" pin jack on the instrument panel.
3. Exception: If using Model 400-B, throw the biasing toggle switch to its "Zero" position.
4. Leave the mil-ameter scale switch in position for readings on the highest available scale of the mil-ameter.
5. If utilizing A. C. power supply, close the Power Plant switch the voltage markings of which corresponds to the filament specifications of the tube which has been placed in one of the "Tube Testing Sockets."
6. When testing screen grid tubes with the Model 400-B, close the "Test S. G. Tubes" switch momentarily for obtaining the proper plate readings of the tube.

7. The plate current, which includes whatever additional current which may be induced by the oscillating circuit, will then be indicated on the mil-ameter.
8. If the current reading does not exceed the next lower scale limit, the mil-ameter scale switch should be closed to the position for readings on the next lower scale. Observe the value of the current.
9. Except when testing rectifier tubes, close the oscillation switch and observe the plate current reading with the tube not in an oscillating condition.
10. Except when testing rectifier tubes with the Model 400-B, the biasing switch may be thrown to its "Bias" position, repeating the two preceding steps.
11. Compare the readings obtained with the readings shown in the "Tube Testing Tables."
12. Repeat above routine for each tube to be tested.

If there is a radical difference between the values of plate current in each of the plate circuits of a full-wave rectifier of the filament type, the tube may not perform as efficiently as it would were both plate current values normal. If it is desired to test both plates of full wave rectifying tubes of the filament type, on the Model **400-B**, depress the "Test S. G. Tubes" for obtaining a reading on the second plate. On other Supreme Models, test one plate by the method shown above, then proceed in testing the other plate in the following manner:

1. Remove oscillator coil.
2. Connect a jumper between the first ("B") and the third ("G") oscillator coil pin jacks, numbering the pin jacks from left to right as the operator faces the front of the panel.
3. Repeat the procedure of the preceding paragraph. The rectified plate current of the other plate will then be indicated on the mil-ameter, and should be practically the same as the reading obtained on the first plate tested.

Setting Up the Rejuvenator. — Where alternating current power supply is available and it is desirable to rejuvenate tubes of the thoriated-filament type, the following procedure should be followed for rejuvenating tubes in the sockets of the SUPREME DIAGNOMETER:

1. Put the Power Plant in operation, but close no switches in the Power Plant.
2. Place a tube to be rejuvenated in the UX "Tube Testiug Socket." If using Model 400-B, a tube to be rejuvenated may also be placed in the UX "Load Socket," by closing the "DC Fil." switch and throwing the "UX-to-HEATER" switch to the "UX" position.

3. On any model except the 100-A, completely close the "Rejuvenator" switch, or on the Model 100-A press the button; the marking of which, in either case, corresponds to the filament rating of the tube or tubes to be rejuvenated.

4. After 15 seconds, on any Model except the 100A, place the "Rejuvenator" switch in its semi-closed (notched) position. On the Model 100A, before releasing the "flashing" button switch, pull up the switch plug corresponding to the button being depressed. This places the "Aging" voltage onto the filaments.

5. After 10 or 15 minutes, take a test reading of the tubes which have been subjected to the rejuvenating process to ascertain the progress of the rejuvenation.

6. If tubes are restored no further rejuvenation is necessary. If not, the process should be repeated until the tube emission is restored or until it is clearly apparent that the tube is worn out or exhausted and will not respond to rejuvenation.

As many as 12 tubes may be rejuvenated at one time by utilizing the tube sockets of a D. C. radio, the filament contacts of which are wired in parallel. An improvised bank of sockets may be utilized for connecting the filaments together. The following procedure should be followed in utilizing the tube sockets of a D. C. radio for holding the tubes during rejuvenation:

1. Disconnect the ground lead from the radio.

2. Disconnect the battery or other power supply leads from the radio.

3. Turn all manually-controlled rheostats to their full "On" positions so as to remove rheostat resistances from filament circuits of the radio.

4. Shunt out all automatic filament control devices.

5. Remove one of the tubes from the radio, and insert the analyzer plug in the vacant socket.

6. Fill all other tube sockets of the radio with tubes to be rejuvenated, the total number of tubes not to exceed 12.

7. Close the "D. C. Fil." switch so as to combine the Analyzer circuits with the Rejuvenator circuits.

8. Repeat steps through 6 of the preceding paragraph.

It must be remembered that only tubes of the thoriated-filament type which have been "paralyzed" or overloaded can be restored by rejuvenation. Worn out or exhausted tubes of this type, or tubes of any other type of filament cannot be rejuvenated.

Tube Socket Analyzing. — As the fundamental operating characteristics are practically the same for all radios, for the purposes of analysis, the circuits of a radio fall into two classifications; namely, (1) the tube socket circuits which are always directly supplied with potentials from the radio power supply system, and may always be subjected to tube socket analysis, and (2) the input (pick-up) and output (audible reproducer) circuits, which may or may not be directly connected to the radio power supply system, and may require the use of some method of testing other than that afforded by tube-socket analysis. The electrical characteristics of the circuits not amenable to tube-socket analysis may be determined by their reaction to the Modulated Radiator with the radio in operation. The location of defects in these circuits will be discussed along with the instructions for the use of the Continuity Tester.

If properly connected, each filament, plate, grid and cathode circuit of a radio terminates at a tube socket. In other words, the radio is built to fit the tube, which is the heart of radio circuits; and the tube circuits constitute the arteries, veins, and nerves of the radio, centering at the tube sockets at which most of the needed information as to the operating characteristics of a radio may be ascertained.

At one time it appeared probable that all tubes would be built on standard UX bases, but the advent of the indirect heater type introduced the UY base. The later appearance of the screen grid tubes introduced another tube element with its contact at the top of the tube. The newer types of radios will probably be built with relative fewer UX sockets. Until a standard socket arrangement is adopted for all tubes and radios, adapters will be necessary for the interchanging of tubes and sockets. A familiarity with the use of adapters is essential for tube-socket analyzing.

Analyzing Adapters. — The Model 400-B SUPREME DIAGNOMETER employs a very ingenious plug which requires the use of only one adapter for analytical tests on all radios, including screen grid types and overhead heater filament types, employing UX or UY tube sockets. No tube-base adapter is required for placing any UX or UY tube in the sockets of this model. A snap-catch is employed on this plug to prevent the separation of the adapter from the plug when inserted in a tube socket. Previous models of the SUPREME DIAGNOMETER employ standard analyzing plugs requiring the use of analyzing adapters for the different types of tubes.

Three regular analyzing adapters are furnished with all models which precede the 400-B and which are equipped with 5-prong analyzing plugs. These adapters are stamped "I," "II," and "III" or "1," "2," and "3," respectively, on the prong bases of the adapters. Numbers "1" and "2" have red rings on their tops, while Number "3" has a green ring. In the Number "1" adapter, the Cathode prong is open, while in the Number "2" it is closed to the negative filament hole with the negative filament prong open. In the Number '3" the Cathode and negative filament (or heater) holes are connected to the negative filament prong.

The SUPREME DIAGNOMETER Pole Changer switch must be used in connection with Adapters "1" and "2." Grid and Plate voltages should be read with the pole changer in its normal position and re-read with the pole changer depressed. Unless no reading is obtained in either case, the lowest reading obtained should be used as the correct reading. The pole changer switch should be depressed when the D. C. voltmeter backs off scale when attempting to read D. C. filament voltages. The red adapter Number "1" should be used for placing UX tubes in the "Load Socket" when analyzing A. C. radios, and when analyzing D. C. radios in which the negative filament terminals are adjacent to the plate terminals. Leave the pole changer switch in its normal position for reading the filament voltages.

When using any model of the SUPREME DIAGNOMETER, (other than the 400-B), which is equipped with the 5-prong analyzing plug, for analyzing D. C. radios in which the filament terminals of the radio sockets are so wired that the positive filament contact is adjacent to the plate terminal contact of each tube socket, the Number "2" red adapter should be used with the pole changing switch depressed for obtaining correct readings.

Special Adapters. — The Model 400-A employs a special UX to UX adapter having two connecting clip leads for testing overhead heater-filament tubes. Special UX to UX and UY to UY Neutralizing adapters, having one open filament connection, are listed in the Accessory Price List. These Neutralizing Adapters permit the neutralizing of radio-frequency stages of parallel-filament-wired radios without the necessity for using three or four-pronged UX or UY tubes, respectively. Models prior to the Model 400-B should not be used for any analytical tests in sockets designed for using screen grid or for using overhead heater-filament tubes.

Special pin-plug clip leads are used on all models for testing screen-grid tubes, and on all models, except the Model 400-A for testing overhead heater-filament tubes.

For analytical tests on radios using the UV-99 types of tubes, Alden No. 999 and No. 429 adapters are furnished. With this pair of adapters, the UV-99 tubes and radios may be satisfactorily tested.

Voltage Tests, Circuits Unloaded. — "No load" filament, plate and grid voltage tests may be made with all tubes removed from the sockets of parallel-filament radios where all of the potentials are supplied from batteries.

"No load" readings may be compared with the "load" readings for ascertaining the extent of battery exhaustion. On all other radios, except those employing series-filaments, "no load" filament and plate voltage readings should be taken with only one of the tubes out of the circuits. "No load" grid readings need not be undertaken except where a "C" battery is used. In battery types of radios where no "C" potential is employed, continuity of the grid circuit may be determined by changing the position of the pole changer switch so as to read the filament voltage across the grid circuit with the "grid" switch closed. All grid and plate "no load" readings, where these voltages are supplied with batteries, should be read with the battery switch open, first with the SUPREME DIAGNOMETER pole changer switch in its normal position, and then read with the pole changer switch depressed.

The lowest reading of value will not include the filament voltage and should be recorded as the correct grid or plate potential, respectively.

Load Tests. — The load test of any device is the most reliable test. A comparison of the "load" test of any electrical device with its "no load" test is a fairly reliable index to the internal resistance of the device. This is especially true of storage batteries. An unloaded storage battery may show a normal voltage reading when not loaded, but show a very low reading when tested under load. Dead cells in storage batteries are easily located by this test. A dead cell will show a reversed reading on the voltmeter when the battery is under load. When a tube is placed in the "load socket" of the SUPREME DIAGNOMETER during analysis with the radio in operation, the current drawn by the tube will be shown on the milliammeter. This reading may be compared with the tables published by tube manufacturers. If there is a radical departure from the specified current reading it indicates a defective tube, or improper relation between the "B" and "C" voltage of the radio. The latter is not an unusual trouble where socket power devices are attached to radios originally designed for battery operation. Wherever this trouble is encountered, the "B" voltage should be adjusted to the proper value for the "C" voltage used. Otherwise the tubes will be subjected to strenuous usage, and the reproduction will not be satisfactory in quality. When taking voltage readings, it may be noticed that the mil-ameter may show a slight deflection, indicating the load of the voltmeter, which, with the "1000-ohm-per-volt" voltmeter, will be 1 milliampere at full-scale voltmeter deflection. All load readings taken with the SUPREME DIAGNOMETER will be accurate within about 2%, this slight variation being accounted for by the losses encountered in the analyzing cord leads.

Setting Up the Analyzer. — The following procedure constitutes the preliminary procedure for putting the Analyzer circuits in operation:

1. Remove the oscillator coil from its prescribed operating position.
2. Open all switches of the SUPREME DIAGNOMETER.
3. Disconnect the A. C. supply cord and clear all jacks of the SUPREME DIAGNOMETER from contact with any electrical conductors which might be grounded or directly connected to the common alternating current supply system, thereby avoiding any possibility of electrical harm to the SUPREME DIAGNOMETER or to the radio.
4. Open the power supply switch of the radio to be analyzed.

Filament Circuit Analysis. — For plugging into UX sockets with the Model 400-B, no plug adapter is necessary. When using other models, use No. 3 adapter on 5-prong plugs for plugging into the UX sockets. A plug adapter is used with the Model 400-B for plugging into UY sockets. With the plug in the first socket and the tube laid aside, close the proper "Fil." switch which will measure the filament voltage. If testing in a D. C. tube socket, the needle of the D. C. voltmeter may back off scale, and the pole changer should be depressed to obtain correct readings; this will indicate the direct current voltage available at the filament terminals, and if the rheostat is turned on full and the other tubes are removed, it will also indicate the "no load" "A" battery voltage. If testing in an A. C. socket, the reading will indicate the voltage available on open circuit. The reading obtained in either case should be recorded.

With the plug still in the radio socket, place the tube in the "load socket" of the Analyzer, using an adapter if necessary on models other than the 400-B, and again read the filament voltage. It is very important that this reading be close to that for which the tube is rated; if it is above the rated voltage, the life of the tube will be correspondingly short, whereas if it is very much below the rated voltage, proper results will not be obtained. If an adjustment is possible with the radio being analyzed, proper adjustment should be made. The best results will be obtained with the filament voltages at, or just below, their rated voltage.

Failure to obtain any filament reading will indicate an open or shorted filament circuit, with the following probable causes:

"A" battery exhausted.
Open rheostat.

Poor connection.
Defective filament switch.
Open primary or low voltage secondary of A. C. power transformer.
Blown fuse.
Poor socket contacts.

Plate Circuit Analysis. — Plate voltage readings may be taken with or without the tube in the "Load Socket." Before taking either voltage, open the "Fil." switch. Close one of the "Plate switches," using the one which will best accommodate the voltage to be read and at the same time give a good discernable reading. The reading obtained with the tube in the "Load Socket" will be less than the reading obtained without the circuit loaded. This difference is occasioned by the internal resistance-current drop of the "B" supply device, and it is, to a certain extent, except in detector sockets, an index to the condition of the apparatus supplying the plate voltage. If this voltage drop materially exceeds 1 volt per milliampere drawn by the tube, the "B" batteries should be replaced, or the rectifying tube in the plate supply device should be replaced. If means are available for adjusting the voltage in socket power devices, the plate voltage should be adjusted to that specified for the particular tube and the particular socket which is being tested. The readings obtained should be recorded. The plate current under load conditions is a very good index to the operating condition of the plate circuit, the current being the result of the potentials applied to the grid and plate circuits. Decreasing the grid potentials has more effect, other factors being equal, on increasing the plate current than may be had by increasing the plate potential.

Failure to obtain proper readings may be caused by any of the following troubles:

Weak or exhausted "B" batteries.
Open primary winding of transformer.
Open series plate resistor.
Shorted by-pass condenser.
Loose connection.
Loose or broken socket contact.
Defective rectifier tube.

Grid Circuit Analysis. — In radios employing batteries for supplying "C" bias, practically the same reading should be obtained without the tube in the "Load Socket" as with the tube in the "Load Socket." This is because the grid circuit has practically no current flow. In radios employing biasing resistors, the correct voltage reading of the bias can be had only when the tube is in the "Load Socket," and the bias voltage should be read with the "Grid" switch closed for the highest scale of the D. C. voltmeter which will afford a discernable reading.

With the plug in the radio socket and the tube in the "Load Socket," closing the "Grid" switch will throw the voltmeter across the grid and one of the filament contacts of the radio tube socket. The pole changer switch should be closed for each reading, and the lowest reading should be taken as the correct bias reading, as one of the readings may include the voltage of the filament. In D. C. radios, a reversed "A" battery may be indicated by the backing off scale of the D. C. voltmeter needle when the "Grid" switch is closed. If no reading is obtained when the "Grid" switch is closed after having tried the pole changer in both of its positions, the following sources of trouble should be investigated, except in radios employing synchrophase circuits:

Open transformer, low voltage secondary.
Open grid suppressor.
Open grid bias resistor.
Poor grid contact in tube socket.

When analyzing from the detector socket of a radio, it will usually be found that a very low voltage reading is obtained. This is due to the fact that a grid leak is usually employed in series with the grid for grid-leak detection, and is of such high resistance that it lowers the reading of grid voltage. The grid leak resistance may be temporarily shunted if it is desired to get a true grid voltage reading.

Cathode Circuit Analysis. — None of the Models of the SUPREME DIAGNOMETER preceding the Model 400-B provide means for obtaining voltage readings of the cathode bias employed in 4 and 5-element tubes. A cathode switch is provided for taking these readings with the Model 400-B. Cathode circuits are rarely the source of radio troubles, but the readings obtained should be recorded and compared with the specifications for the tube and tube socket analyzed. No reading where cathode biasing resistors are known to be employed would indicate an open resistor, and a low reading would indicate a partially-shorted resistor. If no means is available for readnig the cathode bias, a defective bias would probably be indicated by excessive hum.

Screen Grid Analysis. — None of the models preceding the Model 400-B SUPREME DIAGNOMETER provide means for analyzing screen grid sockets. The Models 99-A and 400-A provide means, however, for testing screen grid tubes independently from the radio. With the 400-B, screen grid analysis is accomplished by plugging into the socket to be analyzed, connecting the clip, which ordinarily connects to the top of the tube, to the large control grid lug close to the top of the analyzing plug. The screen grid tube is placed in the "Load Socket" in the usual manner, and one of the clip-pin plug leads is used for connecting the control grid contact of the tube to a corresponding pin jack on the instrument panel.

Overhead Heater-Filament Analysis. — The Model 400-B is the only model of the SUPREME DIAGNOMETER series which will make analysis tests on radios employing overhead heater-filament tubes. The procedure is similar to that for Screen Grid analysis, except that the "trolley" contacts are connected to the "trolley" contact lugs on the analyzer plug, and two clip pin-plug leads are used for connecting the filament contacts of the tube to corresponding "overhead filament" pin jacks on the instrument panel. The 99-A provides Power Plant tests on these tubes without an adapter, while the 400-A provides the same tests utilizing a special adapter.

Distortion Tests. — With the analyzer plugged into the last audio amplifying stage, with all switches of the SUPREME DIAGNOMETER open, the action of the milliammeter is a fair index to the degree of distortion in the audio circuits. The ideal condition is to have the needle steady regardless of the signal fluctuations. If the needle deflects upward with the signal impulses, it is an indication that the "C" voltage is too high for the "B" voltage being used, or that the "B" voltage is too low for the "C" voltage being used. If the needle deflects downward for each signal impulse, it is an indication that the "C" voltage is too low for the "B" voltage being used, or that the "B" voltage is too high for the "C" voltage being used. This test, of course, should only be undertaken when it is known that all of the tubes in the radio are in normal operating condition. The adjustment, if any is possible with the radio being analyzed, will be obvious from the above description. The technical analysis of the causes of the distortion involves a study of the graphs plotting the characteristics of tubes, which is a very long-drawn out discussion and inappropriate for a Manual of the size of this work.

Analysis Charts. — These charts are arranged in duplicating pads and are very useful for recording the readings obtained during tube-socket analyzing. A copy of each chart may be retained for future reference on any radio. Radical readings will be indicated by comparison with other charts on the same type of radio. These charts have space provided for the Power Plant tube tests which should precede the analysis of any radio. Analysis Charts are listed in the Accessory Price List.

Input and Output Circuits. — After completing the analysis of the tube circuits of a radio, the service man should turn his attention to the circuits of the radio system which are not amenable to tests by means of the tube-socket analyzing methods just described. The efficiency of these circuits can best be determined by tuning the radio to a modulated radio-frequency signal known to exist within pick-up distance of the radio. The Modulated Radiator of the SUPREME DIAGNOMETER affords an excellent means for setting up the modulated radio-frequency signal for these tests. The necessary procedure for setting up the Modulated Radiator was covered at the beginning of this chapter. The pick-up circuit should first be checked as to efficiency. This circuit consists of the aerial and the ground or counterpoise system, or of a loop or large pick-up coil, or of two or more capacity areas, or of a combination of any two of these systems, coupled to the grid circuit of the first tube of the radio. The continuity of a loop aerial may be determined by socket analysis where the loop circuit is directly coupled to the first radio tube, but it is sometimes found that loop aerials are capacitively coupled to the tube circuit, in which case the continuity of the pick-up loop cannot be determined by tube socket analysis. Where the pick-up circuit consists of an aerial and ground or counterpoise, no potential is applied between the two, and even where the antenna is connected directly to the grid of the first tube, an open or shorted pick-up circuit cannot be detected by tube socket analysis.

The antenna of the radio being tested should conform as nearly as practicable to the specifications of the manufacturer of the radio. A comparative test of the pick-up capabilities of the antenna may be had by tuning the radio to the Modulated Radiator, and then disconnecting the antenna. The signal strength should fall off when the antenna is disconnected, or a loud "clicking" sound should be emitted from the loudspeaker when the aerial is disconnected and tapped on the antenna binding post of the radio. The absence of a strong "clicking," when this is done with the volume control of the radio at its normal setting, usually indicates an inefficient aerial circuit. The ground circuit should be checked in a smiilar manner, although there should be a very perceptible drop, amounting to about 50%, in audibility when the ground is disconnected. If there is but slight change in signal strength with the ground lead removed, new grounds should be tried on the radio. A high resistance ground is a very common cause of low audibility. In localities where one side of the alternating current supply system is grounded, the ground lead of a radio may be determined by connecting a lamp or A. C. voltmeter between the ground lead and the ungrounded side of the line. This is also an excellent means for determining whether or not the antenna is shorted to the ground lead. This method also affords a very convenient means for differentiating between the antenna and ground leads when it is not convenient to differentiate them by visual inspection. Lightning arrestors should always be checked for shorted electrodes. Stapling the antenna and ground leads together on base boards is a very common source of trouble with antenna-ground shorts.

The output circuit of a radio consists of the loudspeaker, or other device for audible reproduction, and the circuit which couples it to the last audio-frequency stage of the radio. In most of the earlier types of radios the loudspeaker is directly coupled in series with the plate circuit of the last audio tube, and the continuity of the output circuit in such radios may be determined by tube socket analysis. In most of the more recent models of radios, wherein the last audio plate voltage exceeds 135 volts, the loudspeaker is usually indirectly coupled to the last audio stage, and a test of the output circuit cannot be made from a radio tube socket. In either of these types, the efficiency of the output circuit can best be determined by tuning in signals on the radio. If no other apparent defects exist in the radio system, and the loudspeaker does not perform satisfactorily, the loudspeaker circuits can be tested for opens and shorts with the Continuity Tester.

Loudspeaker windings should not be required to carry a current load in excess of that specified by the speaker manufacturer. In the absence of specifications to the contrary, the last audio or power tube chosen and the grid and plate voltages applied thereto should be such that the speaker load should not exceed 10 milliamperes. If the plate current of the last audio-amplifying tube exceeds this value, some type of filter circuit is generally required to protect the loudspeaker windings from overload currents. A '71-A tube should not be substituted for a '12-A in an audio stage without changing the grid bias voltage to correspond to the tube to be used. This change in grid bias voltage must not affect the grid bias voltage of other tubes. Some radios were designed for using a '01-A tube as the first audio amplifier, and a '12-A as the second audio, using 135 volts plate potential and 9 volts grid bias on both tubes. If the '12-A be replaced with a '71-A, the 9 volts grid bias would be incorrect for the '71-A, while a change to 27 volts grid bias for the '71-A would place an incorrect bias on the '01-A used as the first audio tube. Where no filter system is used, the polarity of the loudspeaker should be checked with a D. C. meter, as a reversed polarity will eventually weaken the magnetism of the speaker magnets. (See miscellaneous meter tests).

Putting the Continuity Tester in Operation. — The Continuity Tester is especially adaptable for testing the input and output circuits of a radio when these circuits are not supplied with any potential from the radio power supply system. Care must be exercised, however, not to allow one of the test probes of the SUPREME DIAGNOMETER to come in contact with a grounded conductor. With the Modulated Radiator in operation, the following steps are required for putting the Continuity Tester in operation:

1. Disconnect apparatus to be tested from both the A.C. line and all grounded objects. This is a very necessary precaution for meter protection.
2. Remove the oscillator coil from its prescribed pin-jack position.
3. Plug two test cords in the two left side ("B" and "P") oscillator coil pin jacks.
4. Place a thermionic rectifier tube, such as the '81 or '80, or other heavy current tube, in one of the "Tube Testing Sockets."
5. Close the Power Plant jack switch, the voltage marking of which corresponds to the filament voltage specified for the tube used.
6. Closing the circuit with the free ends of the test leads will cause the plate current of the tube to be shown on the milliameter, indicating continuity of the SUPREME DIAGNOMETER plate circuit with the external circuit under test.

Any three-or four-element tube capable of showing comparatively good discernable plate current readings, such as the '71-A, '12-A, '26, and '01-A types, may be used with its corresponding Power Plant switch closed instead of rectifying tubes for this test, by connecting a jumper between the two oscillator coil pin jacks which are not occupied with the test probe leads.

The Continuity Tester is especially adaptable for testing the input and output circuits of a radio when these circuits are not supplied with any potential from the radio power supply system so that they may be tested with the Analyzer from tube sockets. It is also useful for testing for loose contacts in circuits.

Synchronizing Procedure. — Having determined that the tubes, tube circuits, and the input and output circuits of a radio are in their proper conditions, the next step in servicing should be to check the synchronous relation of the tuning condensers. Two methods of obtaining meter indication of resonance are provided in the Model 400-B; namely, the Thermo-Couple method, and the A. C. Voltmeter method. The latter-named method is available in all models of the SUPREME DIAGNOMETER equipped with the A. C. voltmeter. With the Modulated Radiator in operation, the following procedure puts the thermo-couple Meter Resonance Indicator circuits of the Model 400-B in operation.

1. Disconnect the aerial and ground from the radio.
2. Set the 30-ohm rheostat approximately in its mid position.
3. Connect a jumper between external pin jacks numbers "10" and "11."

4. Connect a jumper between external pin jack No. 9 (30-ohm) and the "Third Winding" external pin jack.
5. Connect a jumper between the number "12" and "+ D. C." external pin jacks.
6. Connect the loudspeaker output terminals of the radio to the "P" and "B" "Audio Transformer" external pin jacks.
7. Connect a test lead to the antenna binding post of the radio and bring it in close proximity to the Modulated Radiator coil.
8. Rotate the tuning knob of the radio, at the same time adjusting the 30-ohm rheostat for the desired needle deflection which will occur on the D. C. voltmeter as each harmonic of the Modulated Radiator is "tuned in" on the radio. Maximum needle deflection indicates resonance with the oscillator circuit of the Modulated Radiator.
9. Adjust each tuning condenser for a maximum reading on a signal between 1000 and 1500 kilocycles, or between whatever other frequency limits specified by the manufacturer of the radio.

With the Modulated Radiator in operation powered from the A. C. line with any Model of the SUPREME DIAGNOMETER equipped with an A. C. Voltmeter, the following procedure puts the Meter Resonance Indicator in operation for synchronizing:

1. Disconnect the aerial and ground from the radio.
2. If using Model 400-B, connect the "Plus-or-Minus A.C." and the "1.MFD." external pin jacks of the SUPREME DIAGNOMETER to the loud speaker terminals of the radio. If using any other model, connect the "plus-or-minus 5-and-15 volt" pin jacks to the loud speaker terminals, place the analyzer plug in the No. 3 adapter, but do not plug into any tube socket. The A. C. Voltmeter Method should not be undertaken with a "top heater" type tube in use in the Tube Testing Socket.
3. Close one of the "A. C. Fil." switches.
4. Connect a test lead to the antenna binding post of the radio and bring it in close proximity to the Modulated Radiator Coil.
5. Rotate the tuning knob of the radio. A decided deflection of the needle of the A. C. Voltmeter will occur as each harmonic of the Modulated Radiator is "tuned in" on the radio. Maximum needle deflection indicates resonance with the oscillator circuit of the Modulated Radiator.
6. Adjust each tuning condenser for a maximum read-

ing on a 60-cycle Modulated Radiator signal between 1000 and 1500 kilocycles, or between whatever other frequency limits specified by the manufacturer of the radio.

Synchronizing Adapters (listed in the Accessory Price List) are useful for connecting the meter in series with the last audio plate circuit for synchronizing purposes on any radio which has four loudspeaker terminals for supplying dynamic speakers. When using this adapter, and when connecting the A. C. pin jacks to radios not provided with inductive or filter speaker output circuits, the A. C. voltmeter will indicate the direct current component of the plate circuit of the last audio stage during the time the connection is made. The reading will be increased, however, by the pulsating component of the signal whenever resonance is attained. When using the Synchronizing Adapter in push-pull stages, the needle deflection of the meter used is very much increased with some radios when the push-pull socket not occupied by the adapter is left vacant during the synchronizing operations.

Neutralizing Procedure. — The neutralization of tuned radio-frequency radios provided with adjustable neutrodon condensers may be accomplished with the SUPREME DIAGNOMETER in the following manner:

1. Place the Modulated Radiator in operation in the manner previously described.
2. Connect antenna and ground to radio to be neutralized.
3. Put radio in operation at its maximum volume.
4. Tune the radio to a strong modulated harmonic at a frequency between 1350 and 1500 kilocycles, or between whatever other frequency limits prescribed by the manufacturer of the radio to be neutralized.
5. Move SUPREME DIAGNOMETER far enough away from the radio so that inductive reactions will not occur between the radio and the SUPREME DIAGNOMETER; but if the signals cannot be picked up, move the instrument closer to the radio, use a better oscillating tube, or use an insulated coupling lead brought in close proximity to the oscillator coil and the antenna lead-in of the radio.
6. Adjust each neutrodon for maximum signal strength so as to increase pick-up.
7. Remove the tube of the radio-frequency stage nearest the detector.
8. If the radio is wired with its tube-socket filament connections in parallel, place the tube in the SUPREME Neutralizing Adapter and replace in the ra-

dio socket; or substitute a "dummy" tube (i. e., a good tube with one of the filament prongs cut off) of the same type in the socket.

9. If the radio is wired with its tube-socket filament connections in series, temporarily strap the filament prongs of the tube together and replace it in its socket.
10. If the signal remains audible, the internal capacity of the cold tube is probably by-passing the signals which should be tuned to maximum strength.
11. Slowly adjust the neutrodon which corresponds to the cold tube stage, using a fibre wrench or fibre screw driver to minimize body capacity effects, until the signal disappears entirely or is reduced to minimum audibility.
12. The stage in which the cold tube is located will then be neutralized, and the cold tube should be removed and replaced by the original tube.
13. Proceed in a similar manner with each of the next preceding stages in order until all of the radio-frequency stages are neutralized.

The degree of accuracy attained when using a "dummy" tube for neutralizing parallel-filament radios is determined by the degree of uniformity of the internal capacities of tubes. It cannot be expected that all tubes, even of the same type, will have the same internal capacity as the "dummy" tube chosen for neutralizing purposes. It is frequently found that an adjustment for neutralizing one tube is an improper adjustment for another tube. For SUPREME Diagnotricians who desire a more accurate and economical means of neutralizing parallel-filament-wired radios the SUPREME Neutralizing Adapter, which permits the neutralizing of a radio-frequency stage with its own tube, is listed in the Accessory Price List. Fibre screw drivers and fibre wrenches are also listed.

Calibrating. — Every broadcasting station operates upon a particular frequency, assigned to it by the Federal Radio Commission. Each channel is designated by the middle frequency.

If one has a graph, plotted to a few representative dial settings corresponding to known frequencies, it is possible for one to tune to any desired broadcasting station within the pick-up distance of the radio, when the frequency at which that station broadcasts is known.

The frequency at which a station broadcasts is required by the Federal Radio Commission to be announced at least once every fifteen minutes. To make a dial calibration graph, tune to at least five or six stations at settings throughout the complete range of the tuning dial. While receiving each station, listen for the announcer's statement of the frequency that his station is using. Then record this frequency and the corresponding dial setting. Lay the frequencies and dial settings off on a sheet of "20-per-inch" cross-section or graph paper, using the vertical axis for the frequencies and the horizontal axis for the dial settings. For each recorded station, mark a point on the graph paper on line with the corresponding frequency (as read on the vertical axis) and the proper dial setting (as read on the horizontal axis). Draw a smooth curve through each of these points. To determine the dial setting for any frequency, locate the frequency on the vertical axis, follow the horizontal line through this frequency to the point where it intersects the curve, from this point follow the vertical line through it to the horizontal axis, and at the intersection of this line with the horizontal axis the proper dial setting will be indicated for the desired station.

Having a particular radio calibrated in the manner described above, it is a simple matter to chart the harmonics of the SUPREME DIAGNOMETER. Once the frequencies of the Modulated Radiator harmonics are known, the SUPREME DIAGNOMETER may be used instead of broadcasting stations for plotting other dial calibration graphs for other radios, or for checking the accuracy of the calibration of radios the dials of which are already calibrated in kilocycles, wave-lengths, or both.

Final Check-Up. — As a final check-up on each completed service job, it is recommended that the Modulated Radiator be set up and each of its harmonics tuned in. The radioman should soon acquaint himself with the relative strength of these signals, and the audible pick-up response of the average radio to these signals. Dial calibration, as described above, affords an excellent final check-up on the operating characteristics of a radio.

Sources of Radio Trouble. — The following list of sources of radio trouble is included in this chapter to afford a quick reference guide for a radio-man during the process of servicing a particular radio. A reference to this list will often direct the service-man to the source of trouble:

WHEN:

All Tubes Fail to Light—

"A" battery discharged.
Open rheostat.
Poor battery connection.
Broken lead in battery cable.
Poor switch.
Burned out tubes.
Open primary of power transformer (AC Set).
Open in AC lead cord.
Fuse blown.

Part of Tubes Fail to Light—

Open rheostat.
Dead tube.
Open in power secondary.
Poor socket contact.

No Reception. (Set Dead)—

B supply dead or defective,

May be "B" batteries down, open in power secondary, defective rectifier tube, shorted power supply condenser, open choke in power unit, defective resistor in power unit, open in plate cable lead.

A battery connections reversed.
Open primary of radio frequency transformer.
Open primary of audio frequency transformer.
Shorted grid condenser.
Open or shorted speaker cord.
Shorted by-pass condenser.
Defective tube.
Open or shorted speaker choke.
Open circuit in wiring.
Short circuit in wiring.
Tube prongs not making contact in socket.
Grid resistors open.
Short between aerial and ground leads.
Shorted lightening arrester.

Weak Reception—

Defective tube.
A or B voltages low.
Corroded battery connections.
Partially shorted audio transformer.
Partially shorted radio frequency transformer.
Open radio frequency transformer secondary.
Leaky audio transformer.
Set out of synchronization.
Poor grid resistors.
Partially shorted power transformer primary.

Partially shorted power transformer secondary.
Poor rectifier.
Incorrect eliminator resistor values.
Poor lightning arrester.
Poor aerial insulation.
Poor ground.
Poor socket contacts.
Defective grid condenser.
High resistance wiring connection.
Speaker weak.
Speaker out of adjustment.

Noisy—

AC plug loose.
Swinging antenna, grounding.
Poor lightning arrester.
Defective ground connection.
Defective by-pass condenser.
Defective tube.
Variable condenser shorted.
Variable condenser dirty.
Defective grid leak.
Defective resistors.
Loose connection in wiring.
Loose contacts in socket.
Defective filter condensers, punctured.
Defective audio transformer, grounded.
Defective eliminator resistors.
Grid resistor open.
Poor battery connections.
Defective B batteries.
Speaker cord shorted. Partially.
Speaker cord tips loose.
Speaker unit defective.
Dirty switch contacts.
Volume control worn.

Distortion—

Defective A or B power supply or overloaded.
Speaker out of adjustment.
Poor tube.
Incorrect type of tubes.
Incorrect battery voltages.
C battery disconnected.
Incorrect C voltage.
Set out of synchronization.
Open biasing resistor.
Shorted biasing resistor.
Poor rectifier tube or elements.
High regeneration.
Reaction between radio and audio frequency elements.
Interaction between transformers.
Acoustic coupling between speaker and set.

Poor by-pass condensers.
Reactive coupling in power leads.

Hums or Continuous Whistle—

Defective tube.
Speaker too close to set.
Defective power supply.
Open grid circuit.
Low detector voltage.
Grounded audio transformer.
Open antenna choke.
Partially open power transformer secondary.
Open filament balancing resistances.
Shorted filter choke.
Open primary circuit.
A. C. plug in wrong position.
Cooked winding of power transformer.
Ground binding posts not making good ground contact.
Grounded choke.
Grounded speaker jack.
Grounded resistors.
Open grid circuits.
Open or shorted or grounded by-pass condensers.
Open resistor.
Open leads in cable.
Shorts in wiring
Reaction between wiring.

Intermittant Reception—

Poor tube.
Loose connections.
Poor lightning arrester.
Poor aerial insulation.
Poor grounds.
Swinging ground or aerial.
Defective grid leak.
Open in grid circuit resistors.
Corroded connections.
Weak A battery.
Defective rectifier tube or elements.
Open biasing resistor.

Over Heating—

Shorted power transformer primary.
Shorted power secondary circuit.

Continued Oscillation—

Defective tube.
Poor ground connection.
Grid resistor shorted.
Excess radio frequency plate voltage.
Open grid circuit.
Antenna lead too close to set.
Reaction or poor shielding.
Poor radio frequency by-pass condensers.

TUBE TESTING TABLES

MODEL 400-B SUPREME RADIO DIAGNOMETERS

TYPE OF TUBE	60-CYCLE A.C. POWER PLANT SUPPLY VOLTAGES																				45-Volt B Battery Supply	
	100				105				110				115				120					
	ZERO		BIAS		ZERO		BIAS		ZERO		BIAS		ZERO		BIAS		ZERO		BIAS			
	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop	oscn	stop
X—00—A	7	4	7	4	9	5	9	5	11	5	10	6	13	6	12	7	16	8	15	9	14	7
X—01—A	5	8	3	3	6	9	4	3	7	10	6	4	9	12	8	4	11	13	10	5	13	7
X—10	22	14	14	4	24	16	17	5	26	17	20	5	28	18	22	6	30	19	23	7	—	—
X—12—A	29	21	23	7	35	26	28	8	41	32	33	10	43	32	33	12	45	33	32	15	32	17
X—20	4	5	3	4	5	6	4	5	6	8	5	6	7.5	10	6	7	9	11	7	7	5	4
X—22	3	3	2	2	4	4	3	3	4	4	3	3	5	5	4	4	6	6	4	4	3	3
Y—24	12	10	11	2	14	11	11	3	17	12	12	3	18	13	14	3	19	13	14	3	—	—
X—26	18	15	13	5	19	15	14	5	20	16	15	6	22	18	17	6	27	20	20	7	—	—
Y—27	16	13	14	5	18	14	15	5	21	15	17	5	23	16	18	5	25	17	19	5	—	—
X—40	6	6	5	1	7	6	6	1	9	7	7	1	11	8	9	1	14	9	11	1	12	3
X—45	31	33	26	22	38	39	30	26	46	46	35	31	49	49	38	32	53	52	41	33	—	—
X—50	21	22	19	14	28	27	23	14	34	33	27	14	35	33	28	16	35	33	28	18	—	—
X—71—A	46	42	36	28	53	46	38	30	61	51	41	32	68	56	44	34	76	61	46	37	33	31
X—80	86	—	—	—	96	—	—	—	107	—	—	—	109	—	—	—	111	—	—	—	—	—
X—81	64	—	—	—	68	—	—	—	73	—	—	—	75	—	—	—	78	—	—	—	—	—
X—99	4	5	2	2	5	6	4	3	7	7	6	4	7	8	6	4	7	9	6	4	3	2
A—22	22	17	17	22	26	20	20	26	30	23	23	30	34	26	26	34	39	30	30	39	—	—
A—26	2	3	2	3	4	6	4	4	7	9	6	4	15	16	10	6	23	23	15	7	—	—
A—28	5	6	4	3	8	9	9	4	12	13	10	6	15	14	12	6	18	14	14	6	—	—
C—79	73	—	—	—	80	—	—	—	87	—	—	—	95	—	—	—	102	—	—	—	—	—
C—89	49	—	—	—	68	—	—	—	77	—	—	—	86	—	—	—	97	—	—	—	—	—
C—182	21	22	22	21	25	24	24	25	30	29	29	30	34	33	33	34	38	35	35	38	—	—
C—280	80	—	—	—	87	—	—	—	93	—	—	—	99	—	—	—	122	—	—	—	—	—
C—484	10	9	9	2	15	12	12	2	20	15	16	3	21	16	16	3	22	18	17	3	—	—
C—585	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K—401	10	8	8	3	13	10	11	3	16	12	13	3	19	13	14	4	22	15	16	—	6	—
K—403	14	13	19	8	20	19	15	12	25	26	20	16	26	26	22	16	28	26	25	17	—	—

The above tabulation shows average readings of tubes furnished by courtesy of the following tube manufacturers:

E. T. Cunningham, Inc.,
National ("Eveready Raytheon") Carbon Co.,
Van Horne Tube Co.,
and
Sylvania Products Co.,

and from R. C. A., Arcturus, Cardon, and Kellogg standard tubes.

X-tubes are standard tubes as manufactured by most tube manufacturers.

Y-tubes are standard 5-prong base types.

A-tubes indicate Arcturns 15-volt filament types.

C-tubes are of the "Cardon" manufacture.

K-tubes are known as "top-heater" (Kellogg) types.

A tolerance of 25% in variation from the above tables may generally be permitted for normal tubes.

AVERAGE CHARACTERISTICS OF CUNNINGHAM RADIO TUBES

GENERAL									DETECTION			AMPLIFICATION									
													AMPLIFIER C VOLTAGE (GRID BIAS)								
													D.C. FILAMENT OPERATION		A.C. FILAMENT OPERATION						
TYPE	USE	FILAMENT SUPPLY	RHEOSTAT RECOMMENDATION NOTE 1	FILAMENT TERMINAL VOLTAGE	FILAMENT CURRENT AMPERES	BASE	MAXIMUM OVERALL HEIGHT	MAXIMUM OVERALL DIAMETER	GRID LEAK MEGOHMS	DETECTOR B-BATTERY VOLTAGE	DETECTOR PLATE CUR. (mA.)	AMPLIFIER B-VOLTAGE	C VOLTS	RESISTOR OHMS See Note 2	C VOLTS	RESISTOR OHMS See Note 3	AMPLIFIER PLATE CURRENT	A.C. PLATE RESISTANCE (OHMS)	MUTUAL CONDUCTANCE (MICROMHOS)	VOLTAGE AMPLIFICATION FACTOR	MAXIMUM UNDISTORTED OUTPUT (MILLIWATTS)
C-11 & CX-12	Detector Amplifier	Dry Cell 1½ V. Storage 2 V.	4 to 6 Ohms	1.1	0.25	C-11 Special CX-12 Lg. Std.	4 1/8" 4 11/16"	1 3/16" 1 7/16"	2 to 5	22½ to 45	1.5	90 135	4.5 10.5				2.5 3.5	15,500 15,000	425 440	6.6 6.6	7 35
C & CX-299	Detector Amplifier	Dry Cell 4½ V. Storage 4 V.	50 to 75 Ohms	3.3	0.063	C-229 Sm. Bay't CX-229 Sm. Std.	3 1/2" 4 1/8"	1 1/16" 1 3/16"	2 to 5	22½ to 45	1.5	45 67.5 90	1.5 3.0 4.5				1.0 1.7 2.5	19,500 16,500 15,500	320 380 425	6.6 6.6 6.6	7
CX-220	Power Amplifier	Dry Cell 4½ V. Storage 4 V.	20 Ohms	3.3	0.132	Small Standard	4 1/8"	1 3/16"	------	--------	--------	90 135	16.5 22.5				9.2 6.5	7,700 6,600	428 500	3.3 3.3	110
CX-322	Screen-Grid Amplifier	Dry Cell 4½ V. Storage 4-6 V.	20 Ohms (with 6 V. source add 15-Ohm Resistor)	3.3	0.132	Large Standard	5 3/8"	1 13/16"	-------	-------	-------	90 135 135	1.5 1.5 3.0	*SCREEN GRID VOLTAGE + 45 Characteristics shown do not apply for space charge connection			1.5* 1.5* 1.0*	500,000 850,000 1,100,000	340 350 280	175 290 300	
CX-300 A	Special Detector	Storage 6 V.	20 Ohms	5.0	0.25	Large Standard	4 11/16"	1 13/16"	2 to 3	45	1.5	45	0					30,000	670	20	
CX 301 A	Detector Amplifier	Storage 6 V.	20 Ohms	5.0	0.25	Large Standard	4 11/16"	1 13/16"	2 to 5	45	1.5	45 67.5 90 135	1.5 3.0 4.5 9.0				0.9 1.7 2.5 3.0	18,500 14,000 11,000 10,000	430 570 725 800	8.0 8.0 8.0 8.0	15 55
CX 340	Detector Amplifier	Storage 6 V.	20 Ohms	5.0	0.25	Large Standard	4 11/16"	1 13/16"	2 to 5	135 180	0.3 0.4	135 180	3.0 4.5	SEE NOTE 4			0.2 0.2	150,000 150,000	200 200	30 30	
CX 326	Amplifier	Transformer 1.5 V.	---------	1.5	1.05	Large Standard	4 11/16"	1 13/16"	------	------	-----	90 135 180			6.0 9.0 13.5	1,700 1,500 1,800	3.5 6.0 7.5	9,400 7,400 7,000	875 1,100 1,170	8.2 8.2 8.2	20 70 160
C-327	Detector Amplifier	Transformer 2.5 V.	--------	2.5	1.75	5 Prong Standard	4 11/16"	1 13/16"	2 to 5	45	2.0	45 90 135 180			0 6.0 9.0 13.5	2,000 1,800 2,250	3.0 5.0 6.0	8,500 10,000 9,000 9,000	1,050 900 1,000 1,000	9.0 9.0 9.0 9.0	
CX-112 A	Power Amplifier	Storage 6 V. Transformer 5 V.	6 Ohms	5.0	0.25	Large Standard	4 11/16"	1 13/16"	2 to 5	45	-----	90 135 157.5 180	4.5 9.0 10.5 13.5	850 1,300 1,050 1,350	7.0 11.5 13.0 16.0	1,300 1,650 1,300 1,600	5.5 7.0 10.0 10.0	5,300 5,000 4,700 4,700	1,500 1,600 1,700 1,700	8.0 8.0 8.0 8.0	30 120 195 300
CX-371 A	Power Amplifier	Storage 6 V. Transformer 5 V.	6 Ohms	5.0	0.25	Large Standard	4 11/16"	1 13/16"	------	-----	------	90 135 157 180	16.5 27.0 33.0 40.5	1,650 1,700 1,850 2,000	19.0 29.5 35.5 43.0	1,900 1,850 2,000 2,150	10.0 16.0 18.0 20.0	2,500 2,200 2,150 2,000	1,200 1,360 1,400 1,500	3.0 3.0 3.0 3.0	130 330 500 700
CX 310	Power Amplifier Oscillator	Transformer 7.5 V.	---------	7.5	1.25	Large Standard	5 3/8"	2 3/16"	-------	------	------	250 350 425	18.0 27.0 35.0	1,500 1,700 1,750	22 31 39	1,800 1,950 1,950	12.0 16.0 20.0	5,600 5,150 5,000	1,330 1,550 1,600	8.0 8.0 8.0	340 925 1,540
CX-350	Power Amplifier	Transformer 7.5 V.	---------	7.5	1.25	Large Standard	6 1/4"	2 11/16"	------	------	-------	250 300 350 400 450			45 54 63 70 84	1,600 1,550 1,400 1,300 1,550	28.0 35.0 45.0 55.0 55.0	2,100 2,000 1,900 1,800 1,800	1,800 1,900 2,000 2,100 2,100	3.8 3.8 3.8 3.8 3.8	900 1,500 2,350 3,250 4,650

SPECIAL TYPES	USE	FILAMENT SUPPLY	CIRCUIT NOTES	FILAMENT TERMINAL VOLTAGE	FILAMENT CURRENT AMPERES	BASE	MAXIMUM OVERALL HEIGHT	MAXIMUM OVERALL DIAMETER	OPERATING CONDITIONS
CX-380	Full-Wave Rectifier	Transformer 5.0 V.	Full-Wave Circuit	5.0	2.0	Large Standard	5 3/8"	2 3/16"	Max. A.C. Voltage Per Plate .... 350 V.(r.m.s.) Max. Rectified Current .... 125 mA.
CX 381	Half-Wave Rectifier	Transformer 7.5 V.	Half-or Full-Wave Circuit	7.5	1.75	Large Standard	6 1/4"	2 3/16"	Max. A.C. Voltage to Plate .... 700 V.(r.m.s.) Max. Rectified Current .... 85 mA.
CX-374	Plate Voltage Regulator	--------	--------	--------	--------	Large Standard	5 3/8"	2 3/16"	Rated Voltage ... 90 V.(d.c.) Starting Voltage 125 V.(d.c.) D.C. Current ... 10-50 mA.
CX 376	Ballast Tube	--------	Trans. Pri. of 65 V. for use on 115 V. line	--------	--------	S't'd Mogul Screw Base	8"	2 1/16"	Current Rating .... 1.7 Amps. Voltage Range .... 40-60 Volts
C-386	Ballast Tube	--------	Trans Pri. of 65 V. for use on 115 V. line	--------	--------	S't'd Mogul Screw Base	8"	2 1/16"	Current Rating .... 2.05 Amps. Voltage Range .... 40-60 Volts

NOTES

NOTE 1. When more than one tube is operated from a single rheostat, the resistance value required is correspondingly reduced. Size specified permits voltage to be reduced below rated, under operating conditions.

NOTE 2. When C voltage is obtained from voltage developed across resistor through which plate current flows, this tabulation shows correct resistor for single tube. When plate current for additional tubes flows through the same resistor, a smaller size will be required. The exact value may be determined as: $R(\text{ohms}) = \frac{E(\text{volts})}{I(\text{amperes})}$; where E is required C voltage and I the total plate current.

NOTE 3. The bias required by a tube supplied with a.c. filament current is slightly higher than when the same tube is used on d.c. due to the centertap grid return. Increase the d.c. value by one-half the filament voltage.

NOTE 4. The correct C voltage for type CX 340 is 1.5 and 3.0 volts respectively when used in a resistance-coupled amplifier. Characteristics of the tube are then identical with values shown if plate resistor is 0.25 megohms.

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AVERAGE CHARACTERISTICS OF RECEIVING RADIOTRONS

	GENERAL									DETECTION				AMPLIFICATION						
	MODEL	USE	CIRCUIT REQUIREMENTS	BASE	MAXIMUM OVERALL HEIGHT	MAXIMUM OVERALL DIAMETER	"A" SUPPLY	FILAMENT TERMINAL VOLTAGE	FILAMENT CURRENT (AMPERES)	DETECTOR GRID RETURN LEAD TO	GRID LEAK (MEGOHMS)	DETECTOR "B" BATTERY VOLTAGE	DETECTOR PLATE CURRENT (MILLIAMPERES)	AMPLIFIER "B" BATTERY VOLTAGE	AMPLIFIER "C" BATTERY VOLTAGE	AMPLIFIER PLATE CURRENT (MILLIAMPERES)	A.C. PLATE RESISTANCE (OHMS)	MUTUAL CONDUCTANCE (MICROMHOS)	VOLTAGE AMPLIFICATION FACTOR	MAXIMUM UNDISTORTED OUTPUT (MILLIWATTS)
DETECTORS AND AMPLIFIERS	RADIOTRON WD-11	Detector or Amplifier	Transformer Coupling	WD-11 Base	4 1/8"	1 3/16"	Dry Cell 1 1/2 V. Storage 2 V.	1.1	.25	+F	3 to 5	22 1/2 to 45	1.5	90 135	4 1/2 10 1/2	2.5 3.5	15,500 15,000	425 440	6.6 6.6	7 35
	RADIOTRON WX-12	Detector or Amplifier	Transformer Coupling	Large Standard UX Base	4 11/16"	1 7/16"	Dry Cell 1 1/2 V. Storage 2 V.	1.1	.25	+F	3 to 5	22 1/2 to 45	1.5	90 135	4 1/2 10 1/2	2.5 3.5	15,500 15,000	425 440	6.6 6.6	7 35
	RADIOTRON UX-112-A	† Detector or Amplifier	Transformer Coupling	Large Standard UX Base	4 11/16"	1 13/16"	Storage 6 V.	5.0	.25	+F	3 to 5	45	1.5	90 135	4 1/2 9	5.5 7	5,300 5,000	1,500 1,600	8 8	30 120
	RADIOTRON UV-199	Detector or Amplifier	Transformer Coupling	UV-199 Base	3 1/2"	1 1/16"	Dry Cell 4 1/2 V. Storage 4 V.	3.0 3.3	.060 .063	+F	2 to 9	45	1	90	4 1/2	2.5	15,500	425	6.6	7
	RADIOTRON UX-199	Detector or Amplifier	Transformer Coupling	Small Standard UX Base	4 1/8"	1 3/16"	Dry Cell 4 1/2 V Storage 4 V	3.0 3.3	.060 .063	+F	2 to 9	45	1	90	4 1/2	2.5	15,500	425	6.6	7
	RADIOTRON UX-200-A	Detector	Transf. or Resist. Coupling	Large Standard UX Base	4 11/16"	1 13/16"	Storage 6 V.	5.0	.25	-F	2 to 3	45	1.5	Following UX-200-A Characteristics apply only for Detector Connection			30,000	666	20	—
	RADIOTRON UX-201-A	Detector or Amplifier	Transformer Coupling	Large Standard UX Base	4 11/16"	1 13/16"	Storage 6 V	5.0	.25	+F	2 to 9	45	1.5	90 135	4 1/2 9	2.5 3	11,000 10,000	725 800	8 8	15 55
	RADIOTRON UX-222	† Radio Freq Amplifier	Special Shielding (See Inst. Sheet)	Large Standard UX Base	5 3/8"	1 13/16"	Dry Cell 4 1/2 V Storage 4.5 V	3.3	.132	—	—	—	—	135	1 1/2 ■	1.5	850,000	350	300 M	—
	RADIOTRON UX-222	† Audio Freq Amplifier	Resistance Coupling (See Inst. Sheet)	Large Standard UX Base	5 3/8"	1 13/16"	Dry Cell 4 1/2 V Storage 4.5 V	3.3	.132	—	—	—	—	180 {	1 1/2 □	.3	150,000	400	60	—
	RADIOTRON UX-226	Amplifier A-C Filament Type	Transformer Coupling	Large Standard UX Base	4 11/16"	1 13/16"	Transformer 1.5 V.	1.5	1.05	—	—	—	—	90 135 180	6 Δ 9 Δ 13 1/2 Δ	3.7 6 7.5	9,400 7,400 7,000	875 1,100 1,170	8.2 8.2 8.2	20 70 160
	RADIOTRON UY-227	Detector or Amplifier A-C Heater Type	Transformer Coupling	5 Prong Standard UY Base	4 11/16"	1 13/16"	Transformer 2.5 V.	2.5 H	1.75	C	2-9 1-1	45 90	2 7	90 135 180	6 9 13 1/2	3 5 6	10,000 9,000 9,000	900 1,000 1,000	9 9 9	30 73 164
	RADIOTRON UX-240	Detector or Amplifier	Resistance Coupling	Large Standard UX Base	4 11/16"	1 13/16"	Storage 6 V	5.0	.25	+F	2 to 5	135 180 {	3 4	135 180 {	1 1/2 3	2 2	150,000 150,000	200 200	30 30	—
POWER AMPLIFIERS	RADIOTRON UX-112-A	† Power Amplifier	No L.S.C. Required	Large Standard UX Base	4 11/16"	1 13/16"	Storage 5 V Transformer 5 V	5.0	.25	—	—	—	—	135 157 1/2 180	9 10 1/2 13 1/2	7 9.5 9.5	5,000 4,700 4,700	1,600 1,700 1,700	8 8 8	120 195 275
	RADIOTRON UX-120	Power Amplifier	No L.S.C. Required	Small Standard UX Base	4 1/8"	1 3/16"	Dry Cell 4 1/2 V Storage 4 V	3.0 3.3	.125 .132	—	—	—	—	135	22 1/2	6.5	6,600	500	3.3	110
	RADIOTRON UX-171-A	Power Amplifier	L.S.C. Except at 90 V.	Large Standard UX Base	4 11/16"	1 13/16"	Storage 5 V Transformer 5 V	5.0	.25	—	—	—	—	90 135 180	16 1/2 27 40 1/2	10 15 [illegible]	2,500 2,200 2,000	1,200 1,360 1,500	3.0 3.0 3.0	130 330 700
	RADIOTRON UX-210	Power Amplifier	L.S.C.	Large Standard UX Base	5 3/8"	2 3/16"	Transformer 7.5 V.	7.5	1.25	—	—	—	—	250 300 350 400 425	18 22 1/2 27 31 1/2 35	10 13 16 18 18	6,000 5,600 5,150 5,000 5,000	1,330 1,450 1,550 1,600 1,600	8 8 8 8 8	340 600 925 1325 1540
	RADIOTRON UX-250	Power Amplifier	L.S.C.	Large Standard UX Base	6 1/4"	2 7/16"	Transformer 7.5 V.	7.5	1.25	—	—	—	—	250 300 350 400 450	45 Δ 54 Δ 63 Δ 70 Δ 84 Δ	28 35 45 55 55	2,100 2,000 1,900 1,800 1,800	1,800 1,900 2,000 2,100 2,100	3.8 3.8 3.8 3.8 3.8	900 1500 2350 3250 4650

	MODEL	USE	CIRCUIT REQUIREMENTS	BASE	MAXIMUM OVERALL HEIGHT	MAXIMUM OVERALL DIAMETER	PURPOSE		
RECTIFIERS	RADIOTRON UX-213	Full-Wave Rectifier	Full-Wave Circuit	Large Standard UX Base	5 5/8"	2 3/16"	Rectification in Eliminators particularly Designed for this Radiotron	Filament Terminal Voltage.....5 Volts Filament Current.....2 Amperes A.C. Plate Voltage.....220 Volts (Max. per plate) } R.M.S.	Max. D.C. Output Current (both plates).....65 Milliamperes D.C. Output Voltage at max. current as applied to filter of typical rectifier circuit.....170 Volts
	RADIOTRON UX-216-B	Half-Wave Rectifier	Half or Full Wave Circuit	Large Standard UX Base	5 5/8"	2 3/16"	Rectification in Eliminators particularly Designed for this Radiotron	Filament Terminal Voltage.....7.5 Volts Filament Current.....1.25 Amperes A.C. Plate Voltage.....550 Volts (Maximum) } R.M.S.	Max. D.C. Output Current.....65 Milliamperes D.C. Output Voltage at max. current as applied to filter of typical rectifier circuit.....470 Volts
	RADIOTRON UX-280	Full-Wave Rectifier	Full-Wave Circuit	Large Standard UX Base	5 5/8"	2 3/16"	Rectification in Eliminators designed for this Radiotron or Radiotron UX-213	Filament Terminal Voltage.....5 Volts Filament Current.....2 Amperes A.C. Plate Voltage.....300 Volts (Max. per plate) } R.M.S.	Max. D.C. Output Current (both plates).....125 Milliamperes Max. D.C. Output Voltage at max. current as applied to filter of typical rectifier circuit.....260 Volts
	RADIOTRON UX-281	Half-Wave Rectifier	Half or Full Wave Circuit	Large Standard UX Base	6 1/4"	2 7/16"	Rectification in Eliminators Designed for this Radiotron or Radiotron UX-216-B	Filament Terminal Voltage.....7.5 Volts Filament Current.....1.25 Amperes A.C. Plate Voltage.....700 Volts (Maximum) } R.M.S.	Recommended / Maximum A.C. Plate Voltage.....650 / 700 Volts D.C. Output Current.....65 / 85 Milliamperes D.C. Output Voltage as applied to filter of typical rectifier circuit.....620 / 620 Volts
MISCELLANEOUS	RADIOTRON UX-874	Voltage Regulator	Series Resistance	Large Standard UX Base	5 5/8"	2 3/16"	Constant Voltage Device	Designed to keep output voltage of B eliminators constant when different values of "B" current are supplied	Operating Voltage.....90 Volts D.C. Starting Voltage.....125 Volts D.C. Operating Current.....10-50 Milliamperes
	RADIOTRON UV-876	Current Regulator (Ballast Tube)	Transformer Primary of 65 Volts for use on 115 Volt Line	Standard Mogul Type Screw Base	8"	2 1/16"	Constant Current Device	Designed to insure constant input to power operated radio receivers despite fluctuations in line voltage	Operating Current.....1.7 Amperes Mean Voltage Drop.....50 Volts Permissible Variation.....±10 Volts
	RADIOTRON UV-886	Current Regulator (Ballast Tube)	Transformer Primary of 65 Volts for use on 115 Volt Line	Standard Mogul Type Screw Base	8"	2 1/16"	Constant Current Device	Designed to insure constant input to power operated radio receivers despite fluctuations in line voltage	Operating Current.....2.05 Amperes Mean Voltage Drop.....50 Volts Permissible Variation.....±10 Volts

† (*) Note other use of this Radiotron above (below)
■ Inner Grid +1 1/2 Volts; Outer Grid +45 Volts, .15 Milliamperes
□ Outer Grid −1 1/2 Volts; Inner Grid +22 1/2 Volts, .6 Milliamperes
{ Applied thru plate coupling resistance of 250,000 Ohms
Δ Grid voltage is given with respect to mid point of filament

Note: All grid voltages are given with respect to cathode or negative filament terminal unless otherwise noted

Max. Values not to be exceeded

A......Except for half ampere filament, UX-112 and UX-171 characteristics are identical respectively to UX-112-A and UX-171-A.
C......Cathode
H......Heater Voltage
L.S.C......Loud Speaker Coupling, consisting of either Choke Coil and By Pass Condenser or Output Transformer of 1:1 or step down ratio, recommended wherever plate current (D.C.) exceeds 10 milliamperes.
M......With a screen grid tube, on account of circuit limitations, the actual voltage amplification obtainable does not bear as high a relation to the voltage amplification factor as in the case of three electrode tubes.

Reprinted by Courtesy of RADIO CORPORATION OF AMERICA

RCA-RADIOTRON

UX-245

Power Amplifier

Radiotron UX-245 is a Power Amplifier tube for supplying large undistorted output to a loudspeaker. It is intended for use in the last stage of an Audio Frequency amplifier, in a socket whose filament voltage is 2.5 volts. (Radiotron UX-245 is not interchangeable with Radiotron UX-171-A or any other power amplifier Radiotron).

Rating and Data.

Filament Voltage		2.5 Volts AC or DC
Filament Current		1.5 Amperes
Plate Voltage	180	250 Volts (Maximum)
Grid Voltage (C-Bias)	—33	—50 Volts
Peak Grid Swing	33	50 Volts
Plate Current	26	32 Milliamperes
Plate Resistance	1950	1900 Ohms
Amplification Constant	3.5	3.5
Mutual Conductance	1800	1850 Micromhos
Undistorted Power Output	780	1600 Milliwatts

Maximum Over-All Dimensions.

Length .... 5 5/8"
Diameter .... 2 3/16"

Socket .... UX

RCA-RADIOTRON

UY-224

Screen Grid Radio Frequency Amplifier

A-C Heater

Radiotron UY-224 is a Screen Grid Amplifier tube containing a **heater-element** which permits operation from alternating current. It is recommended for use primarily as a Radio Frequency Amplifier in **carefully shielded** circuits especially designed for it. It may also be effectively used as a Space Charge Grid tube or as a Double Grid tube in special circuits.

Characteristics.

Heater Voltage .... 2.5 Volts AC or DC
Heater Current .... 1.75 Amperes
Plate Voltage, Maximum and Recommended .... 180 Volts
Grid Voltage (C-Bias) .... —1.5 Volts N
Screen Voltage, Maximum .... + 75 Volts
Plate Current .... 4 Milliamperes
Screen Current .... Not over 1/3 of Plate Current
Plate Resistance .... 400,000 Ohms
Amplification Factor 420
Mutual Conductance .... 1050 Micromhos

Direct Inter-Electrode Capacitances.

Effective Grid-Plate .... 0.01 Mmf. Maximum
Input .... 5 Mmf. Approx.
Output .... 12 Mmf. Approx.

Maximum Over-All Dimensions.

Length .... 5 1/4"
Diameter .... 1 13/16"

Socket .... UY

VICTOR R-32 AND RE-45 MICRO SYNCHRONOUS RADIOS

By Courtesy of Victor-Radio Corporation of America.

The Victor-Micro-Synchronous Radio is a power operated radio frequency receiver of the antenna type, employing an antenna coupling stage and four stages of tuned and neutralized radio frequency amplification, a detector, a first stage audio, and a power stage of push-pull amplification.

A high degree of sensitivity is made possible by means of a mechanical system of micrometer adjustments on the tuning condensers, permitting precision automatic alignment of the tuned radio frequency stages throughout the entire tuning range at all times. Each set of condensers is thus properly aligned at the factory and locked into position. A new method of stabilizing the radio-frequency circuit permits a high degree of selectivity without causing any decrease in sensitivity.

The instrument comprises three standard units as follows: (1) Radio, in which are contained the R. F. stages and the detector; (2) Power Amplifier, containing the first audio, the power stage of push pull amplification, and the rectifier; and (3) Electro Dynamic Reproducer. The units are so designed that all parts are readily accessible for servicing.

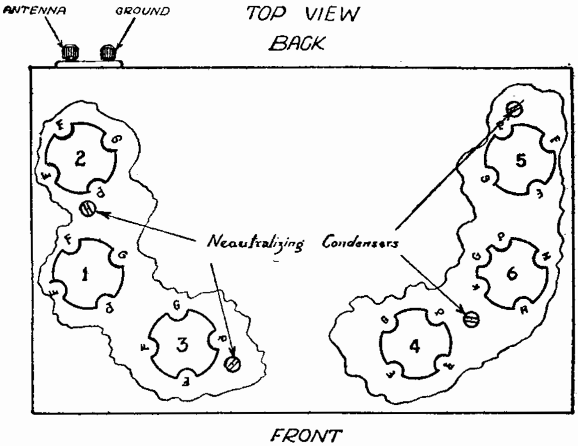


Fig. 1. Top view of Radio, showing layout of tubes and neutralizing adjusting screws.

The Victor Radio is designed for operation on 105 to 120 volts, 50 to 60 cycles, alternating current. Special equipment is available for operation on 105 to 120 volts, 25 to 40 cycles.

AVERAGE ANALYTICAL VOLTAGES

(110 volts A. C. Power Supply)

Socket No.	Tube Type	Location	Filament	Plate	Grid	Cathode
1	X-26	1 RF	1.40	105	9	
2	X-26	2 RF	1.40	105	9	
3	X-26	3 RF	1.40	105	9	
4	X-26	4 RF	1.45	105	9	
5	X-26	5 RF	1.50	105	9	
6	Y-27	Det.	2.10	40	0	0
7	X-26	1A	1.40	100	6	
8	X-45	2A	2.20	230	40	
9	X-45	2A	2.20	230	40	
10	X-80	Rect.	4.60			

For best average sensitivity and selectivity the antenna employed should be as high as practicable and from 50 to 75 feet long including the lead-in and ground wires.

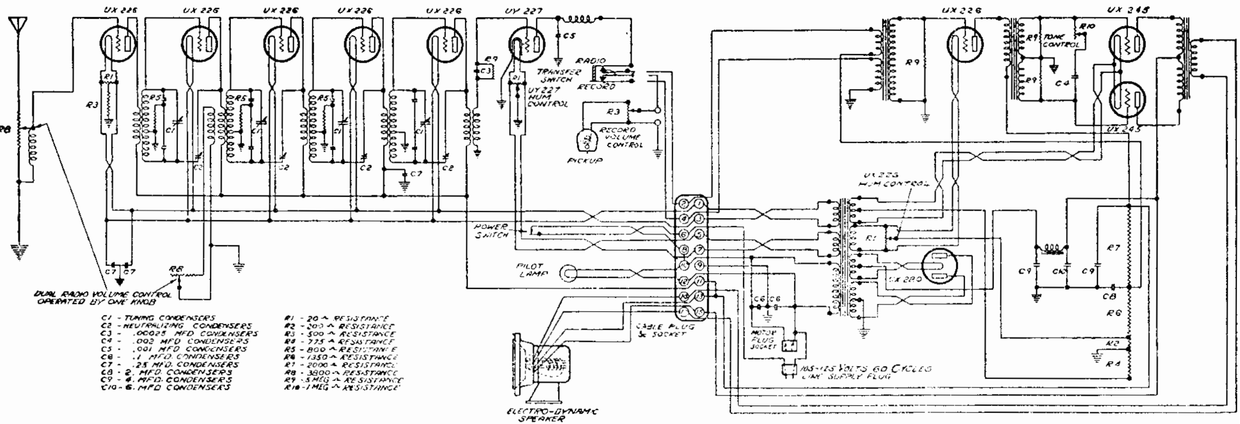


Fig. 2. Schematic Wiring Diagram Victor Radio, Models R-32 and RE-45.

WESTON METER SERVICE OUTSIDE OF UNITED STATES

By T. S. CAUTHORNE, *Assistant Foreign Sales Manager, Weston Electrical Instrument Corp.*

The users of Weston meters whose establishments are outside of the United States of America will find the following lists of institutions abroad of value in the event repair or replacement facilities should be desired.

1. Sales and Engineering Representatives Outside the United States Maintaining Their Own Repair Institutions:

Northern Electric Co., Ltd.,
121 Shearer Street,
Montreal, Que., Canada.

Powerlite Devices, Ltd.,
171 John Street,
Toronto, Ont., Canada.

Weston Electrical Instrument Co., Ltd.,
15 Great Saffron Hill,
London, E. C. I, England.

Dipl. Ing. D. Bercovitz & Sohn,
Belzigerstr. 61,
Berlin, Schoneberg, Germany.

Anciens Establissements V. Duquesne & Cie.,
13 Rue Liedts,
Brussels, Belgium.

Material Electrique de Controle et Industriel,
2, Faubourg Poissonniere,
Paris, France.

Ing. S. Belotti & Co.,
Corso Roma 76-78,
Milano, 114, Italy.

Mitsubishi Shoji Kaisha, Ltd.,
Marunouchi,
Tokyo, Japan.

2. Sales and Engineering Representatives Having Direct Contact with Local Repair Laboratories:

Maskin-Aktieselskapet Zeta,
Stortingsgaten 8,
Oslo, Norway.

Aktiebolaget Zander & Ingestrom,
Fredsgatan 4,
Stockholm, Sweden.

Mr. A. F. Hulsewe,
Keizersgracht 188,
Amsterdam, Holland.

Bartle & Co., Ltd.,
Loveday House, Loveday St.,
Johannesburg, So. Africa.

M. Barros & Co.,
Rua S. Jose N. 70,
Caixa Postal No. 89,
Rio de Janeiro, Brazil.

Cia Standard Electric Argentina,
Paseo Colon 185,
Buenos Aires, Argentina.

Warburton, Franki, Ltd.,
307-315 Kent St.,
Sydney, N. S. W., Australia.

Warburton, Franki (Melb.) Ltd.,
380-382 Bourke Street,
Melbourne, Australia.

M. S. Vernal & Co.,
5, Council House St.,
Calcutta, India.

China Electric Co.,
Kincheng Bank Bldg.,
22 Kiangse Rd.,
Shanghai, China.

Mr. Oskar Orgel,
Ungargasse 15,
Vienna 111, Austria.

Mr. Otto Ahrens,
Ryesgade 3,
Copenhagen, Denmark.

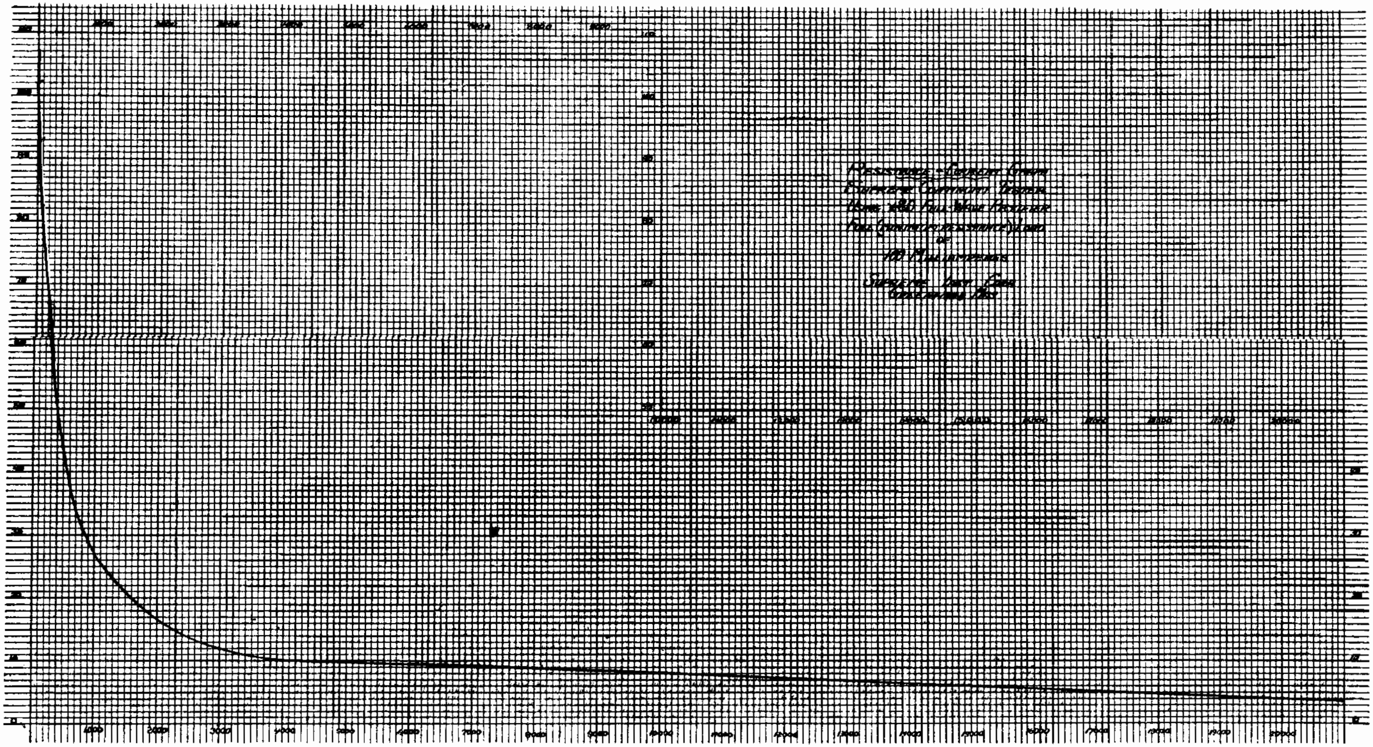
Mr. Rudolf Guth,
Zlatnicka 6,
Prag 11, Czecho-Slovakia.

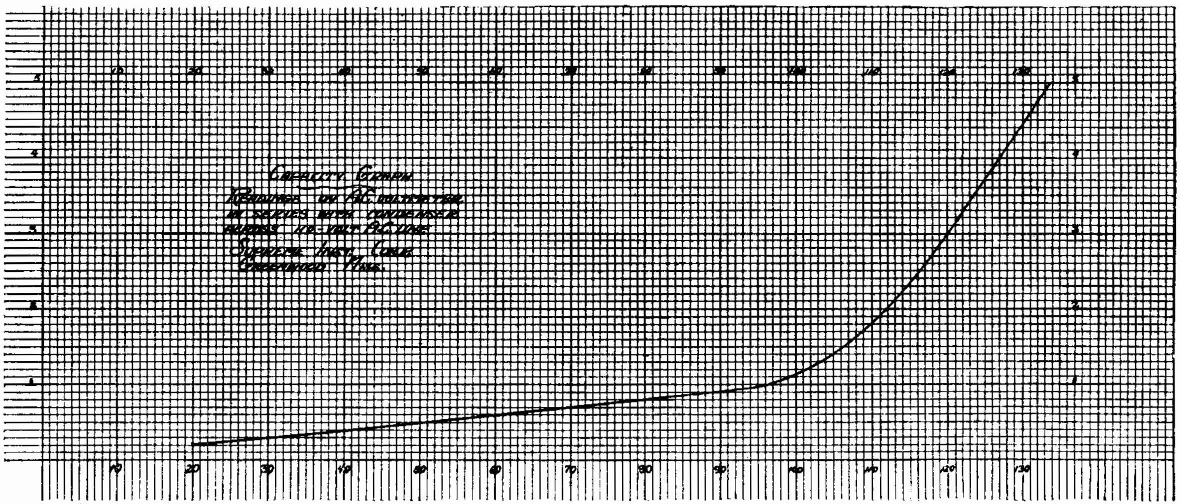
Mr. Carl Engel,
Vorosmarty-utica 16,
Budapest VII, Hungary.

"Noris,"
Gunduliceva 26,
Zagreb, Jugo-Slavia.

Elektroprodukt,
Nowy Swiat 5,
Warsaw, Poland.

"Noris,"
Str. Tudor Vladimirescu 6,
Cluj, Roumania.


Resistance-Current Graph
Supreme Continuity Tester
Using 80 Full Wave Rectifier
Full (continuity resistance) load
of
110 Milliamperes
Supreme Inst. Corp.
Greenwood Miss.
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
18000
19000
20000


Capacity Graph
Readings on AC voltmeter
in series with condenser
across 110-volt AC line.
Supreme Inst. Corp.
Greenwood Miss.
10
20
30
40
50
60
70
80
90
100
110
120
130
1
2
3
4
5

WAVELENGTH—KILOCYCLE CONVERSION TABLE.

Kilocycles	Wavelength	Kilocycles	Wavelength
540	555.6	770	384.4
550	541.1	780	384.4
560	534.4	790	379.5
570	526.0	800	374.8
580	516.9	810	370.2
590	508.2	820	365.6
600	499.7	830	361.2
610	491.5	840	356.9
620	483.6	850	352.7
630	475.9	860	348.6
640	468.5	870	344.6
650	461.3	880	340.7
660	454.3	890	336.9
670	447.5	900	333.1
680	440.9	910	329.6
690	434.5	920	325.9
700	428.3	930	322.4
710	422.3	940	319.0
720	416.4	950	315.6
730	410.7	960	312.3
740	405.2	970	309.1
750	399.8	980	305.9
760	394.5	990	302.8

WAVELENGTH—KILOCYCLE CONVERSION TABLE.

Kilocycles	Wavelength	Kilocycles	Wavelength
1000	299.8	1260	238.0
1010	296.8	1270	236.1
1020	293.9	1280	234.2
1030	291.1	1290	232.4
1040	288.3	1300	230.6
1050	285.5	1310	228.9
1060	282.8	1320	227.1
1070	280.2	1330	252.4
1080	277.6	1340	223.7
1090	275.1	1350	222.1
1100	272.6	1360	220.4
1110	270.1	1370	218.7
1120	267.7	1380	217.3
1130	265.3	1390	215.7
1140	263.0	1400	214.2
1150	260.7	1410	212.6
1160	258.5	1420	211.1
1170	256.3	1430	209.7
1180	254.1	1440	208.2
1190	252.0	1450	206.8
1200	249.9	1460	205.4
1210	247.8	1470	204.0
1220	245.8	1480	202.6
1230	243.8	1490	201.2
1240	241.8	1500	199.9
1250	239.9		

TABLES AND FORMULAE OF VALUE

OHM'S LAW:

$E = RI$
$R = E/I$
$I = E/R$

Where E = Voltage
R = Resistance
I = Current

RESISTANCES, IN SERIES:

$R = r_1 + r_2 + r_3$, etc.

IN PARALLEL:

$1/R = 1/r_1 + 1/r_2 + 1/r_3$, etc.

Where R = Total Resistance
r = resistances to be combined

CAPACITIES, IN SERIES:

$1/C = 1/c_1 + 1/c_2 + 1/c_3$, etc.

IN PARALLEL:

$C = c_1 + c_2 + c_3 +$ etc.

Where C = Total Capacity
c = capacities to be combined

POWER, IN WATTS:

$P = EI$

Where P = Power in watts
E = Voltage
I = Current

DATA SHEET — POPULAR RADIOS

MAJESTIC RADIOS

General Description: The Majestic Model 70 Radio is a 7-tube tuned radio-frequency shielded receiver, with all metal chassis and separate power supply unit, utilizing a dynamic speaker, all three units being designed to fit into several types of console cabinets of different prices.

Power Supply: The primary circuit of the separate power supply unit consists of the "on-off" switch, a resistance bank voltage regulator, and the primary windings of the filament and plate transformers. The voltage regulator ballast assures regulation of voltage to the tube filaments, and of the plate supply for any ordinary line condition. The power transformer cores are grounded. The rectifier system in the power plant consists of a type '80 full-wave rectifier, supplying 200 volts direct current for the "B" and "C" potentials, as well as to the field coil of the dynamic speaker, and the usual 1½, 2½ and 5-volt windings on the power transformer supply, the filaments of the tubes and the pilot lamp. The detector 50-volt plate supply lead is tapped at 2170 ohms on the voltage divider, while the positive 90-volt radio-frequency and first audio amplifier plate lead is tapped 1750 ohms from the "B positive 50" tap. The dynamic speaker field is connected between the positive 90 and 180-volt "B" taps. A grid bias is derived for the two '71-A push-pull audio amplifiers by an approximately 40 volt drop across a 1000-ohm resistance connected between negative "B" and the center tap of the 5-volt filament secondary winding. Radio-frequency grid biases are obtained by means of the voltage drop across a 550-ohm resistor, in the negative "B" supply lead located within the set itself. The electrical center of the filament circuit for the three radio-frequency tubes is obtained by means of a fixed center-tapped 20-ohm resistance.

Volume Control.—The volume control consists of a 10-000-ohm potentiometer connected between the grid and the ground of the first tube.

Input Circuits.—The antenna is connected through a piece of shielded wire to the slider of the volume control potentiometer. For long antenna a .0001 Mfd. condenser is connected in series with the slider to reduce the effective length of the antenna. The trimmer condenser for this tuned circuit consists of a cylindrical shield which fits down over the coil, and is varied by means of a lever shaft on the left end of the panel. The shield, as it fits over the coil, changes the tuning of the coil slightly, and so adjusts it to resonance with the radio-frequency transformer secondary. The effectiveness of this method of volume control and resonance adjustment, as well as the shielding of the set, can be attested by the fact that when no antenna or ground is connected, no signals can be heard at the maximum setting of volume control, even when the set is within a few yards of a powerful generator of radio-frequency signals.

Radio-Frequency System. — The three radio-frequency transformers are of the small diameter, low external field, solenoid type, and are placed in individual copper compartments. The variable condenser group is also shielded. The group is controlled by a single illuminated drum dial control, the control shaft being in the center of the chassis. The individual trimmers for these condensers are adjusted at the factory for proper synchronism. Three type "26" tubes are used as the radio-frequency amplifiers. The neutralizing condensers are connected between the grid and the input circuit of the following radio-frequency stage. By-pass condensers of the .5 microfarad type are used in the radio-frequency amplifiers.

Detector System. — The usual type '27 A.C. tube is used as the detector. A 2-megohm grid leak is used with a .00025 grid condenser. A .002 mfd. condenser is connected across the plate and ground of the detector circuit. The positive 50-volt detector plate lead is also connected to the center tap of the 20-ohm resistance across the 2½-volt detector filament supply, while the cathode is connected directly to the ground. The cathode is, therefore, approximately 50 volts negative with relation to the filament.

Audio Amplifier System. — The two audio transformers and the output transformer, are enclosed in hermetically sealed metal cases. A .002 condenser is connected between the plate lead of the first audio amplifier stage and the ground. A '26 tube is used in the first stage, while the second stage uses two '71-A's in push-pull. Any residual hum which may exist in the receiver is balanced out at the time of installation by a 20-ohm potentiometer across the filament of the first audio tube, this resistance being placed in the back of the chassis, so as to be accessible from the rear of the cabinet. A .5 mfd. condenser is connected between the slider of this potentiometer and the ground.

Out-Put Circuit. — The secondary of the output transformer is connected to the moving coil of the dynamic speaker which is connected to four terminals on one end of the receiver chassis. The speaker field is connected between the positive 90 and 180-volt "B" taps, instead of between the negative and positive 90-volt "B" terminals. The Radio-frequency, detector, and first audio stages of the Models 80 and 81 are practically the same as the Model 70. Two '81 rectifiers are used in these models, delivering about 425 volts "B" and about 36 volts "C" to two type '10 tubes in push-pull in the second audio stage.

ATWATER KENT

Model 44

Description

Four stages of radio-frequency amplification, a tuned detector and two stages of transformer coupled audio frequency. The first tube in the radio frequency circuit is used as an antenna coupling tube. The last stage of audio frequency is of power type with condenser choke coupling to the speaker.

Type of Tubes

All radio frequency ....226 type tube
Detector ....227 type tube
1st. Audio ....226 type tube
2nd. Audio ....171-A type tube
Rectifier ....280 type tube

Placement of Tubes

Facing panel of instrument reading from left to right.
Rear—rectifier.
Front—-1st. R.F., 2nd. R.F., 3rd. R.F., 4th. R.F.
Detector—1st. A.F., 2nd. A.F.

AVERAGE ANALYTICAL TESTS

	Grid Bias Voltage	Plate Voltage		Filament Voltage	
	Load	Load	No Load	Load	No Load
1st. R.F.	13.	160.		1.45	
2nd. R.F.	13.	160.		1.45	
3rd. R.F.	13.	160.		1.45	
4th. R.F.	13.	160.		1.45	
Detector	0.	44.		2.35	
1st. A.F.	13.	155.		1.45	
2nd. A.F.	45.	180.		4.8	

Method of Rectification

Full wave rectification with type 280 tube.

Filter System

Consists of two chokes in series with filter condensers shunted across power supply line. Filter system also includes speaker choke, detector and audio by-pass condensers.

Cable System in Colors.

White	Plate of 1st. R.F., 2nd. R.F., 3rd. R.F., 4th. R.F.
Red-White	Positive heater of detector tube.
Black-White	Negative filament of detector tube.
Yellow	Plate of detector tube.
Black	Negative filament of 1st. R.F., 2nd. R.F., 3rd. R.F., 4th. R.F. and 1st stage of audio.
Red	Positive filament of 1st. R.F., 2nd R.F., 3rd. R.F., 4th. R.F. and 1st. A.F.
Green	To ground.
Black-Green	Negative filament of last stage of audio-frequency.
Red-Green	Positive filament of last stage of audio-frequency.
Brown	Plate of last stage of audio.

Radio Frequency Circuit.

Circuit employed is standard tuned R.F. The first tube of which is used as an antenna coupling tube. The grid return is made through grid resistors, secondary of R. F. transformer and to grounded shield. The radio-frequency transformers are shunted by variable condensers, the rotor plates being grounded to the shield. The R.F. plate supply is through a resistance mounted under chassis.

Detector Circuit.

Detector is of usual design to incorporate the type 227 tubes. The grid return is made through a standard grid condenser with leak shunted between grid and shield.

Audio Circuit.

The standard design of two-stage transformer coupled audio-frequency, ratio not given. 2nd. stage ratio 2.5 to 1.

Output Circuit.

A potentiometer is employed in the antenna circuit and serves as a volume control.

This resistance is connected across a portion of the antenna coupling transformer, the arm of the resistance connects to the ground. By upturning the arm towards the antenna end of the resistance the volume is decreased.

Location of By-Pass Condensers.

R.F. filament and plate circuit by-pass condensers are mounted under chassis. There is also a speaker filater condenser mounted under chassis.

Biasing Method.

"C" bias is obtained by means of a voltage drop across resistors. The resistances for R.F. stages, 1st. and 2nd. A.F. are wound on a single strip, this being mounted on top of panel assembly incorporated within power unit.

Grid and Plate Returns.

All grid and plate returns are at grounded potential and are made to the grounded shield.

A. C. Line Control.

The line is controlled by a ballast resistance in series with the primary of the transformer. This resistor balances voltage due to its greater heat and resistance at higher voltages and its lower heat and resistance at lower voltages with corresponding path to voltages.

Access to Chassis.

Lift the cover off of the power unit and remove nuts from post which pass through holes in cable connection panel, releasing cable from power unit.
Remove dial and vernier knob and two screws which hold antenna and ground post brackets on inside back of cabinet. Remove the six screws, three in a vertical row at each end which clamp the chassis to the inside front of cabinet. Pull chassis straight back horizontally to allow condenser shaft and volume control to clear front of cabinet. Lift set up and out.

ATWATER KENT — MODEL 37

Description.

Model 37 is a six-tube, single-dial A.C. type receiver with a complete power unit incorporated in the metal cabinet that houses the set. The power unit operates from 110-volt, 60-cycle A.C. and supplies complete filament and grid voltages to the set. Three stages of radio-frequency amplification, the first stage acting as an untuned antenna coupling tube, in order to eliminate the detuning effect of different sizes of aerials which would otherwise disturb synchronism of the three tuned circuits.

Type of Tubes.

All Radio Frequency Stages	226 type tube
Detector	227 type tube
1st. Audio	226 type tube
2nd. Audio	171A type tube
Rectifier	280 type tube

Placement of Tubes.

Facing panel of instrument. Reading from left to right. The rectifier tube is encased in a metal cover which has an opening in the left-hand end of the top for insertion.
Front: 1st. R.F., 2nd. R.F., 3rd. R.F., Detector, 1st A.F., 2nd. A.F.

AVERAGE ANALYTICAL TESTS

	Grid Bias Voltage	Plate Voltage Load	Filament Voltage Load
1st. R.F.	12	135	1.4
2nd. R.F.	12	135	1.4
3rd. R. F.	0	30	2.3
1st. Audio	12	110	1.4
2nd. Audio	25	120	4.8

Methods of Rectification.

Full wave rectification with type 280 tube.

Filter System.

Consists of audio frequency chokes and high-capacity fixed condensers serving to smooth out the pulsating direct current delivered by the rectifying tube. Two chokes in series with filter condensers shunted across power supply line. Filter system also includes speaker choke, detector and audio by-pass condensers.

Cable System in Colors.

White..........................Plate of 1st., 2nd. and 3rd. radio-frequency.

Red-White..................Positive filament of detector tube.

Black-White...............Negative filament of detector tube.

Yellow........................Plate of detector tube.

Black..........................Negative filament of 1st., 2nd. and 3rd. radio-frequency and 1st. audio frequency.

Red.............................Positive filament of 1st., 2nd. and 3rd radio-frequency and 1st. audio-frequency.

Green..........................To ground.

Black-Red..................Plate of first audio-frequency.

Black-Green...............Positive filament of 2nd. audio-frequency.

Brown..........................Plate of 2nd. audio-frequency.

Radio-Frequency Circuit.

Circuit employed is standard tuned Radio Frequency. Radio frequency transformer secondaries are shunted by variable condensers the rotor plates being grounded to the shield. The condensers are coupled by the usual Atwater Kent belt drive system. Grid return is made through grid resistor, secondary of radio-frequency transformer and to the grounded shield. Radio-frequency plate leads are grounded to the shield through by-pass condensers. The radio-frequency plate supply is through a resistance mounted under chassis.

Detector Circuit.

Detector circuit is of the usual design to incorporate the type 227 tube. The grid return is made through a standard grid condenser with leak shunted between grid and shield.

Audio Circuit.

The standard design of two-stage transformer coupled audio-frequency amplifier is employed. First stage ratio is not given, and 2nd. stage ratio is 2½:1.

Antenna Control.

A potentiometer in the antenna circuit serves as the volume control, no variable controls being used in either the filament or plate circuits.

Location of By-Pass Condensers.

The radio-frequency filament and plate by-pass condensers are mounted on bottom of chassis.

Biasing Methods.

The "C" bias for all tubes is obtained by means of a voltage drop across resistors incorporated within the power unit.

Grid and Plate Returns.

All grid and plate returns are at grounded potential and are made to the grounded shield.

Access to Chassis.

First remove cover from power unit by taking out the two screws at its lower outside ends, and four screws at the bottom of front, remove nuts from bolts which pass through holes in cable connection panel and lift connection panel off, releasing cable from power unit. Take out six screws, three in a row at each end, which clamp the metal frame of chassis to brackets at inside front of cabinet. Remove vernier knob and tuning dial. Remove two screws which hold antenna and ground post to bracket on inside back of cabinet. Pull sub-panel straight back horizontally to allow volume control knob and dial shaft to clear, then lift set up and out.

ATWATER KENT — MODEL 32

Description.

Seven-tube single-dial battery type receiver, having four stages of radio-frequency amplification, a tuned detector and two stages of audio-frequency amplification. The first radio-frequency amplifying tube is not tuned, being used as an antenna coupling tube for the purpose of preventing the antenna from disturbing the synchronism of the succeeding tuned circuits.

The filaments of the radio-frequency tubes are controlled by one rheostat, another rheostat controls the detector filament, and a fixed resistance is connected in series with the two audio-frequency filaments.

Type of Tubes.

All R.F. ....201A type tubes
Detector ....201A type tube
1st. Audio ....201A type tube
2nd. Audio ....201A type tube

Placement of Tubes.

Facing panel and reading from left to right: 1st. R.F.; 2nd. R.F.; 3rd. R.F.; 4th. R.F.; Det.; 1st. A.F.; 2nd. A.F.

Possible Substitution of Tubes.

Type 171A or 112A may be substituted in the last stage of audio-frequency amplification. This set is so wired that in the last stage of audio-frequency the plate and grid bias voltage may be added to meet the requirements of the tube to be used.

AVERAGE ANALYTICAL TESTS

Proper Readings

	Grid Bias Voltage	Plate Voltage Load	Filament Voltage Load
1st. R. F.	0	67.5	5
2nd. R.F.	0	67.5	5
3rd. R.F.	0	67.5	5
Detector	0	22.5	5
1st. A.F.	0	67.5	5
2nd. A.F.	4½	90	5

Cable System in Colors.

Brown	Plate of last stage of audio-frequency amplification.
Red	Positive filament of antenna coupling tube 1st., 2nd. and 3rd radio-frequency, detector, 1st. and 2nd. audio-frequency.
Yellow	Plate of detector tube.
Green-Yellow tracer	Negative "C" grid bias of last stage audio-frequency.
Black	Negative filament of antenna coupling tube 1st., 2nd. and 3rd radio-frequency, detector, 1st. and 2nd. audio-frequency.
White	Plate of antenna coupling tube 1st., 2nd. and 3rd radio-frequency amplification and 1st. stage of audio-frequency.

Radio Frequency Circuits.

The radio frequency transformer secondaries are shunted by variable condensers the rotor plates of which are connected to negative filament. The condensers are coupled by the usual Atwater Kent belt drive system; Grid return is made through grid resistor, secondary of radio-frequency transformer and to negative filament. The radio-frequency plate leads are connected to a by-pass condenser which in turn is connected to negative filament. This condenser is held by two bolts passing through the fourth radio-frequency socket. The first stage is untuned and acts as an antenna coupling device.

Detector Circuit.

Detector circuit is of the usual design to incorporate the type 200A or 201A tubes. The grid return is made through a standard grid condenser to a center tapped resistance across the filament.

Audio Circuit.

The standard design of two-stage transformer coupled audio-frequency amplifier is employed. The ratio of the first stage audio transformer being four to one, and the ratio of the second stage audio transformer being two and five-tenths to one.

Output Circuit.

One lead of the speaker is connected to the plate of last stage of audio and the other is connected to positive "B" battery of last stage of audio-frequency amplification.

Antenna Control.

Consists of an untuned antenna circuit employing an antenna coupling tube for the purpose of preventing different sizes of antenna from disturbing the synchronism of the succeeding tuned circuits.

Biasing Methods.

A grid bias is used only on the last stage of audio-frequency amplification. This is made by the "C" battery.

Grid and Plate Returns.

Grid return is made through grid resistor, secondary of radio-frequency transformer and to negative filament. Radio-frequency plate leads are connected to a by-pass condenser which in turn is connected to negative filament.

CROSLEY GEMBOX — MODEL 608

Construction of Circuits.

Circuit consists of two neutralized radio-frequency stages, regenerative detector and two stages of transformer coupled audio-frequency amplification. The detector and second radio-frequency stages are tuned. The first stage of the radio-frequency amplifier is untuned.

Type of Tubes.

Rectifier ....280 type tube
R. F. Stages ....226 type tubes
Detector ....227 type tube
1st. A.F. ....226 type tube
2nd A.F. ....171A type tube

Placement of Tubes.

Facing panel and reading from left to right:
Rear—2nd A.F. 1st. R.F.
Center—2nd. R.F.
Front—1st. A.F. Detector Rectifier

AVERAGE ANALYTICAL TESTS

	Grid	Plate		Filament	
		Load	No Load	Load	No Load
1st. R. F.	8	115	130	1.3	1.5
2nd. R.F.	8	115	130	1.3	1.5
Detector	0	30	50	2.4	2.6
1st. A.F.	8	110	130	1.3	1.5
2nd. A. F.	38	150	200	4.5	5.0

Method of Rectification.

Although a type 280 full-wave rectifier tube is used, the two plates are connected together and the tube is used as a half-wave rectifier.

Filter System.

Filter consists of choke in series with positive power supply lead, the choke is shunted by two leads of the Mershon condenser, the third lead of this condenser being connected to the negative side of the power supply.

Cable System in Colors.

All filament leads are of black rubber.
All leads from high voltage secondary are of red rubber.

Antenna Control.

The only variable or volume control provided is a potentiometer connected across the primary of the antenna coupling transformer.

By-Pass Systems.

By-pass condensers are connected to primary of audio-frequency transformer and grounded to shield.

Biasing Methods.

Grid bias is provided by means of a voltage drop across resistors that are incorporated within the power supply.

Grid and Plate Returns.

All grid and plate returns are made to the grounded shield.

Access to Chassis.

Remove knobs from in front of panel, then to remove bottom, take out six innermost set-screws from bottom. To remove case, take out six outer set-screws from bottom.

Radio Frequency Circuits.

Radio-frequency circuit is of standard neutrodyne design; the first stage being untuned; second and third R.F. transformer being connected directly between grid of tubes and ground shield and shunted by variable condensers.

Detector Circuits.

The detector circuit is tuned by a variable condenser across the secondary of the third radio-frequency transformer; the grid return is made through a standard grid condenser and built-in grid leak through the third R. F. transformer and to the grounded chassis; regeneration is controlled by a small variable condenser connected between the detector plate and the plate of the second R.F.

Audio Stages.

Standard transformer coupled two-stage audio-frequency amplifier.

Output Circuits.

The plate of the final audio stage is fed directly into the speaker and no speaker filter is provided.

CROSLEY JEWEL-BOX — MODEL 704

Construction of Circuits.

The circuit consists of three stages of neutralized radio-frequency amplification; the first stage of which is untuned, a non-regenerative detector and two stages of transformer coupled audio-frequency amplification.

Type of Tubes.

All R.F. ....226 type tubes
Detector ....227 type tube
1st. Audio ....226 type tube
2nd. Audio ....171A type tube
Rectifier ....280 type tube

Placement of Tubes.

Facing panel and reading from left to right:
Rear—Rectifier.
Center—2nd. R.F. 3rd. R.F. Det. 1st. A.F.
Front—1st. R.F. 2nd. A.F.

AVERAGE ANALYTICAL TESTS

	Grid Bias Voltage	Plate Voltage Load	Plate Voltage No Load	Filament Voltage Load	Filament Voltage No Load
1st. R.F.	3	70	90	1.4	1.5
2nd. R.F.	3	70	90	1.4	1.5
3rd. R. F.	3	70	90	1.4	1.5
Detector	0	40	45	2.3	2.5
1st. A.F.	6	68	90	1.4	1.5
2nd. A.F.	40	180	220	4.85	5.1

Method of Rectification.

A type 280 tube is used in full-wave rectification system.

Filter System.

The filter consists of the standard filter chokes in series with the positive plate supply line. The plate supply line is shunted by a Mershon filter condenser.

Table System in Colors.

Yellow........................1.5 V. filament leads
Pink........................2.5 V. filament leads.
Black........................5.0 V. filament leads.
Brown........................"B" negative.
Blue........................"B" positive 90.
Red........................"B" positive 180.
Green........................"C" negative.

Radio Frequency Circuits.

The radio-frequency circuit consists of three stages of neutralized radio-frequency amplification. The second and third stage is tuned by means of a variable condenser shunted across the secondary of the radio-frequency transformer. These condensers in turn are each shunted by small vernier condenser termed by the manufacturer as "acuminators." The acuminators serve as means of sharpening the tuning. The grid returns of the R. F. stages are made directly to the grounded shielding. The first stage is untuned and acts as an antenna coupling device.

Detector Circuit.

A standard non-regenerative detector circuit for use with the 227 type tube is employed. The grid return is made through the usual grid leak and grid condenser, secondary of radio-frequency transformer to the shield. The detector circuit is tuned by means of a variable condenser shunted across the secondary of the preceding radio-frequency transformer. This condenser is, in turn, shunted by a small auxiliary variable condenser which provides a means of synchronizing the receiver.

Audio Circuit.

The audio circuit consists of a standard two-stage transformer coupled audio-frequency amplifier. The primaries of the audio-transformers are grounded to the shield through by-pass condensers. Grid returns are made through biasing resistors and return to center tapped resistors that shunt the filament leads.

Output Circuit.

One of the chokes employed in the power supply unit is used as a speaker choke and is in series with the speaker leads.

Antenna Control.

The antenna or volume control consists of a potentiometer shunted across the antenna choke.

Biasing Methods.

Grid bias is obtained by means of a voltage drop across resistors incorporated within the receiver.

Grid and Plate Returns.

All returns to the filaments are made to center tapped resistors that are shunted across the various filament leads.

A. C. Line Control.

A fuse is connected in series with the primary of the power transformer. This fuse may be used as a single pole double throw-switch which provides access to an extra tap in the primary of the power transformer windings; this affords a means of compensating high or low power line values.

Access to Chassis.

Remove knobs from in front of panel, then to remove bottom, take out six innermost set-screws from bottom. To remove case, take out six outer set-screws from bottom.

CROSLEY JEWEL-BOX — MODEL 704-A

Description.

This model incorporates three stages of neutrodyned radio-frequency amplification. The second and third stages are tuned and the first stage being untuned and used as an antenna coupling tube, a non-regenerative detector and two stages of transformer coupled audio-frequency amplification.

Type of Tubes.

All R. F. ....226 type tubes
Detector ....227 type tubes
1st. Audio ....226 type tubes
2nd. Audio ....171A type tubes
Rectifier ....280 type tubes

Placement of Tubes.

Facing panel and reading from left to right:
Rear—Rectifier.
Center—2nd. R.F.; 3rd. R.F.; Detector; 1st. A.F.
Front—1st. R.F.; 2nd. A.F

AVERAGE ANALYTICAL TESTS

	Plate	Filament
1st. R. F.	90	1.5
2nd. R.F.	90	1.5
3rd. R. F.	90	1.5
Detector	45	2.5
1st. A.F.	90	1.5
2nd. A.F.	180	.5

Methods of Rectification.

Type 280 tube is used in full wave rectification.

Filter System.

Consists of a choke in the plate supply lead shunted by a Mershon condenser.

Cable System in Colors.

All filament leads are of black rubber. All leads from high voltage secondaries are of red rubber.

Radio Frequency Circuit.

Three stages of neutrodyned radio-frequency amplification, with the second and third stages being tuned and the first stage untuned, this stage being used as an antenna coupling device. The second and third stages are tuned by variable condensers shunted across the radio-frequency transformer secondaries. These condensers in turn are shunted by a small vernier condenser. They serve as a means of sharpening the tuning when greatest selectivity is required.

Detector Circuit.

A standard non-regenerative detector circuit to incorporate the type 227 tube. The grid return is made through the usual grid leak and grid condenser, secondary of radio-frequency transformer and grounded shield. The detector circuit is tuned by means of a variable condenser shunted across the preceding radio-frequency transformer, this in turn being shunted by an ''alignment'' condenser which serves as a means of aligning the tuning condensers so that they ''track'' together.

Audio Circuit.

The audio circuit consists of a standard two-stage transformer coupled audio-frequency amplifier. Primary of the 1st. stage of audio being shunted to the chassis by a .003 mfd. condenser and by a ½ mfd. condenser.

Output Circuit.

The voltage after going through the Mershon condenser and resistance to cut it down for last stage of audio, goes directly to the musicone terminals, thence through the musicone and finally to the plate of the output tube.

Antenna Control.

The antenna or volume control consists of a potentiometer shunted across part of the antenna choke.

Biasing Methods.

Grid bias is obtained by means of a voltage drop across resistors. The grid bias for the last stage or audio is obtained by means of voltage drop in a 2200-ohm resistance connecting from the mid-tap of a 50-ohm resistance shunted across the filament of the last stage.

Grid and Plate Returns.

All grid returns are made to grounded shield.

A. C. Line Control.

A fuse is connected in series with the primary of the power transformer. This fuse may be used as a single pole double throw-switch, which provides access to an extra tap in the primary of the power transformer windings; this affords a means of compensating high or low power line values.

Access to Chassis.

Remove knobs from in front of panel, then to remove bottom, take out six innermost set-screws from bottom. To remove case, take out six outer set-screws from bottom.

SUPREME DATA

External Use of the 150-A. C. Voltmeter Scale.—When it is desired to use the 150-volt scale of the Supreme A. C. voltmeter in Models 99-A and 100-A, close the "A. C. Line" and "1½-Volt" Power Plant switches, connecting the "Negative Filament Common" and the "Positive Mil-Ameter" pin jacks to the A. C. potential to be measured. The 1½-volt winding of the power transformer secondary will be included in this hook-up, but the effect on the measurement will be negligible for all practical purposes.

These pin jacks are connected in series with the 110-volt A. C. line and a condenser to be measured when using the Capacity Measuring Graph included in this Manual.

MISCELLANEOUS TESTS FROM PIN JACKS

The multiplicity of circuits of the SUPREME furnish almost unlimited possibilities and by making use of the probability formulae it shows that the limit is in the thousands. New uses of the SUPREME are coming to us every day and these new uses will be forwarded to all SUPREME owners as they are developed. The SUPREME is a progressive instrument as it is always giving forth something new.

The first deals with pin jack tests that can be made with all models and the second part headed "400-A and 100-A Only" are additional tests that can be made with these instruments.

EXTERNAL USE OF METERS

Provision is made to use all scales of the three meters externally.

Milliameter. — To use the milliameter, run two test cords from the jacks marked, "Ammeter For External Use," using the proper polarity as marked. Either scale of the combination meters can be used by throwing the Toggle switch to 125 mils. or 2½ amperes.

D. C. Voltmeter. — To use the D. C. Voltmeter, run a test cord from the pin jack marked "Positive," and if the voltage to be tested is under 10 volts run another lead from the pin jack marked "—10." After clipping on to the objective source of voltage, press button or insert master plug in "10 Fil. Scale" to cut the meter in.

If the voltage is over 10 volts, run the negative lead from -100 -600 pin jack, and after clipping the leads on the objective voltage supply, press button or insert master plug in either the 100 or 600 plate scale, according to the voltage, and cut in the meter.

A. C. Voltmeter. — To use the A. C. Voltmeter, run one test lead from the -10 pin jack, and another lead from the -100-600 pin jack to the source of A. C. voltage supply, and press or insert master plug in either the 3v or 15v A. C. Fil. Scale, according to the voltage. Due to the independent cathode reading in the instrument it is necessary to slip on adapter on end of the 5-wire cord plug to close the filament circuit and allow the A. C. Meter to get in circuit.

For line voltage reading use the A. C. lamp cord and run to a light socket. Press button or insert master plunger in "line voltage 150 scale" for reading. This reading can be taken any time the instrument is in use on A. C. tests.

The following relates to tests that can be made only with models 400-A and 100-A. All of these tests are made through pin jacks located on the back of the instrument tray as on model 400-A and in front of panel as on model 100-A.

USING SUPREME FIXED CONDENSERS

Insert test lead in the No. 1 pin jack which is the common lead of all the capacities in the SUPREME. For the other leads of the various condensers, insert in the following pin jacks:

1MF — No. 8
1MF — No. 7
.002MFD — No. 6
.001MFD — No. 5

ACCESS TO 500,000-OHM VARIABLE RESISTOR

Is had by connecting one test lead to No. 1 pin jack. Connect the other to pin jack marked "500,000 ohms."

ACCESS TO 30-OHM RHEOSTAT

Is had by connecting one test lead to No. 1 pin jack. Connect the other test lead to pin jack marked "30 ohms."

FOR 400-A ONLY
INDUCTIVE OUTPUT TO SPEAKER

Plug speaker tips into pin jacks marked 1 and 2. Then run test lead from the plate of the last audio frequency tube to pin jack No. 3. Run test lead from B+ of the last stage of audio to pin jack No. 4.

ACCESS TO AUDIO TRANSFORMER

No. 1 pin jack is F of the transformer.
No. 2 pin jack is G of the transformer.
No. 3 pin jack is P of the transformer.
No. 4 pin jack is B of the transformer.

CONDENSER, CHOKE COIL OUTPUT TO SPEAKER

Run a test lead from the plate of the last audio tube to pin jack No. 1. Run test lead from B+ for the last audio tube to pin jack No. 2. Insert the speaker tip in pin jacks No. 8 and No. 9. Run a test lead from pin jack No. 10 to -A battery.

TESTING FIXED CONDENSERS

Run a test lead from pin jack No. 1 to one side of condenser under test and another test lead from pin jack No. 8 to the other side of object condenser. Now charge the SUPREME condenser and object condenser with 90-V. D. C. by touching the lead of the battery to the two sides. Do not leave this voltage on, but merely touch to the condenser, as this will charge it. Now insert the master plunger in the "10-V. D. C." Selector switch and note the kick. If there is no kick of the meter the object condenser is shorted and has discharged the SUPREME condenser.

RADIO TERMS AND DEFINITIONS

Air Condenser. — A condenser having air as its dielectric, together with a minimum of solid dielectric used as mechanical support.

Alternating Current. — Current which periodically reverses its direction of flow in a circuit.

Alternation. — One-half a complete cycle; that part of a cycle during which the current flow is in one direction.

Ampere. — The unit of electric current. One ampere flows in a D. C. circuit whose resistance is one ohm, when an electro-motive force of one volt is present in the circuit.

Ampere-Hour. — The product of the current in a circuit and the number of hours it flows. A unit of work or electrical energy.

Amplification Factor. — The ratio of the change of instantaneous voltage between filament and plate to a small change of instantaneous voltage between filament and grid for a given constant plate current.

Amplifier. — A device which modifies the effect of a local source of power in accordance with the variations of input power, and produces an increased output power.

Amplitude. — The maximum ordinate of an alternating current or voltage characteristics; the maximum value the current or voltage attains during a cycle.

Antenna. — A device for radiating or absorbing radio waves.

Antenna Resistance. — An effective resistance which is numerically equal to the ratio of the average power dissipated in the entire antenna circuit to the square of the effective current at the point of maximum current. Antenna resistance includes: Radiation Resistance; Ground Resistance; Radio-frequency resistance of conductors in antenna circuit and equivalent resistance of conductors in the antenna circuit; equivalent resistance due to corona, eddy currents, insulator leakage, dielectric loss, and so on.

Aperiodic Circuit. — An electric circuit in which a voltage impulse will produce transient current in one direction only. The word aperiodic means "without period," and the term is sometimes applied to antenna coupling devices or circuits designed to prevent antenna variations from affecting the synchronism of the tuned units of radios. Free oscillations are not possible in a strictly aperiodic circuit.

Atmospheric Absorption. — Diminishing of the amplitude of electromagnetic radiation due to absorptoin of energy by the atmosphere.

Attonuation, Radio. — The decrease, with distance from the radiation source, of the amplitude of the elecrtic and magnetic components constituting an electromagnetic wave.

Audibility. — A measure of the ratio of the audible reproducer current producing a signal in a reproducing device to that producing a barely audible signal.

Audio Frequencies. — The frequencies corresponding to normally audible sound waves. These lie below about 10,000 cycles per second.

By-Pass Condenser. — A condenser used to provide a path for alternating current around some circuit element through which current of high frequency cannot readily pass.

Capacitive Coupling. — The association of one circuit with another by means of capacity common or mutual to both.

Capacitive Reactance. — That part of the impedance which is due to the presence of capacity in the circuit.

Capacity. — The ratio of the quantity of electric charge in a condenser to the voltage across its terminals.

Cat-Whisker. — The fine wire making contact with a crystal detector.

Choke Coil. — A coil possessing great inductive reactance; used for preventing the flow of high frequency currents into or out of oscillating circuits.

Coil Antenna. — An antenna consisting of one or more complete turns of wire.

Coil, Supreme Radiator. — The oscillator coil used in the oscillator circuits of Supreme Radio Diagnometers. It is designed for a maximum radiation of radio-frequency signals and for providing a method of feed-back coupling for affording oscillation tests on the maximum number of types of radio receiving vacuum tubes. The coil for the Model 400-B is provided with a pick-up winding interposed between the primary and secondary windings. The pick-up coil terminals are available at two pin jacks on the base of the coil.

Condenser. — A device having capacity, consisting of an insulating material, which may be air, between two conducting plates or sets of plates.

Condenser Antenna. — An antenna consisting of two capacity areas. The lower capacity area may be the ground on a counterpoise.

Continuous Waves. — Continuous waves (abbreviated C. W.) are a succession of waves of constant amplitude and frequency.

Continuous Waves, Key-Modulated.—Continuous waves of which the amplitude or frequency is varied by the operation of a transmitting key or other circuit-breaking device.

Continuous Waves, Audio Frequency Modulated.—Continuous waves of which the amplitude or frequency is varied in a periodic manner at an audible frequency, as with the radiation of the Supreme Modulated Radiator when supplied with A. C. power, modulation being accomplished at the frequency of the power supply.

Counterpoise. — A system of wires or other conductors (not the ground) forming the lower plate of a condenser antenna.

Coupler. — An apparatus which is used to transfer radio-frequency power from one circuit to another by associating together portions of these circuits. Couplers are of the same types as the types of coupling; that is, inductive, capacitive, and resistive.

Current. — The rate of flow of electricity in a circuit.

Cycle. — A complete succession of events, during which the voltage or current in a circuit passes through all possible values. A complete set of positive and negative values of an alternating current.

Diagnometer, The Supreme Radio. — An instrument utilizing various circuit combinations with the necessary switching systems for testing of tubes and for the diagnosing of radio troubles by measuring electrical values with meters.

Detector. — That portion of the receiving apparatus which, connected to a circuit carrying currents of radio-frequency, and in conjunction with a self-contained or separate indicator, translates the radio-frequency power into a form suitable for operation of the indicator. This translation may be effected either by the conversion of the radio-frequency power or by means of the control of local power. The indicator may be a telephone receiver, relaying device, tape recorder, and so on.

Dielectric. — That portion of a condenser between the plates; it may be air or any non-conducting material.

Direct Coupling. — Association of two radio circuits by having an inductor, a condenser, or a resistor, common to both circuits.

Direct Current. — Current which flows always in the same direction in a circuit; uni-directional.

Direction Finder. — A radio receiving system which permits determination of the direction of the line of travel of received radio waves.

Directive Antenna. — One having the property of radiating radio waves in larger proportion along some directions than others.

Effective E. M. F. — In A. C. circuits, when the wave form of the voltage is sinusoidal, the Effective E. M. F. is 0.707 x maximum voltage occurring during the cycle.

Effective Height of Antenna. — The effective height of an antenna is a height somewhat less than the measured height, upon which the absorbing and radiating qualities of an antenna depend. This lessening of the apparent height is due to the presence of surrounding objects.

Electrolyte. — The active liquid in a battery or electrolytic rectifier.

Electron. — The smallest component of matter which has been discovered. Regarded as the ultimate particle of matter, carrying a negative electric charge.

Electron Tube Rectifier. — A device for rectifying an alternating current by utilizing electron flow between a hot cathode and a relatively cold anode in a vacuum.

Emission. — A term used in the literature pertaining to Supreme Radio Diagnometers signifying the normal plate current of a tube placed in one of the ''Tube Testing Sockets'' when the secondary circuit it shunted with the closed ''Stop Oscillation'' switch.

Ether. — A fictitious agency existing in space by means of which electromagnetic waves are propagated. The existence of the ether has been assumed for the purpose of aiding in the explanation of radiation phenomena.

Fading. — A variation or diminuition of the strength of received radio signals over prolonged, temporary or varying periods, caused by actual variation of wave intensity.

Farad. — The unit of capacity. A condenser which holds one coulomb of electricity having a difference of potential of one volt between its terminals has a capacity of one farad. The micro-farad, which is one-millionth of the farad, is the unit generally used in radio calculations.

Feed-Back, or Reaction Coupling. — Sometimes termed ''tickler'' coupling, and refers to the process by which a part of the output power of an amplifying device reacts upon the input circuit, thereby increasing the amplification.

Filter, Band Pass. — A combination of electric circuits which present low attenuation to alternating currents of all frequencies between certain limiting border frequencies and comparatively high attenuation to alternating currents of all frequencies below the low limiting border frequency or above the upper limiting border frequency.

Flat-Top Antenna. — An antenna having horizontal conductors at the top.

Forced Alternating Current. — A current having a frequency and wave form which are equal to the frequency and wave form of the impressed electromotive force.

Free Alternating Current. — A damped alternating current following a transient electromotive disturbance in a circuit, with no external E. M. F. acting.

Frequency. — The number of complete cycles or half the number of reversals per second of direction of current flow of a wave, or in a circuit. The units in use are the cycle and the kilocycle (one thousand cycles).

Full-Wave Rectifier. — A rectifier so arranged as to rectify and render available all successive half cycles of an alternating current.

Fundamental, Antenna. — The lowest frequency of free alternating current in an unloaded antenna; that is, an antenna with no series inductance or capacity.

Grid Leak Resistor. — A resistor, often termed a grid-leak, connected between the filament and the grid of a three-electrode tube used in association with a condenser to give the voltage between grid and filament a certain average negative value.

Ground Wire. — A conductive connection to the earth.

Harmonics. — Multiples of the fundamental frequency which are often set up in a circuti; the introduction of these introduces elements into speech sounds which cause distortion. Part of the electrical energy is lost in setting up these harmonics. Harmonics which are present in the original speech sounds, however, must be preserved so that the quality is not altered.

Henry. — The unit of induction. One millionth of a henry, called the microhenry, is commonly used in radio calculations.

Hetrodyne Reception. — A method of radio reception for continuous waves, employing the principle of reaction between locally-generated oscillations and incoming oscillations, resulting in a beat frequency which is the difference between the two separate frequencies.

Hydrometer. — An instrument for measuring the specific gravity of liquids, especially that of battery electrolytes.

Inductance. — A property of conductors and circuits by virtue of which opposing E. M. F.'s are induced in them or in other nearby circuits, due to the magnetic fields set up by the current cutting across these circuits.

Impedance. — Ratio of voltage to current in an alternating-current circuit. Impedance is a factor determining the magnitude of current flow in a circuit. The greater the impedance for a given voltage the smaller the current.

Inductive Coupling. — The association of one circuit with another by means of inductance common or mutual to both, more generally used to designate mutual inductance coupling.

Inductive Coupling, Direct. — The association of one circuit with another by means of self-inductance common to both circuits.

Inductive Reactance. — That part of the impedance which is due to the presence of inductance in the circuit.

Inductance. — That property of an electric circuit by virtue of which a varying current induces an E. M. F. in that circuit or in a neighboring circuit.

Inductor. — A conductor having inductance, usually a coil of wire.

Inverted L Antenna. — A flat-top antenna in which the lead-in is taken from one end of the horizontal portion.

Lead-In. — That portion of a transmitting or receiving antenna which serves to connect the larger portion of an antenna or the main elevated conductor to the transmitting or receiving set, or through tuning inductors or condenser to the ground connection or counterpoise system.

Lightning Arrester. — An instrument placed in antenna circuits to furnish an easy path to ground for lightning or other extremely high voltage discharges.

''Load Socket.'' — The Analyzing socket or sockets of Supreme Radio Diagnometers for accommodating radio tubes during analytical load tests.

Loading Coil. — An inductor used to decrease the resonance frequency of an antenna or other circuit.

Loop Antenna. — A coil antenna of a single turn.

Loud Speaker. — A device with or without special amplifying circuits, by means of which received sounds are made audible without the use of telephone receivers held to the ears.

Megohm. — One million ohms. The unit of high resistance.

Meter. — A unit of length, 39.37 inches. Often used to mean a measuring device.

Micro. — A prefix meaning one millionth part of the unit to which it is applied.

Milliampere. — One-thousandth of an ampere; convenient unit in measuring small currents.

Modulation. — Variation of amplitude of a radio-frequency current.

Mutual Inductance. — The inductive effect due to the proximity of two separate electrical circuits.

Ohm. — The unit of resistance. The resistance of a D. C. circuit when a current of one ampere flows under a difference of potential of one volt is one ohm.

Oscillation. — When this term is used in connection with the Modulated Radiator circuits of Supreme Radio Diagnometers it indicates the increase in plate current caused by the oscillatory condition of the Radiator circuits without the ''Stop Oscillation'' switch closed.

Parallel Resonance. — When a single lumped capacity and a single lumped inductance are connected in parallel between terminals to which an alternating E. M. F. is applied, and the inductance or capacity or frequency is varied, the condition or parallel resonance exists when the current supplied by the source is a minimum. Every part of every actual circuit possesses a certain amount of distributed capacity and inductance, and in practice complex arrangements of a considerable number of inductaces and capacities are often used. For this reason the assumption as to a single lumped capacity and a single lumped inductance made in the above two definitions are not strictly realized in practice, and the resonance conditions attained are a combination of series resonance and parallel resonance. This is particularly true in circuits of radio frequency in which the reactances due to leads and other parts of the circuit may be appreciable factors.

Period. — The time of a complete cycle of alternating current or voltage; equal to two alternations.

Plate Condenser Antenna. — A condenser antenna in which the capacity areas consist of wires or metal plates, both elevated well away from the ground.

Plate Current. — The current passing between the plate and the heated cathode in a three-electrode tube.

Potentiometer. — Also known as a ''voltage divider.'' A resistance used for obtaining adjustable voltages by utilizing the voltage drop in the resistance.

Pulsating Current. — A periodic current the average value of which is not zero. A pulsating current is the sum of an alternating and a direct current.

Radiation Resistance. — The ratio of the total power radiated by an antenna to the square of the effective current at the point of maximum current.

Radio Channels. — A band of wave lengths or frequencies of a width sufficient to permit of its use for radio communication without the radiation of subsidiary waves of more than a certain intensity at wave lengths of frequencies outside of such band.

Radio Frequencies. — The frequencies higher than those corresponding to normally audible sound waves.

Reactance. — That part of the impedance of a circuit due to the inductance and capacity in it.

Rectification. — Changing an alternating current into direct or pulsating current.

Rectifier. — A device for rectifying alternating currents.

Resistance. — The opposition offered to the flow of current in a circuit which manifests itself in the evolution of heat in the conductors.

Resistor. — A device having resistance, used to introduce resistance into a circuit.

Resistor, Supreme Protective. — A protective resistor prescribed for placement in series with one side of the A. C. line supply to the power transformer of Supreme Radio Diagnometers so as to protect apparatus connected to the power transformer against over-load current occasioned by possible shorted circuits. The prescribed resistor consists of (1) a regular 100-watt Mazda lamp, (2) a smaller-sized 100-watt Mazda Type T-8½ Medium Screw Base lamp such as manufactured by the Edison Lamp Works or General Electric Company, which may be ordered through agencies or representatives of these people at $2.00 each, or (3) a 100-ohm Ward Leonard Resistor with a medium screw base. Supreme Data Tables involving the use of the Power Plant are based on the use of either of the two 100-watt Mazda lamps.

Resistive Coupling. — The association of one circuit with another by means of resistance common to both.

Resonance. — That condition of an A. C. circuit under which maximum current flows for a given voltage. In a series circuit there is resonance when the inductive reactance is equal to the capacitive reactance.

Rheostat. — A resistor with a means for varying the resistance, to control the flow of current in the circuit in which the rheostat is connected.

Self-Inductance. — A property of wires and coils, due to the magnetic lines of force created by the current in the wire, cutting back on the wires and inducing an opposing E. M. F. in them.

Self-Hetrodyne. — A system of reception of continuous wave signals by the production of audio-frequency beats through the use of a device which is both a radio-frequency generator and a detector of the audio-frequency beat currents produced.

Series Resonance. — When a single lumped capacity and a single lumped inductance are connected in series between terminals to which an alternating E. M. F. is applied, nad the inductance or capacity or frequency is varied, the condition of series resonance and maximum current exists when the inductive reactance equals the capacitive reactance.

Static. — Static is conduction or charging current in the antenna system resulting from physical contact between the antenna and charged bodies or masses of gas.

Stopping Condenser. — A condenser used to provide direct-current insulation, but which permits alternating current to flow in the circuit.

Strays. — Electromagnetic field causing disturbances in radio reception other than those produced by the radio transmitting system or by alternating current induction from wire circuits. The term ''strays'' includes atmospheric disturbances and disturbances caused by electrical apparatus. A reduction of the effect of strays on radio reception increases the single-stray ratio.

T-Antenna. — A flat-top antenna in which the lead-in is taken from the center of the horizontal portion.

Third Winding. — A special winding incorporated in the audio transformer of the Model 400-B Supreme Radio Diagnometer primarily for inductively coupling the Supreme thermo-couple to potentials to be indicated on the one-milliampere movement of the Supreme D. C. voltmeter. This term is sometimes applied to the pick-up winding of the Model 400-B Radiator coil.

Three-Electrode Tube. — A combination of a heated cathode, a relatively cold anode, an a third electrode for controlling the current flowing between the other two electrodes, the whole contained within an enclosure evacuated to a low pressure or filled with a special gas.

Transformer. — A device consisting of one coil of wire placed in proximity with another, for the purpose of coupling two circuits together by virtue of the mutual inductance between the two coils. Also used for raising or lowering alternating voltages and currents. The coil connected to the source of power is called the **primary** and the other coil the **secondary.**

''Tube Testing Sockets.'' — The sockets used with the Modulated Radiator circuits, or with Rejuvenator circuits, of Supreme Radio Diagnometers for the rejuvenation of thoriated-filament tubes, and for accommodation of tubes to be tested or used in the oscillatory circuits of these instruments.

Volt. — The unit of Electromotive force. A potential of one volt exists when oue ampere of current is flowing through a resistance of one ohm.

Watt. — A unit of power, 1/746 of a horsepower; 1/1000 of a kilowatt. A D. C circuit carrying a current of one ampere with an E. M. F. of one volt can deliver one watt of power.

Wave Antenna. — A horizontal antenna the physical length of which is approximately equal to the length of signaling waves to be received, and which is so used as to be strongly directional.

Wave-Length. — The ratio of the velocity of propagation of electric waves to the frequency.

Wavemeter. — An instrument for measuring frequency and wave-length.

Wave-Trap. — A device used with a receiving set to improve its selectivity. A commonly used type is a parallel combination of a condenser and an inductor connected in series with the antenna, operating on the principles of parallel resonance.

X. — The designation of standard four-prong tube bases and sockets, usually preceded by another letter of the alphabet to designate the manufacturer of manufacturers of a particular tube.

Y. — The designation of standard five-prong tube bases and sockets, usually preceded by another letter of the alphabet to designate the manufacturer or manufacturers of a particular tube.

INPUT CIRCUIT TESTS

The input (pick-up) circuit of a radio usually requires the use of some method of testing other than that afforded by tube socket analysis. The high frequency characteristics of the pick-up circuit of a radio may be determined by its reaction to a generator of modulated radio frequency signals with the radio in operation.

The input circuit usually consists of the aerial and the ground or counterpoise system, or of a loop of large pick-up coil, or two or more capacity areas, or of a combination of any two of these systems, coupled to the grid circuit of the first tube of the radio. The continuity of a loop aerial may be determined by socket analysis where the loop circuit is directly coupled to the first radio tube, but it is sometimes found that loop aerials are capacitively coupled to the tube circuit, in which case the continuity of the pick-up loop cannot be determined by tube socket analysis. Where the pick-up circuit consists of an aerial and ground or counterpoise, no potential is applied between the two, and even where the antenna is connected directly to the grid of the first tube, an open or shorted pick-up circuit cannot be detected by the tube socket analysis.

The antenna of the radio being tested should conform as nearly as practicable to the specifications of the manufacturer of the radio on which it is to be used. A comparative test of the pick-up capabilities of the antenna may be had by tuning the radio to a generator of modulated radio frequency signals and then disconnecting the antenna. The signal strength should fall off when the antenna is disconnected, or a loud "clicking" should be emitted from the loud speaker when the aerial is disconnected and tapped on the antenna binding post of the radio. The absence of a strong "clicking," when this is done with the volume control of the radio at its normal setting, usually indicates an inefficient aerial circuit. The ground should be checked in a similar manner, although there should be a very perceptable drop, amounting to about 50% in audibility, when the ground is disconnected. If there is but slight change in the signal strength with the ground lead moved, new grounds should be tried out on the radio. A high resistance ground is a very common cause of low audibility.

In localities where one side of the alternating current supply system is grounded, the ground lead of the radio may be determined by connecting a lamp or A. C. voltmeter between the ground lead and the ungrounded side of the line. This is also an excellent means for determining whether or not the antenna is shorted to the ground lead. Lightning arrestors should always be checked for shorted electrodes. Stapling the antenna and ground leads together on the baseboard is a very common source of trouble with antenna-ground shorts. This method also affords a very convenient means for differentiating between the antenna and ground leads when it is not convenient to differentiate them by visual inspection. The service man should exercise precaution in using this method so as not to introduce a short circuit during test, thereby blowing out a house lighting fuse or causing other harm.

MEASURING UNKNOWN RESISTANCE WITH VOLTMETER AND BATTERY.

An unknown resistance may be calculated from measurements taken with a voltmeter and battery.

The following procedure should be followed in taking the measurement:

1. Connect the voltmeter across the battery and record the reading obtained.
2. Place the unknown resistance in series with the voltmeter and battery and record the reading taken.
3. Divide the first reading by the second reading, subtracting 1 from the result.
4. Multiply the last result by the internal resistance of the voltmeter for the scale used. The product obtained will be the value of the unknown resistance.

In a "1000-ohms-per-volt" voltmeter with 0/600/100/10 scales, the 600-scale will have a resistance of 600,000 ohms, the 100-scale 100,000 ohms, and the 10 scale will have 10,000 ohms.

Example: A voltmeter as described above is available with a used 45 volt "B" battery for measuring an unknown resistance. Use the 0/100 scale which has an internal resistance of 100,000 ohms. A reading of 30 volts is obtained across the battery, and a reading of 20 volts is obtained with the voltmeter, battery and unknown resistance in series with each other. Then,

$$30 \div 20 = 1\tfrac{1}{2}$$
$$1\tfrac{1}{2} - 1 = \tfrac{1}{2}$$
$$\tfrac{1}{2} \times 100{,}000 = 50{,}000 \text{ ohms}$$

A TEST OF AUDIO TRANSFORMERS

Transformers may be tested by momentarily connecting a battery across the primary, with a votlmeter across the secondary. If a kick is indicated on the voltmeter, the windings are neither open or short circuited.

Shorted windings will decrease the kick.

REPAIR POLICY.

While the finest quality meters and other equipment are used, and the utmost care is exercised in the construction of SUPREME DIAGNOMETERS, and everything possible is done to avoid the possibility of needed repairs, service may be required at times, due to accident, misuse, or other causes beyond the control of the manufacturer. A glance at the interior of the SUPREME DIAGNOMETER will reveal the exceptionally high grade construction that is employed in the production of this instrument, and it will be recognized that everything possible has been done to eliminate possible break-downs.

No electrical instrument, however, has yet been devised that is absolutely "fool-proof," or that will not fail occasionally under certain conditions. The type of construction employed in the SUPREME DIAGNOMETER has, however, reduced the danger of damage or failure to the absolute minimum.

The manufacturers of SUPREME DIAGNOMETERS realize what a serious matter it is for the service man to be deprived of his instrument for even a very short time, and when accidents or break-downs do occur, repairs are made with the least possible delay.

The manufacturers will not be responsible for damage or subsequent break-down to instruments repaired outside of their factory. Such repairs can usually be satisfactorily made by competent service men, but the manufacturers must necessarily protect themselves against incompetency and therefore will not assume any responsibility for the possible detrimental effects of repairs made or attempted by others.

In the event of damage to any of the meters, repairs thereto can be made by any of the authorized Weston or Jewell service stations, depending on the make. Such service stations are available in most of the larger cities and are capable of making such repairs with a minimum of delay.

Where such service stations are not available, or at the owner's option, upon receipt of advice either by mail or by prepaid telegram, the Supreme Instruments Corporation will promptly forward a replacement meter by express. Such replacement meter will be shipped C.O.D. and upon receipt of the damaged meter a refund of the C.O.D. charges will be made, less the cost of repairing the returned meter. This cost is usually of nominal proportions. If the break-down in the meter is due to some defect in construction or material the full amount of the C.O.D. charges will be refunded.

The foregoing plan has been placed in effect largely to minimize delay. If the user prefers, he may return the damaged meter, which will be repaired as promptly as possible and the return will be made C.O.D. for the repair charges only, unless the damage is due to defect in construction or material, in which event there will be no charge.

The same policy will prevail as to all other parts contained in the equipment that can be installed or replaced by the user.

If the complete instrument is returned, same will be repaired and returned with the least possible delay. The importance of keeping SUPREME DIAGNOMETERS in constant operation is realized and every effort will be made to minimize inconvenience and delay.

All repairs and parts will be shipped C.O.D. This policy is necessary as charges made cover actual cost, exclusive of overhead, and the additional expense of carrying accounts for such items could not be incurred without increasing the charges made.

If reasonable care is exercised in handling the SUPREME DIAGNOMETER, if the instrument is not abused and is operated intelligently and in accord with instructions, there is small danger of it ever requiring any adjustment or repair and such care and handling is the best assurance that can be given against the annoyance of break-downs.

Do not send any instrument for repair or replacement without written or prepaid telegraphic notice. All communications relating to service must be addressed to:

Service Department,

SUPREME INSTRUMENTS CORPORATION,

Greenwood, Mississippi.

Please confine such communications to matters of repair and service, addressing communications relating to other subjects to the proper department.

Weston Meter Service.—Following is a list of authorized repair stations for Weston meters located at various points throughout the United States. These concerns, in our opinion, are all well qualified to handle repairs on Weston instruments and are furnished with Weston parts for repairs as their requirements demand:

Weston Electrical Instrument Corp.
Newark, N. J.

A. S. Mancib,
26 Wallace St.
Somerville, Mass.

A. Honeychurch,
682 Mission St.
San Francisco, Calif.

Instrument Service Laboratories,
3645 McRee Ave.
St. Louis, Mo.

Standard Laboratories (L. H. Moulton)
141 W. Austin Ave.
Chicago, Ill.

W. E. Todd,
4400 Thomas Ave.
Minneapolis, Minn.

Nieson Electrical Laboratories,
103 Lafayette St.
New York, N. Y.

J. Sayre Christie,
616 St. Clair Ave.
Cleveland, Ohio.

Jewell Meter Service. — The following are the names of the concerns who maintain laboratories that are capable of repairing Jewell instruments:

Mr. John M. Forshay,
52 Vesey St.
New York City, N. Y.

Standard Laboratories,
1334 Oak St.
Kansas City, Mo.

Mr. C. F. Henderson,
Call Building,
San Francisco, Calif.

Mr. E. W. Playford,
1130 Union Ave.
Montreal, Quebec, Can.

D. M. Fraser, Ltd.
24 Adelaide St. E.
Toronto, Ont., Can.

Stromberg-Carlson (Australasia), Ltd.
72 William St.
Sydney, Australia.

SUPREME SERVICE LEAGUE.

Membership in the Supreme Service League is open to all purchasers of SUPREME DIAGNOMETERS. As it is the purpose of this co-operative effort to develop a higher type of radio servicing and build up a prestige for its membership, such tests and examinations will be required, of those desiring to join, as will establish their qualifications for rendering the character of service that the organization typifies. In the event the applicant is at first unable to pass such tests and examination, instructions and assistance will be rendered that will enable him, by close application and study, to attain the standard required.

The Supreme Service League is dedicated to the development of greater efficiency in radio servicing and acquainting the public with the more efficient and dependable service that is rendered by its members; thereby enabling the latter to reap the financial reward to which they are justly entitled.

In the purchase of the SUPREME DIAGNOMETER there is placed in the hands of the service man the best mechanical means available to assist him in rendering truly efficient service. It is the purpose of the League, through the dissemination of technical information, and exchange of ideas, to fully equip the individual member with a knowledge of radio that will enable him to handle the problems entrusted to his care in a manner that will command the respect and admiration of his patrons.

Having thus equipped the individual member with the means of rendering truly efficient service, it then becomes the function of the League, through the medium of judicious advertising and co-operative effort, to acquaint the radio public with the ideals of the Supreme Service League and the character of service that can be obtained from its members. The cumulative effect of such advertising and effort is certain to build for each individual member, a substantial and ever growing business.

As an aid to the establishment of the prestige of the Supreme Service League, the Supreme Instruments Corporation will embody in all their national advertising an appeal to the radio public to patronize members of the League. This advertising appeal will be well prepared and will constitute a sound argument for patronizing members of the League in preference to unknown, unproved, less thorough and less scientific servicing. This advertising has already created tremendous demand for Supreme League Service, and the demand is growing daily.

Upon election to membership, the individual member will be supplied without cost, the following:

1—An attractive button, indicating membership in the Supreme Service League.

2—An engraved membership card, bearing the name of the member and his membership number.

3—100 Supreme Service League folders of very attractive design, printed in two colors, which are designed for public distribution by the individual member. These explain the ideals of the Supreme Service League, the superior and more dependable service that can be obtained from League members, and constitute a well presented appeal that is certain to build business for the member, not only in servicing, but in other lines in which he may be interested. Provision is made on the back cover for the stamping or imprinting of the name of the individual member, together with such other advertising matter as he may wish to employ.

4—A very attractive decalcamania or window sign in three colors, displaying the Supreme Service League emblem with the slogan, "A Guarantee of Efficient Service." The display of this emblem, on store or shop window, associates such business with the national advertising that is being done and will help build business.

Additional decalcamanias or window signs and Supreme Service League folders will be furnished members at a nominal cost and the use of this advertising media will prove of great value. All memberships are individual so that duplicate cards and buttons cannot be issued.

As an additional advertising aid, electrotypes are available to members for use on stationery; other advertising matter and well prepared advertisements are available for use in local papers, programs, etc. Designs showing this electrotype matter in detail are supplied each member or will be mailed upon request. A very nominal charge will be made for these electrotypes, to cover only the handling charge, the price ranging from 30c to 50c. The material for these electrotypes has been most carefully worked out by advertising experts who know how to prepare advertising; this matter presents a most attractive appearance and its proper use is certain to produce splendid results.

A monthly publication which will be called the "Diagnotrician" will be mailed to each member for a period of one year without charge. This publication will contain technical and servicing articles, written by outstanding authorities in the radio field. There will be a query column devoted to answering the many questions, and solving the numerous problems constantly confronting the service man. Another department will be devoted to an exchange of ideas between members, the purpose being that through the exchange of such information to place at the disposal of all members the knowledge gained by each individual. **"We profit most by helping each other."**

Other plans will be worked out, from time to time, to further the interest of members of the Supreme Service League, both in a financial way and through the dissemination of knowledge and information that will enable each member to render better service. With the sincere and whole-hearted co-operation between members of the League, and with each conforming to the ideals of the League in his daily work, a prestige for the organization will be created that will enable all members to reap substantial material rewards from their participation.

CORRESPONDENCE INSTRUCTIONS.

In order to facilitate the handling of correspondence and prevent possible delays, kindly observe the following instructions:

When several subjects are discussed in the same letter, it necessitates passing such letter from one department to another until all of the necessary information has been gathered. This, naturally, causes a great deal of additional work, possibly some features escaping attention, and results in more or less delay. It is requested, therefore, that letters be confined to one subject and addressed to the proper department. Such letters need not be mailed in separate envelopes, but should be written on separate sheets, and marked for the attention of the department concerned.

1—All correspondence relating to statements, maturity of obligations, status of accounts and all similar matters should be addressed to Accounting & Financing Department.

2—All matters pertaining to sales should be addressed to Sales Department.

3—All matters pertaining to repairs or service on instruments or instructions for their operation should be addressed to Service Department.

4—All matters pertaining to technical problems, advertising aids, decalcamanias, lapel buttons, membership cards and other matters relating to the Supreme Service League should be addressed to Secretary, Supreme Service League.

SPECIAL BINDERS.

This manual is printed on a standard size sheet with standard punching such as is employed very generally in the technical field so that other matter, in which the user may be interested, can be inserted in this binder.

The highest quality paper binder is used for this manual, but if the user prefers a leather or better quality binder, same can be purchased at almost any stationery store, as the size and punching employed is standard and is in general use.

If desired we can supply a good quality fabrikoid six ring binder at 80c each, representing actual cost and giving the individual user the benefit of purchases made in large quantities.

SUPREME ACCESSORY PRICE LIST

This price list is intended to cover the cost of replacing items initially furnished with SUPREME Radio Diagnometers, and to cover the cost of additional accessories not initially furnished. Postage will be prepaid on cash orders for these items; C. O. D. orders will be sent postage collect. Prices subject to change without notice.

ITEM	PRICE
Adapters, Analyzing, Nos. 1, 2, and 3, each	$ .60
Adapters, Neutralizing, X to X, each	1.00
Adapters, Neutralizing, Y to Y, each	1.00
Adapters, Plug, for Model 400-B	*Note
Adapters, Synchronizing, each	1.50
Binders, Fabrikoid, each	.80
Charts, Supreme Power Plant—Analyzing, Per pad of 50	.50
Coil, Oscillator, each	2.50
Cuts, Newspaper Advertising, No. 1, each	.50
No. 2, each	.35
No. 3, each	.30
No. 4, each	.45
Cuts, Stationery, etc., S-10, S-11, S-12, S-13, and S-14, each	.30
Decalcomanias, Supreme Service League, each	.30
"DIAGNOTRICIAN," Single copy, each	.20
Yearly subscription, 12 copies	1.50
Folders, Supreme Service League:	
Dealer's space blank, per 100	.75
Dealers' space printed to order, per 1000	7.50
Milliammeters, Weston, 2-scale	8.50
Probes, Test, Insulated Handles,	
With pin plug, each	.25
With spring clip, each	.25
Resistor, Protective, Ward-Leonard, 100-ohm, each	1.00
Screw Drivers, Fibre, each	*Note
Wrenches, Fibre, each	*Note

*Note.—Items listed without corresponding prices are not available at this printing. These prices will be included in a revised price list in a subsequent issue of "Diagnotrician."

INDEX

See, also Radio Terms and Definitions, and other Data Sheets following Chapter VI.

INDEX—(Continued)