THE SUPREME INSTRUMENTS CORPORATION

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

who, backed by many years of experience, in radio ser-
vicing 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 Di-
agnometer and by service men generally.

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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 increased 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 thus far further popularizing radio. Unquestionably, this can best be achieved through the enthusiastic satisfaction of present users, which depends entirely upon obtaining for them the maximum and most plausible 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 direction of the latter, and the growth and operation 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. Herefore, 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 minor center combinations, of very limited range and capacity, have, from time to time, been offered by manufacturers, predominantly 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, it is not only necessary 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 plausible results from the receiving sets in use, contribute its full share to the growth of the radio industry. Its sole functi-
tion is to meet the needs of radio service. All the thought and attention of its capable engineering and research departments are centered in this one problem and it is not surprising, therefore, that, in the comparatively brief span of its existence, its problems have come to be recognized as affording the only practical, economical means of making these thorough and scientific analyses that form the basis of truly efficient radio service.
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DATA—Tube Testing, Tuner, Miscellaneous Parts, Supreme Service League, Repair Policy, Etc.
SUPREME DIAGNOSTICMETERS 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 DIAGNOSTICMETER 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 combination generally known as "Red-Testers." While, naturally, it provides all the readings that can be made by such testers, it goes very much further, 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 appliance 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 soon find new uses for it; in fact, it is difficult to enumerate any problem or situation in radio that this apparatus cannot be quickly and satisfactorily met with this marvelous equipment.

Obviously, it is not intended to include within a service manual of this type a complete treatise on radio service, although a source of errors has always been made to provide such 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 testing 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 DIAGNOSTICMETER 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 can create. It must be borne in mind, however, that as 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 acquire 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 DIAGNOSTERS, 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 DIAGNOSTERS 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 wages more in keeping with the technical knowledge his occupation demands and at the same time the cost of each 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 DIAGNOSTERS 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 each purchase makes the beginning of a mutual interest and it is their desire to develop such effective cooperation with their users as will promote their respective wellbeing 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 devoted to furthering radio every service man is offered an opportunity, through co-operative effort, to build a reputation on his own field that will pay big dividends in a financial way.

This manner is present in the hope that it will be of material aid to the service man. Its compilation has been no easy task and it 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 maxi-
num growth of the radio industry. It may be truthfully
said that the future of radio is in the hands of the ser-
vice man and depends upon the quality of service pro-
vided.

The manufacturers of SUPREME DIASTROMETERS
feel that the success of every individual user of their in-
struments is their interest, and assurance is given that
they will strive extremely to see that maximum results
are obtained from the equipment they sell and that they
will lend every possible aid in the development and pro-
motion of the business interests of their users.
THE SUPREME DIAGNOSTICOMETER.

Chapter 1.

GENERAL DESCRIPTION. — The SUPREME DIAGNOSTEMETER 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 take every conceivable test that might be encountered in radio servicing. It is equipped with an ammeters and milliammeters and voltimeters with a system of multi-contact switches which provides a means for testing the various types of tubes and assuring all desired electrical values in the operation of A.C. and D.C. radio. Contained within the instrument as part of the power plant is a step-down transformer with a tapped secondary for utilizing the ordinary house lighting circuit to provide the various rulings required for testing the numerous types of tubes. The set is also provided with a tube rejuvenator operating from the same step-down transformer, providing a means for rejuvenating tubes of the thoriated-tungsten type. Current is supplied by this transformer for an oscillation, giving the "Oscillation test" on various types of tubes under the actual operating conditions, independent of a radio. This oscillation, modulated by the alternating current, provides a signal for the aligning of condensers and calibration and neutralizing purposes. Connecting cables, plugs, tube sockets and adaptors are provided for facilitating the testing of the various tubes and circuits. Non-Thermonic oscillator tubes may be tested by commencing the output with the normal for the type in question.

Frequency Tests. — A.C. tables and data contained herein are based on the use of 66 cycle A.C. current, but operators of specialty-built 22-cycle Diagnosticometers 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 components 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 enable 300,000 cycles per second (in kilocycles) to obtain the approximate wave length (in meters); as the velocity of radio waves is the same as that of light about 300,000,000 meters (186,000 miles) per second, and this velocity constant in the propagation of the frequency of about 1 kilocycle and wave length (in meters).

Electrical Projection. — The 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 resistance within their scale limit, current measuring meters, especially milliammeters, are generally at the mercy of the operator of the apparatus. SUPREME DIAGNOSTERS are equipped with our finest service meters obtainable, and these meters are surround
ed with every possible protection consistent with their proper performance. The problem of protecting the SUPREME milliammeter has been given most study than any other problem involved in the manufacture of SUPREME DIAGNOSTERS.

When the SUPREME DIAGNOSTER is powered from the alternating current line, protection to the milliammeter and other sensitive apparatus against load current, such as might be encumbered 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 of the alternating current supplies 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 DIAGNOSTER for the various tests it is designed to accomplish. This current limitation can be provided either with a 100-watt Manda lamp or a 100 ohm resistor at the option of the operator. The 100-watt Manda 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 Manda lamp, from which there will be a slight variation in event the 200-ohm resistor is used.

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

Either of these prescribed resistors will protect the milliammeter and circuits only when the SUPREME DIAGNOSTER is supplied with power from the a.c. line. When power is supplied from external batteries, there is no protection to the milliammeter against shorted tube, which is one of the reasons for recommending that the SUPREME DIAGNOSTER be accomplished with the tube testing circuit supplied from the alternating current line.

A protective relay which aborts the meter when the current reaches 16 milliamps is embodied in the Model 501-B to protect the milliammeter against shorted tubes. This relay is included in additional protection and while it will doubtless prevent a high current from passing, it cannot be guaranteed and it is therefore recommended that testing with power supplied from ex-
ternal batteries be recharged to only when A.C current is not available.

When the SUPREME DIAMONETERS alternating current converter circuit 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 ground- ed or connected to either side of any alternating current supply system. This will prevent the possibility of shorting an alternating current line potential into the instru- ment apparatus around the protective resistor. Failure to diligently observe this simple precaution may cause serious damage to the apparatus.

Switching Systems. — SUPREME DIAMONETERS have multipole jack switches designed to be operated with master plunger. 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 plunger, one with a special ground-stub for use in the double-action rejuvenator switches, and three with straight stubs for operating all other jack switches.

Some of the earlier SUPREME DIAMONETERS mod- els were designed with push button switches, and these models do not require master plunger. 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 de- pressed.

Before making any test one should be sure that all switches are open. When making a test only the neces- sary switches should be closed. All switches should be opened after every test. This is an instrument of multi-circuits with multi-wattage, 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 to order not to subject the apparatus to unnecessary elec- trical strain.

The Use of Multi-scale Meters. — Multi-scale meters are employed in SUPREME DIAMONETERS 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 easily. They are general-scale meters.

The simple principles involved are applicable to all multi-scale meters. In this section a typical three-scale voltmeter with 9-10, 0.65, and 9-900 scale, having corre- sponding 10, 30, and 100ohm governing switches will be discussed.

Changing 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, 30 volts giving a full-scale deflection, 1 volt a half-scale deflection, and so on. In other words, the "30" to "15" graduations, only, are used, ignoring all other graduations on the meter dial while using the meter with the "20 scale" switch closed.

Closing the "20 scale" switch automatically brings a corresponding meter resistance into the circuit involved, the value of which is such that whatever voltage, under 20 volts, is applied to the meter circuit will deflect the meter needle a distance over the meter dial in proportion to the voltage applied, 80 volts giving a full-scale deflection, 25 volts a half-scale deflection, and so on. In other words, the "80" to "30" graduations, only, are used, ignoring all other graduations on the meter dial while using the meter with the "20 scale" switch closed.

Similarly, the "30" to "15" graduations, only, are observed when applying voltages under 300 volts through the "300 scale" switch.

In using the meters of the SUPREME DIAGNOS- TIC METER, 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 re- sistance is desirable so that it may practically stop the flow of current and thus minimize the effect of the voltage or current actually acting upon the terminals. A poor voltmeter of low resistance would allow the meter to pass through itself that load which would make the voltage in the measured circuit far below the value which it would have been 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 balance permitted in precision meters, which is based on full-scale deflection. In voltmeters where current is limit, 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 remem- bered 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 oper- ation of the meter, the greater the movement of the meter will be. Thus, when using a current which is much lower than the current at which the meter will deflect, the deflection will be much less than when using a current which is considerably higher than the current required to deflect the meter.

A general rule, easy for the less technical man to re- member, is never to use any meter for testing a potential that the equipment was not designed to handle without having the connection of the proper resistance to make the primary circuit of the potential to be measured the device to be measured as nearly as possible the potential to be measured on a meter, the primary circuit of which is at the maximum safe current voltage you can use on a voltmeter, 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.
THE SUPREME RADIO MANUAL

Chapter II.

SPECIAL SUPREME FEATURES

The Major Features. — The adaptability of the SUPREME DIAGNOSTER 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 Diagnoster Servicing Features:

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

The Power Plant. — The Power Plant consists of the A. G. Committee Grid with the precessed protective resistor and series socket, the A.G. Line switch, a radio-frequency by-passing unit, the 110-volt 60-cycle primary winding and the 15, 25, 50, 75, 150, and 300-volt taps of the secondary winding of a power transformer, with a multi-contact selector switch for connecting any one of these secondary voltages to the nearest contacts of the "Tube Testing Terminals," automatically combing the transformer windings into a specially arranged auto-transformer and completing the plate and grid circuits of the "Tube Testing Terminals" 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 in which is described below in the Modulated Radiator. The Supreme Power Plant is not adaptable, however, for applying power to operate any radio. The A.G. Line switch may be closed whenever it is desired to observe the voltage variations during any test based on a specified line voltage. Only one of the secondary voltage switches should be closed simultaneously in the Power Plant switching system, or more than one channel switch will open circuit part of the secondary winding, causing in inaccurate test and possible harm to the power transformer.

The alternating current supply cord with its seven protective resistor socket should not be subjected to such
use and handling as might damage the initiation of its connections at the series socket, which might result in shunting the protective resistor and rendering it operative. It is recommended that Supreme Dignitaries subject the operation of the protective resistor to a test before inserting the oscillating coil in the pin jacks and before closing any switches other than the "A.C. Line" switch. A simple test is to connect the Supreme Dignitaries modulated current supply, using the regular series socket supply cord with the protective resistor inserted and its socket connections made. The current, which may 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 considered its socket. The A.C. voltmeter should then indicate the alternating current supply voltage, and its operation may then proceed with any Power Plant test.

The Supreme Modulated Radiator—The oscillator feature of the Supreme Dignitaries is designed to meet the needs of radio men for a portable oscillator capable of providing oscillating circuits of practically all types of tones, as well as furnishing modulated radio-frequency signals for the synchronizing and calibration of timing 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 modulator and the "Tube Testing Section," is completed by placing the Radiator coil in its prepared position. This coil should not be used in any test 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;
2. Batteries through external leads.

When the oscillator is removed from the A.C. Line, modulation at the frequency of the applied potential is accomplished in the modulated harmonics. If all of the potentials supplied to the oscillator circuit are direct (i.e. rectified) (120 volt, 60 cycle, A.C. with balanced "click" modulation may be had by unrectification of the oscillator circuit), the current across the grid or secondary winding of the oscillator coil and across the grid resistor, is alternately positive and negative.

The oscillator is in the common plate circuit of the circuit, and the modulated harmonics indicate the self rectified plate current of any tube placed in either of these circuits. This current reading may include additional plate current drain induced by the feed-back of the oscillator.
circuit. Positive protection to this meter from over-load current is afforded when the Supreme Diaphragm is supplied from the Power Plant utilizing the preservative protective resistor in series with the A. C. Line Connecter Cord. This method of supply should always be utilized whenever alternating current supply, of the potential and frequency for which the Supreme Diaphragm 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 oscilla-
tion switch and gradually reducing the reading obtained with the switch closed from the reading obtained with the switch open. This difference is proportional to the audi-
tive strength of the radio-frequency harmonic signals radi-
ed from the Modulated Diaphragm. Any tones desired with elements for alternating or direct current testing, if capable of oscillating, will perform satisfactorily in the Modulated Diaphragn. With the Modulated Diaphragm in operation in close proximity to a receiver, with a tube in one of the "Tube Testing Bases," allowing good oscilla-
tion on the milliammeter, insensitivity to tone in the radio-
ator switches with the knobs would facilitate something de-
termining 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 Diaphragm: 10-24, 71-4, 50, 45, 26, 190, 17, 014, 45, 45, 27.

The Power Plant method of supplying power to the Modulated Diaphragm for generating oscillatory current 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 local oscillator band for other purposes. Using the Modulated Diaphragm 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 tune-
ing dial, or for checking dial 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 Diaphragm may be provided with a better oscillator tube, moved closer to the radio, or both.

The Supreme Resonance Indicator. — The Meter Reso-
nance Indicator utilizes the Modulated Diaphragm for setting up radio-frequency signals to which a radio, the tuning condenser of which is to be synchronized, may be tuned. The A. C. voltmeter of any model of the Su-
preme Diaphragm may be connected to the inductor output terminals of the radio so as to measure the after-
saling 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 condenser, 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 Bemis-Miller Radiator signal the maximum meter reading will be attained.

In addition to the foregoing method, the Model 400-B Supreme Symphonizer incorporates a special thermo-couple water-heating device, so connected 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 indirectly 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 Symphonizer, collectively termed the Analyzer, consist of the Analyzer plug and its connecting multi-wire cable with the plate connections, in addition to the somnator-micrometer 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 end 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 Symphonizer.

Closing the "B. C. 11" switch connects the Analyzer with the Bemis-Miller for the simultaneous examination of the two sets of contacts which can be connected in the Supreme Symphonizer tube sockets.

The Supreme Rejuvenator.— The Rejuvenator utilizes the primary winding and the 3, 5, 10, and 15-miliampere stages of the power transformer which, for this operation, is not connected as an auto-transformer; and includes the boost and the double action, multi-contact Rejuvenator switches, either of which is fully closed by the main "closed" position, with plate-current flowing in the usual direction, and in the "closed" position is applied the desired "aging" voltage to the "Tube Testing Socket."
The 10.3 and 7.3 volts are the “shutting” and “ag-
line” voltages respectively, controlled by the 5-volt Re-
juvenator switch, and the 10.0 and 7.5 are the cor-
responding voltages of the 5-volt Rejuvenator switch. The-
 latter is brought into action with the Rejuvenator unless it is desired to observe the A. C. Line voltage during re-
juvenation.

The Rejuvenator may be combined with the Analyzer by closing the “A. C. Filter” switch for the simulaneous re-
juvination test to be taken in a bank of sockets. The chosen condition of which an encoder in parallel, as is an ordinary D. C. Filter, is the type of radio with its ground and power supply leads disconnected and all ele-
mental resistances disconnected. The Rejuvenator-Ana-
lyzer combination must not be used for the rejuvenation of tubes in radios designed for A. C. only, because, if used, these radios usually employ center-tapped resistances across the element supply leads which might be damaged by the rejuvenation potentials.

The Supreme Continuity Tester. — The Direct (p.-
ality) Continuity test is accomplished by all the-
ing the Power Plate to supply element and plate potentials to an 91, or other heavy plate current type of tube, in one of the tube testing sockets, with the se-
cillator coil removed and two insulated handle test leads connected to the two plates (left) pin jacks ordinarily occupied by the coil. The milliammeter, 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.
Tube testing with the SUPREME DIAGONOMETER is accomplished by subjecting the tube to an oscillation test in the oscillatory circuit of the SUPREME Modu-
lated Radiator, which should preferably be powered through the SUPREME power transformer supplying the test circuit. The vacuum tube is mounted in the SUPREME DIAGNO-
METER in a manner similar to that described in the accompanying instructions. This method provides for oscillation of the filament at the constant values of voltage, capacity and resistance with quiescent electrical values of fixed relation to the power supply. The test method gives accurate indication of simple tube characteristics for comparing the merits of tubes and the milliampere characteristics of the SUPREME DIAGON-
METER is fully protected against shorted tubes by either of the protection resistors. Directing the test volts by whatever method are used 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 tube does not usually enter into a detailed study of tube characteristics curves, involving the relations between plate impedance, mutual conductance, and amplification factors, but he knows that a small change in grid volt-
age or grid bias should affect a large change in plate cur-
rent, and that a good tube should respond in this man-
er over a wide range of grid voltage variation. Tubo-
checkers other than the SUPREME provide only one grid change offering two plate current readings of a tube under test.

The SUPREME oscillation test utilizes the principle of the feed-back from plate to grid, as used in the feedback oscillatory circuits, which are, in any tube, a great extent governed by all of the inherent characteristics of a tube, including element capacity and extent of diathermic extension. When a tube is placed in an oscillatory cir-
cuit the amplification of plate current induced back into plate current amplitude, which in turn causes still greater plate current amplitude. This building-up process con-
tinues until the grid builds up an effective voltage for self-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 com-
parative merit of tubes. This test will also detect der-
ractive 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 dif-

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forest characteristics under an oscilloscope test. This feature clearly establishes the value of the oscilloscope test.

Supreme Companion Tube Test: — Included in this manual are tables compiled from plate curves and plate oscilation current readings obtained from test tubes of known stand and average characteristics with the SUPREMI Modified Radiator supplied with the line voltage as indicated in the tables. These tables may be used as standards of comparison, the service man determining for himself what percentage of variation from these standards he should tolerate for the class of operating he is undertaking. It should be remembered, however, that when the commission 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 illustrated National 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 a radio frequency and in the intermediate frequency stages of a radio should be taken 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 for more sensitive in an oscillating circuit, and in addition, an improved radio amplitude or detector tube. Detector tubes should allow good and average readings with average or slightly below average tubes are suitable for radio 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 Modern Type A. For those tubes emission readings are given in the tables. Oscillation tests can be made with Model 499-A.

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

Real-Plate Tubes. — The 82A type of tubes has a moderate plate resistance. It is an excellent oscillator.
and should be preferred for use in the SUPREME Modu-
lated Radiator when it is desired to broadcast modulated
radio frequency harmonics for test purposes. The type 72 is
practically the same as the 72-A, except that the 72 has a 
one-half ampere element. The 72-A tube is an
excellent detector in radials which have a detector grid
return to positive filament.

Five-Element General Purpose Tubes. — The 727 tube
should be subjected to careful tests as "Flashers" and 
"Oxygen generators" must be discarded if a radio util-
izing these tubes is to function properly. Oxygen within
the tube is indicated by a purple glow during opera-
tion.

Heavy Current Tubes. — In testing these tubes 3 is
advisable to throw the milliammeter 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 cur-
rent output than normal. If this does not occur immedi-
ately 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 table. Tests of these tubes
should be of short duration as it is to disturb
the filament structure. When testing these tubes it will
be noticed that the output at first increases 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 at the test bench for these.
It is believed the output voltage under load with these
tubes in the devices in which they are used. Low
or intermittent voltage indicates a weak tube, provid-
ed, of course, the device in which it is used is not de-
fective. The output voltage can be determined with ex-
ternal connecting leads through the SUPREME D. C.
voltmeter grid for test analyzers may be used for read-
ing the output voltage from the last audio socket of a
radio supplied by the Helium tube rectifier device.

Tungsten Bulbs. — These are low voltage rectifiers and the
only test necessary is to connect the SUPREME am
meter 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 bat-
ter levels are connected to the charger. If the tube is old or weak, it will grow brighter when the charging begins.

Voltage Regulator. A 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 150 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 proper circuit of the plate transformer. This is done to prevent operation of the device unless the tube is in place. It is possible that sometime 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 DIAGNOSTIC sockets. Three tubes sometimes become noisy due to a high frequency are, the tested gas flows across the elements, which will usually start with a slow "pfft," gradually increasing to a high note.

Ballast Tubes. — The 76 or 96 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 D. O. voltmeter and should be the difference between 60 volts and the line voltage. In other words, the tube keeps the voltage across the primary of the transformer at approximately 60 volts regardless of the line voltage. The 76 and 96 types differ only in "operating current," the 76 being rated at 0.75 amperes and the 96 being rated at 1.75 amperes.

Noisy Tubes. — Microphone noise is caused by vibration of some of the parts in the tube itself or in the audio amplifier tubes. The designer is the usual offender in this respect. The grid, plate, or filament of the offending tube may be accidentally bent so that the tip of the quartz waves from the loud speaker is in close contact with the steel wire or filament. The tube starts to vibrate and makes a buzzing sound. The tube may be divided into three stages: (1) the plate current is increased, (2) the plate current is decreased, and (3) the plate current is constant. The plate current in stage (3) is the current which the tube is designed to carry for a given grid voltage. If 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 carbon microphones or carbon tube bases. The noise may further be increased by moving the receiver into a different position with relation to the receiver. If it is impossible to use carbon microphones, the microphone de-
Frets may be prevented by the use of various "Howl Ar-
restors" which are devices on the market for the pur-
goal of abolishing the tube against rapid vibration. It is
not necessary that the tube and its elements remain per-
fectly stiff, 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 hamster types of
these and the offending tube can best be detected by a
process of elimination in actual operation in a radio.

Screen Grid Tubes. "32 and "34 Types. These tubes
cannot be tested with the SUPREME MODULATED Megger,
but one of the SUPREME Diodeometers Model prior to
the Model 460-B are adaptable for complete anal-
ytical or continuity tests on radio sockets utilizing
screen grid tubes. Such tests can, however, be made with
the Model 460-B.

Overhead heater type tubes. The Model 460-B SU-
PREME DIODEOMETER provides both resistor-power
plant and analytical tests on tubes, the diode terminals
of which are connected at the top. Models 96A, 160-A
and 460-A do not permit complete analytical tests on ra-
dio tubes using these tests.

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

"The following types of tubes have thoriated-tungsten
dlaments and may be rectified when necessary: C-259 and
C-230, C-231, C-235, C-236, C-238, C-240, C-241, C-271, C-
371-A and C-390. This filament is not of the coated type,
the thorium content being distributed throughout the body
of the tungsten wire. In the final process of rectification,
the uniform layer of atomic thorium is built up on the sur-
fase of the filament, this layer being responsible for the
high-cuumen efficiency of the thoriated filament. When
this tube is used in this surface layer of thorium very grad-
ually evaporates, but from thorium is continuously sup-
plied at the same rate from the interior of the filament.
This process continues very smoothly, maintaining a uni-
formly 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, the resistance increases rapidly and the
active thorium sur-
face is destroyed and the filament evaporates rapidly de-
creases. In operation the tendency to further increase
the filament voltage, that further overloading the tube
until no emission is obtained. The tube filament is then
said to be "fraction." The emission may be reestab-
ishment from the exhaustion of the thorium content
and is indicated by a decrease in filament emission in
stead of actual failure or burn out of the element with
other types of filament material. If the tube will not
return to normal after evacuation treatment, it is proof
that the tube has either moved its normal life or has
been so heavily overloaded that the thorium content has
been exhausted, or the vacuum impaired.

The rectification possibilities of a thoriated filament
tube with element rating of 5 volts may be judged, with
a fair degree of accuracy, by the SUPREME oscillation
and emission tests. If the test shows an oscillation and
very slight emission readings it is an indication that the
tube has probably been overworked or "pancaked," and
it can be improved by rejuvenation. The method of
coupling in the SUPREME oscillating elements of Models
99A, 90A and 400A does not aggravate the require-
ments for oscillation in the 3-volt tube, and their re-
juvenating 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 "pancaked"
than 2-volt tubes. Tubes which are worn out or exhaust-
ed 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 "Instructions for Rejuvenating" in another sec-
tion of this manual.
CHAPTER IV
ALIGNING OF CONDENSERS.

Problems Involved.—The advent of the single-dial con-
denser receiver emphasized the need of the precision align-
ment of condensers. The constructional problems in-
volved primarily concern the manufacturing engineer, but the problem of maintaining the correspondence relation-
tween tuning units, and especially that of geared tun-
ing condensers, is a problem for the radio service man in the opera-
tion of the receiver.

Importance of Matched Units.—There still remain in use many of the first multi-diode radio-frequency and motorduty type of tuners. Those who are familiar with the operation of these types of receivers have noted that the tuning dial must maintain its settings fairly close to the average setting for the single dial to be in phase with the average setting of the dial being noticed in the dial wheel; hence (the fine tuned motorduty type, the variations being generally propor-
tional) to the variation of the antenna applications from those specifications just suited to the operation of the radio. By observing the better variation a radio man could usually tell a consumer 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 the tuning range, at settings of 9, 11, and 14 for example, the aver-
age setting would be 10. The "9" and "11" dials could be released from their shafts and set at "10" without disturbing the alignment of the condensers. Then the condensers and dials would be synchronized at resonance. If the dials were related 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 match-
ing of the inductances and capacities involved in the tuning units. If the same units were utilized in the con-
struction of a single-dial receiver a loss of tuning effi-
ciency would result, as the receiver would afford accurate geared condenser alignment at only one setting within the tuning range and so this frequency is departed from, with possible consequence of a further in-
crease in noise.

Mechanical Adjustments.—Various methods for auto-
matically or manually compensating for antenna varia-
tions are generally incorporated in single-dial-coated ra-
dis, and these do not usually present any servicing prob-
lem; but many ingenious and apparently successful further in-
ventions are reported.

—13—
is generally a problem for the service man to maintain the adjustment designed in components for the variation in the condenser units. The generally adopted method of building the single-direct-current radio is to see fixed inductances and variable capacities; i.e., to use coils that are not adjustable and base them with variable condensers. Tuning condensers are usually provided with mechanical means of adjusting their electrical condensator with one another. This may consist of set-screw adjustments on common shafts or on belt-driven pulleys, small adjustable vernier condensers, adjustments of tuned driven, or the heading of condenser plate separants. Whatever the mechanical method prescribed, 3; is usually described by the radio manufacturer in his service literature, which should be consulted in all cases.

Anode Reconversion Indication. — If any of the pentode tubes 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 breadth. The degree of synchronism of tuning condensers cannot be determined by tube-set adjustment, and a tone-sweeping tube may be determined by tuning such aid to a generator of modulated radio-frequency signals, observing whether or not there is any variation between the unaided and the master tuning control. The Superior Modulated Radiator and the Superior Metal Reconversion Indication methods afford excellent means for determining any variation from accurate alignment and for the readjustment of the tuning condensers where necessary. The routine involved will be discussed in Chapter VI.

For the average simply constructed single-direct-current radio comprising not more than three dual-tuning-condensers, an audible method of indicating resonances 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 "%A or other grid-coupling tube, of a frequency between 1000 and 1500 kilocycles, or a circuit whose over other frequency sweep 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 audio output. All tubes should be free of any resonant frequency response over the whole tuning range.

Master Reconversion Indication. — It is well-known fact that the ear affords less appreciation of quantitative values than does the eye, and a visual method of indicating resonances, other things being equal, is to be preferred to any auditive method.
with "mill and max" tilt-by-turn tuning. "Twenty per inch" cross-section charts are very useful in plotting dial calibration charts. 

SUPREME DIAGNOSTICIANS may obtain an approximate calibration of their Modulatedシリーズ Radio by tuning the harmonics in on any radio which has its dial accurately calibrated, making a chart from the radio dial setting of the harmonics.

Preamplification of Distant Stations --- Knowing the frequencies and the relative strength of the harmonics radiated by the STRAFM SERIES Receiver, it is easy to make the sidebands then 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 dial chart, which is easily made up by using 100 horizontal divisions of a sheet of "20 per inch" cross-section paper to represent the 100 to 1001 readings of the dial and using 30 of the vertical dimensions to represent the 30 VHF broadcast channels of the 300-1000 kilocycle broadcast band.

Straight Line Frequency Types --- In plotting a dial setting-frequency dialing chart for a radio, it will be found that the plotted points will, when joined from a straight line only when the tuning-condensers employed in the radio are of the "Straight line" type, which evenly space the frequency assignment of broadcasting stations all the way across the dial. In other words, the same number of stations occurs between 0 and 10 on the 1000 kilocycle 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 synchronous be maintained, in order to maintain the line of tuning efficiency.

Various methods for automatically and accurately frequency-tracking for antenna variations are generally employed in single-control receivers and these are not usual for this particular problem. When a condenser is used for the higher frequencies the plate is generally well on mesh and a capacity near the screen is used. A change of the internal capacity of the grill and diameter of the tube will give a larger effect in higher frequencies and changing of a type may upset the balance of the stage in which such change is made. This trouble is sometimes minimized by using a matching- transformer between the condenser of such an antenna that its plates are still fairly well in mesh when tuned to the highest frequency of the broadcast band.
Neutralizing.

Definition. — Neutralizing is a method of balancing to provide a second feedback between various other external circuits through connections outside the tube. This second feedback is arranged so that energy passing through it is equal in amount to the tube feedback but in opposite in phase or polarity. The effect of the tube feedback is then exactly balanced by the external feedback. The result of combining the two feedbacks 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 properly 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 current resistance, the power fed back being sufficient to maintain oscillation without the help of incoming signals. The feedback increases as the tuning frequency is increased. When a tube is oscillating it is impossible to keep the radio-frequency signals out of the speaker and into the microphone by using a detector with a high resistance or by using the radio-frequency circuits in the receiver with a low resistance. The radio-frequency circuits of the receiver are always in a lower resistance than the tuned circuit because of the necessity of connecting the receiver load to the radio-frequency circuit and because of the necessity of using a high resistance to get the maximum efficiency from the receiver. The natural frequency of the circuit is not affected by the load, so it is impossible to prevent oscillations in a receiver with the radio-frequency circuits in a lower resistance than the tuned circuit.
acting as one plate of a small condenser. The capacity between grid and plate, and plate and screen, 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 capacity. The plate capacity is given by the difference between the total capacity of the tube, where the latter affects the tuning almost as much as the minimum tuning capacity, controlling to lower tuning at the highest frequencies of the radio. The capacity between grid and plate is large and has a very marked effect; on the performance of a tube as a radio-frequency amplifier, resulting in coupling between the input and output circuit which causes a feedback of energy in 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 96 types of tube in chosen as the radio-frequency amplifier in some cases 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 drift, the same factors of those being covered in the following discussion.

Stabilizing Methods. — The first method to be widely used consisted of having the grid return variable by a set tension so that a variable potential might be placed in the grid. The grid would then draw current and lower the resistance between grid and plate, 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 damping of the tuned circuit. Another method utilizes a fixed resistor of from 100 ohms and up, placed in the grid lead. This resistance causes a decrease in amplification, which is more pronounced at the higher frequencies; an advantage, however, since the feedback increases with frequency. This method does not avoid broadening of tuning due to the added damping of the circuit. The sensitivity of a tube is increased 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 use a variable which may be variable for the purpose of controlling the current, in the plate supply leads, thus increasing 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 damping of the resonant circuit, which results in better tuning.

Counter-Phasing Methods. — A counterphasing method that is highly regarded by radio engineers and that which is used much and, to neutralize the tube capacity by adding
another capacity, in the form of a small fixed or variable neutralizing condenser, commonly called a "neutralizer," 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 Riso method, the Roberts method and the Hitachi method.

While the connections for these three methods are not quite alike, the method of adjusting neutralizing for neutralization is practically the same.

The Roberts method employs a special winding in the following radio-frequency transformer which is in exactly the same position 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 circuit by way of the tube capacity. In the Riso 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 sensitiv.

ity may be expected when this circuit is used. The end of the input coil opposite the grid is connected to the plate through the neutralizer. The Hitachi method employs a neutralizing circuit from the grid through the neutralizer to a tapped position on the secondary winding of the following stage. Any one of these methods is nearly independent of frequency over the range now occu

Neutroden Adjustments. — When the neutralizing circuits of radio valves are out of balance, it will generally be found that one or more of the radio-frequency tubes will break into oscillation, causing signals of varying pitch to be emitted from the loud-speaker as the tuning dial is moved over the higher frequencies. The best method for avoiding such improper neutralization provided adequate settings are neutr faster neutralization can be obtained by adjusting the neutralizer for the maximum degree of balance. Routines which utilize either the Riso, Roberts, or Hitachi methods for radio-fre

quency amplifier neutralization usually employ a neutroden neutralizer, and provide ample means for service adjustments. When the correct seating of the neutro-

den contacts is determined, they need not be changed unless one of the original tubes in the radio-frequency or detector, due to the tubes replaced by different internal capacitance, in which case the neutralizer should be reaj ust.

In any such operation in well-balanced radio.

Capacity impedance to oscillatory current decrease.

Note should be made of tuned to a frequency of 1000 to 1500 kilocycles, depending on the manufacturer's recommendation.
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 chapter of this book. The repair and replacement of the various types of antenna will follow the principles which should generally be observed in the repair of antennas. The treatment of the various types of apparatus of the average radio. The treatment 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 DIAGNOSTIC, unless specifically excepted. All references to vertical operations on the Model 10-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 at this one best be done by actually tuning the radio to signal. If the radio is not completely operative, it is advisable to test the modulated radiator circuit. After a preliminary examination of the radio, the next step should be the setting of the values used in the radio, which is also accomplished with the Modulated Oscillator, circuits, perfectly proved through the Power Plant.

Putting the Power Plant in Operation. When Altering current power, the potential and frequency for which, the SUPREME DIAGNOSTIC is designed, is the following procedure: put the Power Plant in operation for powering the Modulated Oscillator for a second of tuning characteristics of a radio, for the testing of tubes, and for other purposes:

1. Remove the condenser coil from its plug position.
2. Open all switches on the panel of the SUPREME DIAGNOSTIC.
3. Clear the analyzing plug and all jacks of the SUPREME DIAGNOSTIC 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.
6. Remove the protruding protective resistor from its series-socket of the A.C. connector cord.
7. Connect the SUPREME DIAGONOMETER to a convenient A.C. supply socket, using the A.C. connector cord with its series-socket variant.
8. Close the "A.C. Line" switch. If the A.C. voltmeter shows any reading, the series-socket is shorted, and the incrustation must be corrected before proceeding with any test.
9. 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 applied 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 sudden drop of the voltmeter reading.

Testing the Modified Radiator in Operation. — With the Power Plant in operation, follow the steps complete the setup of the Modified Radiator for a check-up of the pick-up characteristics of a radio, for tube testing, or for other purposes:

1. Insert the auxiliary coil, with its label to the front, in its general position.
2. If using Model 400-B, close the "IX-Hunter" switch to its "Hunter" position.
3. Place a good osculating tube in one of the "Tube Testing Hockets." If using Model 400-A, use special standard heater-flame and heater-socket when using a tube of this type. On all other models, use special slip-pin plug leads for connecting the filament contacts of fuse tubes to their corresponding pin-jacks on the instrument panel. When using a screen grid tube in any SUPREME DIAGNOSTER, see a slip-pin plug lead for connecting the top exit grid contact to the screen grid [1] pin-jack on the instrument panel.
4. If using Model 400-B, throw the flashing toggle switch to the position for maximum oscillation.
5. Leave the ammeter milliammeter scale switch in positions 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 Hockets."
7. When using screen grid tubes with the Model 400-B, close the "Test S. G. Tube" switch momentarily for obtaining plate readings of the tube.
8. The plate current, which includes whatever additional current which may be indicated by the auxiliary circuit, will then be indicated on the milliammeter.
9. If the current reading does not exceed the next lower scale limit, the milliammeter 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 DIAGNOSTER 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 DIAGNOSTER 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 "+40" DC external pin jack to the negative terminal of the filament supply battery.
   (c) Connect the "External Milliammeter Positive" pin jack to the positive terminal of a 6-volt "B" battery.
   (d) Join the negative terminal of the 6-volt "B" battery to the positive terminal of the filament battery.
   (e) Close the "DC Fill" switch of the SUPREME DIAGNOSTER 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 DIAGNOSTER to the positive terminal of a battery suitable for supplying filament current for the tubes to be placed in either of the "The Tube Testing Sockets."
   (b) Connect the "-30-volt" external pin jack to the negative terminal of the filament supply battery.
(c) Connect the "External Mid-Amper Positive" pin jack to the positive terminal of a 6-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 SUPRIIME DIAGNOSTER.

(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 SUPRIIME DIAGNOSTER 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 "B" meter pin jack to the negative terminal of the filament supply battery.

(c) Connect the "External Mid-Amper 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 jack "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 specifications of the tubes to be placed in sockets No. 11.

(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,
(a) Connect the positive terminal of the "A" battery to pin jack No. 12.
(b) Close the Platemount switch No. 19 by partially removing its spring clamps.
(c) Adjust the "A" potential, using the 50-kern rheostat, to that specified for the tube to be placed in socket No. 17.
(d) Place the tube in socket No. 17.

6. "Click" modulation may be had by manipulation of the modulation switch at all times of the SUPREME DIAGNOSTIC.
7. The plate current, which includes whatever additional current which may be induced by the oscillating circuit, will then be indicated on the milliammeter.

8. If the current reading does not exceed the next lower scale limit, the milliammeter 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 rectifiers, place choke oscillation switch and observe the plate current reading with the tube not in an oscillating condition.

10. Except when testing rectifiers, place the "Test 400 B" chassis switch may be thrown to its "Blow" 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 satisfactorily as it would were both plate current values normal. If it is desired to test both plates of full-wave rectifying tube of the filament type, on the Model 400-B, depress the "Test 3 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 ("A") and the third ("C") oscillator coil pin jacks, assuming the pin jacks from left to right as the operator faces the front of the point.

3. Repeat the procedure of the preceding paragraph.

4. The rectifier plate current of the other plate will then be indicated on the milliammeter, 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 thermionic-diode type, the following procedure should be followed for rejuvenating tubes in the sockets of the SUPREME HEMI-DIAMETER:

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 Testing Socket." If using Model 400-B, tube to be rejuvenated may also be placed in the UX "Lead Socket," by closing the "GC FIL" switch and throwing the "UX-HOTER" switch to the "UX" position.
2. On any model except the 100-A, completely close the 'Receivant' switch, or on the Model 100-A press the button; marking which, in either case, correspond to the filament rating of the tube or tubes to be rejuvenated.

3. 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.

4. 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 improved form of socket may be utilized for connecting the elements 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 all shunt resistances from filament circuits of the radio.

4. Short out all automatic element control circuits.

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 Receivant circuits.

8. Repeat steps 6 and 7 of the preceding paragraph.

It may be required that the tube of the filament type which have been 'paralyzed' or overloaded 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 op- erating characteristics are practically the same for all radio, 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 analyser, 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 analyser. The electrical characteristics of the circuits not amenable to tube-socket analyser may be determined by their reaction to the Modulated Radiations with the radio in operation. The location of defects in these cir- cuits 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 the radio circuit; and the tube circuits constitute the various, loads, and sources of the radio, center- ing at the tube sockets at which most of the needed in- formation 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 U.S. bases, but the advent of the im- direct heater type introduced the EY base. The later ap- pearance of the screen grid tubes introduced another tube element with its contact at the top of the tube. The newer types of tubes will probably be built with relatively fewer U.S. sockets. Until a standard socket arrangement is adopted for all tubes and radios, adaptors will be neces- sary for the interchanging of tubes and sockets. A fa- miliarity with the use of adaptors is essential for tube- socket analyzing.

Analyzing Adapters. — The Model 400-B TUFREME DIAGNOSTER employs a very ingenious plug which requires the use of only one adapter for analytical tests on all radios, including screen grid types and overheated heater filament types, employing UX or UX tube sockets. No tube-base adapter is required for plugging any UX or UX tube in the sockets of this model. A snap-catch is em- ployed on this plug to prevent the separation of the adapter from the plug when inserted in a tube socket. Previous models of the TUFREME DIAGNOSTER com- ploy standard analyzing plugs requiring the use of ana- lyzing adaptors for the different types of tubes employed.

These regular analyzing adaptors are furnished with all models which handle the 6D4 and which are equipped with tip-proof analyzing plugs. These adaptors are slugged "1,1","1,2,7," and "1,1" or "1,2,7," or "1,2,7,2," respectively, on the plug boxes of the adaptor. Num-
ters "12" and "13" have red rings on their tops, while Number "3" has a green ring. In the Number "11" adapter, the Cathode probe is open, while the Number "12" is closed to the negative filament side with the negative filament probe open. In the Number "12" the Cathode and Negative Element (or heater) holes are connected to the negative filament probe.

The SUPREME DIODEMETER Pol-Changer switch must be used in combination with Adapters "11" and "12." 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 readings are 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 bars off scale when attempting to read D. C. filament voltages. The red adapter Number "11" 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 DIAGNO- METER, (other than the 600-B), which is equipped with the 6-prong analyzing plug, for analyzing D. C. radios in which the filament terminals or the radio sockets are wired that the positive filament circuit is adjacent to the plate terminal position of each tube socket, the Number 214-B 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 UX to UV Neutralizing adapters, having one open filament connection, are noted in the Accessory Price List. These Neutralizing Adapters permit the neutralization of radio-frequency ranges of parallel-filament-wired radiotubes without the necessity for using three or four-propped UX or UX tubes, respectively. Models prior to the Model 400-A should not be used for any analytical tests in sockets designed for using screen grid or for testing overhead heater-filament tubes.

Special pin-plugging clips are used on all models for testing screened-cathode tubes, and on all models, except the Model 400-A, for testing overhead heater-filament tubes. For analytical 3x3A or 4x4A tubes using the UV-96 type of tubes, Alden No. 999 and No. 628 adapters are furnish with this pair of adapters, the UV-96 type tubes and radios may be satisfactorily tested.

Vacuum Tubes, Girdle Unplugged. — No lead" di- mension plates 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 roads, except those employing series-parallel elements, "no load" element and plate voltage readings should be taken with only one of the tubes out of the circuit. "No load" grid readings need not be taken except where a "C" type battery is used. In battery types of tube 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 element 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, feet with the SUPREME DIAGNOSTER 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 element 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 reduced reading on the voltmeter when the battery is under load. When a tube is placed in the "load socket" of the SUPREME DIAGNOSTER during analysis with the radio in operation, the correct current 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 "C" voltage should be adjusted to the proper value for the "C" voltage used. Otherwise the tubes will be subjected to erroneous usage, and its reproduction will not be satisfactory in quality. When taking voltage readings, it may be noticed that the milliammeter may show a slight deflection, indicating the load of the voltmeter, which, with the "1000-ohm-per-volt" voltmeter, will be 1 milliamperes at full-scale voltmeter deflection. All load readings taken with the SUPREME DIAGNOSTER will be accurate within about 2%, the 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 preparation operating position.

2. Open all switches of the SUPREME DIAMONET.

3. Disconnect the A.C. supply cord and close all jacks of the SUPREME DIAMONET from contact with any electrical conductors which might be grounded or directly connected to the vacuum, alternating current supply system, thereby avoiding any possibility of electrical harm to the SUPREME DIAMONET or to the radio.

4. Open the power supply switch of the radio to be analyzed.

Fluorescent Circuit Analysis. — For plugging into UZ testers with the Model 400-B, no plug adapter is necessary. When using other models, see No. 3 adapter of A-2 plugs for plugging into the XZ sockets. A plug adapter is used with the Model 400-B for plugging into UZ sockets. With the plug in the first socket and the tube out of the set, close the proper "fill" switch which will measure the filament voltage. If testing in a B.C. tube socket, the lead of the D.C. voltmeter may be taken off scale, and the pole shanks should be depressed to obtain correct readings; this will indicate the direct current voltage available at the filament terminals, and if the shunt is turned on full and the other tube is removed, it will also indicate the "900" or "1-A" battery voltage. If testing in an A.C. circuit, the reading will indicate the voltage available on open circuit. The reading obtained in either case must be recorded.

With the plug still in the radio socket, open the tube in the "fill" socket of the Analyzer, using an adapter if necessary, and read the filament voltage. It is very important that this reading be close to that for which the lamp was designed, if it is above the rated voltage, the life of the tube will be correspondingly short, whereas if it is too low, the rated voltage, proper results will not be obtained. If an adjustment is possible, the tube being analyzed, proper adjustment should be made. The best results can be obtained with the filament voltage of, or close below, the 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 filament.
Plate Circuit Analysis. — Plate voltage readings may be taken with or without the tube in the "Land Socket." Before taking either voltage, open the "FIL" switch. Close one of the "Fuse 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 "Land Socket" will be less than the reading obtained without the circuit loaded. This difference is occasioned by the internal resistance caused drop of the "B" supply battery, 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 milli- moper drawn by the tube, the "B" batteries should be replaced, or the rectifying tube in the plate supply device should be replaced. If means can be 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 in which it 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, in 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:

Wrink 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 radio employing batteries for the "G" bias, practically the same reading should be obtained without the tube in the "Land Socket" as from the same tube in the "Land Socket." This is because the grid circuit has practically no current draw in the receiving circuit, wherein the correct voltage reading of the tube can be had only when the tube is in the "Land Socket." And the grid voltage should be read with the "Grid" switch closed for the highest scale of the O. C. voltmeter which will afford a discernible reading.
With the plug in the radio socket and the tube in the "Land Rocket," 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. radio, a reversed "A" battery may be indicated by the backing of 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 radio employing Athmosphere circuits:

Open transformer, low voltage secondary.

Open grid. open bias resistor.

Open pole 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, if of such high resistance that it lowers the reading of grid voltage. The grid leak resistance may be temporarily shorted if it is desired to get a true grid voltage reading.

Cathode Circuit Analysis. — None of the Models of the SUPREME DIAGNOSTIC provide means for obtaining voltage readings of the cathode bias employed in 4 and 6-element tubes. A cathode switch is provided for taking these readings with the Model 400-B. Cathode circuits are rarely the source of radio trouble, but the readings obtained should be recorded and compared with the specifications for the tube and tube socket analyzed. No readings when cathode biasing resistors are known to be employed would indicate an open resistor, and a low reading would indicate a partly shorted resistor. If in use is available for reading the cathode bias, a defective tube would probably be indicated by excessive hum.

Screen Grid Analysis. — None of the models of the SUPREME DIAGNOSTIC provide means for analyzing screen grid circuits. The Tubes 99-A and 400-A provide means, however, for testing screen grid circuits independently of the screen. With the 99-A, screen grid analysis is accomplished by plugging into the socket the tube to be analyzed, connecting the grid, which ordinarily connects to the top of the tube, to the large circular grid hole in the side of the analyzing plug. The screen grid hole is placed in the "Land Rocket" in the manner described in the clip-plug tools used for connecting the control grid contact of the tube to a corresponding pin jack on the instrument panel.
Overhead Heater-Filet Assembly—The Model 400 is the only model of the SUPREME DIAMONITOR series which will make analysis tests on radios employing overhead heater-filet tubes. The procedure is simi-
lar to that for screen Grid analysis, except that the "trolley" electrode is connected to the "trolley" con-
tact lug on the analyzer plug, and two clip-pin plug leads are used for connecting the filament contacts of the tube to corresponding "overhead filet" pin jacks on the instrument plug. The 49 A provides Power Plant tests on these tubes without an adapter, while the 400A pro-
vides the same tests utilizing a special adapter.

Distortion Tests—With the analyzer plugged into the last audio amplifying stage, with all switches of the SU-
PREME DIAMONITOR open, the action of the milli-
ammeter is a fair index to the degree of distortion in the audio circuits. The ideal condition is to have the needles 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 de-
defects downward for each signal impulse, it is an indica-
tion that the "C" voltage is too low for the "B" volt-
age 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 theoretical analysis of the causes of the distortion in-
volves a study of the graphs putting the characteristic of tubes, which is a very long-drawn out discussion and inappropriate for a Manual of the size of this work.

Analyze Charts—These charts are arranged in da-
plotted pads and are very useful for recording the read-
ings obtained during tube-check analyzing. A copy of
each chart may be retained for future reference on any
radio. Radical readings will be indicated by compar-
ison with other charts on the same type of radio. These
draw space have space provided for the Power Plant tube
tests which should provide the analysis of any radio. Analyze Charts are located in the Accessory Price List.

Input and Output Circuits—After completing the an-
alysis of the tube circuits of a radio, the service man should always attempt to look at the circuits of the radio sys-
tem which are not accessible to tests by means of the tubechart analyzing method just described. The ef-
ficiency of these circuits can best be determined by tun-
ing radio circuits. A similar radio-frequency signal known to exist within pick up distance of the radio. The
Modulated Radiator of the SUPREME DIAMONITOR 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 to see if it is efficient. This circuit consists of the aerial and the ground or counter-poise 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 capacity of a loop aerial may be determined by socket analysis where the loop circuit is directly coupled to the first tube tube, but in some instances the loop capacity is capacitively coupled to the tube circuit, in which case its 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 when the antenna is connected directly to the grid of the first tube, an open or shorted pick-up circuit cannot be determined 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 capacities of the antennas may be had by tuning the radio to the Modulated Radiator, and then disconnecting the antenna. The sound strength should fall off when the antenna is disconnected, or a loud 'cracking' 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 'cracking,' when this is done with the volume control of the radio at its normal setting, usually indicates an insufficient aerial circuit. The ground circuit should be checked in a similar manner. Although there should be a very perceptible drop, amounting to about 500, in audibility when the ground is disconnected. If there is still change in sound 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. It occurs where one side of the alternating current supply system is grounded, the ground lead of a radio may be disturbed by connecting a lamp or A.C. voltmeter between the ground lead and the ungrounded side of the line. This will be helpful in determining whether or not the antenna is shorted to the ground lead. This method also effects a very convenient means of differentiating between the antenna and ground leads when it is not convenient to differentiate them by visual inspection. Lightning transformers should always be checked for shorted electrodes. Swapping the antenna and ground leads together on some boards is a very common cause of trouble in ground shorts.

The output circuit of a radio consists of the loud speaker, 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 constancy of the output circuit in such radios may be determined by tube socket analysis. In most of the more recent mod-
ells of radios, whereas the last audio plate voltage exceeds 120 volts, the loudspeaker is usually indirectly coupled to the last audio stage, and a test of the output circuit consists in making 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 loud-
speaker circuits can be tested for open 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 choke 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 radio-amplifying tube ex-
ceeds this value, some type of filter circuit is generally required to protect the loudspeaker windings from over-
load currents. A 77-A tube should not be substituted for a 71-A in an audio stage without changing the grid bias voltage to correspond to the tube in use. This change in grid bias voltage must then affect the grid bias voltage of other tubes. Some circuits were designed for using a 77-A tube as the first audio amplifier, and a 71-
A as the second audio, using 105 volts plate potential and 9 volts grid bias on both tubes. If the 71-A is re-
placed with a 77-A, the 9 volt grid bias would be in-
correct for the 77-A, while a change in 77-A would place an incorrect bias on the 71-A used as the first audio tube. Where no filter sys-
tem is used, the polarity of the loudspeaker should be checked with a C. M. meter, as a reversed polarity will eventually washout the magnetism of the speaker mag-
netes. (See specifications after tests.)

Putting the Continuity Tester in Operation. — The Con-

tinuity Tester is especially adaptable for testing the in-
put 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 DIATR-
OMETER to come in contact with a grounded condens-
in under test. With the test leads short-circuited in operation, the fol-

lowing 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 earthwire from its prescribed plugjack position.

3. Ping two test cords in the two left side ("B" and "P") oscillator coil pin jacks.

4. Place a thermionic rectifier tube, such as the 91 or 90, or other heavy current tube, in one of the "Tube Testing Sockets." These sockets are mounted in the front panel of the instrument and are connected to the high and low voltage line, the high voltage gate and the earth. They may be used for testing the tube, or for testing the tube circuit of the equipment being tested.

5. Close the Power Plate jack switch, the voltage of which corresponds to the diode voltage specified for the tube used.

6. Closing the circuit with the free end of the test leads will cause the plate current of the tube to be shown on the milliammeter, indicating continuity of the SUPREME DIODEMETER plate circuit with the external circuit under test. Any one or four element tube capable of showing comparably good disseminating plate current readings, such as the '74-A, '92-A, '76, and '91-A types, may be used with its corresponding Power Plate 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 Analyst 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 condition, the next step in verifying should be to check the synchronous relation of the tuning condensers. Two methods of obtaining tunercorrection are provided in the Model 400-B; namely, the Thermo-Couple method, and the A. C. Voltmeter method. The Thermo-Couple method is available in all models of the SUPREME DIODEMETER equipped with the A. C. voltmeter. With the Motorized indictor in operation, the following procedure puts the thermo-couple meter because indicator circuits of the Model 400-B in operation.

1. Disconnect the aerial coil ground from the radio.

2. Set the 30-ohm shunt approximately in its mid position.

3. Connect a jumper between external pin jack numbers "16" and "12."
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 115" and 1-1/4" external pin jacks.
6. Connect the microphone output terminal of the radio to the "1" and "2" "Audio Transformer" re- ceivers.
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. Retake the tuning knob of the radio, at the same time adjusting the 30-ohm resistor for the fastest needle deflection which will occur on the D. C. voltmeter as each parameter of the Modulated Radiator is "tuned in" on the radio. Maximum needle de- flection indicates resonance with the oscillatory cir- cuit of the Modulated Radiator.
9. Adjust each tuning condenser for a maximum read- ing on a signal between 1000 and 3200 kilocycles, or turn in 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 DIAGONOMETER equipped with an A. C. Voltmeter, the following procedure may be the Meter Resistance Indicator for operation for synchronizing:

1. Disconnect the aerial and ground from the radio.
2. If using Model No. 507 connect the "Plus or Minus A.C." and the "LMFD" external pin jacks of the SUPREME DIAGONOMETER to the loud speaker terminals of the radio, if using any other model, connect the "plus or minus 5-10-5 volt" pin jacks to the loud speaker terminals, place the analyzer plug in the No. 2 adapter, but do not plug into any tube socket. The A. C. Voltmeter should not be used with the "tip heated" type tube in use in the Type Testing Socket.
3. Close one of the "A.C. Fill" 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. Retake the proper tuning knob of the radio. A decided de- flection 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 de- flection indicates resonance with the oscillatory cir- cuit of the Modulated Radiator.
6. Adjust each tuning condenser for a maximum read-
Using a 60-cycle Modulated Radiator signal between 1500 and 3500 kilocycles, or between whatever other frequency limits specified by the manufacturer of the receiver.

Synchronizing Adapters (listed is 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 independent terminals for supplying dynamic speakers. When using this adapter, and when connecting the A.C. pin jack to radio set provided with indicator 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 connection is made. The reading will be increased, however, by the plate current component of the e.m.f. whenever resonance is attained. When using the Synchronizing Adapter in push-out stages, the needle deflection of the meter will be very much increased with some radio when the push-pull socket not occupied by the adapter is left vacant during the synchronizing operations.

Neutralizing Procedure — The neutralizing of tuned radio-frequency circuits provided with adjustable condensers may be accomplished with the SUPREME DIAGNOSTIC 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 1550 and 3500 kilocycles, or between whatever other frequency limits prescribed by the manufacturer of the radio to be neutralized.
5. Move SUPREME DIAGNOSTIC away from the radio so that effective reactions will not occur between the radio and the SUPREME DIAGNOSTIC. But if the signals cannot be picked up, move the instrument closer to the radio, as a better coupling tube, or use an insulated coupling lead brought to close proximity to the oscillator coil and the antenna lead-in of the radio.
6. Adjust each neutralizer for maximum signal strength as to increase pickup.
7. Remove the tube of the radio-frequency stage near the detector.
8. If the radio is wired with tube socket diaphragm connections in parallel, place the tube in the SUPREME Neutralizing Adapter and replace in the ra-
do socket; or substitute a "dummy" tube (i.e., a good tube with one of its filament prongs cut off) of the same type in the socket.

8. If the radio is wired with its twin-socket filament connections in series, temporarily strap the filament prongs of the tube together and replace it in the socket.

9. If the signal remains audible, the internal capacity of the cold tube is probably too low-passing the signal which should be tuned to maximum strength.

10. Slowly adjust the neutralizer which corresponds to the cold tube stage, using a fine wrench or fine screw driver to maintain body capacity effects until the signal disappears entirely or is reduced to minimum audibility.

11. 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.

12. 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 "dum- my" tube for neutralizing parallel-plate tubes is determined by the degree of uniformity of the internal capacity 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 Diagnosticians who desire a more accurate and economical means of neutralizing parallel-plate-tube radio the SUPREME Restraining Adapter, which permits the neutralizing of a radio-frequency stage with its own type, is listed in The Acconomy Price List. Fine screw drivers and these wrenches are also listed.

Galling.—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 pickup 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 practical it is at least necessary to have 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 is written as using. Then record this frequency and the corresponding dial setting. Lay the frequencies and dial settings off on a sheet of "spiro-com" 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 (or 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 3 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 portable radio calibrated in the manner described above, it is a simple matter to chart the harmonics of the supreme diagnostometer. Once the frequencies of the modulated radio-frequency harmonics are known, the supreme diagnostometer may be used in of broadcast testing for plotting other dial calibration graphs for other stations, or for checking the accuracy of the calibration of value the dial of which are already calibrated in kilowatts, wavelengths, or both.

Final Check-Up. - As a final check-up on each completed service job, it is recommended that the modulated radio-frequency harmonic be set up and each of its harmonics tuned in. The receiving should be turned itself 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 on excellent final check-up on the operating characteristics of a transmitter.

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 resistor.
Poor battery connection.
Battery lead in battery cable.
Poor switch.
Burnt out tubes.
Open primary of power transformer. (AC Set).
Open in AC lead cord.
Fuse blown.

Part of Tubes Fail to Light—
Open.
Shorted.
Dead tube.
Open in power secondary.
Poor socket contact.

No Reception. (See Text)—

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 connecting reversed.
Open primary of radio frequency transformer.
Open primary of audio frequency transformer.
Shorted grid condenser.
Open or shorted speaker cord.
Shorted by fuse condenser.
Defective tube.
Open or shorted speaker choke.
Open circuit in wiring.
Short circuit in wiring.
Tube plug or making contact is loose.
Grid resistor open.
Short between aerial and ground lead.
Shorted lightning arrester.

Weak Reception—

Defective tube.
A == 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 synchronous.
Poor grid resistors.
Partially shorted power transformer primary.
Partially shorted power transformer secondary.
Poor rectifier.
Incorrect eliminator resistor values.
Poor lightingarroter.
Poor aerial insulation.
Poor ground.
Poor socket contacts.
Defective grid condenser.
High resistance wires connection.
Speaker weak.
Speaker out of adjustment.

Noisy—

AC plug loose.
Needing chimera, grounding.
Poor lighting arrester.
Defective ground connection.
Defective bypass condenser.
Defective tube.
Variable condenser shorted.
Variable condenser dirty.
Defective grid link.
Defective resistors.
Loose connection in wiring.
Loss contacts in socket.
Defective filler condensers, punctured.
Defective audio transformer, grounded.
Defective eliminator resistors.
Grid resistor open.
Poor battery connection.
Defective B battery.
Speaker cord shorted.
Partially.
Speaker cord tips loose.
Speaker unit defective.
Dirty switch contacts.
Volume control weak.

Distorted—

Defective A or B power supply or overloaded.
Speaker out of adjustment.
Poor tubes.
Incorrect type of tubes.
Incorrect battery voltages.
C battery disconnected.
Incorrect C voltage.
Set out of adjustment.
Open muting resistor.
Shorted biasing resistor.
Poor rectifier tubes or elements.
High regenerative.
Relation between radio and audio frequency elements.
Interference between transformers.
Misketing between speaker and set.
Poor by-pass condensers.

Incorrect coupling in power leads.

Hum or Continuous Humming—
Defective tube.
Speaker too close to set.
Defective power supply.
Open grid circuit.
Low detector voltages.
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 hunting parts not making good ground con-
tact.
Grounded chokes.
Grounded speaker box.
Grounded resistors.
Open grid circuits.
Open or shorted or grounded by-pass condensers.
Open biaser.
Open base in cable.
Shorts in wiring.
Connection between wiring.

Intermittent Microphone—
Poor tube.
Jones connection.
Poor lighting situations.
Poor aerial isolation.
Poor grounds.
Swinging ground or aerial.
Defective grid leak.
Open or shorted grid circuit resistors.
Grounded transformers.
Weak battery.
Defective oscillator tube or elements.
Open biasing resistor.

Poor Metering—
Shared power transformer primary.
Shared power secondary circuit.

Condenser Connection—
Defective tube.
Poor lead connections.
Grid resistor shorted.
Excess ratings on frequency plate voltages.
Open grid circuit.
Cathode too close to grid.
Selection of poor shielding.
Poor radio frequency bypass condensers.
<table>
<thead>
<tr>
<th>TUBE</th>
<th>ZERO</th>
<th>BIAS</th>
<th>ZERO</th>
<th>BIAS</th>
<th>ZERO</th>
<th>BIAS</th>
<th>ZERO</th>
<th>BIAS</th>
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<td>0.4</td>
<td>+4</td>
<td>0.4</td>
<td>+4</td>
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<tr>
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The above translation shows average readings of tubes furnished by courtesy of the following tube manufacturers:

- E. T. Cunningham, Inc.,
- National ('Kevenly Rhythm') Carbon Co.,
- Via Horse Tube Co.,
- Sylvania Products Co.,

and from R. C. A. Arcotube, Cardon, and Bellagio standard tubes. K-types are standard tubes as manufactured by most tube manufacturers.

T-types are standard 5-string bass types.

C-tubes indicate Arcotube 3-string instrument types.

K-tubes are of the "Cardon" manufacture.

A tolerance of 20% in variation from the above tubes may generally be permitted for normal tubes.
<table>
<thead>
<tr>
<th>Type</th>
<th>Zone</th>
<th>Average Characteristics of Continental Fairs Terms</th>
<th>Description</th>
<th>Numerical Value</th>
<th>Meaning</th>
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<td>Meaning</td>
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<td>Numerical Value</td>
<td>Meaning</td>
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<tr>
<td>736</td>
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<td>Description</td>
<td>Numerical Value</td>
<td>Meaning</td>
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</table>

Reprinted by Permission of "RADIO BROADCAST"
| Model | Type | MTQ | No. | MTQ | MTQ | MTQ | MTQ | MTQ | MTQ | MTQ |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|       |      |     |     |     |     |     |     |     |     |     |     |
|       |      |     |     |     |     |     |     |     |     |     |     |
|       |      |     |     |     |     |     |     |     |     |     |     |
|       |      |     |     |     |     |     |     |     |     |     |     |

**Regulated by Courtesy of RADIO CORPORATION OF AMERICA**
**RCA-RADIOFON**  
**UX-525**  
*Power Amplifier*

Radionuc UX-525 is a Power Amplifier tube suitable for amplifying large undistorted output to a loudspeaker. It is intended for use in the last stage of an Audio Frequency amplifier, in a socket where filament voltage is 2.5 volts. (Radionuc UX-524 is not interchangeable with Radionuc UX-373A or any other power amplifier Radionuc).

**Rating and Data.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
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<tbody>
<tr>
<td>Filament Voltage</td>
<td>2.5 Volts AC or DC</td>
</tr>
<tr>
<td>Filament Current</td>
<td>1.5 Amperes</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>180 Volts Maximum</td>
</tr>
<tr>
<td>Grid Voltage (C-E Bias)</td>
<td>-33 to 50 Volts</td>
</tr>
<tr>
<td>Peak Grid Swing</td>
<td>33 to 60 Volts</td>
</tr>
<tr>
<td>Plate Current</td>
<td>26 to 32 Milliamperes</td>
</tr>
<tr>
<td>Plate Resistance</td>
<td>1500 to 1900 Ohms</td>
</tr>
<tr>
<td>Amplification Constant</td>
<td>1.5 to 2.5</td>
</tr>
<tr>
<td>Metal Conductance</td>
<td>1860 to 1850 Microhms</td>
</tr>
<tr>
<td>Undistorted Power Output</td>
<td>720 to 1600 Milliwatts</td>
</tr>
</tbody>
</table>

**Maximum Over-All Dimensions.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length</td>
<td>5 1/4&quot;</td>
</tr>
<tr>
<td>Diameter</td>
<td>2 1/8&quot;</td>
</tr>
</tbody>
</table>

**RCA-RADIOFON**  
**UY-524**  
*Screen Grid Radio Frequency Amplifier*

Radionuc UX-524 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.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Heater Voltage</td>
<td>2.5 Volts AC or DC</td>
</tr>
<tr>
<td>Heater Current</td>
<td>1.75 Amperes</td>
</tr>
<tr>
<td>Plate Voltage, Maximum and Recommended</td>
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</tr>
<tr>
<td>Grid Voltage (C-E Bias)</td>
<td>-1.5 Volts N</td>
</tr>
<tr>
<td>Screen Voltage, Maximum</td>
<td>12 Volts</td>
</tr>
<tr>
<td>Plate Current</td>
<td>4 Milliamperes</td>
</tr>
<tr>
<td>Screen Current, Net over 1/3 of Plate Current</td>
<td>690,000 Ohms</td>
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<tr>
<td>Plate Resistance</td>
<td>1000 Ohms</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td>1000 Microhms</td>
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</table>

**Direct Inter-Electrode Capacitances.**

<table>
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<tr>
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<tr>
<td>Effective Grid-Plate</td>
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<tr>
<td>Input</td>
<td>5 Mfd. Approx.</td>
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<tr>
<td>Output</td>
<td>12 Mfd. Approx.</td>
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**Maximum Over-All Dimensions.**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Length</td>
<td>3 1/4&quot;</td>
</tr>
<tr>
<td>Diameter</td>
<td>1 1/16&quot;</td>
</tr>
</tbody>
</table>
VICTOR B-32 AND B-40 MICRO SYNCHRONOUS RADIOS

By Courtesy of Victor-Radio Corporation of America.

The Victor Micro-Synchronous Radio is a power-operated radio receiving set and is furnishng three models. It is in all respects a compact, efficient, and is practically a foolproof set. The operating frequency is selected by means of a mechanical frequency selector located in the front panel. Each selector is a dial, by means of which the desired operating frequency can be selected. The set is supplied with a complete set of instructions and a tuning key. The unit may be used for any purpose for which a broadcast radio receiver may be used.

Fig. 1. Top view of radio, showing layout of tubing and mechanical and electrical connections. The set is designed for operation on 105 to 120 volts, 60 to 60 cycles, alternating current. For all other voltages, the proper transformer will be supplied. For this reason, all equipment is designed for operation in 105 to 120 volts, 60 to 60 cycles.

AVERAGE ANALYTICAL TOPOGRAPHIES

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Type</th>
<th>Load</th>
<th>Plate</th>
<th>Grid</th>
<th>Colours</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>1-25</td>
<td>1-25</td>
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</tr>
<tr>
<td>3</td>
<td>A</td>
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<td>4</td>
<td>A</td>
<td>1-25</td>
<td>1-25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For best average results, use transformer and rectifier for operation of constant voltage from 105 to 120 volts.
WESLEY METER SERVICE OUTSIDE OF UNITED STATES

By T. S. CAUTHERNE, Assistant Foreign Sales Manager, 
Western Electrical Instrument Corp.

The name of Wesley meters whose establishments are outside of the United States of America will find the following list 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., 221 Beaver Street, Montreal, Que., Canada.
- Powerline Devices, Ltd., 231 John Street, Toronto, Ont., Canada.
- Dipl. Ing. D. Borevits & Sohn, Dolsbergerstr. 61, Berlin, Schleswig-Holstein, Germany.
- Anciens Establissement V. Duquesne & Cie., 26 Rue Lisey, Brussels, Belgium.
- Mitsubishi Seki Kasha, Ltd., Marunouchi, Tokyo, Japan.

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

- Maskin-Aktiebolaget Zeta, Stora Kungsgatan 8, Oslo, Norway.
- Mr. A. P. Holm, Hammersenweg 188, Amsterdam, Holland.
- Barrie & Co., Ltd., Lavery House, Lavery Street, Johannesburg, S. Africa.
<table>
<thead>
<tr>
<th>Kilocycles</th>
<th>Wavelength (microns)</th>
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<th>Wavelength (microns)</th>
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<tr>
<td>10000</td>
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<td>10000</td>
<td>333.9</td>
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</tbody>
</table>

WAVELength-KILOCYCLE CONVERSION TABLE.
OHM'S LAW:

\[ V = IR \]
\[ I = \frac{V}{R} \]

Where \( V \) = Voltage
\( R \) = Resistance
\( I \) = Current

**RESISTANCES, IN SERIES:**

\[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_n} + \text{etc.} \]

Where \( R \) = Total Resistance
\( n \) = Resistances to be combined

**CAPACITORS, IN SERIES:**

\[ \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_n} + \text{etc.} \]

\( C \) = Total Capacity
\( n \) = Capacitors to be combined

**POWER, IN WATTS:**

\[ P = \frac{V^2}{R} \]

Where \( P \) = Power in watts
\( V \) = Voltage
\( I \) = Current
MAJOR RADIOS

General Description: The Majestic Model 'B' Radio is a 7-tube tuned radio-frequency audion 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 compact cabinets of different prices.

Power Supply: The primary circuit of the separate power supply and control of the 'B' audion receiver, a radio-frequency valve voltmeter regulator, and the primary windings of the filament and plate transformers. The voltage regulator features separate regulation of voltage to the tube filaments and of the plate supply for any ordinary load conditions. The power transformer cores are grounded only at the filament and plate leads to the chassis. A 1,000 ohm resistor is connected in series with the filament supply, the filament of the tubes and the plate lamp. The detector and audio plate supply leads are tapped at 217 volts on the voltage divider, while the variable audio frequency and first audio amplifier plate lead is tapped at 159 volts from the 320 plate 'R' 5936. The dynamic supply is connected between the plate 300 and cathode 'R' 5936. A grid bias is derived for the two-100 volts plate supply amplifier by an approximately 40-ohm drop across a 1,000-ohm resistance connected between the grid and cathode. The cathode bias is derived from the 300-ohm secondary winding. Radio-frequency grid bias is obtained by means of the voltage drop across a 500-ohm resistor, in the negative 'R' bias lead situated within the oscillator. The frequency of the filament, grid bias for the three radio-frequency tubes is obtained by means of a 2500-ohm 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 grid of the volume control resistor. A separate power supply unit, similar to that described above, is connected in series with the slide to restore the cathode bias to its normal value. The filament condenser for this tuned circuit consists of a cylindrical shield which fits over the coil and is held fixed by means of a screw shaft on the front end of the panel. The slide, in fixed contact with the slide, takes the bias of the tank slightly, and is adjusted to balance with the radio-frequency transformer in the tank. The effectiveness of this method of volume control and resistance adjustment, as well as...
the shielding of the set, can be affected by the fact that when no antenna or ground is connected, no signal can be heard at the maximum setting of volume control, even when the set is within a few yards of a powerful genera-
or of radio-frequency signals.

Radio-Frequency System. — The three radio-frequency transformers are of the same diameter, have external field, shielded type, and are placed in individual copper com-
ponents. The variable condenser group is also shielded. The group is controlled by a single illuminated arm dial-
control, the control shaft being in the center of the chas-
sis. The individual transformers for these condensers are adjus-
ted at the factory for proper synchronism. Three type "1411" tubes are used as the radio-frequency am-
plifiers. The neutralizing condensers are connected be-
tween the grid and the input circuit of the following radio-
frequency stage. By-pass condensers of the J.

Detector System. — The usual type, 27 A.C. tube is used as the detector. A "megohm grid leak is used with a 20,000 grid condenser. A 200 ufd condenser is con-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-
in the plate load of the first audio amplifier stage and the ground. A 20 turn is used in the first stage, while the second stage uses two "J-A's in push-pull. Any resi-
dual load 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 resi-
dential being placed in the back of the chassis, so as to be ac-

Audio Amplifier System. — The two audio transformers and the output transformer, are enclosed in hermetically sealed metal cases. A 250 ufd condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

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Dip-Put Circuit. — The secondary of the output trans-

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Dip-Put Circuit. — The secondary of the output trans-

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Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-

Dip-Put Circuit. — The secondary of the output trans-

A dip condenser is connected, be-
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 con- 
ductor choke coupling to the speaker.

Type of Tubes
All radio frequency..............................22A type tube
Detector...........................................227 type tube
2nd. R.F.........................................22A type tube
2nd. Audio........................................271A type tube
Beedle.............................................280 type tube

Placemat of Tubes
Facing usual of instrument reading from left to right.

Rear—rectifier.

AVERAGE ANALYTICAL TESTS

<table>
<thead>
<tr>
<th>Stage</th>
<th>Plate Voltage</th>
<th>Plate Current</th>
<th>Plate Voltage</th>
<th>Plate Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. R.F.</td>
<td>150</td>
<td>160</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>2nd. R.F.</td>
<td>150</td>
<td>160</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>3rd. R.F.</td>
<td>150</td>
<td>160</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>4th. R.F.</td>
<td>150</td>
<td>160</td>
<td>1.45</td>
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<tr>
<td>Detector</td>
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<td>44</td>
<td>2.55</td>
<td></td>
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<tr>
<td>1st. A.F.</td>
<td>155</td>
<td>155</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>2nd. A.F.</td>
<td>45</td>
<td>190</td>
<td>4.8</td>
<td></td>
</tr>
</tbody>
</table>

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 con- 
densers.
Polaroid Radios

Cable System in Colors.

Red-White: Positive heater of detector tube.
Black-White: Negative element of detector tube.
Yellow: Plate of detector tube.
Green: To ground.
Black-Green: Negative element of last stage of audio-frequency.
Red-Green: Positive element 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 tuning tube. The grid return is made through grid resistor, secondary of X.F. transformer and to grounded shield. The radio-frequency transformers are shunted by variable condensers, the varied plates being grounded to the shield. The R.F. plates supply is through a resistance mounted under chassis.

Detector Circuit.

Detector is of usual design to incorporate the type 257 tubes. The grid return is made through a standard grid condenser with look shunted between grid and shield.

Audio Circuit.

The standard design of two stage transformer coupled audio-frequency, ratio set given. 2nd stage ratio 2.5 to 1.

Output Circuit.

A pentode is employed in the output circuit and serves as a volume control. This resistance is connected across portion of the antenna coupling transformer, the arm of the resistance encompasses the ground. By upturning the arm to curtail the antenna end of the resistance the volume is decreased.

Location of By-Pass Condensers.

R.F. element and plate circuit by-pas condensers are mounted under chassis. There is also a speaker by-pass condenser mounted under chassis.
Biasing Method.

This is obtained by means of a voltage drop across resistors. The resistors for R.F. stages, i.e., 22k and 22k A.C. are wound on a single strip, this being mounted on top of panel assembly incorporated with-in 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 double resistor in series with the primary of the transformer. This resistor balances the voltage due to the greater heat and resistance at higher voltage 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 protrude holes in cabinet connec-tion 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 back panel which clamp the chassis to the inside front of cabinet. Pull chassis straight back hori-zontally to allow condenser shaft and volume control to clear front of cabinet. Lift set up and out.

ATWATER KENT — MODEL 27

Description.
Model 27 is a six-tube, single-diode 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, 50-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 elimi-nate the detuning effect of different sizes of aerials which would otherwise disturb synchronization of the three tuned circuits.

Type of Tubes.

<table>
<thead>
<tr>
<th>All Radio Frequency Stages</th>
<th>225 type tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector</td>
<td>222 type tube</td>
</tr>
<tr>
<td>1st. Audio</td>
<td>225 type tube</td>
</tr>
<tr>
<td>2nd. Audio</td>
<td>171A type tube</td>
</tr>
<tr>
<td>Rectifier</td>
<td>200 type tube</td>
</tr>
</tbody>
</table>
Placement of Tubes.

Facing panel of instrument. Reading from left to right. The rectifier tube is enclosed in a metal cover which has an opening in the left-hand end of the top for insertion.


AVERAGE ANALYTICAL TESTS

<table>
<thead>
<tr>
<th>Grid Wire Voltage</th>
<th>Plate Voltage</th>
<th>Plate Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. R.F.</td>
<td>12</td>
<td>150</td>
</tr>
<tr>
<td>2nd. R.F.</td>
<td>12</td>
<td>150</td>
</tr>
<tr>
<td>3rd. R.F.</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>1st. Audio</td>
<td>12</td>
<td>150</td>
</tr>
<tr>
<td>2nd. Audio</td>
<td>25</td>
<td>150</td>
</tr>
</tbody>
</table>

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 in standard tuned Radio Frequency. Radio frequency transformer secondary are shielded by variable condensers the rotor plates being ground -ed to the shield. The condensers are coupled by the usual Atwater Kent bell 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 2C7 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 25:1.

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

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

Basing Methods. The C1/C1' line 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 hole 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 astenm 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.**
Screw-in 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 discharging the condensers of the succeeding tuned circuits. The elements of the radio-frequency tubes are ou-
design by one circuit, another rheostat controls the detector filament, and a fixed resistance is connected in series with the two audio-frequency elements.

**Type of Tubes.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2LA type tube</td>
<td>1</td>
</tr>
<tr>
<td>3TA type tube</td>
<td>1</td>
</tr>
<tr>
<td>3LA type tube</td>
<td>1</td>
</tr>
<tr>
<td>3TA type tube</td>
<td>1</td>
</tr>
<tr>
<td>2SL type tube</td>
<td>2</td>
</tr>
</tbody>
</table>

**Placement of Tubes.**

**Possible Substitution of Tubes.**
Type 171A or 112A may be substituted in the last stage of audio-frequency amplification. This is so noted that in the last stage of 4th-frequency the plate and grid bias voltages may be noted to meet the requirements of the tube to be used.

**AVERAGE ANALYTICAL TESTS**

<table>
<thead>
<tr>
<th>Proper Readings</th>
<th>Grid Max. Voltage</th>
<th>Plate Voltage</th>
<th>Filtered Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int. R.F.</td>
<td>0</td>
<td>67.5</td>
<td>0</td>
</tr>
<tr>
<td>2nd. R.F.</td>
<td>0</td>
<td>67.5</td>
<td>0</td>
</tr>
<tr>
<td>3rd. R.F.</td>
<td>4</td>
<td>67.5</td>
<td>0</td>
</tr>
<tr>
<td>Detector</td>
<td>0</td>
<td>67.5</td>
<td>0</td>
</tr>
<tr>
<td>Int. A.P.</td>
<td>0</td>
<td>67.5</td>
<td>0</td>
</tr>
<tr>
<td>2nd. A.P.</td>
<td>450</td>
<td>99</td>
<td>0</td>
</tr>
</tbody>
</table>
Radio Frequency Circuits.

The radio frequency transformer secondary are shielded by variable condensers the rotor plates of which are connected to negative filament. The condensers are coupled by the usual A-value 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 across condenser which in turn is connected to negative filament. This condenser is held by two bolts passing through the fours radio-frequency socket. The first stage is untuned and acts as an antenna coupling device.

Detector Circuits.

Detector circuit is of the usual design to incorporate the type 2DN or 2DA 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 oscillator 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-thirds 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 forms of oscillations from disturbing the synchronism of the succeeding tuned circuits.

Standing Methods:  
A grid leak 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 loads are connected to a by-pass condenser which in turn is connected to negative filament.
Construction of Circuits.

The circuit consists of two stabilized radio-frequency stages, a regenerative detector and two stages of transformer-cumulated radio-frequency amplification. The detector and second radio-frequency stage are tuned. The first stage of the radio-frequency amplifier is not tuned.

**Type of Tubes**

- Rectifier: 230 type tube
- R. F. Stages: 220 type tubes
- Detector: 222 type tube
- Mt. A.P.: 235 type tube
- 2nd A.P.: 2P1A type tube

**Placement of Tubes**

Firing point and reading from left to right:

- Near-Lead F. P.
- Mt. R.F.
- Odler-Lead R.F.
- Front-Lead A.P.

**Detector Rectifier**

**AVERAGE ANALYTICAL TESTS**

<table>
<thead>
<tr>
<th>Grid</th>
<th>Plate</th>
<th>Mt. Lead</th>
<th>Lead</th>
<th>Filament</th>
<th>Mt. Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. R. F.</td>
<td>115</td>
<td>130</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>2nd. R. F.</td>
<td>115</td>
<td>130</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Detector</td>
<td>110</td>
<td>110</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Mt. A. P.</td>
<td>110</td>
<td>125</td>
<td>1.5</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>2nd. A. P.</td>
<td>150</td>
<td>160</td>
<td>2.0</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

**Method of Rectification.**

Although a type 230 half-wave rectifier tube is used, the two plates are connected together and the tube is used as a full-wave rectifier.

**Filter System.**

Filter consists of choke in series with positive power supply and, the choke is inserted by two leads of the Meissner coil; the third lead of this coil is connected to the negative side of the power supply.

**Cable System in Colors.**

- All d.c. 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 Method.
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 stainless set-screws from bottom. To remove case, take out six outer set-screws from bottom.

Radio Frequency Circuits.
Radio-frequency circuit is of standard symmetrical design, the first stage being untuned; second and third B.F. transformer being connected directly between grid of tubes and grounded shield and shunted by variable capacitors.

Detector Circuits.
The detector circuit is tuned by a variable condenser across the secondary of the third radio-frequency transformer. The tuning is made through a second set of grid condenser and built-in grid leak through the first B.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 B.F.

Artic 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 an audio 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.
- Excessive
- 12AT7 type tube
- Mt. Audio
- 500 type tube
- 2nd Audio
- 371A type tube
- Rectifier
- 240 type tube

### Placement of Tubes
Racing panel and reading from left to right:
- Rear - Rectifier
- Center - 2nd R.F.
- 3rd R.F.
- Det. lst. A.F.
- Front - 1st R.F.
- 2nd A.F.

### Average Analytical Tests

<table>
<thead>
<tr>
<th>Grid Bias</th>
<th>Plate Voltage</th>
<th>Load</th>
<th>Measured</th>
<th>Plate Voltage</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. R.F.</td>
<td>3</td>
<td>70</td>
<td>95</td>
<td>1.8</td>
<td>1.2</td>
</tr>
<tr>
<td>2nd. R.F.</td>
<td>2</td>
<td>70</td>
<td>95</td>
<td>1.8</td>
<td>1.2</td>
</tr>
<tr>
<td>3rd. R.F.</td>
<td>2</td>
<td>70</td>
<td>95</td>
<td>1.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Detector</td>
<td>0</td>
<td>60</td>
<td>45</td>
<td>2.3</td>
<td>2.5</td>
</tr>
<tr>
<td>1st. A.F.</td>
<td>6</td>
<td>60</td>
<td>90</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>2nd. A.F.</td>
<td>40</td>
<td>140</td>
<td>220</td>
<td>4.85</td>
<td>5.1</td>
</tr>
</tbody>
</table>

### Method of Rectification
A type 280 tube is used in full-wave rectification system.

### Filter System
The filter consists of the standard filter choke in series with the positive plate supply line. The plate supply line is shunted by a 1.25 microfarad capacitor.

### Table System in Colors
- Yellow - 1.5 V. Element leads
- Pink - 1.5 V. Element leads
- Black - 1.5 V. Element leads
- Brown - """" positive
- Blue - """" negative
- Red - """" negative
- Green - """" negative

### Radio Frequency Circuits
The radio-frequency circuit consists of three stages of tuned and amplified radio-frequency amplification. The second and third stages are 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 variable condenser turned by the manufacturer as """"accumulator."" The accumulators serve as means of obtaining the tuning. The grid returns of the R.F. stages are made directly to the grounded shield. The first stage is saturated and acts as an antenna coupling device.
Detector Circuit.
A standard non-representative 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 grid. 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 chassis through by-pass condensers. Grid returns are made through biasing resistors and return to center tapped resistors that shunt the filament loads.

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 loads.

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 elements are made to center tapped resistors that are shunted across the various filament loads.

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 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 706-A**

**Description:**
This model incorporates three stages of neon-stabilized 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 radio-frequency amplification.

**Type of Tubes:**
- All R.F. — Neat balanced, 26 tubes
- Detectors — 257 type tubes
- 1st. Ant. — 267 type tubes
- 2nd. Ant. — 276 type tubes
- 2nd. R.F. — 311A type tubes
- Rectifier — 280 type tubes

**Placement of Tubes:**
- Tuning panel and wiring from left to right: Nut—2nd. R.F.; 1st. R.F.; Detector; 1st. A.F.
- Front—1st. R.F.; 2nd. A.F.

**Average Analytical Tests:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. R.F.</td>
<td>90</td>
</tr>
<tr>
<td>2nd. R.F.</td>
<td>90</td>
</tr>
<tr>
<td>3rd. R.F.</td>
<td>90</td>
</tr>
<tr>
<td>Detector</td>
<td>50</td>
</tr>
<tr>
<td>1st. A.F.</td>
<td>50</td>
</tr>
<tr>
<td>2nd. A.F.</td>
<td>150</td>
</tr>
</tbody>
</table>

**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 Moshon condenser.

**Cabinet System in Coils:**
All filament leads are of black rubber. All leads from high voltage secondaries are of red rubber.

**Edis Frequency Circuits:**
Three stages of neon-stabilized 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 capacitors shunted across the radio-frequency transformer secondaries. These condensers D turn are shunted by a small series condenser. They serve as a means of sharpening the tuning when greatest selectivity is required.
Detector Circuit.
A standard non-linear detector circuit is incorporated the type 227 tube. The grid return is made through the usual grid lead and grid condenser, secondary of radio-frequency transformer and grounded shield. The detector circuit is tuned by means of a variable condenser situated across the preceding radio-frequency transformer, this in turn being shunted by an "alignment" condenser which serves as a means of aligning the tuning conditions so that they "come" together.

Audio Circuit.
The audio circuit consists of a standard tetrode stage Transformer coupled audio-frequency amplifier. Primary of the 1st, stage of audio being shunted to the chassis by a .005 mfd, condenser and by a 1/8 mfd, condenser.

Output Circuit.
The voltage after going through the Version condenser and resistance is cut down for last stage of audio, goes directly to the output terminals, thence through the output and finally to the plate of the output tube.

Antenna Control.
The antenna or volume control consists of a potential meter shunted across part of the antenna choke.

Scoring Methods.
Grid bias is obtained by means of a voltage drop across resistors. The grid bias for the 2nd 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 Return.
All grid returns are made to grounded shield.

A. C. Line Control.
A 270 is connected in series with the primary of the power transformer. This fuse may be used as a main fuse should trouble arise. The grid bias across the resistor tap in the primary of the power transformer is adjusted for a 700 volt setting, this affords a means of compensating high or low power-line voltage.

Access to Chassis.
Remove knobs from front panel, then to remove bottom, take out six inconspicuous 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 both 50 A. and 500 A., close the "A. C. Line" and "D. C." Power Float switches, comprising the "Negative Potential Contact" and the "Positive Mill-Ampere" pin jack to the A. C. potential to be measured. The indicating needle of the power transformer secondary will be included in this book-up, but the effect on the instrument will be negligible for all practical purposes.

These pin jacks are connected in series with the 150-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 possibility formula it shows that the limit is in the thousands. New ones of the SUPREME are coming to every day and their 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 "50 A. and 200 A. Only" are additional tests that can be made with these instruments.

EXTERNAL USE OF METERS

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

Millimeter.—To use the millimeter, run two test cords from the jacks marked,"Ammeter For External Use," using the proper polarity as marked. Either cord of the combination meters can be used by throwing the Toggle switch to 125 volts or 25 amperes.

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

If the voltage is over 10 volts, run the negative lead from the pin jack and after clipping the leads on the objective voltage supply, cross button or insert master plug in either the 100 or 400 plate scale, according to the voltage, and cut in the meter.
A. C. Voltmeter. — To use the A. C. Voltmeter, run one lead from the 10-pin jack, and another lead from the 310-000 pin jack to the source of A. C. voltage supply and press or insert master plug in either the 3v or 100 A. C. Fd. Scale, according to the voltage. Due to the independent cathode reading in the instrument it is necessary to slide on or adapt end of the wire cord plug to close the diaphragm 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 plug in 110 line voltage 100 scale" for reading. Bias reading can be taken any time the instrument is in use on A. C. tests.

The following resistors / tests that can be made only with models 400-A and 150-A. All of these tests are made through pins jacks located on the back of the instrument tray as on model 600-A and in rear 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 is the following pin jacks:

1M F = No. 8
1M2 = No. 7
.001MF = No. 6
.003MF = No. 5

ACCESS TO 0.02OHM-0.05OHM VARIABLE RESISTOR

Is had by connecting one test lead to No. 1 pin jack. Connect the other to pin jack marked "5000, 000 ohms."

ACCESS TO 30-OMH REHOSMAT

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

FOR 0-100 A. ONLY

INDUCTIVE OUTPUT TO SPEAKER

Plug speaker wire into pin jacks marked 1 and 2. Then run test lead from the plot of the last scale, frequency tube to pin jack No. 3. Run test lead from top of the last stage of audio to pin jack No. 4.

ACCESS TO AUDIO TRANSFORMER

No. 1 pin jack is P of the transformer.
No. 2 pin jack is K of the transformer.
No. 3 pin jack is P of the transformer.
No. 4 pin jack is K of the transformer.
CONDENaER, 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 6H-4 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 subject condenser. Now change the SUPREME'S condenser and object condenser with 90-V. D. C. by touching the leads of the battery so 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 "90-V. D. C." Selector switch and note the sound. If there is no lack of the meter the object condenser is shorted and has discharged the SUPREME condenser.
**RADIO TERMS AND DEFINITIONS**

**Air Conductor.** — A conductor 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 flow is a 1 C, 1 circuit whose resistance is one ohm, when an electric-motive force of one volt is present in the circuit.

**Amper-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 in instantaneous voltage between element and plate to a small change in instantaneous voltage between element 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 as increased output power.

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

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

**Antenna Resistance.** — As 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. Anomalous resistance includes: Radiation Resistance; Ground Resistance; Mod-frequency resistance of conductors in antenna circuit; and equivalent resistance of conductors in antenna circuit; equivalent resistance due to strays, soil contacts, limb losses, galvanic losses, and so on.

**Apodized Circuit.** — An a.c. circuit in which a voltage impulse will produce transient current in one direction only. The word apodized 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 equal units of voltage. Five oscillations are not possible in a strictly periodic circuit.

**Atmospheric Absorption.** — Diminishing of the amplitude of electromagnetic radiation due to absorption of energy by the atmosphere.
Attestion, Bells. — The decrease, with distance from the radiation source, of the amplitude of the electric and magnetic components constituting an electromagnetic wave.

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

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

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

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

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

Cepacity. — 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.

Cold Grid. — A coil possessing great inductive re-

stance; 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.

Cold, Supreme Radiator. — The oscillator coil used in the oscillator circuits of Supreme Radio Diaphones. It is designed for a maximum radiation of radio-frequency waves and for providing a method of feed-back coupling for affecting oscillation tests on the maximum number of types of radio receiving vacuum tubes. The coil for the Model 10-65 is provided with a pick-up winding inter-

posed between the primary and secondary windings. This pick-up end terminals are available at two pin jacks on the back of the coil.

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

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

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 Suprathc Modulator transmitter when supplied with A. C. power, modulation being accomplished at the frequency of the power supply.

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

Coupler.—An apparatus which is used to transfer radio-frequency power from one circuit to another by associating together portions of those circuits. Couplers are of the same types as the conductors thus coupled, 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.

Diathermy, The Supreme Radio.—An instrument utilizing various circuit combinations with the necessary switching systems for testing of blood and for the diagnosis of blood 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, transmits the radio-frequency power into a form suitable for inspection by the indicator. This translation may be effected either by the emission of the radio-frequency power at bays means of the control of local power. The indicator may be a thermal or receiver, relaying device, tape recorder, and so on.

Distant.—That portion of a conductor between the places; it may be all or any non-conducting material.

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

Directivity Antenna.—One having the property of radiating radio waves in larger proportions along some direction than others.
Effective B. M. F. — In A. C. circuits, when the wave form of the voltage is sinusoidal, the Effective B. M. F. is 0.707 x maximum voltage occurring during the cycle.

Effective Height of Antennas. — The effective height of an antenna is a height equivalent to the mass of wire used, equal to that value which will produce the same radiating qualities as the antenna itself. The meaning of the apparent height is due to the presence of surrounding objects.

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

Electrode. — The smallest component of matter which has been discovered. Supposed to be 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 Diagnosticians signifying the normal plate current of a tube placed in one of the "Tube Testing Socket" when the secondary circuit it served with the closed "Stop Oscillation" switch.

Filter. — 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 diminishment 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 "discharge" 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 "tucker" coupling, and refers to the process by which a part of the output power of an amplifying device re-enters upon the input circuit, thereby increasing the amplification.

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

Filter, Top Antenna. — An antenna having horizontal conductors at the top.
Forced Alternating Current. — A current having a fre-
quency and wave form which are equal to the frequency
and wave form of the impressed electromotive forces.
Free Alternating Current. — A damped alternating
current following a transient electromotive disturbance
in a circuit, with no external E. M. F. setting.
Frequency. — The number of complete cycles or half
the number of reversals per second of direction of cur-
rent 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 undamped circuit; that is, no
antennas with no series inductance or capacity.
Grid Leak Rectifier. — A resistor, often termed a grid-
leak, connected between the grid 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 circuit; the introduction of
these introduces elements into speech sounds which cause
distortions. 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.
Heterodyne Reception. — A method of radio reception
for continuous waves, employing the principle of reaction
between locally-generated oscillations and incoming oscil-
lations, resulting in a beat frequency which is the diff-
erence between the two separate frequencies.
Hydrometer. — An instrument for measuring the spe-
cific gravity of liquids, especially that of battery electro-
ytes.
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 flowing across these circuits.
Induction. — Ratio of voltage to current in an alter-
ning-current circuit. Impedance is a factor determin-
ing the magnitudes 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 in designate mutual inductance coupling.

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

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

Inductance. — This 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.

Inverting 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 electrical conductor to the transmitting or receiving set, or through testing instruments or connections to the ground connection or subtransmitting system.

Lightning Arrestor. — An instrument placed in a telephone circuit to break any easy path to ground for lightning or other extremely high voltage discharges.

Liquid Circuit. — The analyzing circuits of \textit{Sunset} Radio Diagnostics for accommodating radio tubes through analytical test sets.

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

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

Load Speaker. — A device wherein without special amplifying circuits, by means of which received sounds are made audible without the use of telephone receivers held to the ear.

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

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

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

Millihenry. — One-thousandth of an henry; convenient unit in measuring small inductance.

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 Multiductor Radiator circuits of Supreme Radio Diaries-type 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 simple lumped capacity and a simple 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 of parallel resonance exists when the current supplied by the source is a maximum. Every part of every actual circuit possesses a certain amount of distributed capacity and inductance, and in practice simple arrangements of a considerable number of inductances and capacitances are often used. For this reason the assumption to a simple lumped capacity and a simple lumped inductance made in the above two definitions are not strictly realized in practice, and the resonance conditions attained are a compromise of series resonance and parallel resonance. This 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 alterations.

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

Plate Current. — The current passing between the plate and the heated cathode is a time-averaged value.

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

Pointing Current. — A period current the average value of which is not zero. A disturbing current is the sum of an alternating and a direct current.

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

Radio Frequency. — The frequency higher than those corresponding to normally usable sound waves.
Resistors. — 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 conductor.

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

Resistor, Supreme Type. — A protective resistor prescribed for abandonment in reserve with one side of the A. C. line supply to the power transformers of Supreme Radio Diagrammatics as to protect apparatus connect- ed to the power transformer against over-load storms occasional by possible shorted circuits. The prescribed resistor consists of (3) a regular 100-watt Mazda lamp, (2) a miniature 10-watt Mazda Type T-544, Miniature 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 peo- ple at 25¢ each, or (3) a 100-watt West Leonard Resistor with a medium series base. Supreme Data Tablets involving the use of the Power Plant are based on the use of either of the two 100-watt Mazda lamps.

Resistor 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 re- sistance is equal to the capacitive resistance.

Resonant. — 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 op- posing E. M. F. in them.

Self-Induced. — A system of receiver of continuous wave signals by the production of audio-frequency beats through the use of a device which is both a radio-fre- quency generator and a detector of the audio-frequency best currents produced.

Series Resonance. — When a single lumped capacitance and a single lumped inductance are connected in series be- tween terminals to which an alternating E. M. F. is ap- plied, and the inductance or capacity or frequency is varied, the condition of series resonance 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 objects or masses of gas.

stepping condenser — a condenser used to provide direct-current induction, but which permits alternating current to flow in the circuit.

stray — electromagnetic field causing disturbances in radio reception other than those produced by the radio transmitting system or by alternating current inside wires. The term "stray" includes atmospheric disturbances and disturbances caused by electrical apparatus. A reduction of the effects of strays in radio reception increases the single-dip ratio.

t-antenna — a dip-in antenna in which the lead-in is taken from the center of the horizontal portion.

third winding — a special winding incorporated in the radio transformer of the Model 400-A Supreme Radio Di-marker primarily for inductively coupling the Supreme thermocouple to be indicated on the one-millimeter movement of the Supreme D. C. voltmeter. This item is sometimes applied to the pickup winding of the Model 400-A Recorder coil.

three-electrode tube — a combination of a heated cathode, a relatively cold anode, a filed electrode for controlling the current flowing between the other two electrodes, the whole combination 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 induction 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 socket — the sockets used with the Multipoint Recorder circuits, or with Releventor circuits, of Supreme Radio Di-markers for the regeneration of insulated filament tubes, and for accommodation of tubes to be tested or used in the oscillatory circuits of these instruments.

volt — the unit of Electro-motive force. A potential of one volt exists between the open ends of a flowing stream of one ampere of current.

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 has a power output of one watt of power.

wire antenna — a length of wire an antenna the physical length of which is approximately equal to the length of a wavelength to be received, and which is so used as to be directionally strong.
Wave-Length. — The ratio of the velocity of propagation of electric waves to the frequency.

Wave-Meter. — An instrument for measuring frequency and wave-lengths.

Wave-Trip. — 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 resonators.

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

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 af
forced by tube socket analysis. The high frequency characteristic 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 high
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 circuit may be determined by socket analysis where the loop cir
cuit is directly coupled to the first radio tube, but it is so
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 an
alysis. Where the pick-up circuit consists of an aerial and ground or counterpoise, no potential is applied be
 tween the two, and even when 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 analy
sis.

The antenna of the radio being tested should conform as nearly as practicable to the specifications of the manufac
turer of the radio on which it is to be used. A com
parative test of the pick-up capabilities of the antenna
may be had by testing the radio to a generator of modu
lated 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 loudspeaker when the aerial is discon
nected and bypassed on the antenna binding post of the
radio. The absence of a strong “clicking,” when this is
true with the volume control of the radio at its normal
setting, usually indicates an inefficient signal circuit.
The ground should be checked in a similar manner,
although there should be a very perceptible drop, amount
ing to about 50% in audibility, when the ground is dis
connected. 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. Lighting arresters should always be checked for shorted electrodes. Steps the antenna and ground leads together or on the house line 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 measurements:

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 0/100/100/10 scales, the 0 scale will have a resistance of 600,000 ohms, the 10 scale 100,000 ohms, and the 100 scale will have 10,000 ohms.

Example: A voltmeter as described above is available with a scale 0 volt "B" battery for measuring an unknown resistance. Use the 0/100 scale which has an internal resistance of 600,000 ohms. A reading of 20 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,

\[
\frac{30 - 20}{15} = 1 \implies \frac{15}{15} = 1
\]

\[
\frac{15}{15} \times 100,000 = 10,000 \text{ ohms}
\]
A TEST OF AUDIO TRANSFORMERS

Transformers may be tested by momentarily connecting a battery across the primary, with a voltmeter across the secondary. If a leak is indicated on the voltmeter, the windings are either open or short circuited.

Shorted windings will decrease the kink.
REPAIR POLICY.

While the utmost quality materials and other equipment are used, and the utmost care is exercised in the construction of SUPREME DIAMONDTINES, 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 DIAMONDTINE 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 de

In the event of damage to any of the meters, repairs thereof 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 within a few days.

Where service stations are not available, or at the owner's option, upon receipt of advice either by mail or by personal letter, 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 replacing the returned meter. This cost is usually of nominal proportion. 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 parts, 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 DIAPOGMETERS 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 over actual cost, exclusive of overhead, and the additional expense of carrying accounts for such items could not be incurred without incurring the charges made.

If reasonable care is exercised in handling the SUPREME DIAPOGMETER, 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 test assurance that can be given against the annoyance of break-downs.

Do not send any instrument for repair or replacement without writing 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 departments.
Wosten Meter Service.—Following is a list of authorized repair stations for Wosten meters located at various points throughout the United States. These concerns, in our opinion, are all well qualified to handle repairs on Wosten instruments and are furnished with Wosten parts for repairs as their requirements demand:

Wosten Electric Instrument Corp.
Newark, N. J.

A. K. Mench,
28 Wallace St.
Somerville, Mass.

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

Instrument Service Laboratories,
3641 Murray Ave.
St. Louis, Mo.

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

W. E. Todd,
4408 Thomas Ave.
Minneapolis, Minn.

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

J. Sayre Christie,
608 N. Clark 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. Forsyth,
77 Verry St.
New York City, N. Y.

Standard Laboratories,
1213 Oct St.
Kansas City, Mo.

Mr. C. P. Henderson,
501 Building
San Francisco, Calif.

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

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

Macquarie-Carson (Australia), Ltd.
Sydney, Australia.

v. William St.
SUPREME SERVICE LEAGUE

Membership in the Supreme Service League is open to all purchasers of SUPREME DIAGNOSTICS. As it is the purpose of this cooperative 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 desires. In the event the applicant is at first unable to pass such tests and examinations, in 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 customer to reap the financial reward to which they are justly entitled.

In the purchase of the SUPREME DIAGNOSTIC 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 patients.

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 periodic advertising and cooperative 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 up 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 kindly pay in full all national advertising an appeal to the 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 to preference in unknown, unproved, low 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:
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 contributing 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:

1. When several subjects are discussed in the same letter, it necessitates passing each 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 wearying at times, 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.

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

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

4. All matters pertaining to technical problems, advertising kits, denominational 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 man- ual, but if the user prefers a leather or better quality binder, one can be purchased at almost any stationery store. At the store, and punching employed is standard and in general use.

If desired we can supply a good quality fabricoid six ring binder at low cost, representing actual cost and giving the individual user the benefit of purchasing made in large quantities.
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<td>Adapters, Neutralizing, X to Y, each</td>
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*Note—Items listed without corresponding prices are not available at this printing. Those prices will be included in a revised price list in a subsequent issue of "Diagnostician.""
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