SERVICE

A MONTHLY DIGEST OF RADIO AND ALLIED MAINTENANCE

Crazy over horses . . . .

(see page 124)

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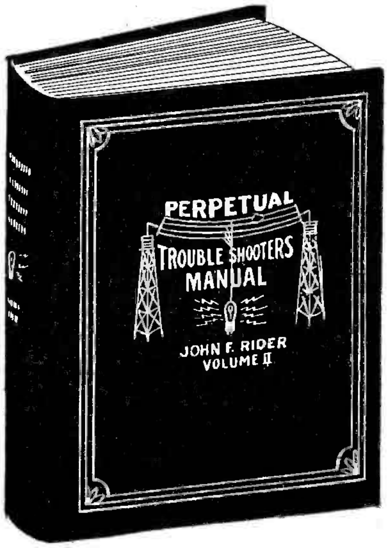
JUNE
1932

GOING OVER BIG . . .

Volume No. 2
of the Perpetual Trouble Shooter's Manual

. . . By JOHN F. RIDER



Volume No. 2 of the Perpetual Trouble Shooter's Manual picks up where Volume No. 1 left off. It contains all 1932 receivers announced and manufactured up to date.

More than 700 pages of the finest type of radio service material that it was humanly possible to secure. Volume 2 of the Perpetual Trouble Shooter's Manual is the only one which contains all the data you require to service a receiver at a profit.

In this Manual John F. Rider fulfills every demand made by the servicing industry for service data. For the first time in the history of radio service publications, every radio receiver shown in the manual contains full electrical values of resistances and condensers.

Radio Service Men have continually asked for electrical values. . . . You will find them in Volume 2 and we guarantee that every diagram shows these values. Radio Service Men have continually asked for electrical values of Atwater Kent receivers. You will find them in Volume No. 2 of the Perpetual Trouble Shooter's Manual.

Point-To-Point Resistance Data

Rider's Volume No. 2 of the Perpetual Trouble Shooter's Manual now offers to the radio service man circuit breakdown of commercial receivers. Not only do the diagrams in the manual show the resistance and capacity values, but special pages are included which show the point-to-point resistance, between any two points in the receiver. NO OTHER MANUAL CONTAINS THIS TYPE OF INFORMATION.

This point-to-point resistance data has no equal in information which enables rapid and accurate servicing. With this data at hand, you can use your ohmmeter or other resistance measuring unit and check the circuit by simply contacting different points upon the receiver or amplifier tube socket.

The point-to-point resistance data contained in the manual represents the finest and latest advancement in the art of radio receiver servicing. When you have this information you can check a receiver and locate the defective part without pulling the chassis from the cabinet. . . . Resistance measurement in this fashion removes all circuit limitations. . . . You need not worry about line voltages—voltage tolerances. . . . It makes possible measurement of resistance between any two points in the receiver and there are no "ifs"—"ands"—or "buts." . . . The circuit is either correct or incorrect.

This is a partial listing of this information as applied to one receiver in Volume No. 2 of the Perpetual Trouble Shooter's Manual. If you will examine this data and try to apply it to any receiver by working between the various points suggested, you will realize how easy it is to analyze a receiver without removing it from the cabinet. Of course, the values given in this table apply only to this receiver.

From '47 Space Grid to 2nd Detector Plate	29,454 ohms
" " " " " IF Plate	50 ohms
" " " " " 1st Detector Plate	50 ohms
" " " " " RF Plate	26 ohms
" " " " " IF Screen Grid	6,000 ohms
" " " " " 1st Detector Screen Grid	6,000 ohms
" " " " " RF Screen Grid	6,000 ohms
" " " " " Ground	13,000 ohms
" " Control Grid to Ground	59,250 ohms
" IF Screen Grid to Ground	7,000 ohms
" " Control Grid to AVC Tube Plate	50 ohms
" " Cathode to RF Cathode	0 ohms
" " " " RF Control Grid	200 ohms
" 1st Detector Control Grid to Ground	26 ohms
" '80 Filament to RF Plate	26 ohms

Wiring Diagrams—Chassis Layout—Etc. . . .

The contents of Volume No. 2 has been prepared with the idea of aiding the service man. John F. Rider sent out several thousand questionaires to service men at large and to owners of Volume 1. The answers to these questionaires indicated the type of information required. Everything you need in the form of data you will find in Volume No. 2. Wiring diagrams—chassis layouts—socket layouts—alignment data—peak frequencies—location of trimmers—color coding—electrical continuity of units sealed in cans—special notes—circuit peculiarities—voltage data—and much more. Special attention has been paid to auto-radio receivers—installation notes—special data—automatic record changers—superheterodyne converters—everything to help the Service Man.

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SERVICE

A Monthly Digest of Radio and Allied Maintenance

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THE ANTENNA...

THERE is a seven-pin tube in the offing. From what is heard it will have three grids, a plate, a cathode and a heater. All of the elements will terminate at the socket; no cap used. By properly combining the grids, the tube will be suitable for use as an output pentode, class A triode or class B triode.

Perhaps the future receiver will incorporate but one type of tube, with different grid combinations so as to adapt the tube for any specific use.

• • •

WE know for a fact that several major manufacturers are working out a program of selling certain complete units to the service fraternity—giving the Service Technician the opportunity of making the sale and the installation. Other manufacturers are embarking upon the production of major accessories, intended particularly for distribution to the service trade and for sale by the service group. Some of these products are secondary speakers and remote-control apparatus. The potentialities of the Service Technician as a qualified technical salesman are being recognized.

One of the snags presented in connection with Service-Salesmen has been the fact that some Service Technicians working for dealers do not approve of the product sold by their dealer and consequently cannot go about the process of selling wholeheartedly. This problem is not beyond solution. You can always find products sold by your dealer which meet with your approval. Recommend those products. If you are an independent, then make your contacts with those dealers who sell the products you like.

• • •

THE independent Service Technician has a part in the commercial auto-radio servicing program. One of the major auto-radio manufacturers has advised us of the fact that their distributors are authorizing Service Organizations in different communities to handle all radio service for the automobile dealers in that territory. Examine the list of auto-radio manufacturers. Secure the names of their jobbers in your territory and present the plan, proving that you are capable of doing the work, to take over all radio service on cars sold by the dealers in your section of the country.

• • •

WHAT about condenser color coding? Resistances are color coded. Why not condensers? Some manufacturers now are employing color combinations to distinguish between condensers of various sizes. Why not all? There are numerous problems, as for example the container which houses four or five condensers of different value, but the problem is not beyond solution.

• • •

GOING up! 10, 12, 14, 16 and 19 tube receivers at the recent RMA Show in Chicago. To replace a set of these tubes is going to cost money. However, that is beside the point. A far more important subject is the servicing of these receivers. The fact that a large number of tubes are used should not lead you to believe that they represent a single receiver. The receivers with many tubes are combination short- and broadcast-wave systems. When service is involved, bear this in mind. The parts of these multi-tube receivers can be segregated into the short-wave and broadcast systems. Tackle them individually.

Six-prong sockets . . . r-f. pentodes . . . several special circuits. Let the design of receivers continue advancing along the lines being followed at the present time and the service field will conform to the law of the survival of the fittest. 12, 14, 16 and 19 tubes means just that many tube circuits. What with the interdependence of many of these circuits and the different sections of the receiver, you'll have to know what you are about when tackling one of these jobs.

• • •

AN excellent plan is in practice among some Philco dealers. Maybe you can convince your dealer (boss, to you) to do the same. If you are an independent, mayhap you can come to some arrangement with a number of dealers. When an old receiver is taken from the customer's home for service in the shop, leave a new midget with him. As long as he is listening to his old receiver, he is satisfied with it. However, if he listens to a more modern receiver during the time that the old one is gone, he may realize that modern receivers have more to offer. Maybe he will not want the midget . . . but at any rate his curiosity and interest will have been aroused in a new receiver.

If the service call does not require removal of the old receiver, leave a new one anyway. . . . If not, try arousing interest in a secondary speaker. Examine the home for the possibility of utilizing another speaker. If possible, make a temporary installation to demonstrate its advantages. It will mean added sales. Present the problem to your dealer. You will find him quite responsive.

• • •

RESISTANCE as a factor in service analysis is becoming of great importance. Point-to-point resistance measurements are dealt with in detail elsewhere in this issue. An examination of the set tester and analyzer field shows great activity among manufacturers to produce equipment which will enable checking of resistance in circuits and the production of ohmmeters which will really cover the range of resistance to be found in modern receivers.

Do you know Ohm's law? . . . You had better become thoroughly acquainted with it, for you will need the information in future servicing. Every reliable text book covers the subject. Spend a couple of hours during the next week-end applying this law to various problems. Quite a large number of modern receivers have parallel and series-parallel circuits. When troubles develop in a receiver, parallel and series-parallel circuits are formed. It will be highly advantageous for you to recognize the type of circuit formed by the defect. The servicing field is becoming "resistance conscious." The greater your knowledge of Ohm's law the more readily will you be able to break down a receiver and locate the trouble.

John F. Rider.

Resistance Measurement Method of Service Analysis

By JOHN F. RIDER

PART I

THE resistance measurement method of analyzing a defect in a radio receiver is at the present time receiving a great deal of attention. The writer admits being responsible for agitation along such lines, because he honestly feels that it represents a superior method of operation.

It is difficult at times, in the face of certain facts, to reconcile certain conditions. In presenting point-to-point resistance measurement, which is an elaboration of continuity testing, as a means of service analysis, we do not lay claim to the introduction of something new. It is by no means new. Radio receiver manufacturers have been using resistance measurement in their plants for inspection and trouble-shooting operation for a long time. Many Service Technicians have been doing the same thing in the field. Many Distributor Service Organizations have been doing the same thing. Herein lies the rub. If the manufacturer of the receiver which you are called upon to service employs resistance measurements between points to indicate a fault, why should some other method be used in the field?

Effect of Receiver Design

In every case where the writer visited the manufacturing plant voltage tables are prepared for the servicing industry only. Why? Because service work started off on that foot when receivers were simple—when a voltage test indicated the location of the fault, because the number of units to be found in any one circuit were few. The system started and was continued.

Times have changed. Receivers have changed in design. Modern receivers are far more complex than those manufactured in years gone by. Service operation must keep apace with receiver development . . . and, strange as it may seem, it is now necessary to revert back to a system which has been used in certain circles for years past, but which never became general in use. Perhaps this is due to the fact that the actual data required to enable resistance measurement was not available. We cannot help but recognize that the last two or three years have witnessed the dissemination of radio service literature, wherein was contained the type of information required so as to allow operation along such lines.

To give credit where credit is due, we must acknowledge that many Service Technicians—unfortunately, the figure does not run into many thousands—have been using resistance measurement methods of service analysis. We take this opportunity to quote a brief resume of such work as presented by one man. The article follows.

ANALYSIS BY MEASUREMENT OF CIRCUIT RESISTANCE

By Mortimer K. Barber

This method of circuit analysis contemplates the location of any type of circuit defect by measurement of the continuity resistance of the circuit, in contrast to the older method of measuring socket voltages. Due consideration of this method of analysis, when compared to the older method of measuring socket voltages, will show that it has numerous advantages over the older method whenever there is a real defect within the receiver, although it is not intended to supersede entirely voltage measurements.

The system removes the variable factors and somewhat uncertain effects of tubes from the factors undergoing investigation. The tubes being tested separately will not affect the analysis (filament excepted) unless shorted internally. Having been tested prior to commencing the tests upon the chassis, it is most convenient to leave them out during the analysis of the radio proper.

Practically every circuit, with the exception of the 110-volt primary in a-c. receivers and sometimes the voice coil or the antenna system in certain receivers, is either directly or indirectly connected to the chassis on one side and the respective socket terminal upon the other side. Therefore the measurement of circuit resistance is possible by contacting the chassis as one testing point and the other end of the particular circuit, which terminates in the tube socket, as the other test point.

This may be conveniently done from the terminals of the "load" socket upon the tester or analyzer, when the tester or analyzer plug is inserted into the socket representing the circuit being tested.

Mr. Barber is brief in his references, and has not enumerated many advantages presented by this method of operation. Thus one of the major advantages is that a complete test can be made without entirely removing the chassis from the cabinet. It is significant to note a reference in his letter that *he has been using the system for years* and that it has given utmost satisfaction during this time.

Our own discussion describing resistance measurement methods of analysis shall be divided into two parts. In this, the first part, we shall briefly state the advantages and show the operation of the system. The second installment will show why service work predicated upon resistance measurement, is superior to service analysis predicated upon voltage tests.

For the defenders of the faith, we want to repeat that resistance measurement does not entirely supplant voltage tests. Voltage measurement has its place, but not as the usual major test. There are times when a voltage test should be applied, but they are not as general as is practiced today.

Testing Tubes Separately

Service analysis based upon resistance measurement requires that the tubes be tested independently of the receiver or its voltages. Also that the tubes be removed from the sockets when the receiver is being checked. Proponents of voltage measurement as a basis of service analysis claim that tube troubles represent the major portion of service calls. Accordingly, voltage measurement, being affiliated with tube troubles, is the most frequently employed observation and consequently is the paramount service operation. In a way we agree that tube troubles represent the major portion of service calls; at least they did in the past. Certain factors have entered into radio receiver design and service which makes independent tube testing, separate from the receiver, an improved operation. Just why this is so is reserved for the second installment of this discussion.

Basic Advantages

We claim that resistance measurement as a basis for service analysis offers certain definite advantages which are not available in any other system. We assume that the tubes have been removed and do not enter into the discussion.

1. The various parts of a receiver, such as condensers, windings (chokes and transformers) and resistances can be isolated by means of a point-to-point test, and the circuits can be broken down to indicate the actual defect.

2. Resistance measurement is the ultimate test in a receiver which has been checked for voltage and the presence of a defect, location unknown, indicated. If it is the ultimate test, why not make it the primary test and save time?

3. Special circuits can be checked, since the most complicated of systems is nothing more than a resistance network. Consequently all systems, irrespective of circuit design, are placed upon the same service level. Examples of these are automatic volume-control systems, direct-coupled amplifiers, etc.

4. Defects in units which will not influence voltage indications are determinable by means of a resistance test. Examples of these are resistances connected in shunt with transformer windings. Also defects in condensers in the form of short circuits, which take place across a transformer winding.

5. Isolation of a defect by interpretation of the resistance between two commonly used points in a receiver. An example of this is the measurement of the total voltage-divider resistance and interpretation of the observed value, to indicate defects in associated circuits.

6. Freedom from the hazard of damaging tubes during the testing period. An example of this is the following: During the time that the voltage test is made, operating potentials must be applied. If the circuit defect is of such nature that the incorrect voltages are being applied, there exists the hazard of damaging one or more tubes in the receiver. The rectifier in an a-c. receiver is a typical example. Any one of a number of defects will cause overloading of the rectifier. During the process of voltage measurement, the rectifier is being overloaded. If the excessive load is applied for too long a time, as may develop within the rectifier, its normal life is being reduced and there exists the hazard of damaging the filament. There also exists the hazard of damage to filter condensers, etc., during the period of testing.

7. The findings are definite and decision can be made without much cogitation. The standard of comparison is a definite figure with minimum tolerance variations.

8. The effects of line voltage variations are removed, since the test is made without connecting the receiver to the power-supply circuit.

9. There are very few, if any, resistance measurements which tend to confuse. All observations are definite and immediately comparable with established comparison standards.

10. Universal type of testing apparatus is satisfactory, providing that the correct ranges are available. The type of equipment employed to prepare the original table for comparison purposes is of no particular significance.

11. A far more accurate and more easily understood table of defects indicated by observations can be prepared for resistance measurements than for voltage measurements. The supplementary test required to prove any one defect is singular in number when working along resistance measurement lines, whereas it may be plural when working with voltages.

12. There are fewer possibilities of confusing observations and measurements.

13. The receiver can be checked without removing it from the chassis. This has several advantages. In the first place it makes testing in the home of the customer an easier operation. Second, it enables the rendering of an estimate covering the cost of the repair before the receiver is removed from the customer's home, if this be necessary. This creates greater confidence on the part of the customer. The service industry at large needs this confidence more than anything else.

14. A great deal of time is saved by the combination of testing tubes separately and making resistance measurement the major operation. In the first place, the separate tube checker furnishes information pertaining to the condition of the tubes with a minimum number of switch changes, etc. When the tubes are checked in the receiver, each tube may require four or five switch changes in order to indicate the operating conditions. Furthermore, in many cases it is impossible to remove a tube from the receiver without disconnecting the power supply, for fear of damaging the tubes. In the event of a defect, another routine test—resistance, primarily—must be made over the same ground. Tubes are removed, placed into the analyzer, the analyzer plug is inserted into the tube socket, etc. After the tubes have been checked and the voltages determined, the complete process is reversed. This multiplicity of motions must be made for each tube and it is a costly waste of time.

Independent Conditions

There are conditions under which neither voltage nor resistance tests are of value, such as:

1. When tuning condensers do not track properly.
2. When neutralizing condensers are not correctly adjusted, or when the location of certain tube leads in such respect to each other as to cause excessive regeneration.
3. When tuning condensers or bypass condensers are open circuited.

There are certain times when neither resistance nor voltage measurements means anything, primarily so because the character of the defect has nothing to do with either voltage or current.

Voltage and Resistance

This is not an exposition of Ohm's law. What we are referring to is that the voltage measured at each tube socket depends entirely upon the resistance in the circuit. If the resistance in the circuit is excessive, the voltage will be low. If the resistor is open, there will be no voltage at the tube elements. If the resistor or the circuit is shorted, voltage may be high, or there may be none, depending upon the character of the fault. You can therefore see that everything hinges upon the resistance of the various units in the system, that is, everything related to voltage. Perhaps you feel that the plate current is also an indicator. In a way it is, and then again it is not. The plate current depends upon several factors, such as tube condition, the resistance in the circuit, the bias voltage, the bias resistance, contacts, etc. There is no one condition which may be observed by means of a voltage and current test, which will indicate the trouble and eliminate the need for a resistance test. It is always the resistance which influences the observations, as long as the tube is good. Unfortunately, because of tube and tube circuit structure, several different faults will produce a similar effect. Thus, plate voltage and no plate current, with voltage between control-grid and cathode may be due to at least four different conditions. One of these is a defective biasing resistor. Another is an open biasing resistor plus the action of the control-grid bias measuring voltmeter resistance functioning to complete the bias resistor circuit and produce the high bias. The third is an open plate or cathode in the tube, but indicating a bias voltage because of a bleeder resistance between the plate circuit and the cathode. The fourth is a deactivated tube. Why have such a complication of conditions?

There was a time when receivers were simple. With the present mode of automatically developing various tube voltages through complicated circuits, and analyzing a receiver with the tubes in the sockets is making things harder than they should be. Remove the tubes, and irrespective of the type of defect, the most complicated item which can present itself is a series-parallel circuit of resistances. The formation of the circuit is due to the defect. A simple test proves the defect and the problem is solved.

Resistance Tables and Charts

We have had numerous comments from people concerning resistance measurement, wherein the statement was made that electrical values for all the resistances in the receiver would be required and that a table of resistances would be required in order to know whether or not the correct value was available between any two points. That is granted in its entirety. Is it any different from voltage measurements? Voltage measurement as a basis of service work requires a table for comparison—and after this table has been referred to, then it is still necessary to have the electrical values to check the different circuits! The fact that you have a voltage table does not eliminate the need for electrical values.

If you did not have the voltage table, you could not check voltages, for the simple reason that there are no standard values applied to receivers. There are standards for independent checking of tubes, which would be applicable at all times, but when the tubes are used in the receiver, a separate voltage table is required for each receiver.

As far as resistance measurement is concerned, you have a resistance table instead of a voltage table. It is true that the resistance tables will have more individual items than the voltage table, but please bear in mind that when you make the resistance test, you then are making the test which would normally follow as the secondary operation after the voltage measurements. Consequently, you are saving yourself the time required to make the voltage test.

Resistance vs. Voltage Tests

The problem of resistance values is not as great as it may appear upon the surface for, after all, you are no worse off making a resistance test between points, following a wiring diagram, without having the electrical values, than you are making a similar test after you have found that a voltage discrepancy exists in one or more circuits and you do not have the correct values of resistance for that receiver. In the modern receiver, such voltage indications mean very little, for the simple reason that so many resistances are tied together (electrically speaking) that the actual reason for the discrepancy may be located external of the circuit where the indication appears. If this fault is due to some short circuit, resistor or condenser, that same condition will be found via a resistance test, without ever checking voltage, and at the same time the exact location of the defect will be known because the condition of that circuit is indicated in the resistance test.

Lack of voltage at one point will indicate an open circuit. But that open circuit would also be found if the voltage test were never made, but instead a resistance test were made between the same two points.

Perhaps you are giving thought to the fact that the voltage indication will show whether the units in that circuit are "high" or "low." That is true, but how are you going to check the various units in that circuit if you do not have the ohmic values of the various units? And if you have the values, why should it be necessary to first employ some system which will show if they are "high" or "low" and then check them to determine if your voltage finding was correct? Instead of the voltage test you could employ the resistance test and secure this information.

Mayhap you are now thinking of the case where the voltage measurement shows the circuit to be perfect, which eliminates the need for a resistance test. If so, have you considered the fact that it would be just as easy to make the resistance test as the voltage test and arrive at the same conclusion? In both cases it is just one operation.

Relative Examples

Let us look at this problem from another angle. Suppose that you have a receiver to service which is dead. You have no wiring diagram, no voltage data and no electrical values. What would be your first step? (We are assuming that the speaker, aerial and ground circuits are O. K.) We are certain that if you followed routine methods as dictated by past actions, you would check the voltages at the sockets and thus determine the condition of the tubes and seek a sign of a defect. If you thought the tubes were good and some circuit appeared defective, you would naturally examine that circuit. Bear in mind that you have no basis for knowing whether or not the voltages which you measured are correct. Please do not say that you can judge by the average values of the plate, control-grid and screen voltages, as applied to that set. That is not true in the modern receiver. Let us quote an example. Here are plate, screen and control-grid voltages for the r-f. and first detector tubes in three types of a single model receiver produced by a well-known manufacturer.

		Plate	Screen	Control Grid
R-F.	Type 1	100	45	—3
	Type 2	150	40	—3
	Type 3	205	70	—3
1st Det.	Type 1	100	40	—5
	Type 2	135	35	—4
	Type 3	150	70	—4

Compare these figures with those classed as standard. The tube is the '35. Here they are:

	Plate	Screen	Control Grid
As r-f. Amplifier	180	75	—1.5
As 1st Detector	250	90	—7

You must admit that there is quite a discrepancy between these values. The designer of the receiver follows his own ideas with respect to voltages applied, bearing in mind of course certain definite requirements pertaining to the tubes. Furthermore, the standard figures quoted are not related to loads of various kinds, whereas some of the voltages which you measure already include resistances in the plate circuit. You must admit that as far as judging correct or incorrect voltages from standards is concerned, it is a mighty difficult matter, if not impossible.

Now, if what we say is true, and we have had reasonably frequent evidence that it is true, is there not the hazard of incorrectly judging the condition of the tubes because you do not know whether the voltages are correct and what change in plate current to expect for any predetermined grid bias change, if you use that method? Would it not be much better to determine the condition of the tubes used in that receiver by regular methods independent of the receiver voltages? We feel that you will agree with us upon this point.

We also feel fairly certain that you will agree with us when we say that you could just as easily check the resistance across the two points you employed for the voltage test, working right through the sockets. Since you can check the voltage through the sockets, there is no reason why you cannot check the resistance through the sockets. However, whether you work through the sockets or with the chassis pulled is of no consequence. In the first place, you do not know the function of the various tubes, unless the sockets bear functional as well as tube-type designations. In either case it will make very little difference.

Common Circuits

As a Service Technician you are familiar with certain fundamental facts about radio receivers. You fully realize that if a receiver is of the a-c. type that the rectifier filament circuit, which is the start of the positive or plus voltage system, would be directly or indirectly connected to the various plate circuits. Furthermore, that the plate voltage fed to all of the tubes is applied through some type of transformer winding—perhaps through the voltage divider. Accordingly, the circuit between the rectifier filament circuit and the plates of the various tubes in the receiver and amplifier should show continuity. Also, the state of continuity should never be zero resistance.

You are also familiar with the fact that the filament and anodes of the rectifier tube are joined through a voltage-divider system, inclusive of the filter chokes. Accordingly, the resistance measured between these two points should always be in excess of the resistance representing one-half of the rectifier anode winding, which means in excess of 125 to 250 ohms.

You are also familiar with the fact that the chassis of the receiver is connected to the cathodes of the various indirectly-heated a-c. type tubes and to the filaments of the filament-type of a-c. tube. Thus, checking between these circuits should show some form of continuity. An open circuit would arouse suspicion. You are also familiar with the fact that the control-grids of all tubes return to the chassis by some means or other. Hence, there should be continuity between the control-grids and the chassis. However, there are no circuits wherein the control-grid is connected directly to the chassis without any resistance in the circuit, small as it may be. Consequently, short circuits arouse suspicion. You also know that screen-grid circuits are connected to the plate-voltage supply system, but at no time is there a direct short between the screen-grid and plate.

(*To be continued*)

The Man on the Cover

Carol M. Sell

Service Manager, All-American Mohawk

LIKE most men who have purposely devoted their lives to science of one kind or another, Mr. Sell is inclined to be modest. Yet it is very much to his credit that he has reached his present office while still a young man.

Mr. Sell was born in Pennsylvania, October 8th, 1907 —about the time of one of this country's major depressions. From his early days he tinkered with radio, as most of us did, but his tinkering turned to something more definite when he entered High School, for he spent all of his spare time working for a Radio Dealer in Gettysburg, Pa. This part-time position gave him much fine practical experience, and though he makes no mention of it, we are quite sure that Mr. Sell got his first real taste of Radio Servicing on this very job.

At any rate, whether or not he went in for servicing at that time, he desired a more thorough practical training in the technical field, and after graduating from High School, packed his belongings (which probably included at least one good ammeter or voltmeter) and struck out for Chicago.

Luck or ability walked with him, for he landed a job as Tester with the All-American Radio Corporation. We think it must have been ability because they made him a full-fledged Inspector before many moons.

During his stay in Chicago, Mr. Sell studied Mathematics and Electrical Engineering in the evening classes at the Armour Institute of Technology. In February of 1930 he was transferred to North Tonawanda, N. Y., with the All-American Mohawk Corporation, where he has been ever since.

Mr. Sell is a veteran golfer, but his big hobby is horses. He gallops and canters around North Tonawanda and when weary of that he returns to his home "lab" to experiment with circuits and read the latest radio dope.

Mr. Sell believes that the quality of service rendered the radio public today is far better than ever before because the Service Men have realized the need of technical training and take advantage of the many opportunities within their reach to better themselves. He says that the Radio Service Man of today must have a thorough understanding of the fundamental principles of radio in order to efficiently service present-day receivers.

Noise-Reducing Aerials

BY FLOYD FAUSETT

Chief Engineer, Supreme Instruments Corporation

THIS discussion outlines some theories involved in the installation of simple transposition aerials for minimizing the broadcast reception of locally-generated man-made static. The use of twisted duplex wire for obtaining the transposition effects is described. Since most initial aerial installations are relatively inefficient, this paper suggests a possible source of increased service income derived from the replacement of dilapidated aerials with more efficient noise-reducing installations.

In almost every locality it is found that the full sensitivity of modern radio receivers cannot be utilized because of locally-generated "static." The importance of the subject of radio interference caused by poorly-designed or defective electrical apparatus is evidenced by the fact that a Joint Committee on Radio Interference has been appointed by the RMA, NELA, and NEMA. This committee of the three large national organizations is engaged on the important work of reducing radio interference, to improve performance of radio sets, increase public satisfaction and stimulate sales of electrical as well as radio products. At a recent meeting of this committee, an educational program was adopted to include press releases by the RMA to aid the radio public in *installing proper aerials* and other measures to improve the performance of receiving sets.

Characteristic Noises

Locally-generated "static" is generally recognized by its mechanical regularity or consistency as contrasted to natural atmospheric static which generally consists of irregular crashes or of a frying roar which varies in intensity with changes in atmospheric conditions. The distinction between natural and man-made static is not always clear, however.

It is sometimes found that defects in a radio or in the radio tubes can cause noises which sound like locally-generated or atmospheric static, but the Service Man can easily determine whether or not noises are generated within the radio by removing the aerial and short circuiting the aerial and ground terminals of the radio, which will eliminate or greatly reduce external noises. Any noises which are generated within the radio will generally persist undiminished after short circuiting the aerial and ground terminals. There may be exceptions to this rule, but the exceptions are very rare.

It may be suggested that if noises are being carried into the radio by the power supply system, the elimination of the aerial pick-up by the procedure outlined above would not eliminate the pick-up of the noises carried by the power supply system. However, experience has proven that noises are rarely carried into radios via the power supply circuits, probably because one side of most power-supply systems is generally grounded, and because the power transformer of an a-c. operated radio is a very effective choke against the high-frequency energy of undesirable signal interference. Most Service Men have tried commercial "line filter" devices and found that they are ineffective, simply because the undesirable noises, in almost every case, are picked up by the aerial system. It is true, however, that power supply and telephone lines may carry noise energy which may be reflected or re-radiated and easily picked up by the aerials which are in close proximity to such lines. It is also possible for trees, roofs and walls to reflect or re-radiate high-frequency signals. Some non-conductors are affected by electro-static energy, as every student of electro-static phenomena knows. The intermittent contacting of a shrubbery limb against a clothes line has been known to cause static noises in all of the radios in the vicinity.

Excellent work has been done by the leading manufacturers of filter devices in inducing the manufacturers of electrical apparatus to apply filters so as to eliminate or minimize the mechanical generation of disturbing signals, and the whole radio industry should encourage these efforts by way of whole-hearted cooperation. Municipal governments, in many places, are enacting ordinances aimed at improved radio reception by compelling the users of defective or poorly-designed electrical apparatus to apply filters for suppressing the interference radiation. However, this is a tremendous undertaking, and it will probably be many years before the objectives are accomplished.

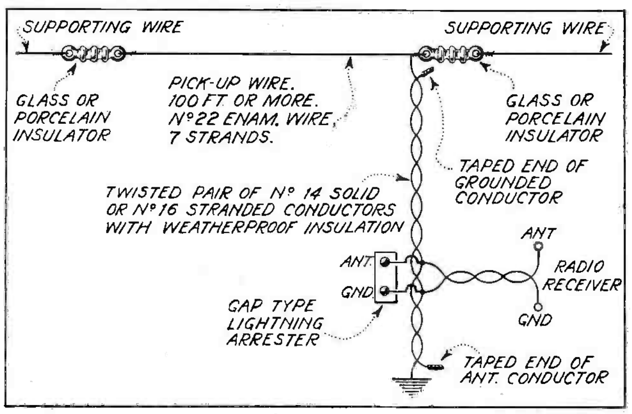
Minimizing Interference

It is the purpose of this discussion to suggest a method for minimizing the pick-up of undesirable man-made static, without minimizing the importance of eliminating the static at its source, if practicable. It is generally conceded that man-made static is generated close to the ground, and remains close to the ground, except when it is carried, reflected, or re-radiated by wiring, structures, etc., whereas the field of desirable broadcast signals is practically as strong or stronger at considerable distances above the ground. The plausibility of this theory has been demonstrated by carrying a portable radio receiver in an elevator from the ground floor to the top floor of a tall building, during which it was observed that static noises decreased in strength as the top floor was approached. It may then be concluded that most of the man-made noises heard in a radio are picked up by the aerial lead-in, or by those portions of the aerial system which are in close proximity to grounded objects, pipes, power supply and telephone wires, roofs, walls, etc., which conduct or re-radiate undesirable high-frequency electrical or electro-static noises.

The problem, then, resolves itself into one of (1) getting the horizontal pick-up portion of the aerial out of the noise field, and (2) eliminating or greatly minimizing the pick-up of the lead-in conductor which must pass through the noise field to the radio. The first method commercially suggested for accomplishing these purposes consists of the use of shielded lead-in wire, using separate grounds for the shielding. Some excellent results have been reported for this method, especially where the shielding was grounded at several points along the lead-in conductor. It is probable that ideal results cannot be accomplished with this method, because a shielded lead-in constitutes a capacitor, the shielding being one plate or electrode, the insulation being the dielectric and the conductor being the other plate or electrode. An electric charge on one plate of a capacitor causes an electric charge of equal potential and opposite polarity to appear on the other plate, so that a noise or signal potential inductively or electro-statically established on the shielding of the conductor will cause a noise or signal potential to be carried into the radio by the conductor. This action appears to be minimized by grounding the shielding at several points.

Transposition Method

Working on the basis of the theory outlined above, experiments have been conducted with ordinary outside twisted duplex wire, utilizing one of the weather-proof insulated conductors as the aerial lead-in, and grounding the other conductor, in the manner indicated by the accompanying drawing. The capacitive effect of two conductors separated by an insulating dielectric is practically the same as that existing with shielded lead-in conductors, but the pick-up of



Details of the Transposition Aerial installation. The twisted duplex wire used for the lead-in functions the same as a condenser. With this arrangement the signal to noise ratio is greatly increased

the twisted duplex is neutralized by the transposition effects resulting from the twist, just as cross-talk on telephone lines is neutralized by frequent transposition of the lines. The effect of twisting the wires is to make the average distance between the interfering signal and each side of the twisted pair the same, so that the potential induced in one wire will exactly equal and neutralize the potential induced in the other wire.

The capacitive effect of the paired wires weakens the signals somewhat, but the locally-generated static noises are weakened in much greater proportion, so that the ratio of signal level to local noise level is greatly increased. It has been found that the slight losses, resulting from the capacitive effect of the twisted pair lead-in, can be reduced somewhat by the use of a step-down r-f. transformer for coupling the pick-up portion of the aerial to the twisted pair lead-in, with a step-up r-f. transformer for coupling the twisted pair lead-in to the "Antenna" and "Ground" terminals of the radio. The use of the transformers reduces the r-f. potentials between the paired lead-in wires, but introduces the usual transformation losses and usually necessitates leaving the radio un-grounded which is undesirable from the Underwriters' viewpoint and subjects some types of radios to the effects of body capacity during manual operation of the radio controls. However, some radio manufacturers are apparently offering for sale, with their radios, noise-reducing aerial parts which include transformers under other technical names.

Length of Aerials

The slight losses resulting from the use of the twisted pair lead-in can be more easily and economically compensated for by the more desirable expedient of making the horizontal "pick-up" portion longer than the usual aerial. Some Service Men have believed that short aerials pick up less noise than long aerials. While this is true, it is also true that the short aerials pick up desired signals with less intensity than long aerials. It has been found that, in locations subject to severe industrial noise interference, a very short antenna affords unsatisfactory reception. On the other hand, a long higher aerial intercepts signals of intensities well above the noise level of undesirable signals closer to the ground. Horizontal aerial lengths between 100 and 150 feet are suitable, depending on circumstances.

The twisted duplex wire should be continuous from the aerial and ground terminals of the radio to the elevated pick-up portion of the aerial. This is very important, as leaving the pair untwisted for a few inches at the radio or lightning arrester may offset most of the advantages which should otherwise be obtained.

The pick-up portion of the aerial system should be supported with glass or porcelain insulators so as to be at least four feet from surrounding objects, as this distance seems to be sufficient to get away from the re-radiation of surrounding objects. It should be as nearly perpendicular as practicable to all other adjacent wires.

If the radio is located several feet from the ground, it may be advisable to extend the twisted duplex wire to the ground, with the dead end of the aerial conductor taped so as to provide permanent insulation from the ground rod, which is generally preferred to water pipes for ground connections. The lead-in pair should be brought through the wall, or floor, in approved porcelain tubes.

Good Installation Necessary

This discussion is the result of experiments which have proven quite satisfactory, and no claim is made for the accuracy of the theories advanced for explaining the results accomplished. After all is said and done, results are more important than convenient theories. The Service Man is urged not to expect ideal results from transposition aerials, but to remember that each installation has its own problems. If he will install the pick-up portion of his aerial as high as practicable, as nearly at right angles as practicable to other wiring, and keep the pick-up portion four feet or more from surrounding objects, splicing well and resin-core soldering all necessary joints, it is believed that transposition aerials will be found very helpful.

The twisted duplex weather-proofed wire may be obtained from electrical supply dealers, and is easy to handle. Since a plurality of grounds is not necessary, the installation involves no more labor than is involved with the usual aerial.

General Data . . .

RCA Victor R-78

The RCA Victor Model R-78 Bi-Acoustic Super-Heterodyne (also General Electric J-125) uses four '58 tubes, five '56 tubes, two '46 tubes and an '82 mercury vapor rectifier. The average power consumption of the receiver is 110 watts, but due to the use of Class B audio amplification the wattage may vary from 70 to 130 watts depending on the output volume being used. (See data on Class A and Class B amplification in this issue.)

It will be noted from the circuit diagram of the R-78, shown in Fig. 1, that there is a single tuned r-f. stage feeding into the first detector, and followed by two i-f. stages. Note that the control grids of these two i-f. tubes are connected in parallel. The function of this second i-f. tube is to drive the automatic volume control tube.

The first i-f. tube feeds into a type '56 second detector which in turn is coupled to a pair of '56s in push-pull. These two '56 tubes operate as Class A amplifiers and the grids are biased by the drop in voltage across

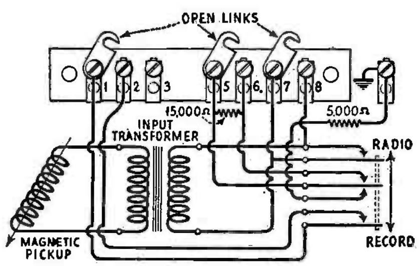


Fig. 3. Showing the manner in which a magnetic pickup and transformer are connected up to the terminal strip of the R-78

the resistor R-23. The '56 tubes in push-pull drive the two '46 tubes in the output Class B power amplifier. Note that T-3 is a step-down transformer. This is necessary as the '46 tubes require a low-impedance input circuit due to the fact that the grids function only on the positive half of the cycle and considerable grid current flows.

Automatic Volume Control

Now, let us go back to the automatic volume control circuit for a moment, and explain its whys and wherefores. The input signal for the i-f. amplifier is also applied to the AVC amplifier tube due to the grids of both being coupled together by the 300-mmfd. condenser C-19. The output of the i-f. amplifier is applied to the second detector through a sharply tuned transformer. However, the output of the AVC amplifier is coupled to the AVC tube through a broadly tuned transformer. The reason for this is that too much selectivity ahead of the AVC tube is not desirable as it introduces excessive distortion and overload as a station is tuned in. Nevertheless, a certain amount of selectivity is essential, otherwise the AVC will be caused to function by a local station when it is desired to tune in a weaker station on an adjacent channel.

It will be noted that the grid and plate of the AVC tube are tied together. This gives a straight rectifier action and the drop across resistors R-2, R-3 and R-4 gives the bias for the r-f. stage. The drop across R-3 and R-4 comprises the grid voltage for the first detector and that across R-4 the grid voltage for the i-f. amplifier. As the drop in these resistors is due to the signal voltage applied to the AVC tube and this voltage in turn dependent on the bias of the r-f., detector and i-f. amplifier, an automatic action is obtained. The reason for the greater voltage applied to the r-f. stage and first detector than that applied to the i-f. is to prevent overloading of these tubes on the side of a strong carrier.

Manual Volume Control

Since there is no danger of overload on the detector grid, the manual volume control is located in the audio circuit. It will be found between the second-detector coupling impedance L-14 and the input push-pull transformer T-4. Note that the first section of the volume control variable resistance is 30,000 ohms and at this point is connected a trap circuit, consisting of reactor L-15 and condenser C-31, directly in the output circuit of the detector.

The trap circuit tunes to approximately the middle of the audio response range and causes greater attenuation of the middle register than at either end as the volume is reduced. The effect as this point is reached is to reduce the general volume level of the middle register a greater amount than at the low and high ends. From this point to the minimum position the volume control acts as a potentiometer across the trap circuit and reduces the volume without changing the response at any greater degree.

The foregoing description applies to only one section of the volume control. Actually, there are two sections, the other being between the r-f. and first detector cathodes and varying the overall sensitivity. This control prevents all noises and signals of a very weak character from being received and only functions over the last twenty degrees of the angular movement of the volume control. However, if such signals are desired it is only necessary to advance the volume control in the usual manner to its maximum position.

It will be noted that the value of the coupling condensers in the second detector output circuit varies, depending on the position of the switch S-2. The purpose of this switch is to decrease the low-frequency output when receiving stations that have carrier waves with an excessive hum component. Also a certain amount of low-frequency growl due to heterodyning of stations may be eliminated by this switch. (The reason for the necessity of having this attenuation for certain conditions will become apparent when

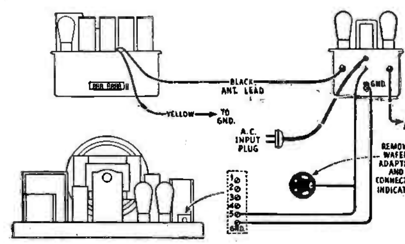


Fig. 4. Connections for attaching Short Wave Converter Model SW-2 to the chassis of the R-78

it is learned that the frequency response of this receiver is approximately 35 to 5,000 cycles.—Ed.)

Service Data

It is very important that a good ground always be connected to the yellow lead of the receiver chassis. Unless this is done excessive hum and noise will be obtained, even at low volume, from the '82 mercury vapor rectifier. Also the lack of a good twist in the volume control leads will cause an excessive amount of hum due to pickup by the tone control reactor.

The automatic volume control heretofore described is so designed that it maintains a constant output only on signals in excess of 100 microvolts. In most locations this action is entirely satisfactory, as stations rarely drop below this value. However, if the receiver is to be operated in a locality remote from stations where the usual signal intensity is low, a slight change may be made in the receiver chassis that will extend the AVC action to signals of a much lower input. This may be done by removing the chassis and connecting a wire from the terminal on the 400-ohm section of the volume control to ground, as shown in Fig. 2. It should be remembered that this change will greatly increase the noise level between stations, due to the secondary section of the volume control not being in the circuit.

R-78 VOLTAGE READINGS

Tube	*Cathode Volts*	*Control Grid*	*Screen Grid*	*Plate Volts*	*Plate Current*
R-F.	7.0	0	100	210	3.0
1st Det.	10.0	0	95	210	1.5
Osc.	7.0	0	—	70	5.0
I-F.	8.0	0	95	210	2.5
I-F., AVC	7.0	0	95	210	3.0
AVC	15.0	0	—	0	0
2nd Det.	12.0	12.0	—	200	1.0
A-F. 56s	11.0	8.0	—	210	5.0
Pwr. 46s	—	0	—	400	6.0

R-F. Alignment

Four adjustable condensers are provided for aligning the r-f. circuits and adjusting the oscillator frequency so that the oscillator will maintain a constant frequency (175 kc.) difference from that of the incoming signal. Poor quality, insensitivity, poor AVC action and possible inoperation of the receiver may be caused by these condensers being out of adjustment.

The following procedure may be used for aligning these condensers: A dummy '56 is necessary to substitute for the one normally used in the AVC socket. This should be a tube that is otherwise normal in all respects but having one heater prong removed. Insert this tube in the AVC socket.

First check the chassis and carefully ascertain that the dial pointer reads exactly at the short line on the scale when the tuning condenser rotor plates are fully meshed with the stator plates.

Place an r-f. oscillator in operation at exactly 1,400 kc. and couple its output to the antenna. Set the dial scale at exactly 1,400. Connect an output meter to the set (an 0-5 milliammeter connected in series with the plate supply to the second detector, or a low-range a-c. voltmeter connected across the dynamic cone coil will suffice) and place the volume control at its maximum position. Adjust the oscillator input so that an excessive reading on the output meter is not obtained.

With a wrench (the adjusting nuts are at ground potential) adjust the oscillator, first detector and r-f. line-up condensers, until a maximum deflection is obtained in the output meter. These adjusting nuts are accessible through holes located in the bottom cover of the chassis, the one to the front being the r-f., the detector next and the oscillator to the rear.

Now set the oscillator at 600 kc. Tune in the signal with the receiver until a maximum deflection is obtained in the output meter. Now adjust the 600-kc. series condenser until a maximum deflection is obtained in output meter. Rock the tuning condenser back and forth while making this adjustment as the tuning condenser and oscillator series condenser adjustments interlock. The 600-kc. adjusting screw will be found on top of the chassis just to the left of the antenna coil.

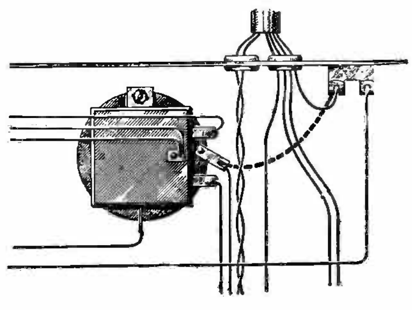


Fig. 2. Wiring change for altering the action of the dual volume control. The dotted line indicates position of new wire

Now, change the frequency of the oscillator to 1,400-kc. and set the dial at 1,400. From here on follow the same procedure as outlined above.

I-F. Alignment

Although the receiver has two i-f. stages, one for the second detector and one for the AVC tube, only two of the three i-f. transformers are tuned by adjustable condensers and require adjustment. The adjusting nuts are located on the side of the chassis frame just above the connector strip numbered from 1 to 8. (This strip permits the connection of a phonograph pickup and switch.)—Ed.

For this alignment job a modulated r-f. oscillator, which provides a modulated 175-kc. signal, is required. Also a non-metallic screw driver. You must also use an output meter, connected up in one of the two manners mentioned before, and the same dummy '56 tube in the AVC tube socket. With this fixed up, proceed as follows:

Remove the oscillator tube and make a good ground connection to the chassis. Place the oscillator in operation and couple its output from the control grid of the first detector to ground. Adjust oscillator output, with receiver volume control at maximum, until a deflection is obtained in the output meter.

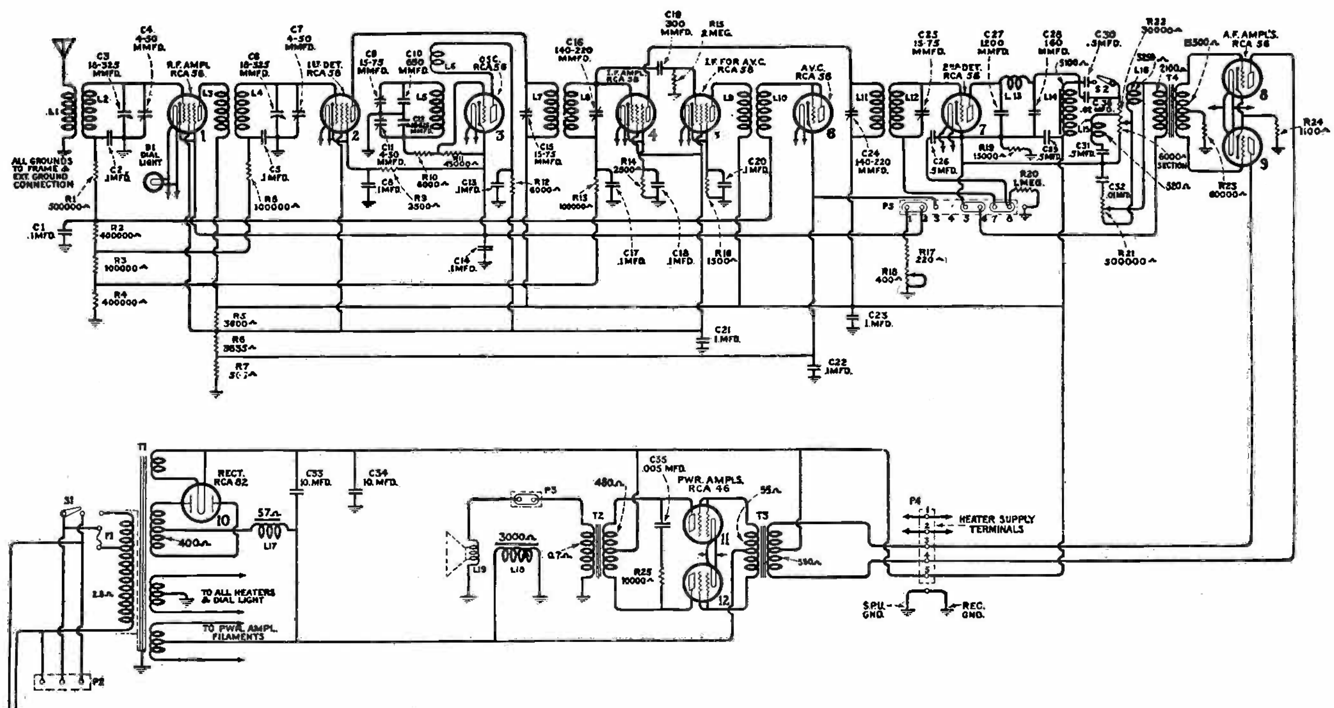
Now adjust the secondary and primary of the second (holes on left) and then the first (holes on right) i-f. transformer until a maximum deflection is obtained in the output meter. Make these adjustments twice as a slight readjustment may be necessary.

Due to the interlocking of adjustments, it is good practice to follow the i-f. adjustments with the r-f. and oscillator line-up condenser adjustments.

Voltage Readings

Voltage readings should be taken with no signal being received and the volume control at minimum. Voltage tabulation as given is based on 120-volt a-c. line. The plate currents given are not necessarily accurate for each tube due to the cable in the test box causing some circuits to oscillate. Remember that four of the tubes used in the receiver have six-prong bases. An adapter will be necessary in order to take suitable readings.

Fig. 1. The schematic diagram of the RCA Victor R-78 receiver. Note that a push-pull Class A driver stage feeds a push-push Class B output stage employing two of the new '46 tubes. Two separate tubes are employed for the automatic volume control



Stromberg-Carlson 38, 39 and 40

The same chassis is used in Models 38, 39 and 40. It is a nine-tube superheterodyne with a power consumption of 110 watts and an undistorted power output of 3.2 watts.

The circuit, shown in Fig. 1, uses four '58 triple-grid (r-f. pentodes) as r-f. amplifier, mixer, i-f. amplifier and demodulator-AVC. Two '56 tubes are used as the oscillator and first audio amplifier. A pair of '45s are used in the push-pull amplifier and an '80 as the rectifier in the power supply section.

A bi-resonator is used to couple the antenna to the r-f. amplifier to prevent any cross modulation. The r-f. amplifier is coupled to the mixer by an ordinary tuned r-f. transformer. This gives three tuning circuits (four-gang tuning condenser) for r-f. selectivity ahead of the mixer; thus the image response ratio is exceedingly high. The oscillator is coupled to the cathode circuit of the mixer tube in the regular manner. The i-f. output of the mixer tube is fed into a tri-resonator (three-tuned-circuit transformer) and from there to the i-f. amplifier tube. This tube is coupled to the diode-triode demodulator-AVC (a combination second detector and automatic volume control circuit with a linear characteristic) by a single tuned circuit transformer.

The load resistor of the diode portion of the diode-triode circuit forms the resistor unit of the first potentiometer of the dual volume control. The AVC voltage and the rectified audio signal are built up across this resistor. The AVC voltage is fed back to the grids of the first two tubes (r-f. and mixer) through a filter composed of resistance and capacity units. The audio voltage is applied to the control-grid of the triode portion of this system through the movable contact of the 250,000-ohm potentiometer. The screen of this same tube acts as the plate of the triode portion of the system, thus forming the triode audio amplifier in conjunction with the diode rectifier.

The output of this "plate" circuit is coupled to the second unit of the dual volume control (another 250,000-ohm potentiometer) which feeds the grid of the first audio tube. The output of this audio stage is coupled to the push-pull output tubes. The adjustable "Clarifier" system (tone control) is connected across the primary winding of the input push-pull transformer.

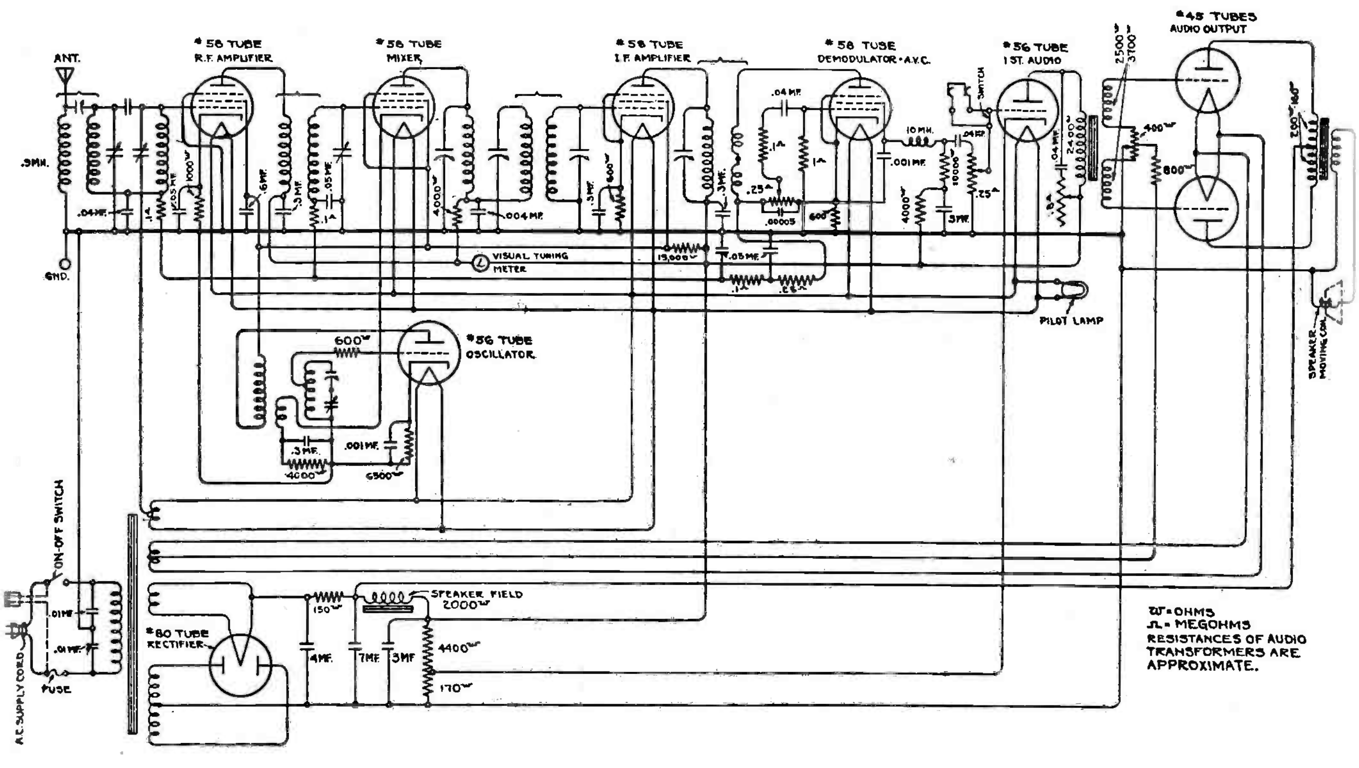
The power supply system employs two filter sections, the first being of the resistance type and the second the field winding of the dynamic speaker used as a choke. The plate supply for the two '45 tubes is tapped off

MODELS 38, 39 AND 40 VOLTAGE READINGS

Voltage	*Scale and Meter*		*Reading*
Heater, 56 and 58 tubes	0-4	A-C	2.5
Fil. 45 tubes	0-4	A-C	2.5
Fil. 80 tube	0-8	A-C	5.0
Plate, r-f. tube	0-250	D-C	165
Plate, mixer tube	0-250	D-C	150
Plate, osc. tube	0-250	D-C	80
Plate, i-f. tube	0-250	D-C	170
Plate, demodulator	0-250	D-C	0
Plate, 1st audio	0-250	D-C	160
Plate, 45 tubes	0-750	D-C	285
Bias, r-f. tube	0-10	D-C	6.0
Bias, mixer tube	0-10	D-C	8.0
Bias, osc. tube	0-250	D-C	25
Bias, i-f. tube	0-10	D-C	3.0
Bias, demodulator	0-10	D-C	2.5-3
Bias, 1st audio	0-10	D-C	6.5
Bias, 45 tubes	0-250	D-C	47[1]
Screen, r-f., mixer and i-f. tubes	0-250	D-C	85
"B" voltage, r-f., i-f. mixer, 1st audio and demodulator	0-250	D-C	160[2]
"B" voltage, 45 tubes	0-750	D-C	300[3]
Speaker field	0-250	D-C	125[4]
Plate, per anode type '80 tube	0-750	A-C	340[5]

[1]Across 800-ohm biasing resistor.
[2]Between high side of voltage divider and chassis.
[3]Between mid-tap of output transformer and chassis.
[4]Across small pins on speaker connector socket.
[5]Between plate terminals of '80 socket and chassis.

Fig. 1. The schematic diagram of the new Stromberg-Carlson receiver chassis, employing the new '56 and '58 tubes. The second detector also functions as the automatic volume control. Type '45 tubes are still used in the power stage, in order to obviate odd-harmonic distortion



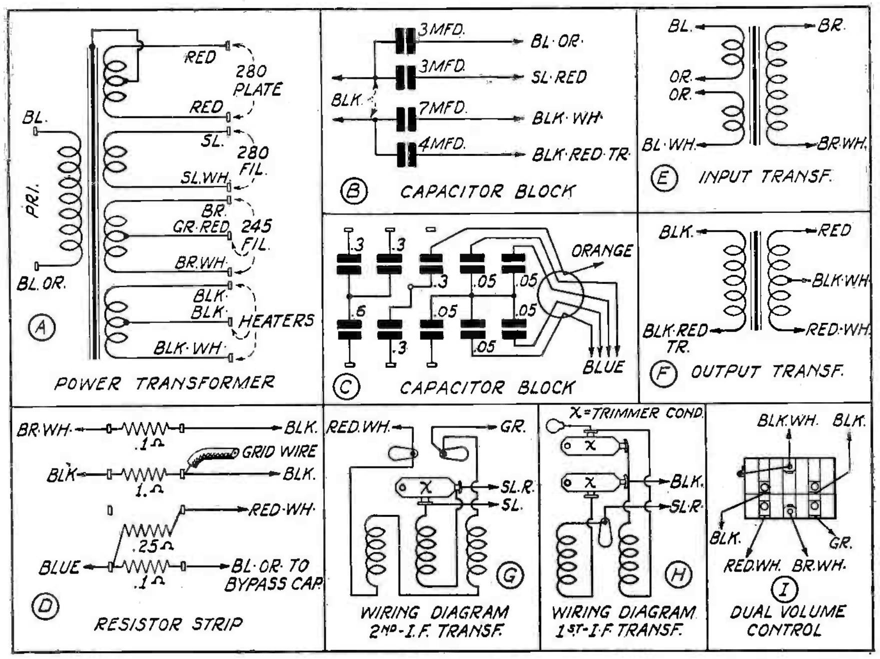


Fig. 2. The nine diagrams grouped above supply the color coding and values of the major units in the new Stromberg-Carlson receiver chassis. These diagrams will assist you in tracing circuits. The units marked X in diagrams (G) and (H) are the trimmer condensers for the intermediate-frequency transformers

between these filter sections, while the remainder of the voltages are supplied from the voltage divider resistor.

SERVICING

The small diagrams grouped together in Fig. 2 readily indicate the color coding of the leads from the most important units. Where it is essential the values of the units are also given.

The voltage readings given in the accompanying table correspond to a line voltage of 120. When voltages are measured, proper allowances should be made for a difference in line voltage above or below 120. Be sure to make these readings with the type of Voltmeter and Scale indicated in the table, for otherwise the results will not agree with the voltage values tabulated. Another thing, when taking the voltage readings the dial on the receiver should be set at about 1,000 kc. All readings should be made between the respective tube terminals and the chassis base unless otherwise indicated in the table.

The small unit diagrams grouped in Fig. 2 are marked A, B, C, etc. When working under the chassis of a Model 38, 39 or 40 most of the units will be located without much difficulty, and when necessary the color coding can be picked up from Fig. 2 and traced through under the chassis. But, here are a few reference points for your convenience: When viewing the underside of the chassis, with the front end above, the voltage divider will be found mounted on the upper left edge of the chassis frame. The terminals of condenser block B are just to the right of the voltage divider. Terminals of condenser block C are approximately in the center of the chassis base, and resistor strip D is just to the left of this condenser block.

Brunswick Servicing

The Brunswick Radio Corporation has appointed the United Radio Service Co., 619 West 54th Street, New York, N. Y., as their authorized service representatives for the United States. All orders for Brunswick replacement parts and service can now be filled through this organization.

A staff of Brunswick factory service engineers are now connected with the United Radio Service Co., which assures a thorough knowledge of all Brunswick and Bremer-Tully instruments.

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Philco I-F. Frequencies

Below are listed the intermediate frequencies used in the various Philco Superheterodynes.

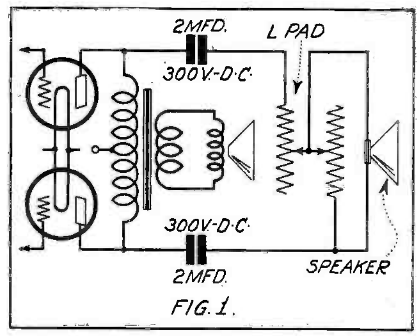
Model	*Kilocycles*
111	175
112	175
70	260
70 AVC	260
90 with '45s	175
90 with '47	175
90 with '47s	260
51	175
35	260
7 Transitone	175
15 Series	175
91 Series	260
71 Series	260
52 Series	175
47 D-C. Series	260
36 Series	260
22 Series	260
23 Series	260
4 Series	3,600 Adjusting Freq.
4C Series	3,600 Adjusting Freq.

Independent Speakers

One or more magnetic or dynamic speakers may be added to the output of a radio set or amplifier, the number added being dependent upon the power output. The power output itself is obviously dependent upon the type and number of tubes used in the power stage of the amplifier, and this again brings up the matter of impedance matching.

It is well to consider first the various types of output push-pull, parallel and single '45, '50 and '47 tubes. The output impedances are as follows: The '45 or '50 tubes in push-pull, 8,000 ohms; in parallel, 2,000 ohms; single, 4,000 ohms. The type '47 pentode in push-pull, 14,000 ohms; parallel, 3,500 ohms, and a single pentode, 7,000 ohms.

The arrangement of multiple speakers should have a total impedance equal to or greater, but never less than the output impedance of the amplifier. If a number of speakers are to be used, the amplifier output impedance should first be considered. Suppose we have an amplifier with two '45s in push-pull. The output impedance is then 8,000 ohms. Then, if we had two magnetic speakers each with an impedance of 4,000 ohms, it would be proper to connect them in series across the output, in which case their total impedance would also be 8,000 ohms. On the other hand, if these speakers each had an impedance of 10,000 ohms it would still be necessary to connect them in series, for if they were connected in parallel the total impedance would be only 5,000 ohms.



Showing the manner of adding an independent speaker to the output of a push-pull amplifier. The 2 mfd. condensers are not necessary but will prevent the possibility of a shock

which is less than the output impedance of the amplifier. But, if the amplifier were using a couple of '47 tubes in parallel—which would give an output impedance of 3,500 ohms—the parallel connection for the speakers would be far superior than a series connection.

In the case of dynamic speakers it is a question of the impedance of the speaker coupling transformers.

The addition of not more than 12 magnetic speakers on push-pull or paralleled '50s, eight for push-pull '45s or '47s, and one on a single '45 or '47 is recommended.

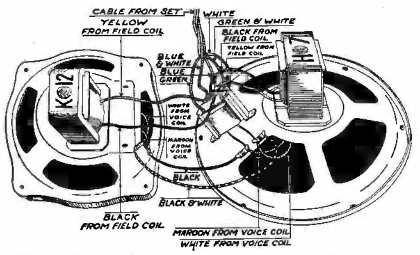
For the independent volume control of each speaker used, L pads are recommended. A typical arrangement is shown in Fig. 1.

(*W. L. Parsons,*
Radio Engineering, May, 1932)

Philco Model 15

The Philco 15 chassis is used in the new Philco Models 15X and 15DX only, these two models having the slanting baffle board. There are eleven tubes in all, and the manner in which they are used can be determined from the accompanying schematic diagram.

The tube labeled "Det. Rectifier" in the diagram is connected up to function as a diode and serves both as the detector and automatic volume control. The type 37 tube immediately following may rightfully be called the detector amplifier as it is utilized to boost the comparatively weak output of the diode tube.



Showing the connections and color coding for the dual speaker system in the Philco Model 15. Both are dynamics

The tone control (53) is in the plate circuit of the second audio tube. The output consists of two Philco type 42 power pentodes in push-pull which feed two dynamic speakers connected in parallel. The connections and color coding for these speakers are given in the accompanying sketch.

Note that there are two pilot lights. Light (14) is a standard pilot while light (46) is a part of the Philco shadow tuning device. These two lights are connected across the 6.3-volt terminals of the power transformer. There is also a cabinet lamp in the receiver —used for lighting up the speaker grill. This lamp (65) is connected right across the 110-volt line, as indicated in the diagram.

The on-off switch and the local-distance switch (18) are ganged together and have three switching positions. The tuning meter (37) is connected in series with the plate circuit of the first i-f. tube and first detector.

The total power consumption of this receiver is approximately 115 watts. The intermediate frequency is 175 kc.

TABLE 1

No.	*Watts*	*Ohms*
(66)	..	305
(36)	.5	1,000
(45) (55)	.5	5,000
(1) (52)	.5	10,000
(32)	1.0	13,000
(50)	.5	25,000
(21)	.5	51,000
(40)	.5	99,000
(10)	.5	160,000
(57)	.5	240,000
(9) (17) (54)	.5	490,000
(28) (47)	.5	490,000
(51)	.5	1 meg.

Table 1 herewith gives the values of the resistors in the diagram, by number, and Table 2 provides tube socket voltage data. All filament voltages are 6.3 with the exception of the '80 rectifier, which is 5 volts.

TABLE 2

Tube	*Plate Volts*	*Screen Volts*	*Grid Volts*	*Cathode Volts*
R-F.	165	55	15.	30
1st Det.	250	90	.85	10
Osc.	60	—	15.	10
1st I-F.	250	90	.85	10
2nd I-F.	275	90	3.3	10
Det. AVC	0	—	.2	10
1st A-F.	75	—	.4	10
2nd A-F.	100	—	.2	10
A-F. P-P.	255	270	15.	15
A-F. P-P.	255	270	15.	15
Type '80	(320 volts on each plate)			

All readings taken from under chassis with test prods, in each case from element listed to cathode. Read cathode volts from cathode to filament. Volume control at maximum, dial turned to low-frequency end and power switch in middle position.

MODEL 15 CHANGES

There is the possibility of some distortion on powerful local stations with some of the Model 15 Philco receivers shipped as samples. In the event of such a complaint a fixed condenser (Part No. 6853) should be connected across the plates of the two type 42 tubes in the output stage. The plates of these tubes are wired to the green and white wires in the speaker cable.

A 250,000-ohm resistor (Part No. 3768) should also be connected across the two outside terminals of the volume control.

Model 15 chasses bearing Nos. 20 and 21 must be changed in accordance with the instructions given. Chasses bearing Nos. 22 and 23 have the condenser connected across the primary of the output transformer, but do not have the resistor referred to. In some cases it may be advisable to add the resistor.

Chasses bearing numbers above 23 will have both the changes included.

•

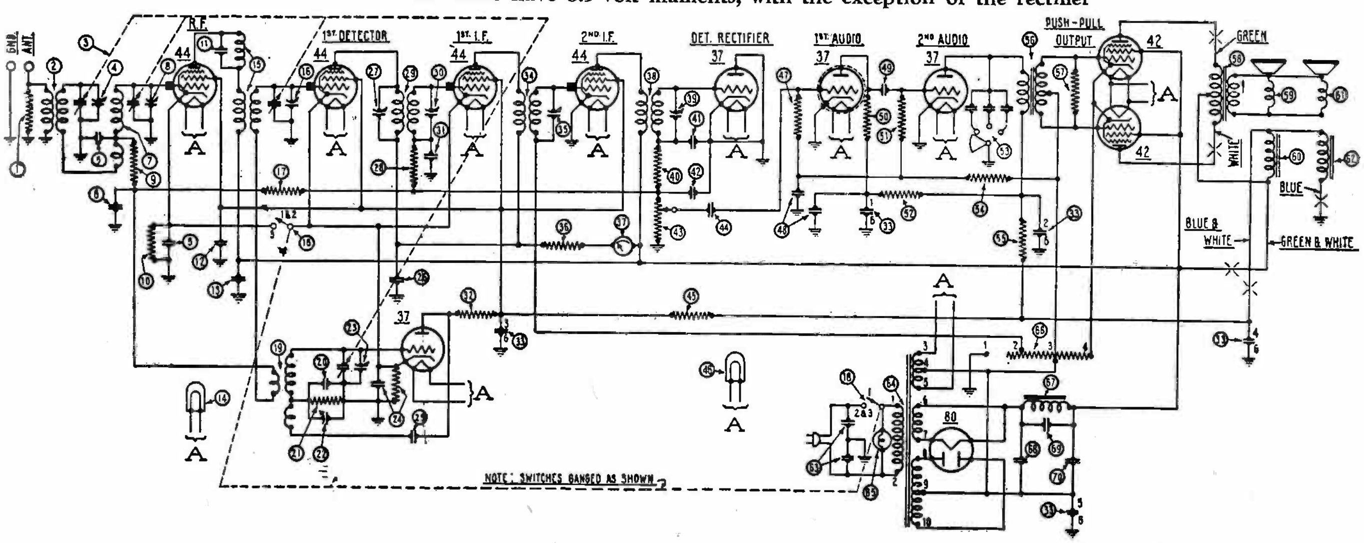
Tubes 56, 57 and 58

The types '56, '57 and '58 tubes arrived just in time to upset the applecart for a number of radio manufacturers, but they had good representation at the RMA trade show nevertheless and will be found in most of the new sets. (See Stromberg-Carlson Models 38, 39 and 40 in particular, described in this issue.)

All three of these tubes have newly designed, quick-heating cathodes and in each case the cathode power consumption is 43 per cent less than the former tubes, or in round numbers, one ampere instead of 1.75 amperes. So you may look for smaller power transformers in the sets. These new cathodes are supposed to be quieter in operation as well.

A new control-grid construction is also used in all three of these tubes and is responsible for the higher mutual conductances. With the old style construction the internal side rods prevented a close grid-cathode spacing. Now the rods have been shifted out and the shape of the grid changed

Schematic diagram of the new Philco Model 15 "slanting baffle" series. Two '42 pentodes are used in the power audio stage. All tubes used in this series have 6.3-volt filaments, with the exception of the rectifier



as shown in Fig. 1, which permits a close grid-cathode spacing. This arrangement also provides better heat dissipation, which lowers secondary emission.

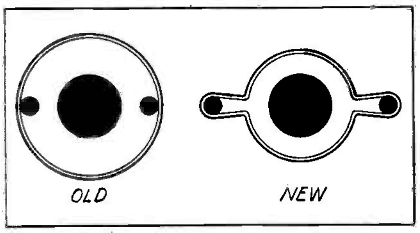


Fig. 1. Showing the old and the new form of grid suspension. The new method permits closer spacing between grid and cathode

It will be found that the bulbs of these tubes are likewise smaller, so that they require less space in the set.

THE TYPE '56

To all intents and purposes, the '56 tube replaces the '27 though the two are not interchangeable. The '56 has an amplification factor of 13.8 as against 9 for the '27. The plate resistance of each is much the same . . . 9500 ohms for the '56 and 9000 ohms for the '27.

The type '56 tube is being used as a bias detector, an oscillator and as a first stage audio amplifier. When used with a plate voltage of 180 the grid bias should be —13.5 volts, which is the same for the '27. But the tube is generally used with a plate voltage of 250, in which case the grid bias is—20 volts.

The characteristics and operating conditions of the type '56 tube are as follows:

Plate Voltage	250 max.
Grid Voltage	—13.5
Amp. Factor	13.8
Plate Res.	9500
Mutual Cond.	14500
Plate Current	5.0 ma.

In a few of the new sets the type '56 tube is being employed as the driver (first stage audio) feeding a couple of Class B amplifier tubes in a twin-push circuit. However, it is generally used as a detector or oscillator.

THE TYPE '57

This tube is an r-f. pentode. It is comparable in purpose to the '24 and is an intermediate or radio-frequency amplifier with a suppressor grid, a screen grid and a six-prong base.

The suppressor grid practically eliminates the effects of secondary emission between the screen and plate and allows an increase in the impedance of the tube, resulting in sharper tuning and an increased amplification factor. The elimination of the effects of secondary emission also prevents the plate from overloading on strong signals, making it possible to operate the tube on higher a-c. components of plate voltage, without distortion.

Through the use of a new type of shield (the reason for the dome-shaped bulb used) the interelectrode capacities have been reduced, which makes the tube quite suitable for short-wave work.

When used as an r-f. or i-f. amplifier the type '57 tube has an amplification factor exceeding 1500 as against approximately 400 for the type '24. Its plate resistance is greater than 1.5 megohms, whereas the '24 has a plate resistance of about 400,000 ohms.

The operating conditions and characteristics of the type '57 when used as a Class A r-f. amplifier are as follows:

Plate Voltage	250 max.
Screen Voltage	100 max.
Grid Voltage	—3
Amp. Factor	1500 plus
Plate Res.	1.5 megs.
Mutual Cond.	1225
Plate Current	2.0 ma.
Screen Current	1.0 ma. max.

When the tube is employed as a biased detector the grid voltage should be approximately —6 volts, and a plate load of 250,000 ohms should be used. An alternative load is a 500-henry choke shunted by a 250,000-ohm resistor, which will provide a higher voltage at the plate.

The type '57 tube is being used principally as a detector and AVC in some of the new sets.

THE TYPE '58

This tube is called a "Super-Control" pentode, for it is of the variable-mu type and replaces the type '35 tube. Like the '57, it has a suppressor grid, a six-prong base and the same dome-shaped bulb.

Its inherent features are reduction in cross-modulation, reduction in modulation distortion, adaptability to automatic volume control design and the ready control of a large range of received signals without the use of local-distance switches or antenna potentiometers. The tube also lends itself to what may be termed "Automatic Fidelity Control" by means of an automatically varying bias on the suppressor grid. Thus, when receiving powerful local signals the tube acts as one with a low impedance and no distortion occurs.

The '58 is being used extensively in the new receivers both as an r-f. and i-f. amplifier, and also as a mixer and detector-AVC. Because of its low inter-element capacity it is also being used extensively in short-wave adapters and converters.

The operating conditions and characteristics of this tube when used as an r-f. or i-f. Class A amplifier are as follows:

Plate Voltage	250 max.
Screen Voltage	100 max.
Grid Voltage	—3 min.
Amp. Factor	1280
Plate Res.	800,000
Mutual Cond.	1600
at —40 v. bias	10
at —50 v. bias	2
Plate Current	8.2 ma.
Screen Current	3.0 ma.

When used as a first detector or mixer in a superheterodyne the '58 tube should have a grid voltage of —10 volts minimum with the plate and screen voltages given above.

Resistance Tolerances

In making measurements on resistances in radio receivers, it might be well to know what the tolerances are that most set manufacturers place on the resistors which go into their sets. The highest degree of accuracy is called upon for hum-balancing resistors. The tolerance permissable in this case is usually plus or minus 5 per cent. A tolerance of plus or minus 10 per cent is called for on the following: voltage dividers, plate and screen voltage-reducing resistors and grid bias resistors. Plate filters, plate coupling resistors and bleeder resistors are usually permitted a tolerance of 15 per cent. Grid filters and grid leaks are permitted a tolerance of plus or minus 20 per cent.

Two-Speaker Sets

Two speakers mounted close together act as a single diaphragm having the same area for frequencies for which the wavelength is long in comparison with the average distance between the areas on the two cones. Under these conditions the added pressure on one diaphragm or cone due to the other is nearly in phase with its displacement. The effect of using two identical speakers then is to increase both the energy and "absolute" efficiency by 100 per cent. Two speakers show an average improvement of 3 db. when used in this manner, except near the resonant peaks of the two which may differ by about 20 cycles. Near these frequencies the two diaphragms are slightly out of phase.

The improvement is equivalent to increasing the output of a pair of '45 tubes in push-pull from 4.5 to 9 watts. Actually the improvement is even more important because the speaker has more distortion than the tubes at low levels, hence there is less steady state distortion at room levels.

To get a given output from two speakers only half the former input is needed to the pair. This means only 25 per cent of the former input to a single speaker, so the system will give four times the output with no greater distortion.

The use of a single large diaphragm, instead of the dual speaker system, is unsatisfactory because of the difficulty of controlling the higher modes of vibration. The mass per unit area must also be increased to give the desired stiffness and the increased mass reduces the steady state output and increases the transient distortion.

Practical realization of these improvements requires mounting the speakers on a horizontal line on the front of the cabinet. Where they are mounted on a false baffle several inches back from the front there is an objectional cavity resonance effect. When the speakers are mounted on an angle so one reflection from the floor occurs there is quite naturally an absorption of high frequencies on this reflection from the rug. The effective baffle length is also usually reduced.

Grill cloths should be even more open than usual since the low-frequency output from a speaker travels not only through its own grill but through the adjacent one to increase the pressure on that diaphragm. Contrary to usual belief the grill cloth has its principal effect near the resonant frequency of the speaker where the velocities are large.

(*Hugh S. Knowles, Electronics, May,* 1932)

Air-Cell Battery Conversion

By W. P. HORNE

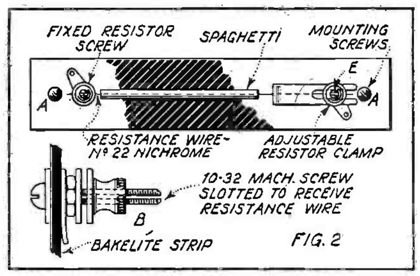
It is not necessarily difficult to change over a standard battery set to one using the new 2-volt tubes and the Air-Cell battery, but if the job is not done correctly in the first place good results cannot be expected.

The writer has had considerable experience in this form of set conversion and feels that information on the "reconstruction" of a receiver using three '32 tubes in the r-f. circuits, a '32 as the power detector and a '33 as the power output tube, with dynamic speaker, will prove interesting and instructive to other Service Men who are called upon to modernize the old battery sets in the rural districts.

There appears to be quite a call for this type of conversion, particularly in cases where the owner has a set of the console type to which he has become attached. A set of this type can be converted to one using the 2-volt tubes and the Air-Cell battery at a cost much less than that of a new set and, if similar to the type mentioned above, will produce results comparable to a 6-tube a-c. set.

Important Considerations

In converting a battery set for Air-Cell use, it should be kept in mind that there are rigid current and voltage requirements which must be met. The current drawn from the Air-Cell battery must not in any event exceed 650 milliamperes, and the voltage applied to the 2-volt tubes must not exceed 2.20 volts nor be less than 2.15 volts at the filament terminals. If these requirements are not met the life of both the tubes and the Air-Cell battery will be greatly shortened.



Here is shown the construction of the special adjustable filament resistor for an Air-Cell-operated receiver

An examination of the performance graphs of this battery indicates an initial voltage of about 2.53 volts which drops after 100 hours of use to about 2.48 volts, and thereafter decreasing gradually to about 2.33 volts at the end of 1,000 hours of service. This means that at the end of the battery service there is only 2 volts being applied to the filaments of the tubes.

It is evident that the critical point in the conversion lies in the construction of the resistor regulating the filament voltage. This may be estimated as the resistance required to produce a drop of .33 volt, figuring the current at 2.20 volts (Ohm's Law). In addition to this the resistance of the circuit from the battery to the filaments must be taken into consideration or the voltage at the filament terminals will be below the required value. The writer estimated the size of the resistor required, and after deducting the resistance of the filament circuit from the battery to the tubes, found the value to be exactly .50 ohm.

Special Filament Resistor

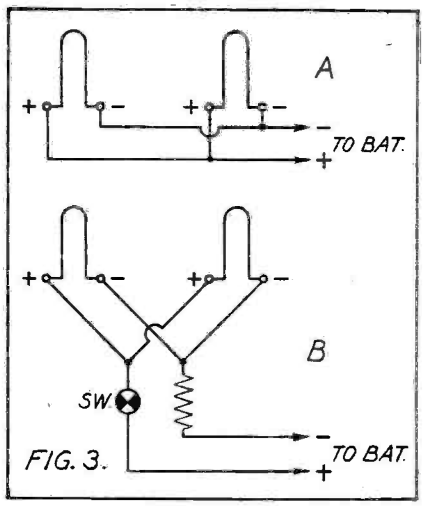
It might be well to mention that all the necessary measurements were made on a high-grade laboratory bridge, but if no such bridge is available, the arrangement shown in Fig. 1 will be satisfactory. Before explaining the adjustment of this arrangement, let us refer to Fig. 2 which illustrates the construction of the special adjustable resistor unit which will take the place of any or all of the fixed or variable resistors which may have been used in the battery set for the adjustment of filament voltage. The resistor used (Fig. 2) was No. 22 Nichrome wire, such as is used in the repair of small table stoves, and measured exactly five inches from contact to contact. This wire has a resistance of .10 ohm per inch. The major portion of the wire is covered with cambric tubing to prevent the possibilities of a short circuit, but the right hand section is left uncovered so that the sliding contact E may be moved along the bare wire. The other details are self-explanatory.

Now, the whole unit shown in Fig. 2 is the variable resistor R-1 in Fig. 1, and must be adjusted to obtain the proper voltage at the filament terminals of the tubes. Now, as to making the necessary measurements and adjustments with the arrangement shown in Fig. 1: Before closing switch SW, adjust resistance R to obtain a reading of 2.50 volts on the voltmeter VM-1. Then place the resistor clamp E of R-1 at the extreme limit, so that all the resistance of the Nichrome wire will be in the filament circuit. Next, insert the tubes in the set and measure the voltage at the sockets with meter VM-2 and then adjust resistance R until VM-1 reads exactly 2.53 volts. Follow this by moving the sliding contact E of resistance R-1 until voltmeter VM-2 reads exactly 2.20 volts. When the contact E is finally in the correct position, clamp it tightly.

Be sure and use extreme care in reading the voltmeters as therein lies the major part of the secret of the whole adjustment and the difference between success and failure.

Special Connections

The filament circuits in the set should be rewired. They are not wired in the conventional manner of looping from one socket to another, as shown in Fig. 3-A, but are wired in the manner shown in Fig. 3-B. This arrangement will equalize the resistance in the respective filament circuits as well as assist in stabilizing the operation of the receiver. The "B" and "C" battery circuits are conventional except that the negative 3-volt "C" tap runs directly from battery to ground, as shown in Fig. 4. This particular tap is the bias connection for the '32 tubes in the r-f. circuits.



The right and the wrong way to wire up the filament circuits. Arrangement B equalizes the resistance in each filament circuit

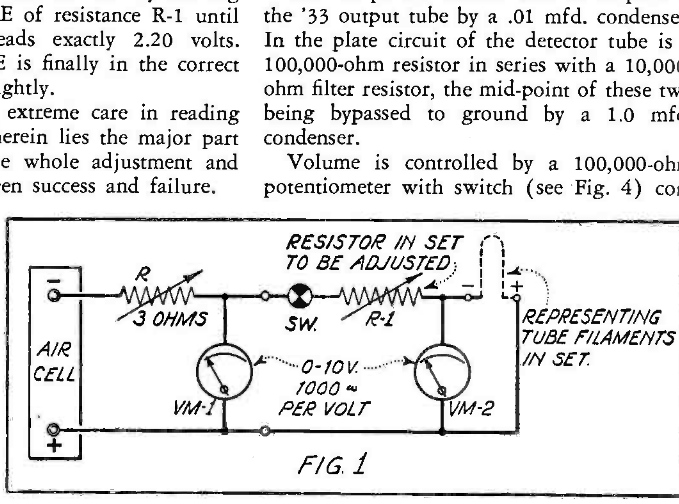
All ground connections should be made to the chassis. In addition to this, run a wire to all ground connections and then connect this wire to the chassis. This removes the possibility of a poor ground connection at some point, and consequent oscillation.

All plate and screen circuits of the '32 tubes should contain r-f. chokes, these being bypassed to ground by .1 mfd. condensers. A bias of 13.5 volts is applied to the grid of the '33 power output tube through a one-half megohm resistor.

The '32 power detector tube is coupled to the '33 output tube by a .01 mfd. condenser. In the plate circuit of the detector tube is a 100,000-ohm resistor in series with a 10,000-ohm filter resistor, the mid-point of these two being bypassed to ground by a 1.0 mfd. condenser.

Volume is controlled by a 100,000-ohm potentiometer with switch (see Fig. 4) con-

Set-up for making the correct voltage adjustments for the tube filaments. Resistance R simulates eventual voltage drop of the Air-Cell



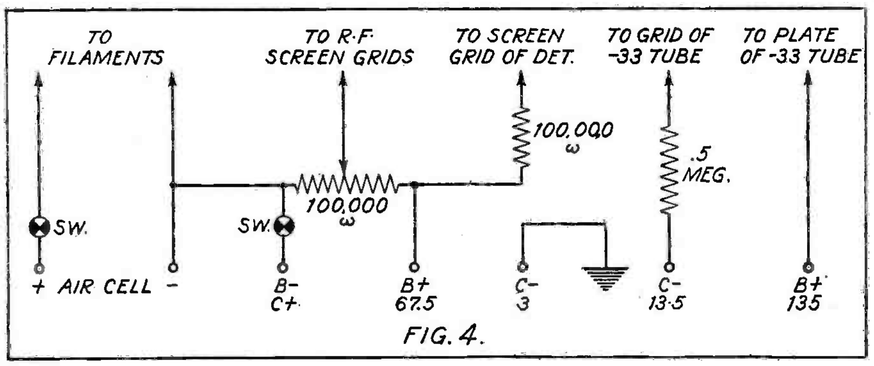


FIG. 4.

Showing the proper battery connections and resistor values for a set to be operated from an Air-Cell battery. The correct voltages are given. The two switches SW should be mounted on a single shaft

nected from the 67.5-volt tap to negative "B." The slider regulates the voltage on the screen-grids of the r-f. tubes. Another branch off the 67.5-volt tap, with a 100,000-ohm resistor in series with it, supplies the proper voltage for the screen of the '32 power detector tube.

EQUIPMENT

Most any type of dynamic speaker may be used in connection with the reconstructed set providing it is of the permanent magnet type.

If the tuning condensers in the receiver are to be used and they have no trimmers, it is advisable to install one on each condenser. These are used to line up the receiver at 1,400 kc. Adjustments at 1,000, 800 and 600 kc. are made by bending the outside rotor plates.

Any good r-f. coils suitable for screen-grid tubes may be used in place of the old r-f. transformers, but they must be shielded. It is also necessary to shield the r-f. and detector tubes, and the gang condenser. Try to keep each circuit for each tube in its own shielded compartment as far as possible.

And, before concluding, here is a very important point which you might possibly overlook: If there is a pilot light in the set by all means discard it. A pilot or dial light cannot be used due to the excess amount of current required.

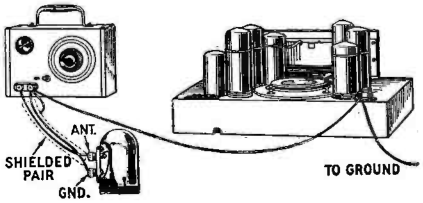
A circuit diagram, or any other information relative to the conversion of the receiver outlined, may be obtained by writing to SERVICE and requesting the writer's address.

Exploring Coil Tests

Certain tests in the Victor Micro-Synchronous Radios R-35, R-39 and RE-57 are made with the use of an oscillator and an easily constructed exploring coil. The equipment consists of a standard r-f. oscillator, an 0-4-volt a-c. voltmeter and an exploring coil made of several turns of No. 18 insulated solid copper wire fitted into a UY-227 tube shield. The shield is equipped with a set of antenna and ground binding posts (see accompanying illustration) to which the terminal leads of the exploring coil are connected. The ground post is also connected to the shield. Now, the two posts on the exploring coil shield are connected to the antenna and ground posts on the r-f. oscillator (when Victor oscillator is used) that is, the posts on the oscillator which connect to the oscillator pickup coil. The voltmeter is then connected to terminal 3 of the amplifier terminal strip (which is a grounded connection) and to the link terminal on the amplifier base which is in the secondary circuit of the push-pull output transformer.

METHOD OF TEST

With the power turned on, if the shield cap is removed from any of the r-f. tubes and the exploring coil brought over the tube and the set then tuned to the frequency of the oscillator, the oscillator signal will be induced into the grid of that tube and will be indicated on the voltmeter, providing all tubes and circuits, including and beyond the particular stage under test, are functioning properly.



Testing a Victor set with exploring coil and oscillator. The coil is mounted in a tube shield

In the Victor models mentioned, the test should be carried out as follows: Remove the shield cap from the third r-f. tube and place the exploring coil over this tube. If a readable signal is indicated on the a-c. voltmeter, it will be known that the third r-f. and detector tubes are O.K., that the grid cricuits of the two are correct, and the plate circuit of the third r-f. is correct. However, if no readable signal is obtained, it will be known that a defect, such as an open or short circuit, or a faulty tube, exists at some point in the circuits or tubes just mentioned.

If the third r-f. tests O.K. replace the shield cover over this tube and then make a similar test on the second r-f. tube and circuit. An increased meter reading will be obtained if this circuit is O.K. If no meter reading is obtained, however, it will be known that the second r-f. tube, the plate or grid circuit of this tube, or the link circuit is not functioning properly. The defect can be isolated by replacing the tube in question and by testing the voltages in the tube sockets.

A lack of reading when the exploring coil is placed over the first r-f. tube will indicate a poor r-f. tube, or a faulty connection either in the secondary of the antenna coupling coil, or in the plate circuit of the first r-f. tube.

After a number of such readings have been taken on good sets, a knowledge of the approximate gain per stage with the particular oscillator being employed will be obtained. A lower gain in any particular stage than that which should be expected will indicate a low emission tube or improper alignment of the tuning condensers. The approximate readings on the 0-4-volt a-c. voltmeter, for the Victor sets mentioned are: Det., zero; 3rd r-f., 1.1; 2nd r-f., 2.0; 1st r-f., 2.6.

This method of a preliminary test with an exploring coil and oscillator saves considerable time, and has the further advantage that none of the circuits in the set are disturbed, or voltages altered. Once the fault has been isolated, it is a simple matter to make a test in that particular circuit.

Obviously, the same system may be used for the testing of any standard tuned radio-frequency receiver, although the voltage readings given above for the Victor sets will not hold with others. The system cannot very well be used on superheterodynes, except for the testing of any r-f. stages which may be used, unless an additional oscillator is employed to cover the intermediate frequency employed.

RCA Pickup Data

The various models of RCA Victor Electrolas and combination Radiolas and Electrolas have used electric phonograph pickups of a number of different impedance values. It is handy to know the correct impedance and resistance values of these pickup coils when servicing any of these models, or in the event that the replacement of a pickup coil is necessary. In the latter case, a new coil of the correct value may be obtained from RCA by quoting the stock number, which is given for each coil in the following list:

Coil No. 2254 has a d-c. resistance of 900 ohms and an impedance of 3,300 ohms at 1,000 cycles. Used in Electrolas CD-10X, CD-20X, CD-30X and CD-60X.

Coil No. 2255 has a d-c. resistance of 900 ohms and an impedance of 3,300 ohms at 1,000 cycles. Used in VE-8-60X, VE-9-2X, VE-9-25X and VE-9-55X.

Coil No. 2314 has a d-c. resistance of 5 ohms and an impedance of 20 ohms at 1,000 cycles. Used in VE-7-26X, VE-9-16X, VV-9-18X, VE-9-54X and VE-9-56X.

Coil No. 2769 has a d-c. resistance of 5 ohms and an impedance of 20 ohms at 1,000 cycles. Used in Radiola 86, RE-57 and RE-17.

Coil No. 10777 has a d-c. resistance of 85 ohms and an impedance of 200 ohms at 1,000 cycles. Used in RE-45, RE-75, RE-154, E-35 and E-152.

Coil No. 10897 has a d-c. resistance of 85 ohms and an impedance of 200 ohms at 1,000 cycles. Used in the Electrola E-135.

Coil No. 2641 has a d-c. resistance of 56 ohms and an impedance of 200 ohms at 1,000 cycles. This coil is used in the RCA standard pickup Model AZ-1604.

If only one nickel has been inserted, the pin "C" will engage the contact lever and open the switch "D." However, if more than one nickel has been inserted, the machine must go through an equal number of cycles before the pin "C" will engage the contact arm and open the circuit.

Public Address . . .

RCA. CE-29 (Continued)

The general details and voltage readings of the RCA Victor CE-29 Coin-operated Automatic Electrola were given on page 95, May issue of SERVICE. More specific details of a servicing nature are given herewith.

The complete circuit diagram of the CE-29 is shown in Fig. 1. Take note that the magnetic pickup L-1 is connected directly across the volume-control potentiometer, the arm and one side of which are in turn connected across the primary of the input transformer T-5. Connected across the unused portion of the volume control is a reactor L-4. The purpose of this reactor is to increase the volume of the lower frequencies—from 400 cycles down—at low volume settings. The coil in the magnetic pickup L-1 (Stock No. 2769) has a d-c. resistance of 5 ohms and an impedance of 20 ohms at 1,000 cycles.

Note from Fig. 1 that the type '30 first stage audio tube receives its filament supply from the '80 rectifier, this supply being rectified and filtered so that there is no introduction of hum.

A variable tone control is included in this Electrola. It consists of a 200,000-ohm variable resistor (R-10) connected in series with a .01 mfd. condenser (C-2). This unit is shunted directly across the secondary winding of the input transformer (T-5).

THE COIN MECHANISM

Fig. 2 shows a detailed view of the coin mechanism with its adjacent wiring. An explanation of its functioning follows.

A coin inserted in the coin slot makes a momentary contact of the coin switch and thereby energizes the additive magnet. This magnet is energized by a small transformer (T-2 in Fig. 1), having a 16-volt secondary winding, the primary being permanently connected across the line.

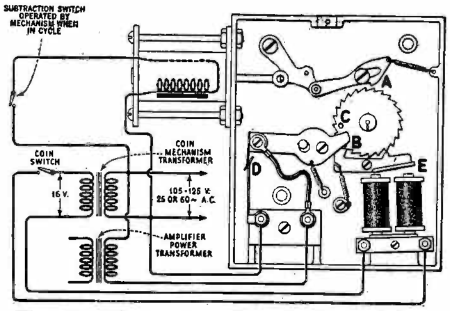


Fig. 2. The automatic coin box wiring and mechanical details from which its operation may be understood

The energizing of the magnet pulls the lever "E" to the magnet and releases it after momentary contact of the coin switch. This closes the contact "D" by releasing the pressure on the contact arm by the pin "C." Also the lever "E" moves the ratchet due to its contact at "B." The ratchet will therefore move one notch for each nickel placed in the slot up to a maximum of 23 nickels, it having only 23 teeth. As the contact "D" closes the power to the amplifier and turntable as soon as one nickel is inserted in the slot, the machine begins operation.

Upon completing one record the substraction switch closes momentarily and energizes the solenoid which pulls the lever "A" sufficiently to move the ratchet back one notch.

Class A and B Amplifiers

There are indications that there is a great deal of confusion about the identification and operation of amplifiers in the Class A and Class B categories. The designations "A" and "B" mean nothing in themselves, of course; the letters are merely used to classify a certain type of operation in much the same way that "B" and "C" voltages identify plate and grid voltages.

But, there is a big difference in the operation of Class A and Class B amplifiers, and this difference in operation is very important in connection with radiotelephone transmission.

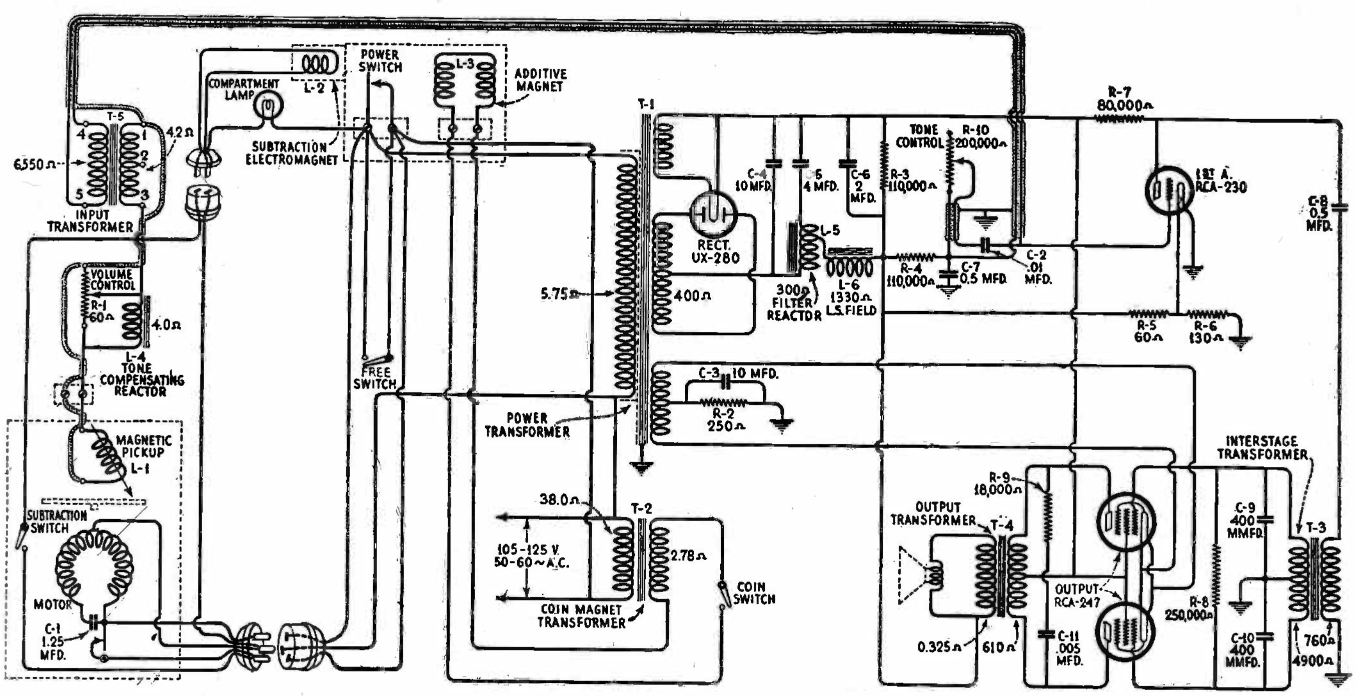
THE CLASS A AMPLIFIER

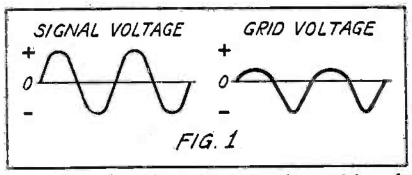
The Class A amplifier is one which gives, in its output circuit, a faithful reproduction of the signal fed into its grid circuit. This means that the wave in the output of the amplifier will have the same shape as the wave induced at the input, but much larger of course.

The definition can be put in another way: Class A voltage or power amplifier or modulator; one which operates so that the plate output wave shapes are essentially the same as those of the exciting grid voltage.

Now, to get the lovely effect referred to above, it becomes necessary to place a fairly stiff negative bias on the grid of the tube, for without sufficient negative bias the positive halves of the signal voltage will cause grid current to flow, and as soon as this happens the output wave is no longer a faithful reproduction of the original signal wave, but rather a very decent facsimile of the grid

Schematic diagram of the RCA Victor Coin-Operated Automatic Electrola, which employs a couple of pentodes fed by a '30 tube. The latter receives its filament current from the output of the '80 rectifier, this supply being rectified and filtered so that there is no introduction of hum. Note that this Electrola also has a tone control (R-10)





This is what happens to the grid voltage when grid current flows in the circuit

voltage, which is something else again. (See Fig. 1.) So, a negative grid bias is necessary, but if it is made excessive—and this was often the case in the past—the negative peaks of the signal voltage add to the already excessive negative grid voltage and cause a complete cutoff of the plate current long before any grid current can possibly flow. The result in the output is a sine wave with its lower peaks sliced off . . . and thus we have a distortion of another type. (See Fig. 2.)

Now, you can well appreciate that with a tube like the old 201-A it was quite impossible to obtain a sizable undistorted power output when using the tube in a Class A amplifier circuit. Because of its characteristics and voltage limitations it was impossible to employ a negative grid bias that would prevent the flow of grid current without at the same time introducing the plate current cutoff just referred to. That is, you couldn't reach a happy medium between the two forms of distortion and still get undistorted power. So, the engineers designed the 171, the 245, the 250, etc., and it was possible to use a high grid bias with these tubes because of their higher voltage and power ratings.

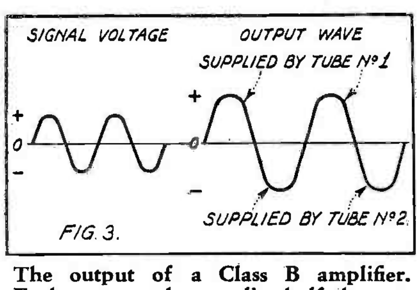
A tube, then, used as a Class A amplifier employs a certain negative grid bias to satisfy the conditions and limitations outlined. Most of our broadcast amplifiers in the past, including the first stage audio, were Class A jobs.

THE CLASS B AMPLIFIER

The Class B audio amplifier is an enitrely different animal, and the basis of its functioning rests in one of the limitations of Class A operation.

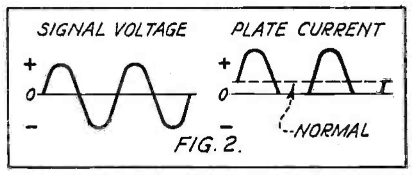
A Class B amplifier is one which operates so that the power output is proportional to the square of the excitation grid voltage. It is of no earthly value in this connection unless two power tubes are used in a push-pull connection, as will be explained.

First of all, when using standard triodes as the power tubes, the grids are given such a high negative bias that no plate current flows. This means there is a very distinct plate-current cutoff. (Again refer to Fig. 2.)



The output of a Class B amplifier. Each output tube supplies half the output wave, as indicated

Obviously, then, when a signal voltage is impressed on one of the grids plate current will flow only during the positive halves of the cycles, at which time there will be a large flow of plate current. But in this case only half-waves would be produced in the plate circuit, since no plate current flows at all during the negative cycles. However, there are two tubes in a push-pull connection and therefore, while one grid is excited by a negative half of the signal wave, the other grid is excited by a positive signal voltage. Therefore, tube number one supplies the positive half of the amplified signal wave in the output while tube number two supplies the negative half. In other words, each tube amplifies one side of the exciting wave, and it is for this reason that this type of amplifier is referred to as a "push-push" or "twin-push" amplifier. (See Fig. 3.)



This is what happens to the plate current when the negative grid bias is excessive

The main advantage of the Class B amplifier is its ability to produce a large amount of undistorted power; the push-pull connection eliminates the even harmonic distortion. It is being used in a few of the new broadcast receivers because it is far more capable of handling peak loads than a Class A amplifier. There is the further advantage that practically no plate current flows when there is no signal, and the amount of plate current is always proportional to the value of the signal voltage. This feature introduces a certain economy.

It should be mentioned that the new type '46 power tubes designed for Class B work operate at zero bias. Do not let this confuse you. The tube has an extra grid which, when tied to the control grid, boosts the amplification factor of the tube to such a point that practically no plate current flows with the grid at zero bias. Thus, the same condition is obtained in a different manner.

(*Based on the article by George Grammer, in QST, June,* 1932.)

Crystal Speakers and Mikes

And now come well-developed piezo-electric loud speakers and microphones. Both use a special form of Rochelle salt crystal cut into plates of different types and thickness. Both of these devices may play an important part in the progress of "radio fidelity" because of their highly suitable characteristics.

One type of the piezo-electric loud speaker, which is a general-purpose unit, is made up of two of these "crystal" plates 2½ inches square and each ⅛-inch thick. These plates are placed together and mounted in a casing by clamping at three corners. To the fourth or free corner is attached the tone arm which actuates a conventional cone. The tone arm ratio is approximately 2½ to 1, between crystal plate and cone. The motion of the end of this arm is dependent on the voltage applied to the crystal and is about .007 inch per 100 volts a-c. This speaker weighs only two pounds as against 5½ pounds for a dynamic with same size cone.

The crystal speaker is a voltage-operated device, and the power consumption is very low; as many as ten crystal speakers may be operated at the same volume as one electro-dynamic or magnetic speaker at a given power input. Due to its high sensitivity, astonishing volume is obtainable across a pair of 230's in push-pull, and for battery-operated sets a speaker of this type should be ideal when operated by a pair of these tubes in a Class B amplifier.

Crystal speakers may also be used with advantage in dual speaker installations, in parallel with a dynamic, to increase the acoustical range, improve the power factor and help to keep the load impedance constant at all frequencies.

CRYSTAL MICROPHONES

Piezo-electric microphones require no current supply, or polarizing voltage, cannot be overloaded, and because they are silent (no carbon hiss) may be situated a long distance from the amplifier.

The voltage generated by this new microphone is proportional to pressure on the crystal, and not on the velocity of a conductor in a magnetic field, as in a magnetic or dynamic microphone.

Piezo-electric phonograph pickups, similar in design and operation to the crystal microphone, are also being experimented with.

(*Alfred L. Williams, Electronics, May,* 1932)

About Acoustics

Editor, SERVICE:

Referring to the comment that appears on page 94 of the May issue of SERVICE concerning the desirability of using several dynamic speakers located in different parts of the room and operated at low levels, as against a single or group of speakers at one radiating center, I would refer you to a recent installation which, as originally made, consisted of individual speakers mounted around an auditorium. This arrangement proved itself to be decidedly impractical.

I think that the most important point that you overlooked in making this recommendation is the radiation characteristics of the dynamic cone speaker which are notoriously poor above 1,000 cycles. A radiation diagram of this type of speaker will readily explain why a number of these speakers at low levels cannot even give a fair guaranty of satisfaction.

C. J. BROWN,
Sales Engineer
RACON ELECTRIC COMPANY.

(*Your explanation sounds reasonable, though we have been advised to the contrary in many cases. We would appreciate some details of the special installation to which you make reference, as no doubt this will serve to clinch matters once and for all.* —*The Editors.*)

Auto-Radio . . .

American Bosch Model 100

A general description of the Bosch 100 was given in the May issue of SERVICE. Herewith is given the schematic diagram together with the values of the units. In actual inspection, the value of the resistors can be determined by the following color code:

RESISTOR COLOR CHART

Value	*Body*	*Tip*	*Dot*
1,000 ohms	Brown	Black	Red
1,500 ohms	Brown	Green	Red
2,000 ohms	Red	Black	Red
3,000 ohms	Orange	Black	Red
5,000 ohms	Green	Black	Red
10,000 ohms	Brown	Black	Orange
0.1 meg.	Brown	Black	Yellow
0.5 meg.	Green	Black	Yellow
1.0 meg.	Brown	Black	Green

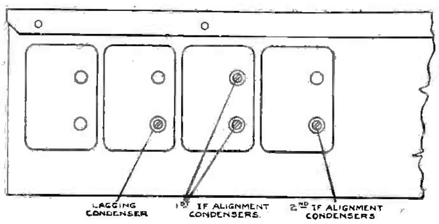


Fig. 2. Showing the location of the i-f. alignment condenser and lagging condenser adjusting screws

The socket voltage values for each tube, as given below, are average readings. If a Bosch Magmotor is being used in place of the "B" batteries the readings will be somewhat higher. In any event, if the readings are low, or cannot be obtained, it is obvious there is something wrong in the circuit.

The filament voltage reading on each tube should be 5.8 volts. The other readings are as follows:

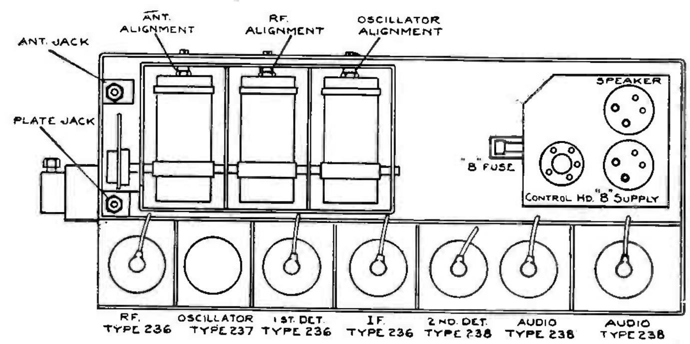


Fig. 1. Details of the Model 100 chassis, showing the location of the antenna, r-f. and oscillator alignment condensers, and the location of each tube. The antenna and plate jacks are also shown

In cases where re-alignment is necessary, an output meter and an oscillator designed for superheterodyne service are necessary. A small insulated screwdriver is necessary to fit the alignment condensers. For the location of these condensers see Figs. 1 and 2.

The receiver operates on an intermediate frequency of 175 kc., so proceed in the following manner for alignment:

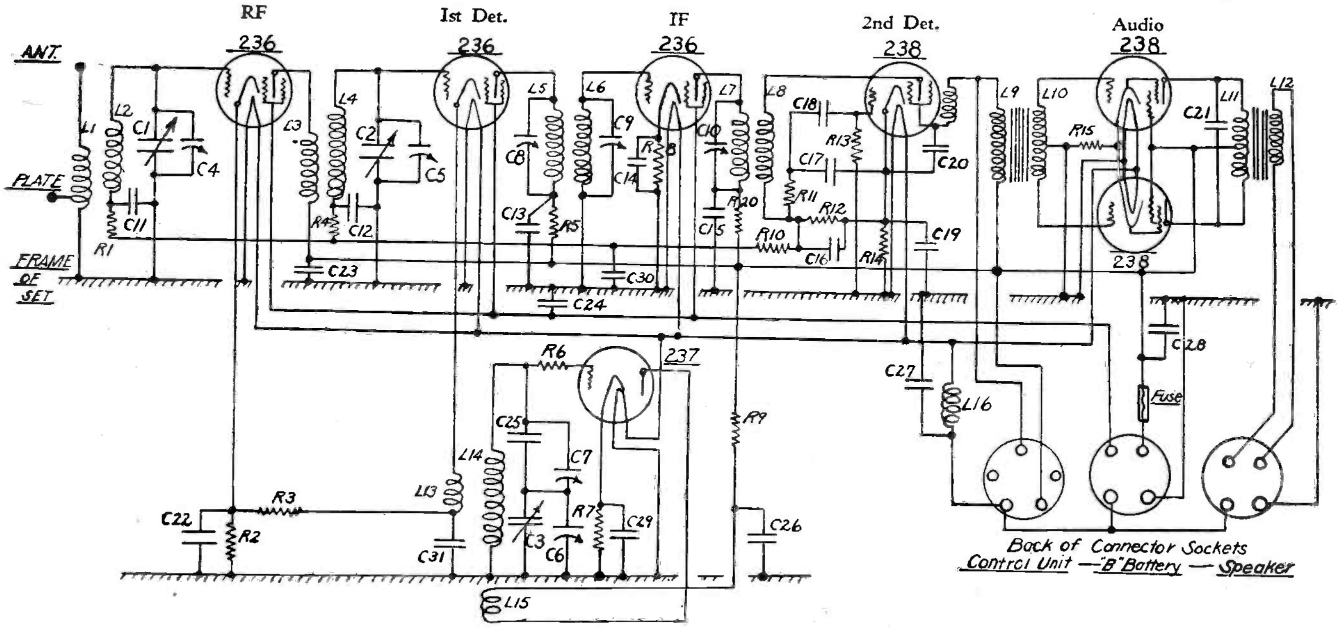
(1) Connect 175 kc. output of oscillator to the grid of the 1st detector tube. Align 2nd i-f. condenser. (Fig. 2.)
(2) With oscillator as above align both 1st i-f. condensers. (Fig. 2.)
(3) Recheck adjustment (1).
(4) Set dial and condenser gang at 100 and connect the 1,400 kc. output of the oscillator to the grid of the 1st detector.
(5) Turn dial to 7½ reading and align the oscillator tuning condenser. (Fig. 1.)
(6) Connect the 1,400 kc. output of oscillator on the antenna jack and align both r-f. condensers. (Fig. 1.)

TUBE VOLTAGE READINGS

Tube	*Cathode*	*Grid*	*Screen*	*Plate*	*MA*
R-F	0.5	1.0	60	130	1.0
Osc.	3.0	8.0	—	130	3.0
1st Det.	9.0	0.5	55	120	1.0
I-F	2.0	2.5	60	130	1.5
2nd Det.	5.0	0.1	120	1.0*	6.0*
A-F	12.0	12.0	135	130	10.
A-F	12.0	12.0	135	130	10.

* It will be noted that the type 238 second detector is not connected in the usual manner. The plate voltage is applied to the screen and consequently the screen current is read instead of the plate current.

The schematic diagram of the Bosch Model 100. The plate jack referred to above is connected to the primary of the antenna coupler and is used only when the Bosch Plate Antenna is employed in the car. The Plate Antenna replaces the usual aerial



(7) Tune in the 600 kc. output of the oscillator and adjust the lagging condenser (Fig. 2) by the "max-max" method, that is, move the gang condenser back and forth slightly as the alignment condenser is adjusted until maximum output is obtained.

(8) Change the oscillator input to antenna to 1,400 kc. and realign all gang condensers.

A 1.0-mfd. condenser should be used in series with the oscillator output lead as a dummy antenna for the 175 kc. alignment, while a 200-mmfd. condenser should be used in this lead for the 600 and 1,400 kc. output.

The maximum power output of the receiver is about 800 milliwatts. At the standard output of 100 milliwatts the voltage across the voice coil of the dynamic speaker is 0.6 volt. The sensitivity is from 1 to 5 microvolts at frequencies from 1,400 to 1,000 kc., and from 5 to 10 microvolts between 1,000 and 550 kc.

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Emerson "B" Unit

As will be seen from the accompanying sketch, the Emerson "B" Power Unit employs a dynamotor, together with a filter block composed of a 25-henry choke and three filter condensers. This diagram should assist you in checking for opens or shorts.

The complete unit measures 7¾ by 6 by 8⅞ inches and weighs 18 pounds. When in operation it draws approximately 2 amperes from the storage battery in the car and delivers at its output a maximum of 180 volts at 40 ma.

Mounting

Mount the complete unit in the box originally used as the container for the "B" batteries and fasten securely. If there is no battery box mount in any convenient place under the floor board or in the body of the car, but in any event do not mount the unit in the engine compartment of the car.

The unit is assembled for mounting with the base plate down. If mounted in suspended or side-wall position loosen the two screws in the clamping strap of the dynamotor and turn the dynamotor until the bearing oil holes are at the top. Do not mount with dynamotor shaft in vertical position.

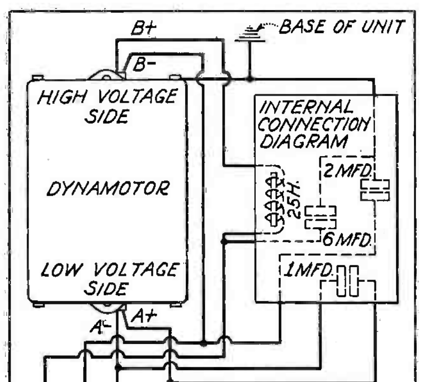

Diagram of the Emerson "B" Power Unit, showing the connections for the filter system and the values of the units

Connections

Use shielded rubber-covered wire for the connections. Use No. 14 or No. 16 for the ground and battery leads and No. 18 or No. 20 for the "B" connections. The shielding on the leads should terminate a few inches from the case of the unit and should be grounded to the chassis at this point with copper braid or ribbon.

Determine which side of the storage battery is grounded and connect the corresponding lead from the terminal plate in the "B" unit to ground (chassis). Connect the remaining "A" lead from the terminal plate to the radio control switch. Make positive connection from "ground" connection on unit to the chassis of the car.

If the radio set requires only 135 volts, insert a 2,000-ohm resistor between the "B" plus terminal of the unit and the "B" plus lead of the radio set.

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Ignition Interference

It is said among receiver manufacturers that it is possible to completely eliminate ignition interference, or for that matter all forms of noise interference, which originate in the automobile. The exact methods or doing this are not generally made public. However, here you will find a tabulation of points to be considered in this work. Perhaps certain manufacturers who have been successful in their installations discount some of these items, but it is necessary that they be included for the simple reason that they do represent possible sources. It is significant to note that one major automobile radio receiver manufacturer disclaims the need for bonding of the car chassis in the effort to eliminate noise. On the other hand, other manufacturers have given thought to the subject and recommend the practice where the noise problem refuses to be cured by normal processes.

Bear these in mind when working on auto-radio receivers.

The radio receiver chassis must be completely shielded and perfectly shielded.

The leads to the batteries must be shielded right from the battery terminals to the connections in the receiver. The shielded cable should enter the shield surrounding the receiver.

Keep all cables out of the engine compartment of the automobile.

Keep all cables distant from any ignition wires which find their way to the dashboard for connection to the instruments upon the panel. This means speaker leads as well as other leads.

Speaker cables should be shielded.

All mounting screws must be solidly fastened.

Every soldered joint must be perfect.

All spark plugs must be perfect. Old plugs will cause noise.

All corroded terminals must be replaced with new ones.

Distributor points must be clean and all cables emanating from the distributor head must be free of all grease and oil.

All BX cables running through the engine compartment and fastened to the chassis by means of brackets, must be solidly fastened at various points and electrically connected to the chassis at these points. All grease and oil should be removed from between the surface of the cable and the mounting bracket.

A copper bus connecting the various joints of the car chassis has been found successful.

Although from 2 to 3 inches is the usual separation between the aerial and the metal parts of the car top, increased separation has been found successful. This is particularly true in the case of the separation between the dome light and the aerial.

All lights and light circuits must be perfect. Flickering lights will cause noise.

Keep all metal cables which may become coated with grease from rubbing upon other metallic surfaces.

Check the primary side of the ignition system. Every contact must be perfect.

While it is true that with the receiver and battery cables shielded, the only entry of noise into the receiver is supposedly through the aerial system, and the aerial system is far removed from the engine, you will find that slight disturbances travel a long way to get into the receiver.

Shielding and bonding of cables cannot be carried to extremes. There can be no half-way jobs. If a cable is shielded, the shield must enter the can and be the full length of the cable.

All brackets used for the support of condensers or resistors must be rigidly bolted to the chassis at the nearest point.

All condensers must be checked for open circuit before installation.

All collection of dirt, lint, grease, etc., must be removed from the space between the condenser terminals. Condensers used as ignition suppressors should be located in cans which will allow a ground connection, and equipped with brackets so as to enable location adjacent to the connecting points.

Generator commutators should be cleaned. No arcing at brushes.

Separate high- and low-tension leads. Do not run the low-tension wires parallel to the high-tension cables.

All choke wires and other movable connections should be bonded to the chassis with flexible copper braid. If the high-tension wires run parallel to choke wires, ground the choke wires at various points—also the housing for the choke wires.

High-frequency interference from the ignition system will find its way out of the ignition compartment via brake rods, choke wires, rear light cables, etc.

Check up on fuse connections. Filter condensers may be required at the fuse block.

A filter condenser where the dome light wiring enters the front corner post may help.

A filter condenser at the ammeter may help.

Ground all rods and pipe lines at various points. One-point bonding may not be sufficient.

Connect the "A" lead of the receiver to the car battery. Do not attempt to save wire by connecting to some point on the dashboard.

Short Waves . .

Converter Troubles

If trouble develops in the short-wave converter in the form of low sensitivity and all voltages appear normal, make a critical investigation of the waveband switch contacts and the switch arm. In certain types of installations, continued use loosens this connection, or rather one of the many connections. A high-resistance contact develops and sensitivity drops. A very good method of checking these contacts is to use a low-range scale ohmmeter and measure the resistance between the two leads connected to the circuits both sides of the contact.

Another item to remember is non-synchronous movement of the switch blades which control the grid and plate windings of the converter oscillator tube. In some cases one of the blades moves the required distance when switching to a different waveband and the other blade moves just enough to connect to two waveband contacts at the same time.

Check the soldered contacts. The continued shocks (physical) as the switch is rotated oftentimes loosens the soldered connection in such manner that the solder rests upon the wire, but the connection is purely a friction contact. Sufficient contact is had not to interfere with the application of voltage, but sufficient resistance is present in the circuit to interfere with sensitivity.

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Noise From Contacts

One point of noise in a short-wave converter is the electrical contact between the tuning condenser rotor and the connection thereto. Make sure that this connection is perfect. It may be in good condition soon after purchase, but several weeks or months of use will invariably cause sufficient change to produce noise and a reduction in sensitivity.

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100-KC. Trap Circuits

The Philco Model 4 and the Majestic Model 10 short-wave converter chassis—also used in the Philco 470 and 490 receivers, and in the Majestic 11 converter and Viking and Explorer Models—contain a 1000-kc. trap circuit in the aerial lead, between the aerial post and the short-wave tuning coils. The trap is of the parallel resonant type and is used to minimize interference from stations operating on 1000 kc. The reason for this trap is that the broadcast receiver is also tuned to 1000 kc., this frequency representing the intermediate-frequency of the short-wave converter.

While it is true that an incorrect setting of the trap circuit will in no way interfere with regular short-wave reception, an off-resonant condition of this trap will increase the possibility of interference from a 1000-kc. broadcasting station.

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Harmonic Relations

You will find this information of value in connection with troubles in short-wave converter systems, in superheterodynes and also in connection with the use of a variable intermediate-frequency for selectivity adjustment.

A harmonic is always of some frequency higher than the fundamental. The relation between the fundamental and the harmonic frequency is numerical. The progression of the harmonics is arithmetical in the form of multiples. Thus, if the fundamental frequency is "n," then the harmonics will be "2n," "3n," "4n," "5n," etc. These harmonics will be the 2nd, 3rd, 4th, 5th, etc. For a fundamental frequency of 550 kc., the harmonics up to the fifth will be 1100, 1650, 2200 and 2750 kc.

The number of harmonics for any one fundamental wave depends entirely upon the source of the fundamental wave. In certain generating systems, where a pure wave is desired, only the fundamental is produced. In other types of generators, as for example an oscillator tube in a short-wave system or in a superheterodyne, the output is rich in harmonics. The oscillator used in test systems for aligning r-f. and i-f. amplifiers is extremely rich in harmonics, so much so that as high as the 20th, or even a higher order of harmonics, may be detected and used.

The following is a table of fundamental frequencies between 125 and 3500 kc. and harmonics up to the 5th, for these fundamental frequencies.

FREQUENCY AND HARMONIC TABLE

Frequency	*2nd*	*3rd*	*4th*	*5th*
125 KC	250 KC	375 KC	500 KC	625 KC
126	252	378	504	630
127	254	381	508	635
128	256	384	512	640
129	258	387	516	645
130	260	390	520	650
131	262	393	524	655
132	264	396	528	660
133	266	399	532	665
134	268	402	536	670
135	270	405	540	675
170	340	510	680	850
171	342	513	684	855
172	344	516	688	860
173	346	519	692	865
174	348	522	696	870
175	350	525	700	875
176	352	528	704	880
177	354	531	708	885
178	356	534	712	890
179	358	537	716	895
180	360	540	720	900
200	400	600	800	1000
220	440	660	880	1100
240	480	720	960	1200
260	520	780	1040	1300
261	522	783	1044	1305
262	524	786	1048	1310
263	526	789	1052	1315
264	528	792	1056	1320
265	530	795	1060	1325
280	560	840	1120	1400
320	640	960	1280	1600
350	700	1050	1400	1750
400	800	1200	1600	2000
450	900	1350	1800	2250
500	1000	1500	2000	2500
550	1100	1650	2200	2750
600	1200	1800	2400	3000
650	1300	1950	2600	3250
700	1400	2100	2800	3500
750	1500	2250	3000	3750
800	1600	2400	3200	4000
850	1700	2550	3400	4250
900	1800	2700	3600	4500
950	1900	2850	3800	4750
1000	2000	3000	4000	5000
1100	2200	3300	4400	5500
1200	2400	3600	4800	6000
1300	2600	3900	5200	6500
1400	2800	4200	5600	7000
1500	3000	4500	6000	7500
2000	4000	6000	8000	10000
2500	5000	7500	10000	12500
3000	6000	9000	12000	15000
3500	7000	10500	14000	17500

Home Talkies . .

RCA Type PG-29 Photophone

As briefly outlined in the May issue of SERVICE, the PG-29 Photophone is a portable 35 mm. talking motion-picture unit, with sound on film. Though, admittedly, there are not many of them being used in homes, nevertheless this equipment is being employed extensively by lecturers, etc., and one may turn up in your vicinity at any time with a cry for servicing.

Fig. 1 shows the schematic diagram of the audio amplifier with the connections to the projector, loudspeaker and power sources. Polarizing voltage for the photoelectric cell is provided by the power supply in the amplifier unit.

The output of the photocell is coupled to a high-impedance primary of an auto-transformer located in the projector housing. The secondary of this transformer is then coupled to the '24 audio amplifier tube. A 500,000-ohm potentiometer in the grid circuit of the '27 tube functions as the volume control.

A separate cable supplies the power to the projection lamp. Power for this purpose may be either a-c. or d-c. at 110 volts. Fifty or sixty-cycle a-c. power is supplied through another cable to the projector drive motor, the exciter lamp transformer and the threading lamp. The exciter lamp transformer steps down the voltage to 10 volts at which rating the exciter lamp operates. The maximum current through the exciter lamp should not exceed 7½ amperes, as a very slight increase in current above this value will greatly reduce the lamp life.

A toggle switch marked 110V-120V is provided on the top of the amplifier chassis to compensate for small line-voltage variations. If the voltage at the power source is greater than 115 volts, the switch should be set on the 120-volt position, while if less than 115 volts, the switch should be left on the 110-volt position.

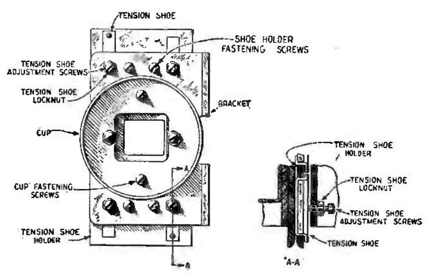


Fig. 3. Front section of the picture gate, showing the location of adjustment screws

A single pole, double throw toggle switch is provided on the base of the amplifier for fading sound from one projector to the other when two projectors are used. A special input jack is connected across the primary circuit of the input transformer, and is used for coupling a turntable or similar device to the amplifier.

A hum adjustment potentiometer, connected across the filament supply transformer for the '24 and '27 tubes is provided with a slotted shaft for adjustment with a screw driver. Adjust for minimum hum with volume control set at maximum.

Since the field winding of the dynamic speaker serves as a choke in the power supply filter unit, it should be connected at all times when the power supply is on . . . otherwise the amplifier may be seriously injured.

The tube socket voltages for the various tubes in the amplifier unit are given in Table 1. The filament voltages are normal for the tubes used.

ADJUSTMENTS

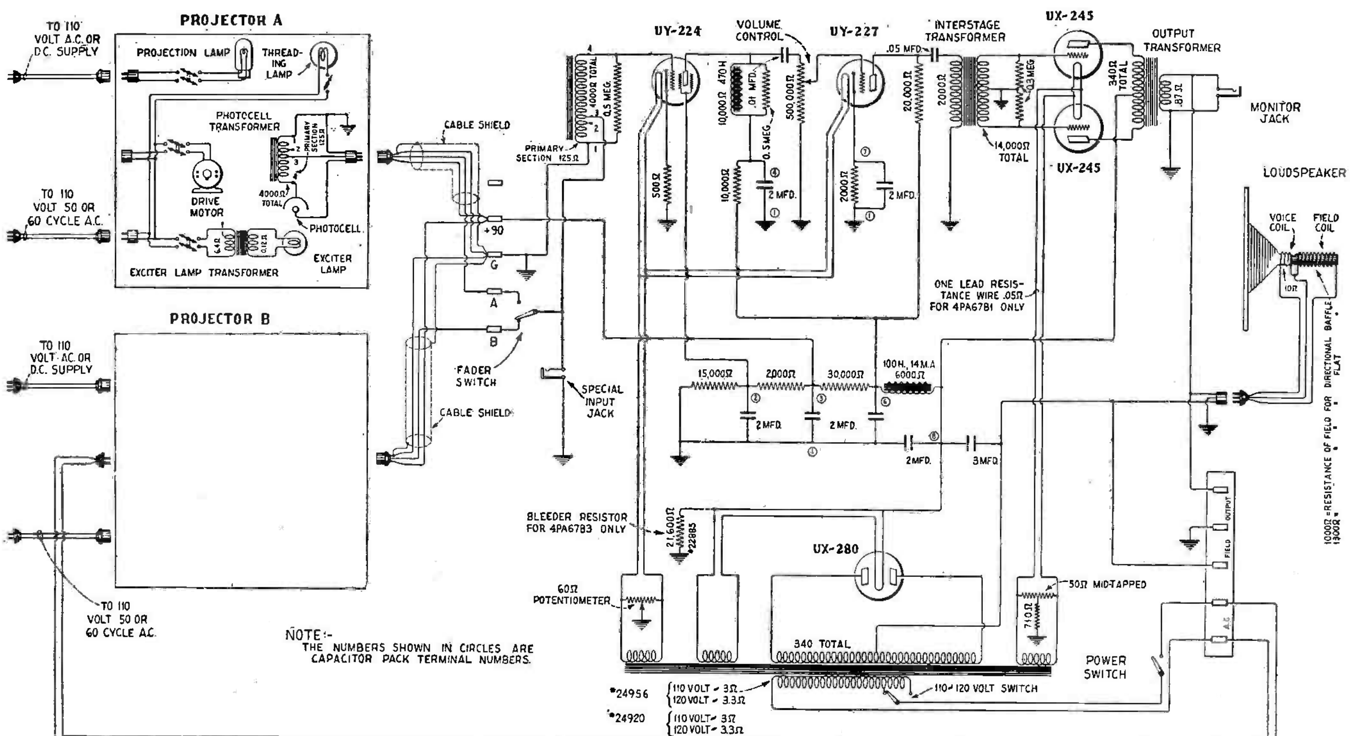
Aside from the usual reasons, low volume from the amplifier may be due to the following: Defective photocell; exciter lamp current low due to low a-c. line voltage; exciter lamp old or dirty; exciter lamp out of adjustment; optical system partially obstructed, in which case inspect the optical system lenses and sound gate for foreign material, such as dirt, oil, film emulsion, etc.

No sound whatsoever may be due to one or more of the following: Burned out exciter lamp; optical system completely obstructed, in which case inspect sound gate and objective lens of the optical system for oil, dirt or film emulsion; defective photocell; inter-

TABLE 1

Tube	*Control Grid*	*Screen Grid*	*Plate*	*Plate Current*
224	1.8	50	180	2
227	6.0	—	128	4
245	44.0	—	248	30
245	44.0	—	248	30
280	—	—	—	42-50

Fig. 1. Schematic diagram of the complete PG-29 Photophone. The wiring for Projector B is the same as shown for Projector A



connecting cable plugs not securely attached to receptacles; inoperative fader switch.

Noise or motorboating may be due to dirty contacts on tubes or photocell, in which case clean with No. 00 sandpaper, or the sprocket holes or frame lines of film interrupting the light beam. The latter will require an adjustment of the sound gate lateral guide roller.

If low volume is due to the exciter lamp being out of adjustment, remove the photocell cap, and with the exciter lamp lighted adjust the position of the lamp in its socket so that the light spot is centrally located and evenly illuminated on the plate of the photocell.

Sound Gate

The adjustment of the sound gate lateral guide roller is not difficult. The idea is to adjust this roller so that it will keep the film in lateral alignment as the sound track passes the reproducer light beam.

For this adjustment it is necessary to obtain a section of test film (Stock No. 22898) with a "buzz-track" edge. This track consists of two chopper tracks so spaced that neither will effect the light if the film is in lateral alignment. If the film is not in alignment, one or the other of the chopper tracks will come into the line of the light and cause a fluctuation of the beam to the photocell and result in a sound in the loudspeaker. One of the chopper tracks will give a 700-cycle note and the other will give a 300-cycle note, thus giving an indication as to the direction the guide roller should be moved to correct the alignment.

When using the buzz-track film to make the lateral adjustment of the guide roller, use the following procedure:

Remove the magazines from the projector and thread the projector in the usual manner with the loop of buzz-track film. (The film being in the form of a loop can then be run continuously through the machine.)

With the exciter lamp lighted and the equipment connected for the reproduction of sound, start the projector and listen for a 300-cycle or 700-cycle note from the loudspeaker. If neither note is heard the guide roller is in proper adjustment. If either of the two notes is heard, loosen the lock nut (See Fig. 2) at the end of the guide roller assembly. Make the lateral adjustment while the film is in motion by turning the large hexagonal nut at the end of the guide roller assembly until no signal is heard. If the 300-cycle note is heard, the nut should be turned counterclockwise. If the 700-cycle note is heard, the nut should be turned clockwise. In any case, attempt to arrive at the midway position between the two signal notes.

The picture gate lateral roller (See Fig. 3) should be adjusted so as to align the film picture horizontally with the picture gate aperture. To make the adjustment, project a sound film on the screen and note whether or not a light streak shows on either side of the screen picture. If a light streak is noticed, loosen the lock nut at the end of the guide-roller-post and screw the adjustment nut in to eliminate a streak on the right-hand side of the picture, or out to eliminate a streak on the left-hand side of the picture.

"Sound Focusing"

To properly focus the sound optical system a 9,000-cycle parallel line sound track (Stock No. 22898) is used. Proceed as follows:

Thread the projector with the film loop so that the 9,000-cycle recording is in front of the optical system, and be sure the emulsion side of the film is toward the optical system objective lens. Now, turn on the exciter lamp, and be sure it has been adjusted, as already described. Then remove the photocell and place a white card in the photocell shield so that the projected light spot is visible on the card. When this is O.K. pull the film very slowly by hand along the line it normally travels between the idler-roller and constant-speed sprocket. Note the direction of motion of the 9,000-cycle parallel line shadows across the light circle on the card. If the shadows move downward, loosen the optical barrel clamping screw and turn the knurled adjustment ring so that the lens system is moved closer to the film. If the shadows move upward move the lens system away from the film. When one parallel line of the film completely covers the light beam the optical system is in proper focus. This condition is indicated on the card when the light circle is alternately completely shadowed and lighted as the film is slowly moved. Also at this point there should be no apparent upward or downward motion of the shadow on the light circle.

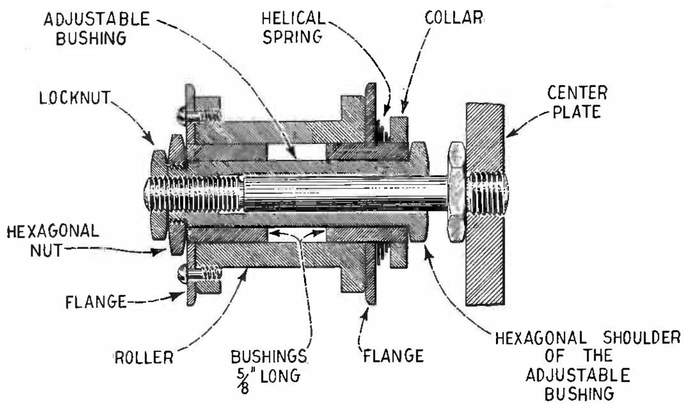


Fig. 2. A cross-sectional view of the sound gate. The proper adjustments are made by turning the hexagonal nut (held by locknut) at the left

Size of Projected Images

The average home talking-movie projector is equipped with a projection lens with a focal length of 1 inch. This lens will produce an image of the following proportions when the screen is the following number of feet from the projector.

Distance from Screen in ft.	*Size of Image. Width*	*Height*
5	1' 10"	1' 5"
8	3' 1"	2' 3"
10	3' 10"	2' 10"
12	4' 7"	3' 5"
15	5' 9"	4' 3"
20	7' 8"	5' 8"

For any one projector lamp and lens system, the greater the distance from the projector to the screen, the larger will be the picture, but the less will be the intensity of the picture. The smaller the picture from any projector the greater the brilliancy. For each variation of distance between the projector and the screen, a different adjustment of the projector lens is required. These lenses are adjustable and may be varied during the operation of the machine.

The purpose of various focal lengths is to enable the projection of a certain sized image at greater distances. Projection lenses of greater than 1 inch focal length are not required when the screen is within 20 feet of the projector.

•

Sparton Visionola Data

Motor

Type: Synchronous.
Horsepower: 1/25.
Speed: 1,800 r.p.m.
Voltage: 100-125.
Current: 2.5 ampere.
Watts: 275 under load.
Watts: 100 idle.

Projector Lamp *

Type: General Electric T-10 Prefocus.
Watts: 200.
Voltage: 115.
Current: 1.75 ampere.
Base: Special.

Pilot Lamp

Type: General Electric T-8.
Watts: 15.
Voltage: 115.
Current: .13 ampere.
Base: Intermediate Screw.

Lens

Focal Length: 1 inch.

* If increased illumination of the projected image is desired, or when projecting pictures for an audience at a distance, the use of a 300-watt projector lamp is recommended. This size lamp can be purchased from the factory.

THE FORUM . . .

Service and Sales

Editor, SERVICE:

After a careful analysis of the past several issues of SERVICE, I have decided that the magazine will fast become the outstanding publication in the servicing field, even though I differ from you somewhat in regards to Service Men becoming salesmen. Most Service Men of today are highly trained Technicians and take their work to heart. They are not willing to sell or recommend a receiver that is not up to standard. If you are working for a Dealer as a salesman he expects you to sell his receivers regardless of their merits—and regardless of what Mr. Dealer thinks of what his Service Man may have to say.

The Service Man is fast becoming organized, and another year will show quite a change in servicing methods, price rates, etc.

Detailed information such as referred to by Mr. A. E. Teachman in your *Forum* for April may be preferred by many. As for myself, I can always skip over same if I do not find it of value. Public-Address is quite a problem these days and more of this might help. Thanks for the tip on phasing voice coils.

W. E. SMITH,
Oak Forest, Ill.

(*We realize that Service Technicians take their work to heart, and we believe that there is all the justification in the world for their professional pride. It is not our belief that Service Men should go in for high-pressure selling, irrespective of the additional income inducements, nor do we believe that they should attempt to sell or recommend products in which they themselves have no faith. Nevertheless, we feel that it is part of the Technician's duty to his own profession—just as it is a part of the doctor's duty to his profession—to recommend that which is of benefit to his client. The fact that a recommendation may prove a sale of a new receiver, or an accessory is in no wise demoralizing to the servicing profession. Quite to the contrary, it becomes an act of benefit, and adds that much to the intrinsic value to the client of the whole servicing profession. We certainly agree with you that Mr. Dealer is often a thorn in the side of the self-respecting Service Man. In time, we trust Mr. Dealer will fall in line with the progressive servicing movement and refrain from "pushing" the Technician into disagreeable, and in the long run, unproductive sales schemes.—The Editors.*)

Whoops!

Editor, SERVICE:

Your latest brain child, SERVICE, is certainly filling a long-felt need in reliable radio service literature. But I greatly missed the lines of sarcasm such as dotted the first issue. Why not let us have a bit of fun in between lines, to brighten up the gloomy hours?

Did you hear the latest one about Scotty? Well, here goes: Scotty bought a radio. On his first visit to the store the dealer asked him how he liked his set, and Scotty said: 'Weel, 'tis aright, I suppose, boot the toobes are noot quite bright anoof that I ken read by their light."

Thanks for your stories about the men on the cover. Whenever I come home with one of those "terrible" mystery books I have to hide it from my wife. But after I read those lines to her about Mr. Fenner, "who walks in the footsteps of Sherlock Holmes," she gave me her kind permission to buy them every week. After all, I am not the only "Radiobuck" who likes them.

I am extremely pleased with the way you run your articles. In fact, so much so that I am not able to suggest any improvement. And with Mr. Corbett I say "Bring SERVICE out every week and quadruple the price."

WALTER STUEDEMAN,
RETLAW RADIO SERVICE,
New York, N. Y.

(*Say, Walter, did you hear this one? . . . When the Scotch delegation of Radio Engineers in this country complete their work of recording just a few more of America's ace programs they are to return with the records to Scotland, at which time said land is going in for sponsored programs in a big way. But the main reason the delegation hasn't returned at an earlier date is because they haven't as yet collected enough old phonograph needles!—Ye Editors*)

What Price Service?

Editor, SERVICE:

In the May issue of SERVICE, under the heading of "The Antenna," you asked for viewpoints on the matter of a rightful service charge from among your readers everywhere. In answer to this request we wish to say that anyone who will take the time to analyze the costs of servicing will be better able to state what price service. If the public continues in its belief that one service organization is as good as the next, things will remain difficult, for we are aware of many cases in which "good service" was wanting and at a price that was justified.

We feel that with so many radio schools turning out students who are eagerly seeking work in the servicing field, and willing to do this work at next to nothing just for the experience it will afford, will keep the better class of Service Men in many cases from their daily bread. We trust that all the newer men entering this field will see the folly of cheap practice and learn to set prices according to costs, or by a set rule of service charges similar to those given by J. P. Kennedy in *Radio Retailing* for June. We have here a basis upon which we may build, and certainly a profit should be realized on everything that is handled regardless of the fact that it may have come from a mail-order house or from the manufacturer. It is obvious that anyone doing any class of business should reap a profit, or leave the business for those who can. It follows that they will be forced to do so in the end to save themselves from the law of economics.

We have been in the business of radio servicing since 1921 and have successfully met all classes of rackets, but never by cutting costs. Our instruments are of the best, our personnel likewise. Our methods are modern and our prices reasonable. We clear a profit, of course, as we do not care to work for nothing.

Educate the public to the fact that good servicing, like anything else, costs a little more but is worth it in the long run.

L. A. LAGASSE, Prop.,
LAGASSE RADIO SERVICE,
Beverly, Mass.

(*We certainly appreciate the time you have taken to give us your views on servicing charges and competition, and we wish to thank you for the data on costs which we hope to make use of in the near future. Suggestions such as you have given are assisting us to formulate definite plans which we hope to publish within a month or so.—The Editors.*)

Class B Amplifiers

Editor, SERVICE:

When we were at the RMA Trade Show in Chicago we were handed a sample copy of your new publication called SERVICE. It is the best magazine of its kind for the Service Man we have seen, and trust that all issues will be as good as the one we have. We are enclosing a check to cover one year's subscription.

We were interested in the article on the new type '46 tube and its possibilities as a public-address amplifier. We think it would be nice if you would show a schematic of a p-a. system, using these tubes and the '82 rectifier. It should have facilities for a radio tuner, phonograph pickup and microphone.

R. B. SWIGERT,
ST. JOE RADIO SERVICE,
St. Joseph, Mich.

(*We will publish the data you request in the near future.—The Editors.*)

The Triple-Twin

Editor, SERVICE:

Have waited until now to pass comment on your magazine, SERVICE, and must say it's sitting in the front row for the main show. Worth the money and has enough items listed to *almost* please everybody.

Would like to ask one thing about the article on the Triple-Twin Tube. Was that comment "reason for name of tube unknown" placed there for replies? If so, here's my theory . . . the tube has two plates, two grids and two filaments, which is three times two, or *triple* twin. Right?

EDWARD J. BROCKWAY,
SUPREME RADIO SERVICE,
Wildwood, Annex, N. J.

(*Well, maybe you're right. It sounds reasonable.—The Editors.*)

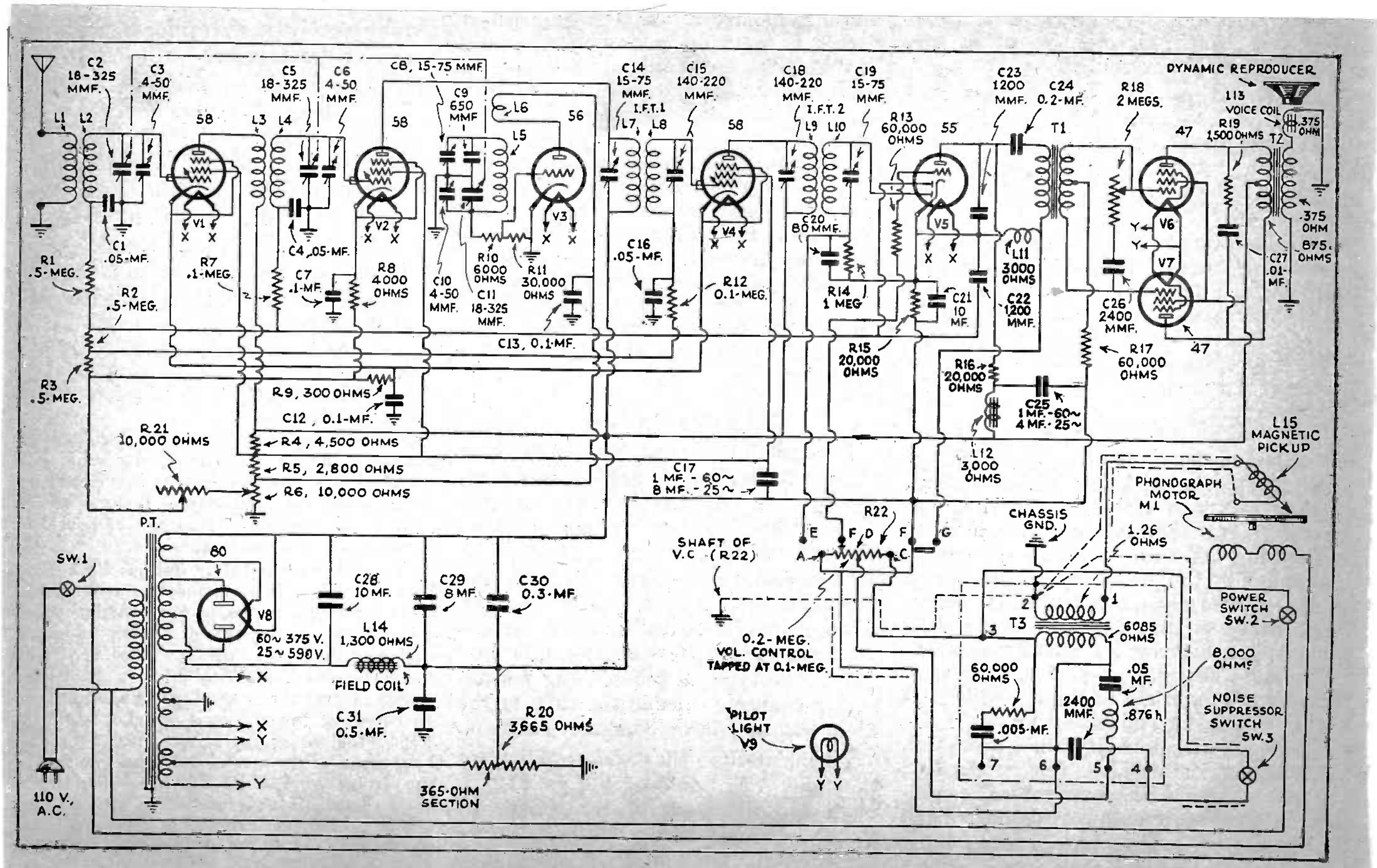


Fig. 1
Schematic circuit of the RCA-Victor RE-80 receiver. Note that this receiver is different from the RCA model 80.

THE MANUFACTURERS . . .

The AKAformer

Amy, Aceves & King, Inc., of New York, N. Y., have placed on the market a new device, called the AKAformer, designed to remedy the greatest of all complaints of the radio broadcast listener, namely, noise. This device is illustrated in Fig. 1.

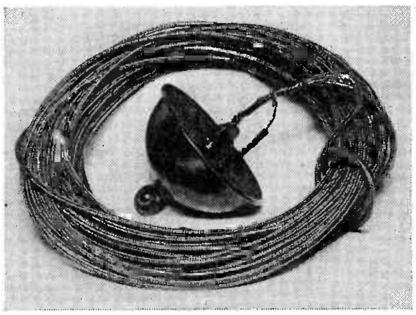


Fig. 1

Briefly, the unit consists of a matching impedance transformer used in conjunction with a shielded lead-in wire. The AKAformer proper is attached directly to the antenna, as shown in the left-hand sketch of Fig. 2, and the opposite terminal R connected to the lead-in wire. The terminal G is connected to the shielding on the lead-in wire, and at the termination of the lead-in wire at the radio receiver this shielding is grounded, as shown in the right-hand sketch of Fig. 2. The impedance-matching transformer really compensates for the loss in the shielded downlead.

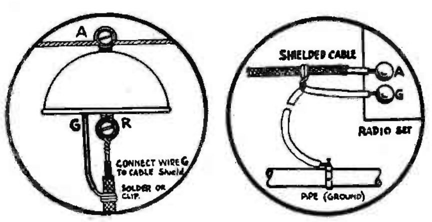


Fig. 2

This method of reducing interference is novel in that it tends to raise the signal energy from the antenna above the noise level. Heretofore, the common method of eliminating noise was to insert choke coils, condensers, or a combination of both in series with the power line.

The AKAformer may also be used effectively in connection with the Multicoupler Antenna System whereby two to thirty radio receivers may be operated from one antenna.

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Supreme Duplex Wire

The Supreme Instruments Corporation, of Greenwood, Miss., have stocked for the benefit of Service Men, No. 18 stranded weatherproof twisted duplex wire for use in the installation of Transposition Aerials. One conductor of this wire is identified by a distinctive tracer to facilitate proper installation connections.

New Philco Parts Catalog

During the past few years more and more of the radio service work has been passing from the radio dealers to individual Service Men and Radio Service Organizations employing a number of men. Realizing the importance of this transition of servicing work, Philco has started an aggressive sales campaign on replacement parts for Philco radios, and also on the sale of those parts which can be used for other radio work. And what is probably the best news—the prices of these parts have been materially reduced.

This new Parts Catalog supplies the necessary information of part numbers and dealer net prices, but the sale of the parts is not limited to authorized Philco radio dealers—any Service Man capable of repairing a radio can secure a copy of this catalog and purchase parts at the prices listed.

This catalog should be of great help to Service Men because it contains the only officially complete list of the more common replacement parts in every model of Philco radio from the very beginning up to and including the models shown at the recent RMA Show in Chicago.

Should you wish a copy of this new Philco Replacement Parts Catalog, just drop a post card to Readers' Service Department, SERVICE, 1440 Broadway, New York, N. Y.

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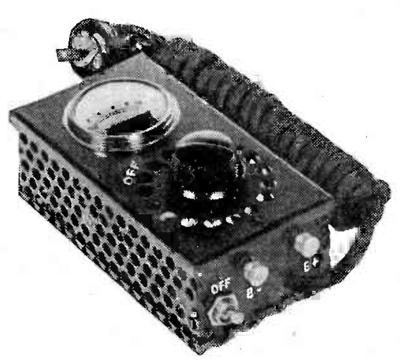
New "A" Eliminator

The new type radio sets for use in rural districts where 110-volt supply lines are not available have created a need for a variable resistor to adapt 32-volt farm lighting plants to the purpose of supplying the energy for the 2- and 4-volt tubes.

The "King Cole" unit illustrated is offered by the Anylite Electric Co., of Fort Wayne, Ind., to fill this need. This unit will furnish the filament current for any of the 2- or 4-volt tubes, ranging from 5 tubes requiring 1/3 ampere to the ones requiring one ampere. At the same time the adjustment takes care of variation in line voltage.



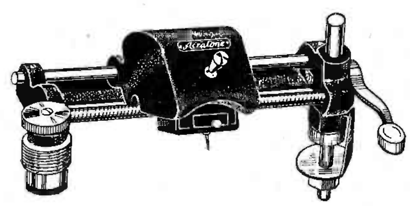
The unit is equipped with a voltmeter and regulating dial so that an exact adjustment of voltage may be made. It is claimed that the unit, once adjusted, will take care of any variation in line voltage.

Acratest Recording Head

The Acratest Products Co., of New York City, have designed a new recording unit which requires but a single hole for mounting. The standard unit will record on discs from 5 to 12 inches at either 78 or 33 1/3 r.p.m. turntable speeds, while the special unit will record on discs up to 16 inches.

As seen from the accompanying illustration, the recording head travels along a closely-threaded worm gear. A diamond needle is used for the recording and has an extremely long life.

This recording head is of the type that cuts and records simultaneously and therefore aluminum record blanks are employed. It is claimed that the remarkable number of 96 grooves per inch has been accomplished with this outfit.



A powerful amplifier is not required to actuate this recording head, but of course it is necessary that the amplifier have good frequency characteristics if the resultant recording is to be good. The only other requisite is an electric phonograph motor of sufficient power to maintain an unvariable turntable speed at all times. Very few standard turntable motors will do this because of the excessive drag of the cutting and recording head.

•

New Na-Ald Adapters

The Alden Manufacturing Company, of Brockton, Mass., has introduced a number of new adapters for set analyzers which will permit the measurement of values in sets employing the new tubes.

The first series of adapters is for the purpose of putting the type '57 and '58 tubes in tube checkers. There are then two types of adapters to be used with existing set analyzers. One is a pair of adapters connected by a four-foot lead. The six-prong adapter locks to the analyzer plug and goes into the socket of the set, and the lead is connected to another adapter which is plugged into the UY socket of the set analyzer. The '57 or '58 tubes are then put into this adapter.

Two other adapters of interest are the No. 982 and the No. 955G-2. The former is employed for testing the new type '82 mercury-vapor rectifier and the latter for the testing of the Majestic G-2-S Diode tube. Both these adapters have toggle switches which permit readings first on one plate and then on the other.

There is also an adapter which permits the testing of the Wunderlich tube.

Index of Monthly Literature

All articles listed on this page are cross-indexed for your convenience. Titles given are not necessarily the titles of the original articles, but in each case serve to determine the substance of the article. Listings marked with an asterisk (*) are abstracted in this issue. The material in each issue of SERVICE is alphabetically indexed on the Contents Page.

IRC Service . . .

Make Your Own Set Analyzer

It is safe to say that under present radio set requirements no Serviceman can do a good job and stay out in front in competition without a set analyzer. Whether it is tubitis that is spoiling your customer's radio pleasure; whether it is faulty resistors or condensers or a grounded or shorted screen-grid circuit or what-not—an up-to-date testing apparatus is an absolute necessity to rectify the trouble with minimum time and labor. The service technician without it cannot be a technician in the true sense of the word.

In this issue of "Service" we are offering you the opportunity of securing a first-class Sprayberry Set Analyzer at a big money saving by **building it yourself.** F. L. Sprayberry, of the National Radio Institute, Washington, D. C., one of the country's foremost radio engineers, has designed an analyzer that has attracted nation-wide attention by its simplicity and effectiveness.

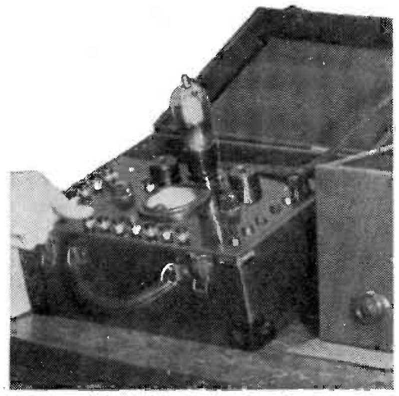
An instruction folder will be sent you free of charge and a kit of I.R.C. Precision Wire Wound Resistors supplied at nominal cost, if you write the International Resistance Company at Philadelphia. These will enable you not only to make the instrument complete, but will give you all you need to know as to the correct procedure in its use in the repair of any radio set.

The set analyzer can be built from scratch—or if you have a Weston 301 Universal A.C.-D.C. Meter — you can build around this at even less cost.

You can take this statement at 100 per cent:—The quickest way to go at the "hum and clatter" problem in any receiver is to use a tester such as we are here discussing. You have studied to make yourself competent and efficient. You take pride in your work. First rate equipment is positively necessary if your radio hospital is to function as it should. On rainy days and in the evenings an hour or so devoted to making your own testing apparatus will bring rich rewards.

In writing to the International Resistance Company for this data ask for Form F-6.

Plate voltage, plate current measurements and filament voltage, sometimes hard to determine, are easily arrived at with a set analyzer. If the filament voltage is low, for instance, the complete circuit may be shorted or grounded (the ground may be to the core of the transformer, or to the chassis of the receiver)—and a continuity test between filament and core of the transformer and chassis will quickly establish where the ground exists.



Sprayberry Set Analyzer

This cut shows the Set Analyzer in its completed form, easily built from instructions available as indicated in the adjoining column.

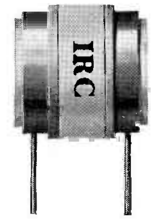
A set analyzer is a short cut to trouble finding. Many Servicemen, owing to conditions, have trouble in buying one—but the difficulty is easily solved with the I.R.C. Precision Wire Wound Kit and instruction folder.

The International Resistance Company has also put out a bulletin giving in convenient form full information on the proper grid biasing of the new 56-57-58-46 tubes. They will gladly send you a copy gratis if you ask for Form F-7.

New Handy Grid Bias Kit

This is a great time saver in the biasing of radio tubes. It is put out by the International Resistance Company and contains 10 assorted resistors of MF-4—MR-4 and Power Wire Wound (5-Watt) types needed to bias these tubes:—'24—'26—'27—'71A—'10—'45—'50—'47. A check or money order for \$2.15 (\$2.90 in Canada) to the International Resistance Company will bring you the Kit, together with complete instructions on the proper biasing of tubes.

To make the Sprayberry Analyzer, a kit of precision wire wound resistors is necessary. And of course the better the resistors—the more accurate and more rugged—the better will be your results. The two units here shown are manufactured to high standards, and make up the convenient I.R.C. kit of eleven resistance units which will answer every requirement.



WW 3

There are four WW3 Precision Wire Wound Resistors of 50,000 ohms, 40,000 ohms, 5,000 ohms and 4,950 ohms.

WW 4

There are seven WW 4 Precision Wire Wound Resistors of .25 meg., .15 meg., .505 ohm, 2.083 ohms and 33.33 ohms.

Motor Radio Suppressor Kits

The popularity of radio in motor cars is growing fast. Handy I.R.C. Resistor Kits with Metallized units are now available for four-, six-, and eight-cylinder cars—together with complete wiring diagram of the electrical system of an automobile.

The greatest trouble with automobile radio is the proper installation of the radio set, together with the parts necessary to eliminate the radio noises from the ignition system of the car.

The wiring diagrams and kits above mentioned are of big help to the Serviceman installing sets. The International Resistance Company will be glad to give you full information on these kits and prices if you write them.

Metallized

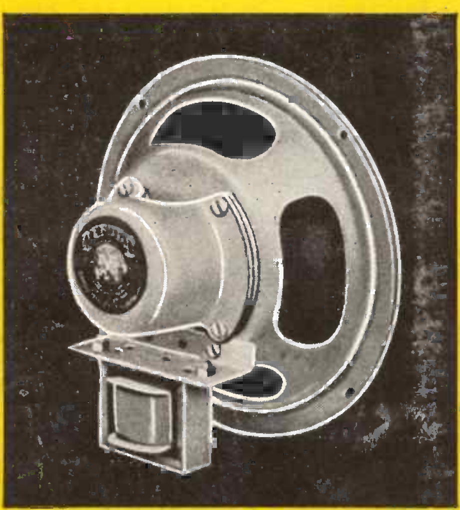
Resistors for Replacements

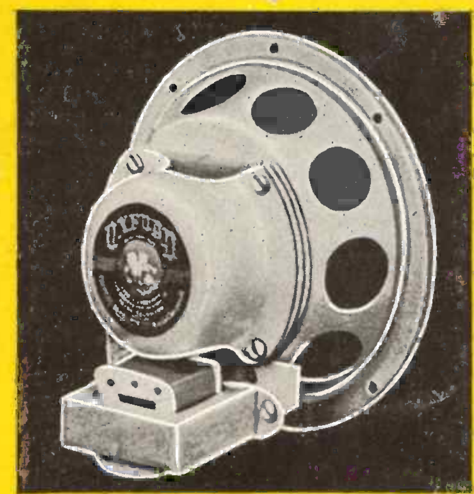
Precision Wire Wound Resistors for Meters and Test Equipment

INTERNATIONAL RESISTANCE COMPANY

2006 Chestnut Street, Philadelphia

74 Wellington St., West, Toronto, Canada





SPEAKER BY OXFORD

IMPROVED SPEAKER practice is found first in Oxford Speakers, leading the advance in radio tone with super standards of precision and original scientific development. Oxford meets the requirements of every speaker application with a full line of sizes and types.

The sizes are:

6", 8", 11" and 12",

Singles, dual combinations, large cups, medium cups, A.C. types, and Auditorium.

Automobile Models in both 6" and 8" sizes.

Made under the patents and designs of Frank Reichmann, oldest speaker manufacturer in America.

Write for our complete Bulletins

Manufactured by
OXFORD PRODUCTS COMPANY
Division of THE POTTER COMPANY
North Chicago, Illinois

CONDENSERS BY POTTER

NO matter what type of condenser may be required, there is a Potter for every need. Back of Potter Condensers is a large modern factory that guarantees production to meet the requirements and delivery.

Careful selection of materials and critical inspection of workmanship insure quality products that are not sacrificed for price.

Lay your condenser problems before us. Our engineers will carefully consider them, working out units best suited for the use.

Write for our free Replacement Chart

THE POTTER COMPANY
NORTH CHICAGO, ILLINOIS